UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

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MEMORANDUM

SUBJECT: Revised Benefits of Agricultural Uses of Chlorpyrifos (PC# 059101)

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Summary

The United States Environmental Protection Agency (EPA) is currently in the process of re-evaluating the risks posed to human health from the use of chlorpyrifos. Chlorpyrifos (0,0-diethyl-0-3,5,6-trichloro-2-pyridyl phosphorothioate) is a broad-spectrum, chlorinated organophosphate (OP) insecticide that has been registered for use in the United States since 1965. Currently registered use sites include a large variety of food crops (including fruit and nut trees, many types of fruits and vegetables, and grain crops), and non-food use settings (e.g., golf course turf, industrial sites, greenhouse and nursery production, sod farms, and wood products). Public health uses include aerial and ground-based fogger mosquito adulticide treatments, containerized ant and roach bait products for residential usage. On average, 8.8 million acres of agricultural crops were treated with chlorpyrifos annually from 2014 – 2018 (Kynetec, 2019).

The timing of the agency's recent regulatory work has been substantially dictated by court-ordered deadlines regarding this insecticide. In 2015, EPA issued risk assessments covering risks to human health posed by dietary exposure to chlorpyrifos. The Agency has revised these risk assessments (US EPA 2020a, 2020b) and is also evaluating the pest management benefits of chlorpyrifos in selected agricultural and non-agricultural use settings. This memorandum provides risk managers within the Agency a high-level assessment of the usage, role and pest management benefits of chlorpyrifos in agricultural settings. The benefits of chlorpyrifos in non-agricultural settings are available in another document (US EPA, 2020c).

Benefits of Chlorpyrifos to Agriculture

The total annual economic benefit of chlorpyrifos to crop production is estimated to be $19 - $130 million. These estimates are based on the additional costs of alternative pest control strategies likely to be used in the absence of chlorpyrifos or reduced revenue for some crops that do not have effective alternatives to chlorpyrifos for some pests. In some cases, effective alternatives could not be found; for those crops, the benefit of chlorpyrifos was estimated by yield or quality losses if chlorpyrifos were no longer available for use.

The high benefits estimate reflects the wide use of chlorpyrifos on many different crops. However, despite the wide use of chlorpyrifos, the majority of the benefits are concentrated on specific crops and regions that rely on chlorpyrifos without available alternatives to control pests. In particular, there are potentially high total costs for some Minnesota and North Dakota sugarbeets, soybeans (nationwide), California oranges, Southeast peaches, and apples (nationwide); the high-end total cost for each of these crops is estimated to be in excess of $7 million per year. High total costs are driven by high per-acre costs in the case of sugarbeets, orange, apple and peach, and by the extent of acres treated in the case of large field crops like soybean despite relatively low costs per acre.

When considering the benefits of chlorpyrifos, some recent developments are important to keep in mind. California is ending almost all agricultural uses of chlorpyrifos by the end of 2020 (CDPR 2019), so high benefits in crops grown in California, reflect past use, rather than benefits that will remain if these uses are still registered nationally in the future. Since 2019, several states, including California, Hawaii, New York, Maryland, and Oregon, have initiated state-level actions to phase out all or most uses of chlorpyrifos.

Chapter 1. Background

The Federal Insecticide Fungicide and Rodenticide Act (FIFRA), Section 3(g), mandates that EPA periodically review the registrations of all pesticides to ensure that they do not pose unreasonable adverse effects to human health and the environment. This periodic review is necessary in order to consider scientific advancements, changes in policy, and changes in use patterns that may alter the conditions underpinning previous registration decisions. In determining whether effects of pesticide use are unreasonable, FIFRA requires that the Agency consider the risks and benefits of any use of the pesticide.

Safety to Human Health

There are inherent risks associated with the use of pesticides, which are substances that are toxic by design. Therefore, EPA imposes requirements on the use of pesticides with the intent to avert unreasonable adverse effects to human health and the environment. However, EPA uses a more stringent standard for dietary risks, which is that food and drinking water exposure will have a reasonable certainty of no harm. The Federal Food, Drug, and Cosmetic Act (FFDCA) defines safe to mean that "there is a reasonable certainty that no harm will result from aggregate exposure to the pesticide chemical residue, including all anticipated dietary exposures and all other exposures for which there is reliable information." This includes exposure through drinking water and all non-occupational exposures (e.g., in residential settings) but does not include occupational exposures to workers.

Under the FFDCA, risks to infants and children are given special consideration. Young children and infants may face greater household exposures because of their behaviors (via combined mouthing and intense play activities) and due to age specific diets. Specifically, pursuant to section 408(b)(2)(C), EPA must assess the risk of the pesticide chemical based on available information concerning the special susceptibility of infants and children to the pesticide chemical residues, including neurological differences between infants and children and adults, and effects of in utero exposure to pesticide chemicals; and available information concerning the cumulative effects on infants and children of such residues and other substances that have a common mechanism of toxicity (21 U.S.C. 346a(b)(2)(C)(i)(II) and (III)).

There are risks to human health from chlorpyrifos exposure. Chlorpyrifos residues can appear in food from crops that were treated with the pesticide, and in drinking water from spray drift or runoff from treated fields. Bystanders and farmworkers can be exposed through application to crops.

Organophosphate insecticides inhibit acetylcholinesterase (AChE), which is an enzyme essential for nervous system function. AChE helps break down the neurotransmitter acetylcholine, and it is essential to the function of the nervous system. When acetylcholinesterase is inhibited, acetylcholine builds up at nerve endings leading to overstimulation of the nervous system. The symptoms of mild acetylcholinesterase inhibition include headache, nausea, dizziness, sweating, and salivation. More severe reactions include muscle twitching and tremors, lack of coordination, vomiting, abdominal cramps, and blurred vision. Very high exposure, such as from an accident, can lead to respiratory paralysis and death (Roberts and Reigart 2016). AChE inhibition has been the health endpoint that EPA has used in risk assessments for chlorpyrifos and setting tolerances for chlorpyrifos (US EPA, 2016).

There is also epidemiological data that reports an association between chlorpyrifos exposure and potential adverse neurodevelopmental effects in infants and children as a result of prenatal exposure to chlorpyrifos (Raugh *et al.* 2006, Rauh *et al.* 2011) or organophosphate pesticide metabolites (Engel et al. 2007, Engel et al. 2011, Young et al. 2005, Eskenazi et al. 2007).

Chlorpyrifos is a widely used pesticide in agricultural settings, with an average of about five million pounds applied annually on about 8.8 million acres (Kynetec, 2019, years 2014 – 2018). There are potential exposures from residues of chlorpyrifos that remain on food when it is eaten. Runoff from agricultural applications can lead to exposure to chlorpyrifos or its metabolites from drinking water. These issues are more fully described in the risk assessment memoranda supporting the Preliminary Interim Decision (PID).

This document replaces an earlier version with incorrect per acre benefit estimates for some crops in Table 2.1-1.

Chapter 2. Estimated Benefits of Chlorpyrifos Agricultural Uses

Section 2.1 Introduction and Summary

This chapter presents the estimates of the total and per-acre benefits of chlorpyrifos in agriculture, based on the costs of alternative pest control strategies likely to be used in the absence of chlorpyrifos. In some cases, effective alternatives could not be found; for those crops the benefits were modeled with yield or quality losses if chlorpyrifos were no longer available for use. The total benefit of chlorpyrifos is estimated to be between $19 and $130 million annually. The high benefit reflects the wide use of chlorpyrifos on many different crops. However, despite the wide use of chlorpyrifos, the majority of the total benefits are concentrated on specific crops and regions that rely on chlorpyrifos without available alternatives to control pests. In particular, there are potentially high benefits for some Minnesota and North Dakota sugarbeets, soybeans nationally, California oranges, Southeast peaches, and apples nationally. The total cost for each of these crops is estimated to be above $7 million per year. High total benefits are driven by high per-acre cost of alternatives in apple and orange, a lack of alternatives leading to potential yield loss in Southeastern peach and Minnesota and North Dakota sugarbeet, and by the extent of acres treated in the case of large field crops like soybean despite relatively low benefits per acre. The large range in cost estimates is due to the differences between the high- and low-cost estimates, mostly for the aforementioned crops.

Section 2 of this chapter describes the methodology used for estimating the benefits of chlorpyrifos. The methodology follows that of previous EPA estimates of the impacts on small businesses (EPA, 2015a). Cost estimates are updated using more recent pesticide usage data, information from the USDA Office of Pest Management Policy, and information obtained through public comments on EPA's small business impact estimates (EPA, 2015a). This analysis was originally performed in 2016, using pesticide usage data from 2010-2014. More recent usage data are now available, and EPA used 2014 – 2018 data to evaluate chlorpyrifos usage in agricultural crops to see if there were significant changes that warranted further analysis. There appeared to be large changes in usage for *Brassica* and sugarbeet; both crops had significant costs in the earlier analysis, so these are revaluated in this document using more recent information. Sorghum was also re-evaluated because of chlorpyrifos use against an emerging invasive pest. Section 3.3 highlights some uncertainties and data limitations in the cost estimates for individual crops. The analysis in this chapter is based on a number of conservative assumptions which are likely to overestimate the actual impacts. For example, the analysis assumes the same pest pressure on every chlorpyrifos treated acre, and the least expensive alternatives are not always chosen as replacements. The analysis also does not account for any changes in cropping patterns and the development of new pesticides or new uses for existing pesticides to fill gaps in pest control without chlorpyrifos.

Table 2.1-1 summarizes the results of the crop-specific assessments for those crops. For most of the crops listed, EPA concludes that there are adequate alternatives to chlorpyrifos to provide control of the pests typically targeted by chlorpyrifos. However, use of alternatives may entail additional control costs to the grower. In some cases, alternatives may not be as efficacious as chlorpyrifos and yield or quality losses may occur. In addition, there do not appear to be adequate alternatives in some crops or regions (e.g., cutworms in Michigan asparagus, borers in

Michigan cherries and Southeast peaches, wireworm in Northern sugarbeets, and symphylans in Oregon strawberries), so for these uses yield losses are estimated.

Table 2.1-1. Benefits of Chlorpyrifos Tolerances, Per-acre and Total Annual Benefits.

Crop	Impact/Acre	Acres Affected	Total Annual Benefit
Alfalfa	$0 - $1	1,029,000	$0 - $1,029,000
Almond [0]	$7 - $35	144,000	$1,009,000 - $5,040,000
Apple [0]	$12 - $51	196,000	$2,346,000 - $9,971,000
Apricot [1]	$7 - $33	100	$1,000 - $4,000
Asparagus, Michigan	$0 - $450	6,000	$0 - $2,569,000
Asparagus, other states [2]	$6 - $20	8,000	$89,000 - $178,000
Beans, succulent [3]	$29	5,000	$137,000
Beans, dry	$0 - $19	6,000	$118,000
Brassica crops[7]			
Broccoli	$8 - $68	6,000	$44,000 - $374,000
Cabbage	$14 – $78	3,000	$42,000 - $234,000
Cauliflower	$11 - $90	200	$2,000 - $18,000
Celery	negligible	100	negligible
Cherry, Sweet	$3 - $65	28,000	$84,000 - $1,811,000
Cherry, Tart	$18 - $201	12,000	$292,000 - $482,000
Corn	$6 - $8	677,000	$4,060,000 - $5,414,000
Cotton, seed treatments	$0 - $9	482,000	$0 - $4,338,000
Cotton, foliar treatments	$0 - $14	126,000	$0 - $1,768,000
Cranberry	$14 - $35	12,000	$174,000 - $434,000
Fig	negligible	negligible	negligible
Garlic	negligible	200	negligible
Grapefruit	$9 - $44	22,000	$202,000 - $987,000
Grape, Raisin	$4 - $30	11,000	$331,000
Grape, Table	$7 - $130	42,000	$293,000 - $5,439,000
Grape, Wine	$4 - $91	23,000	$90,000 - $2,058,000
Hazelnut	$0 - $3	3,000	$0 - $10,000
Lemon	$10 - $290	16,000	$156,000 - $4,526,000
Mint [4]	$19	92,000	$876,000 - $2,582,000
Onion	$11 - $66	58,000	$636,000 - $3,815,000
Orange, California	$8 - $201	39,000	$310,000 - $7,795,000
Orange, Florida	$2 - $33	95,000	$190,000 - $3,134,000
Peach, Georgia and South Carolina	$12 - $430	18,000	$215,000 - $7,703,000
Peach, other states	$8 - $29	11,000	$88,000 – $297,000
Peanut [0,4]	$10	114,000	$1,143,000
Pear	$5 - $37	6,000	$30,000 - $223,000
Peas, succulent	$10 - $370	400	$4,000 - $166,000
Pecan	$1 - $11	115,000	$115,000 - $1,262,000
Pepper	$5 - $10	500	$5,000 - $14,000
Pistachio	negligible	negligible	negligible
Plum/Prune	$7 - $33	3,000	$20,000 - $96,000
Potato	negligible	400	negligible

Crop	Impact/Acre	Acres Affected	Total Annual Benefit
Sorghum[6]	$3 - $4	108,000	$324, 000 - $756,000
Soybean	$1 - $4	3,080,000	$3,080,000 - $12,321,000
Strawberry, Oregon	$6 - $7,813	600	$3,600 - $4,258,000
Strawberry, other states	$10 - $65	11,000	$105,000 - $686,000
Sugarbeet, Minnesota and North Dakota[6]	$13 - $498	60,000	$774,000 - $29,639,000
Sugarbeet, other states[6]	$10 - $13	140,000	$1,403,000 - $1,823,000
Sunflower	$0 - $1	123,000	$0 - $123,000
Sweet Corn[5]	$1 - $3	54,000	$54,000 - $163,000
Tobacco [3]	$4	37,000	$149,000
Tomato[3]	$7	2,000	$11,000
Walnut	$2 - $36	124,000	$248,000 - $4,457,000
Wheat, Spring	$0 - $1	783,000	$0 - $783,000
Wheat, Winter	$0 - $1	549,000	$0 - $549,000
Total		**8,484,000**[7]	**$19,134,000 - $129,675,000**

Sources: EPA estimates of per-acre impacts (Chapter 3.3); average acres treated at least once with chlorpyrifos based on Kynetec, 2016 and 2019 (years: 2010-2014 and 2014-2018, respectively). Figures subject to rounding.

Footnotes:

0 Cost estimates do not account for possible yield losses.

1 Assumes same per-acre cost as for plums/prunes.

2 Range is from $6-10/acre, with some acres treated twice, average of 1.4 applications per affected acre (2010-2014).

3 No range estimated. Limited data suggest only single alternative.

4 No range estimated for per-acre cost. Limited data suggest only a single alternative. No information available on acres treated with chlorpyrifos; range is from 50-100% of the crop.

5 Seed treatment usage data were not available for sweet corn, so the percent of the crop treated is underestimated and thus the per acre cost of revoking the chlorpyrifos tolerance may also be underestimated.

6 Estimates of per-acre impacts are based on Kynetec (2019) usage data from 2014-2018.

7 Estimated total acreage treated from 2014-2018 is 8.8 million acres annually. This estimate in the table is lower because it excludes some crops, is based on usage from 2010-2014 for most of the crops, and because acreage for this table is based on estimates of percent crop treated and harvested acreage (see Section 2.2).

The estimated total cost has a wide range, between $19 and $130 million per year. The midpoint of this range is $74 million. The extremes will have a low probability of occurrence, since all affected acres would have to incur either the lowest or the highest impact. To better characterize the likely benefits for chlorpyrifos, EPA considers three factors.

First, we consider the range of costs for those sites that contribute the most to the total national cost. The average cost for crops with the greatest affected area, such as soybean (3.1 million acres treated with chlorpyrifos), alfalfa (1.0 million acres treated with chlorpyrifos), and cotton (608,000 acres treated with chlorpyrifos), may tend to be at the lower end of the range, since these sites have numerous alternatives from which a grower could choose to replace chlorpyrifos. The estimated range of costs for these crops is relatively small. In contrast, the average cost for crops such as vegetables and fruit in specific areas with important pest problems, is likely to be closer to the upper end of the estimated ranges. For several crops, a range of estimates was not created because of limited alternatives to chlorpyrifos. Some of the highest per-acre crop costs are for *Brassica* crops, which are based on yield loss estimates and information from the original analysis in 2016. This information indicated that there were no feasible registered alternatives, but more recent data suggests growers have largely stopped using chlorpyrifos, indicating the presence of feasible alternatives, as discussed below.

Second, there are several sites for which alternatives may not provide the same level of pest control as chlorpyrifos, but for which estimates of yield loss are not available. Almonds and peanuts are examples, in that estimates of damage caused by borers are not available. Per-acre costs may exceed the upper bound estimate shown in Table 2.1-1, at least on some acres. This factor suggests that total costs would tend toward the upper end of the range.

Finally, another source of variation in the estimated total benefits of chlorpyrifos tolerances is the variability in the number of affected acres. Pest pressure varies from year to year which leads to variation in the number of acres that are treated. Further, as with any input to production, usage may vary according to the cost of the input and the value of the output. Variation in acres treated within individual crops could have substantial impacts on variability in total cost. If, in a given year, there is particularly high pest pressure in a crop with high per-acre impacts, total cost is likely to be relatively high. The converse would lead to a relatively lower total cost. This factor suggests that the range in cost may be wider than shown in Table 2.1-1 in some years, but does not suggest where, over a period of years, costs may fall within the range.

Overall, consideration of these three factors leads EPA to conclude that the total benefits of chlorpyrifos is likely to fall near the midpoint of the range.

Section 2.2 Methodology

To estimate the benefits of chlorpyrifos, EPA has to determine the difference in per acre cost of pest control with and without chlorpyrifos for each crop, multiply that by the acres affected if chlorpyrifos were not available, and sum across crops to find a total. In the equation below, TB is the total benefit of chlorpyrifos, b_i is the estimated per-acre benefit of chlorpyrifos for crop *i*, and A_i is the average acres in crop *i* treated with chlorpyrifos:

$$TB = \sum_i b_i \cdot A_i$$

The variable b_i, which we estimate in this chapter for crops treated with chlorpyrifos, should be interpreted as the average per acre benefit of chlorpyrifos for crop *i*. Multiplying b_i by the average acreage treated with chlorpyrifos in crop *i* yields the expected benefit for crop *i*.

The benefits of chlorpyrifos are the difference in per acre cost of production using the identified alternative, plus yield losses if any. To estimate the benefits for each use site (b_i,), we compare the baseline situation using the per acre cost of production using chlorpyrifos, to a situation where the producer of the crop uses the next best available control strategy, which may mean there are additional pesticide costs or possible yield losses.

There are several steps to estimate of the components of the total benefit equation. First, we identify the acreage treated with chlorpyrifos for each crop to estimate A_i. The second major piece is to estimate b_i. That involves several steps. First, identify the pests targeted with chlorpyrifos in those crops, and then identify reasonable alternative control strategies using registered alternatives to chlorpyrifos, if they exist. After the target pests and alternative control strategies are determined, we estimate the per acre cost of pest control with and without chlorpyrifos; the difference is the per acre benefit of chlorpyrifos, b_i. In most cases, a range of cost estimates are used. The last step is to multiply the per acre incremental benefit for each crop by the acres treated with chlorpyrifos to estimate a total incremental benefit per crop, which are then summed for a total incremental benefit. These estimates represent annual benefits.

Estimating Acreage Treated with Chlorpyrifos

Chlorpyrifos is registered on many crops, but its importance, and therefore the magnitude of impacts, will vary according to the pests that might damage the crop and the registered alternatives available for their control. The percent of a crop that is treated (PCT) can often be an indicator of the importance of a chemical like chlorpyrifos because it is applied at the discretion of the farmer who often is able to scout for the presence of pests before deciding whether to make an application. In particular, low PCT of a chemical often indicates that cost-effective alternatives are available or that pests controlled by the chemical are sporadic or not very damaging and, therefore, the costs in the absence of chlorpyrifos will be negligible.

Market research data from Kynetec (2016, 2019) used for estimating acreage and cost are collected and sold by a private market research firm for the years 1998-2018. Data are collected on pesticide use for about 60 crops by annual surveys of agricultural pesticide users in the continental United States. The survey methodology provides statistically valid results at the state level. To develop the market research data, growers are surveyed about pesticide use on the crops they grow, and they can identify up to three pests they are targeting with a pesticide treatment. To estimate the acres affected by a change to chlorpyrifos registration, we used Market Research Data average number of acres treated from 2010 – 2014 or 2014 - 2018 in the states surveyed divided by the acres grown in those states to estimate the PCT. This PCT is used to extrapolate total treated acreage in the whole country, by multiplying the PCT by national acres harvested reported by the USDA National Agricultural Statistics Survey (Table 2.2-1). This analysis was originally performed using market research data (Kynetec, 2016) for the years 2010 – 2014, but was updated for three crop crops (*Brassica*, sugarbeets, and sorghum) using data (Kynetec, 2019) years from 2014 – 2018 when that data became available. These crops appeared to have significant differences in chlorpyrifos use patterns, and *Brassica* and sugarbeets were also significant contributors to the original high benefit estimates for chlorpyrifos.

Table 2.2-1. Percent Crop Treated with Chlorpyrifos and Acres Harvested.

Crop	Acres Harvested	Percent Treated with Chlorpyrifos	Acres Treated with Chlorpyrifos
Alfalfa	18,375,000	6%	1,029,000
Almond	822,000	18%	144,000
Apple	327,000	60%	196,000
Apricot	11,000	<1%	100
Asparagus, Michigan	10,000	60%	6,000
Asparagus, other states	16,000	50%	8,000
Beans, succulent	269,000	2%	5,000

Crop	Acres Harvested	Percent Treated with Chlorpyrifos	Acres Treated with Chlorpyrifos
Beans, dry	1,533,000	<1%	6,000
Brassica crops			
Broccoli	125,000	4%	6,000
Cabbage	57,000	5%	3,000
Cauliflower	41,000	<1%	200
Celery	29,000	<1%	<100
Cherry, Sweet	87,000	30%	26,000
Cherry, Tart	37,000	32%	12,000
Corn	84,700,000	1%	677,000
Cotton, seed treatment	9,270,000	5%	482,000
Cotton, foliar treatment	9,270,000	1%	126,000
Cranberry	40,000	31%	12,000
Fig	8,000	<1%	<100
Garlic	24,000	1%	200
Grapefruit	73,000	31%	22,000
Grape, Raisin	201,000	6%	11,000
Grape, Table	105,000	40%	42,800
Grape, Wine	592,000	4%	23,000
Hazelnut	29,000	11%	3,000
Lemon	55,000	28%	16,000
Mint[1]	92,000	50-100%	46,000-92,000
Onion	145,000	40%	58,000
Orange, California	177,000	22%	39,000
Orange, Florida	434,000	22%	95,000
Peach, Georgia and South Carolina	26,000	70%	18,000
Peach, other states	84,000	13%	11,000
Peanut	1,260,000	9%	114,000
Pear	52,000	12%	6,000
Peas, succulent	179,000	<1%	400
Pecan	494,000	23%	115,000
Pepper	67,000	1%	500
Pistachio	179,000	<1%	300
Plum/Prune	75,000	4%	3,000
Potato	1,070,000	<1%	400
Sorghum	6,104,000	2%	108,000
Soybean	77,100,000	4%	3,080,000
Strawberry, Oregon	1,900	32%	600
Strawberry, other states	57,000	19%	11,000
Sugarbeet, Minnesota and North Dakota	627,000	28%	140,000
Sugarbeet, other states	498,000	9%	60,000
Sunflower	1,630,000	8%	123,000
Sweet Corn[2]	554,000	10%	54,000

Crop	Acres Harvested	Percent Treated with Chlorpyrifos	Acres Treated with Chlorpyrifos
Tobacco	347,000	11%	37,000
Tomato	372,000	<1%	2,000
Walnut	272,000	46%	124,000
Wheat, Spring	14,000,000	6%	783,000
Wheat, Winter	32,600,000	2%	549,000
Total			**8,484,000**[3]

Sources: USDA NASS, 2010-2014; Kynetec, 2016 (years 2010-2014). For *Brassica*, sorghum and sugarbeet, USDA NASS, 2014-2018; Kynetec, 2019, (2014-2018). Figures are rounded.

Footnotes:

1 No data were available for percent treated. A range of 50 – 100% is used to avoid an underestimate.

2 Percent treated and acres treated with chlorpyrifos do not include use of seed treated with chlorpyrifos.

3 Estimated total acreage treated from 2014-2018 is 8.8 million acres annually. This estimate in the table is lower because it excludes some crops, is based on usage from 2010-2014 for most of the crops, and because acreage for this table is based on estimates of percent crop treated and harvested acreage (see Section 2.2).

In addition to the crops listed in Table 2.2-1, there are other crops that have tolerances for chlorpyrifos. These crops include bananas, cucurbits (cantaloupe, cucumber, pumpkin, squash, and watermelon), rutabaga, sweet potato, and turnips. These crops are relatively small-acreage crops and would typically be grown in combination with other, similar crops, e.g., vegetable growers, fruit and nut growers. The benefits associated with chlorpyrifos are not estimated for these crops, so they are not included in the total.

Estimating the Difference in Cost for Chlorpyrifos Alternatives

EPA identified the primary pests targeted by chlorpyrifos through a review of the chlorpyrifos labels and from private pesticide market research data consisting of the results of marketing surveys of growers (Kynetec 2016, 2019). Growers of about 60 crops are surveyed about pesticide use on the crops they grow, and they are asked to identify the pests they are targeting with a pesticide treatment. The data were queried to identify the major target pests for chlorpyrifos applications (Kynetec 2016, 2019).

EPA identified likely alternatives to the use of chlorpyrifos using biological and economic considerations, which are based on market research data on chemicals targeting the same pests as chlorpyrifos and verified by state extension service pest management recommendations to ensure that they are effective. In some cases, possible alternatives are less expensive than chlorpyrifos, but EPA does not consider these alternatives, at least in isolation. This is based on the assumption that if a less expensive product works as well as chlorpyrifos, the grower would use it. Therefore, it is likely that a less expensive product will not be as efficacious or not used for another reason. In addition, EPA only considered currently registered alternatives to chlorpyrifos. However, existing chemicals can be registered on additional crops and new products can be developed. As a result, estimated impacts to growers may decrease over time.

Some growers, particularly those producing for export market, may be constrained in the choice of alternatives to chlorpyrifos, because maximum residue levels (MRLs) allowed for export crops may not be established for particular chemicals in key international markets, or are set at levels not feasible to achieve. This could be more of an issue for newer chemistries in small acreage fruit and nut crops; establishment of MRLs for minor uses may take time. As a result, some growers may have to use more costly control methods than those identified in EPA's assessment below or forego an export market and potentially receive a lower domestic price for their produce.

For some crops, public comments or the USDA identified pest problems that only applied to specific regions of the country, such as strawberry in Oregon, peaches in the Southeast, and sugarbeets in specific counties in Minnesota and North Dakota. For these crops, additional analysis on costs for those regions is included in the crop-specific cost estimates presented in Section 2.3.

Estimating the Cost of Control with Chlorpyrifos and Alternatives

Market research data provide cost estimates for pesticide applications by crop and pest. Variation in the costs of a pesticide occur due to differences in application rates required for control of pests in each crop. The incremental cost of the rule is estimated as the difference in cost between a chlorpyrifos pest control program and alternative strategies. Differences in insecticide costs were estimated on a per-acre basis. In situations where crops have no alternatives or less efficacious alternatives to chlorpyrifos, yield and/or quality losses were also considered. For some crops, such as cranberry and mint, market research data are not available, and cost and usage estimates were derived from information submitted by the industry or by extrapolating cost information from other crops.

In developing scenarios for the use of alternatives, EPA generally assumes that all target pests are present on each acre treated with chlorpyrifos. Therefore, estimates of additional costs may be based on the use of multiple alternatives to control multiple pests. Data on acres treated by pest, however, indicate that problems with many pests are limited to a portion of the area treated with chlorpyrifos. Thus, estimates involving the use of multiple chemicals to replace a single chlorpyrifos treatment may significantly overestimate impacts. In some cases, such as Michigan asparagus, growers may see yield or quality losses without the ability to use chlorpyrifos. When information on those losses are available, we include yield losses in our estimates of benefits, in some cases extrapolating from one crop to similar crops. In the case of some crops, almonds, for example, there is not sufficient information to estimate quality or yield losses quantitatively.

Section 2.3 Uncertainties

The results of this analysis are subject to uncertainty. This section provides a brief description of the major sources of uncertainty, as well as simplifying assumptions and their implications.

Target Pests

For most crops, EPA identified the primary target pests based on responses of growers to market surveys on the use of pesticides. However, those responses may not fully capture the suite of pests controlled by a broad-spectrum insecticide like chlorpyrifos. Past analyses (*e.g.*, Zalom *et al*. 1999) have shown that broad-spectrum materials such as chlorpyrifos can serve a 'keystone' role in some IPM programs. Removal of such broad-spectrum insecticides from pest management programs can result in unexpected outbreaks of previously minor pests or even the emergence of new pests. As a result, additional control costs could manifest themselves in the short term or develop over time.

Regional Differences

Most of EPA's estimates are national in scope. However, pests and pest pressure may differ across agroclimatic conditions. As a result, the assessment may be missing or underestimating losses in one or more regions of the United States due to differences in target pests and appropriate alternatives. For some crops, EPA was provided with information from crop experts that indicated that regional conditions or pest problems warranted further examination. Additional analysis on regional impacts is included for these crops, which include Michigan asparagus and cherries, Oregon strawberries, Minnesota and North Dakota sugarbeets, and Southeastern peaches. For these areas, the costs were higher than the national estimates for the same crops, but the national estimates would overstate costs in areas with low pest pressure.

New Methods of Insect Control

In this analysis, EPA only considered currently registered alternatives to chlorpyrifos. However, as pesticide markets open through the loss of a control option or new pests emerge, existing chemicals are registered on additional crops or new products are developed. EPA also assumed that growers who use chlorpyrifos will replace it with other insecticides, instead of non-chemical management tactics such as biological control with insect natural enemies. However, some growers may find these approaches to be cost effective over time as understanding of their optimal deployment improves. As a result, estimated impacts to growers may decrease over time.

Intensity of Pest Pressure

In developing scenarios for the use of alternatives, EPA has generally assumed that all target pests are present on all acres treated with chlorpyrifos. Therefore, estimates of additional costs are based on the use of multiple alternatives. Data on acres treated by pest, however, indicate that situations with many pests are limited to a proportion of acres treated with chlorpyrifos. Thus, estimates involving the use of multiple chemicals to replace a single chlorpyrifos treatment may significantly overestimate impacts.

Emerging Pest and Resistance Problems

Most of EPA's cost estimates are based on reported use of chlorpyrifos against specific pests using market research data (Kynetec, 2016) from 2010 – 2014. However, if growers of a crop face relatively new pests or pest problems that are growing in intensity, using historical data on chlorpyrifos use will underestimate any estimate of the cost of alternatives or yield loss at an aggregate level. This may be a particular problem with trunk and limb-boring insects in tree crops, for example, where the potential damage is severe. Currently, most of the affected acreage is in the Southeast, but the pest problem could spread to other areas in the future. In addition, in some crop systems that have only one or two pesticide modes of action registered, the loss of chlorpyrifos may accelerate the evolution of pest resistance against whatever alternative modes of action remain. This could be a result of growers no longer being able to rotate pesticides with different modes of action during seasonal pest management, which is a fundamental resistance management strategy. If resistance develops, unless additional modes of action are registered, the cost impact of chlorpyrifos loss will be higher.

Export Restrictions

EPA identified alternatives to the use of chlorpyrifos based on state recommendations and/or common use as reported in market surveys. However, as mentioned above, some growers may be constrained in the choice of alternatives, particularly those targeting the export market because maximum residue levels (MRLs) may not be established for particular chemicals in key international markets. This could be an issue, especially for small acreage fruit and nut crops for newer chemistries because establishment of MRLs for minor uses may take time. International MRL harmonization is a focus of several ongoing efforts between the Agency and international trade partners but in the short term some growers may have to use more costly control methods than identified in EPA's assessments. However, since EPA frequently based the assessment of impacts on the most expensive likely alternative, any underestimation of costs may be small. Further, small entities may be less likely to target the export market than large growers and those that do target the export market may have higher gross revenue per acre than the average small grower.

Data Limitations

Costs are not estimated for some uses of chlorpyrifos due to data limitations. In particular, there are registered uses of chlorpyrifos as seed treatments that may be important for some crops. However, the extent of impact from loss of chlorpyrifos seed treatments remains uncertain at this time because usage information for seed treatments is not available for chlorpyrifos and alternatives. As a result, this analysis may underestimate the acreage affected by any changes to the registration of chlorpyrifos. Any such underestimation is likely small, however, as the crops for which data are lacking are generally small acreage.

Section 2.4 Crop Benefit Estimates

This section reports estimates of the per-acre benefits of chlorpyrifos for individual crops. Crops are presented in alphabetical order. In most cases, the estimates are made at the national level, but where EPA has found important variation of pests or crop conditions in specific areas, estimates are made by state or region. For some crops, where alternatives may be substantially more costly than chlorpyrifos or there may be a yield and/or quality loss with the use of alternatives to chlorpyrifos, the benefits of chlopyrifos may be quite large. The majority of the estimates are based on reported use of chlorpyrifos against specific pests using market research data from 2010 – 2014, which were the most recently available when the majority of this analysis was initially conducted. More recent usage data (2014 – 2018) were reviewed and suggest that for the majority of crops the situation has not changed and therefore the analysis was not revised. For sugarbeets, sorghum and the *Brassica* crops, the more recent usage data suggests that the situation may have changed, so these crops are reevaluated for that time period below.

Alfalfa

Chlorpyrifos use on alfalfa is primarily targeted at the alfalfa weevil. Although nationally, use of alfalfa is low in terms of percent crop treated, in some states like Kansas, Colorado and

California, growers appear to rely on chlorpyrifos somewhat more heavily. The alternatives consist of synthetic pyrethroids (Table 2.4-1).

Table 2.4-1. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Alfalfa.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternatives ($/acre)	Difference in Cost ($/acre)
Alfalfa	$5	Alfalfa Weevil	Zeta cypermethrin	$4	($1)
			Cyfluthrin	$4	($1)
			Lambda-cyhalothrin[1]	$5	<$1

Source: Kynetec 2016 (years 2010-2014)
Footnote:
1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos.

The alternative scenario to chlorpyrifos ($5/acre) consists of one application of lambda-cyhalothrin ($5/acre) to control alfalfa weevil. This alternative is essentially the same cost as chlorpyrifos, implying costs to the farmer of less than $1 per acre. Gross revenue is $546 per acre, so additional costs are less than 0.2% of gross revenue.

According to market research data (Kynetec 2016; years 2010-2014), just over one million acres of alfalfa are treated annually with chlorpyrifos. With alternatives essentially the same cost or at most one dollar more, EPA estimates the total benefit of chlorpyrifos for alfalfa to be up to one million dollars per year.

Almonds

Chlorpyrifos use on almonds is limited to three applications per year, including dormant/delayed dormant sprays, in-season foliar sprays, and trunk sprays targeting borers. Usage data, however, indicate that growers average 1.25 applications per year. While usage is significant against navel orangeworm and peach twig borer (Kynetec 2016; years 2010-2014), this is due in part to the prevalence of the pests. Numerous alternatives are available for control of these two pests and chlorpyrifos does not rank that highly, relative to these alternatives in terms of acres treated and per university extension recommendations (UC IPM 2014a, b). Substitution of alternatives would be one-for-one with chlorpyrifos.

Emerging pests of concern are leaffooted bugs (at least three species), which have been specifically identified by the almond industry in recent years (Almond Board of California 2015, UC IPM 2012a, Goodhue *et al.* 2019). While the overall average chlorpyrifos usage targeting this pest has been relatively low since 2009 (though sporadically higher in prior years), there was a sharp increase in 2013, and future usage data is likely to reflect a pest of emerging importance. The industry has identified chlorpyrifos as a very important chemical and cites clothianidin as the main effective alternative (Almond Board of California 2015), but usage data indicate that pyrethroids are also being used (Table 2.4-2). At least one recent research article indicates that pyrethroids are the main set of insecticides now used for leaffooted bugs (Daane *et al.* 2019). Extension recommendations also list bifenthrin and esfenvalerate (both pyrethroids) as chlorpyrifos alternatives, but caution against their disruption of beneficial insect populations (UC IPM, 2012a). Because the suitability of the alternatives to chlorpyrifos is questionable, there is the potential for yield/quality losses as well under high pest population pressure in the absence of chlorpyrifos availability. Loss of chlorpyrifos as a leaffooted bug control option may also increase the risk of resistance to pyrethroids developing in pest populations as growers over-use this class of insecticides. If pyrethroids begin to lose effectiveness yield/quality losses would become inevitable.

Table 2.4-2. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Almonds.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternatives ($/acre)	Difference in Cost ($/acre)
Almonds	$17	Navel Orangeworm	Bifenthrin[1]	$12	($5)
			Methoxyfenozide	$24	$7
			Chlorantraniliprole	$31	$14
			Esfenvalerate	$6	($11)
			Lambda-cyhalothrin	$6	($11)
		Peach Twig Borer	Methoxyfenozide	$24	$7
			Esfenvalerate	$6	($11)
			Diflubenzuron	$20	$3
			Lambda-cyhalothrin	$6	($11)
			Chlorantraniliprole	$31	$14
			Bifenthrin[1]	$12	($5)
		Leaffooted Bug	Bifenthrin[1]	$9	($5)
			Esfenvalerate	$6	($11)
			Clothianidin[1]	$16	($1)

Source: Kynetec 2016, 2010-2014.
Footnote:
1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos.

Assuming all three pests could be controlled simultaneously with one application of chlorpyrifos ($17/acre), a high-cost alternative scenario would consist of one application of bifenthrin ($12/acre) to control navel orangeworm, one application of methoxyfenozide ($24/acre) to control peach twig borer, and one application of clothianidin ($16/acre) to control leaffooted bug. Together, this strategy would cost approximately $52/acre (total is not exact due to rounding of some costs). This is about $35/acre more than one single application of chlorpyrifos. Average gross revenue is about $6,205 per acre (see Appendix A), implying impacts of about 0.6% of gross revenue per acre, for a total benefit of $5.0 million.

In the absence of the leaffooted bug, growers might apply methoxyfenozide for control of either or both the navel orangeworm and peach twig borer with additional insecticide costs of about $7-14/acre, depending on the number of applications. Methoxyfenozide is highly effective against Lepidoptera (caterpillar pests) but has little to no impact on other insect taxa.

As discussed above, using the alternatives (particularly in regard to controlling leaffooted bugs) might result in yield/quality losses, leading to impacts in addition to chemical cost increase. As a result, almond growers might face additional lost revenue from lower yield or reduced price received for lower quality.

About 144,000 acres of almond are treated with chlorpyrifos each year, on average (Kynetec 2016; years 2010-2014). Additional insecticide costs are estimated to range from $7 to $35 per acre, implying total annual benefits of between $1.0 and $5.0 million, not considering possible yield losses.

Apples

Chlorpyrifos use on apples is limited to one application per year. For airblast applications, only a dormant or delayed dormant spray can be made to the canopy. For post-bloom applications, only trunk applications (to the lower 4 feet of trunk, not to contact fruit or foliage) are permitted. Such trunk applications would be used to target dogwood borers and black stem borers. These are mainly pests in the eastern United States and especially on young or newly planted trees. This is notable, because even though the available usage data shows little usage against borers (Kynetec 2016; years 2010-2014), most applications would only be made to very young trees that have many years of fruit productivity ahead of them. Therefore, while borers contribute little to chlorpyrifos usage in terms of market share or percent of crop treated, the control of borers is important in apple production, and chlorpyrifos is an important tool for this pest. The main alternatives are listed below in Table 2.4-3 and include hand-applied mating disruption dispensers to control dogwood borers. If mating disruption is not effective, as is the case with borers in other tree fruit, then there may be additional yield losses without chlorpyrifos. A comment from Dr. D. Breth of Cornell University stated, in part:

> "In 2013, infestations of [black stem borer] were seen for the first time in commercial apple trees, in multiple western NY sites. In these sites, growers were seeing 30% of trees in parts of their orchards collapsing. To date, at least 30 additional infestation sites have been documented, extending as far as to Long Island." (USDA OPMP, 2017).

While the description shows the seriousness of this pest problem, it does not have enough description of likely affected acreage to allow a detailed economic impact analysis.

In addition to use against the borer pests, pre-bloom dormant or delayed dormant applications on apples would typically target rosy apple aphids, San Jose scale, and overwintering pests including leafrollers, plum curculio, and codling moth. Control of leafrollers, plum curculio, and codling moth is mostly incidental, and growers are unlikely to target these pests specifically during the dormant or delayed-dormant period, but rather, would normally target control tactics for the petal-fall stage, and subsequent foliar sprays. Therefore, EPA does not examine likely alternatives for these pests, since such applications would still be made with or without the availability of chlorpyrifos during the early season.

While petroleum oil is listed as an alternative with a high percentage of crop treated for rosy aphids and San Jose scale, oil is often not an efficacious stand-alone tactic. IPM recommendations call for applications of oil with an insecticide during the dormant/delayed dormant period to target susceptible stages. If this control measure fails for rosy apple aphids, neonicotinoid applications at petal fall can be made to target them (PSU, 2013). For San Jose scale, growers may resort to trying to control the 'crawler' stage later in the growing season using spirotetramat, pyriproxyfen, or pyrethroids (PSU, 2013).

For control of rosy apple aphid and San Jose scale, the alternative active ingredients to chlorpyrifos are projected to substitute one for one with chlorpyrifos. Timing would differ (i.e., chlorpyrifos would go on at delayed dormant, whereas the alternatives would be used at petal fall, targeting different stages of the same pest), but in either case, only one application would be necessary for season-long control. Efficacy is expected to be similar.

As mentioned above, chlorpyrifos use on apples is limited to one application per year. Growers can use it to control borers as a trunk application or the other pests pre-bloom. For the latter situation, a high-cost alternative strategy would be that chlorpyrifos ($14/acre) is replaced by one application of imidacloprid ($6/acre) to control rosy apple aphid/aphid, one application of a tank mix of petroleum oil ($15/acre) and pyriproxyfen ($38) to control San Jose scale/scale (Table 2.4-3). The total cost of the alternative regime is estimated to be $63/acre, which is about $49/acre more expensive than chlorpyrifos (difference may not be exact due to rounding). This is likely to overestimate the cost because chlorpyrifos is already commonly tank-mixed with petroleum oil, but for this analysis it is assumed that chlorpyrifos is applied alone. A low-cost scenario would be an application of acetamiprid to control both pests, with incremental insecticides costs of about $12/acre. For borers, one application of chlorpyrifos being replaced by an application of mating disruption ($65/acre) to control borers, which is about $51/acre more expensive than chlorpyrifos ($14/acre). Average gross revenue is about $8,852 per acre (Appendix A), implying impacts of as much as 0.6% of gross revenue per acre in either scenario. Given an average of 196,000 acres treated annually with chlorpyrifos, total benefits for apples are estimated to range from $2.3 to $10.0 million per year. This may understate benefits if mating disruption cannot control borer pests and if the affected acreage and damage from borers increases over time. Based on Market Research Data from 2010 – 2014, there is little use of chlorpyrifos targeting borers in apples.

Table 2.4-3. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Apples.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternatives ($/acre)	Difference in Cost ($/acre)
Apples	$14	Rosy Apple Aphid/Aphid	Petroleum Oil	$15	$1
			Acetamiprid	$26	$12
			Imidacloprid [1]	$6	($8)
			Lambda-Cyhalothrin	$5	($9)
			Spirotetramat	$46	$32
			Thiamethoxam	$11	($3)
			Esfenvalerate	$5	($9)
		San Jose Scale/Scale	Petroleum Oil [1]	$15	$1
			Pyriproxyfen [1]	$38	$14
			Spirotetramat	$46	$32
			Acetamiprid	$26	$12
			Lambda- Cyhalothrin	$5	($9)
			Imidacloprid	$6	($8)
		Borers/ Dogwood Borers	Mating Disruption [1]	$65	$51

Source: Kynetec, 2016; years 2010-2014. Numbers may not add due to rounding.
Footnote:
1 Chemicals used to estimate the upper range of cost of control in the absence of chlorpyrifos.

Asparagus

The major pests targeted by chlorpyrifos in asparagus production are shown in Table 2.4-4. Chlorpyrifos labels allow one pre-harvest application and up to two post-harvest ("fern stage") applications per year in this crop. Based on market research data chlorpyrifos is applied 1.4 times per year, on average, to asparagus. Applications are mainly for control of the asparagus aphid in the western U.S., while in Michigan the primary pests are cutworms and asparagus beetle.

Among various aphid pests of asparagus is the European asparagus aphid. While this insect occurs throughout the United States, it appears to be a consistent problem mainly in states west of the Rocky Mountains (Natwick *et al.* 2012, USDA 2003a). According to the University of California (UC), the asparagus aphid causes damage to the plant mainly because its saliva contains toxins that cause distorted growth in the subsequent year that in turn reduces yield. In addition, heavy infestation produces honeydew and may lead to secondary infestation with ants. Major crop damage would occur during this perennial crop's second year (Natwick *et al.* 2012).

Chlorpyrifos is at the top of the University of California's list of insecticides useful in an integrated pest management (IPM) program for the asparagus aphid (Natwick *et al.* 2012), and in California it has been the most-used insecticide for this pest (Kynetec 2016; years 2010 - 2014). Based on University of California recommendations, proprietary pesticide usage data, and EPA's professional judgement, likely alternatives for chlorpyrifos use against this pest would be dimethoate. Dimethoate is a systemic organophosphate (OPs) and thus probably more attractive options than other alternatives for growers (regardless of which region/state is considered). EPA assumes that yield losses with these materials will be unlikely.

The asparagus beetle refers to either of two species, the asparagus beetle or the spotted asparagus beetle. (Natwick *et al.* 2012, USDA 1999a, 2003a). Injury to the plant is by direct feeding on shoot tips; damage is most critical in young stands of plants. For these pests, any one of the leading alternatives (identified by proprietary pesticide usage data and listed in Table 2.4-4) should work as a one-to-one replacement for chlorpyrifos, with no significant changes in yield or quality loss.

Cutworms (several species) damage young asparagus spears as they emerge from the soil surface (USDA 2000b, Natwick *et al.* 2012). Damage often occurs in the spring. Data show some use of carbaryl and permethrin. However, the 2002 Pest Management strategic plan for Michigan asparagus indicated that neither provide control equivalent to chlorpyrifos, and permethrin can fail under some conditions, such as hot weather (USDA 2000b).

Table 2.4-4 shows the difference in cost between the alternatives and chlorpyrifos for the target pests. Use of acetamiprid to control the asparagus aphid would lead to an increase in pesticide costs of $11 per acre, up to $22 per acre if two applications were needed. Average gross revenue is about $3,369 per acre, implying impacts of less than 0.5% of gross revenue per acre. The affected acreage is about 8,100 acres outside Michigan, for an annual benefit of $89,000 to $178,000.

Table 2.4-4. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Asparagus.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternative ($/acre)	Difference in Cost ($/acre)
Asparagus, other than Michigan	$9	Asparagus Aphid	Acetamiprid[1]	$20	$11
			Dimethoate	$6	($3)
			Malathion	$7	($2)
Asparagus, Michigan	$7	Cutworms	None	25% yield loss	
		Asparagus Beetle	Carbaryl	$7	<$1

Source: Kynetec, 2016; years 2010-2014. Numbers may not add due to rounding.
Footnote:
[1] Chemicals used to estimate the cost of control in the absence of chlorpyrifos.

In Michigan, carbaryl is by far the leading insecticide for the asparagus beetle and is approximately the same cost as chlorpyrifos. Industry experts who commented on the tolerance revocation petition (Bakker, 2016) estimate that yields would be 25% lower with the use of carbaryl or permethrin than with chlorpyrifos. Gross revenue for Michigan asparagus averages $1,800 per acre from 2010 – 2014 (USDA, 2016a), so a 25% yield loss is equivalent to $450 per acre. Costs, therefore, could range from near zero for control of the asparagus beetle to $450 per acre. An average 5,700 acres of asparagus are treated with chlorpyrifos in Michigan (Kynetec 2016; years 2010-2014), so total costs, in terms of lost production, could be as much as $2.6 million per year.

The total benefit of chlorpyrifos or asparagus for the country as a whole is estimated to be $48,500 to $2.7 million per year.

Brassica: broccoli, cabbage, cauliflower

The analysis for broccoli, cabbage and cauliflower was updated more recently than other crops, using usage data from 2014-2018. At the time the original analysis was done, there was substantial use of chlorpyrifos in these crops, but more recent usage data has shown a significant decline in use. Chlorpyrifos applications primarily target cabbage root maggots in *Brassica* crops (Kynetec 2019; years 2014-2018), with over 95% of the chlorpyrifos pounds applied in broccoli and cauliflower and over 70% of the pounds applied in cabbage are targeting root maggots. These pests are in the soil, feed on the roots, and require a soil insecticide application for control. Young plants are more susceptible to damage. For *Brassica* vegetables, it appears that growers can use a diamide insecticide such as cyantraniliprole, the pyrethroid bifenthrin or the neonicotinoid clothianidin to successfully control these pests (UF 2018, Shimat and Zarate 2015).

Table 2.4-5 shows the primary target pest for chlorpyrifos in *Brassica* crops as well as potential alternatives and the difference in cost between the alternatives and chlorpyrifos.

Table 2.4-5. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, *Brassica* crops.

Crop	Cost of Chlorpyrifos ($/Acre)	Target Pest	Alternatives to Chlorpyrifos	Cost of Alternatives	Difference in Cost ($/Acre)
Broccoli	$29	Cabbage Root Maggot	Clothianidin	$21	$8
			Cyantraniliprole[1]	$97	$68
			Bifenthrin	$6	($23)
Cabbage	$12	Cabbage Root Maggot	Clothianidin	$26	$14
			Cyantraniliprole[1]	$90	$78
			Bifenthrin	$4	($8)
Cauliflower	$10	Cabbage Root Maggot	Clothianidin	$21	$11
			Cyantraniliprole[1]	$100	$90
			Bifenthrin	$9	($1)

Source: Kynetec 2019; years 2014-2018. Numbers may not add due to rounding.
Footnote:
1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos.

The alternative scenario to chlorpyrifos for broccoli, cabbage and cauliflower consists of one application of cyantraniliprole. For broccoli, the baseline treatment of chlorpyrifos costs $29 per acre, and the replacement cyantraniliprole cost $97 per acre, resulting in an increased cost of control of $68 per acre (Table 2.4-5). Average gross revenue in broccoli is about $7,000 per acre, so the increase in cost is just under 1% of gross revenue. According to the available usage data (Kynetec 2019; years 2014-2018), about 5,100 acres of broccoli are treated with chlorpyrifos annually to control root maggots, so the benefit of chlorpyrifos is about $347,000 per year in broccoli.

For cauliflower, the baseline treatment of chlorpyrifos costs $10 per acre, and the alternative scenario of cyantraniliprole costs about $100 per acre, $90 more expensive than the baseline (Table 2.4-5). Average gross revenue in cauliflower is about $9,700 per acre, implying benefits of under 1% of gross revenue per acre. According to the available usage data (Kynetec 2019; years 2014-2018), less than 200 cauliflower acres are treated with chlorpyrifos annually, so the benefit of chlorpyrifos over alternatives is about $9,000 per year.

For cabbage, the baseline treatment of chlorpyrifos costs $12 per acre, and the alternative scenario of cyantraniliprole costs about $90, $78 per acre more expensive than the baseline chlorpyrifos treatment (Table 2.4-5). Average gross revenue in cabbage is about $7,000 per acre, implying benefits of about 1% of gross revenue per acre. According to the available usage data (Kynetec 2019; years 2014-2018), about 2,100 acres are treated with chlorpyrifos annually, so the estimated benefit of chlorpyrifos is about $164,000 per year.

These benefits of chlorpyrifos as estimated above are based on usage data from 2014 – 2018, but chlorpyrifos usage has fallen substantially, with no use reported in three of the last five years for broccoli, and two of the last five years for cauliflower, and in those years, there was substantially less use of chlorpyrifos than in prior years. The estimates here are based on usage over five years (2014 – 2018), so they may not reflect benefits going forward. In addition, California, the primary producer of broccoli and cauliflower, is eliminating the use of chlorpyrifos by the end of 2020 (CDPR, 2019).

Cherries (sweet)

In all cherries, the available pesticide usage data for 2010 to 2014 indicate that an average of 27% of all cherry acreage was treated per year with this insecticide.

The major pests targeted by chlorpyrifos in sweet cherry production are black cherry aphid, San Jose scale, and obliquebanded leafroller. Chlorpyrifos can be phytotoxic to sweet cherry foliage (Pscheidt *et al.*, 2015). Therefore, almost all of its use in sweet cherries occurs before budbreak. EPA also received information (NWHC 2016) about increasing prevalence of grape mealybug problems and the potential issues with lesser peachtree borer, but there did not appear to be much use of chlorpyrifos against these pests (Kynetec 2016; years 2010 – 2014).

Table 2.4-6 shows the primary target pests for chlorpyrifos in sweet cherries, as well as a list of the most likely alternatives to chlorpyrifos for these pests and the difference in cost between the alternatives and chlorpyrifos. As with other crops in this analysis, selection of alternatives was based on recent pesticide usage data (from Market Research Data) as well as extension service guidance and other information. There are less expensive alternatives for black cherry aphid, but EPA concluded that some of these alternatives must be used in combination with each other to get an effect similar to that of chlorpyrifos, such that there would be a modest overall cost increase. If chlorpyrifos was not available for use to control the black cherry aphid, current users would most likely replace one application of chlorpyrifos with one application of petroleum oil plus diazinon and a later in-season application of imidacloprid.

Table 2.4-6. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Sweet Cherries.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternative ($/acre)	Difference in Cost ($/acre)
Cherries (sweet)	$16	Black Cherry Aphid	Imidacloprid [1]	$7	($9)
			Petroleum Oil [1]	$18	$2
			Diazinon [1]	$21	$5
		San Jose Scale	Petroleum Oil [1]	$18	$2
			Buprofezin	$42	$26
			Pyriproxyfen [1]	$35	$19
		Obliquebanded Leafroller	Chlorantraniliprole	$42	$26
			Spinosad	$34	$18
			Diazinon [1]	$21	$5

Source: Kynetec, 2016; years 2010-2014. Numbers may not add due to rounding.
Footnote:
1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos. Chlorpyrifos is assumed to be mixed with petroleum oil for a total cost of $34/acre. One application of diazinon (mixed with petroleum oil) is estimated to provide control of both black cherry aphid and obliquebanded leafroller.

The likely alternatives for the San Jose scale and obliquebanded leafroller are more expensive. If chlorpyrifos was not available for use to control the San Jose scale, current users would most likely replace one application of chlorpyrifos with one application of a petroleum oil mixed with either buprofezin or pyriproxyfen. These combinations can also be used in the dormant stage but require thorough coverage to be effective (Varela *et al* 2015). For obliquebanded leafroller, extension literature suggests that another organophosphate, such as diazinon, mixed with oil, should provide control during the dormant season that is similar to chlorpyrifos (UC IPM 2015f).

Given the increased cost to control scale, however, sweet cherry growers would experience an increased cost in chemical control as a result of not being able to use chlorpyrifos to control these pests.

For the upper bound impact, EPA assumes that currently, one application of chlorpyrifos per season is used to control all three major pests in sweet cherries: black cherry aphid, San Jose scale, and obliquebanded leafroller. Although there is concern in the industry about grape mealybug and lesser peachtree borer, they do not appear to be significant targets of chlorpyrifos (Kynetec 2016; years 2010 – 2014).

The alternatives scenario consists of one application of chlorpyrifos with petroleum oil ($16 + $18 = $34/acre) being replaced by one application diazinon with petroleum oil ($21 + $18 = $39/acre); this application of diazinon to control black cherry aphid would also control the obliquebanded leafroller. Additionally, EPA estimates growers would make a later, in-season application of imidacloprid ($7/acre) to control the black cherry aphid and one additional application of pyriproxyfen with petroleum oil ($35 + $18 = $53/acre) to control San Jose scale. The baseline scenario of using chlorpyrifos is $34/acre and the cost of the alternative scenario is $99/acre ($39 + $7 + $53). Therefore, the alternative scenario is about $65/acre more expensive than chlorpyrifos (difference may not be exact due to rounding). Average gross revenue for sweet cherry growers is about $9,530/acre (Appendix A), implying benefits of about 0.7% of gross revenue per acre.

The lower bound impact would be replacing chlorpyrifos with diazinon, at an increase in insecticide cost of $5/acre, for control of either black cherry aphid or obliquebanded leafroller. If scale were the only pest problem, the estimated cost would be about $3/acre to use pyriproxyfen instead of chlorpyrifos.

On average, about 26,900 acres of sweet cherry are treated annually with chlorpyrifos. Estimated per-acre increases in insecticide cost imply total benefits of $77,700 to $1.7 million per year for sweet cherry.

Cherries (tart)

According to the available pesticide usage data for recent years (Kynetec 2016; years 2010-2014), the major pests targeted by chlorpyrifos in tart (also called sour) cherry production are green fruitworm and plum curculio. In young orchards, insects that bore into the wood can also be targets of chlorpyrifos use (as a trunk drench) (USDA 2011). However, this use is a minor component in terms of the area of the crop treated with chlorpyrifos, according to the available pesticide usage data used by EPA to identify major target pests (Kynetec 2016; years 2010-2014). Nevertheless, as for other tree fruit crops, EPA acknowledges that borer pest control is a potentially important chlorpyrifos use.

Table 2.4-7 shows the primary target pests for chlorpyrifos in tart cherries, as well as potential alternatives and the difference in cost between the alternatives and chlorpyrifos. There are less expensive alternatives for green fruitworm as a one to one replacement for chlorpyrifos. If chlorpyrifos was not available for use to control this pest, then farmers would likely use esfenvalerate, phosmet, or zeta-cypermethrin. For plum curculio, growers could use phosmet, an organophosphate, or a neonicotinoid, while for borers, phosmet may be an option; the Table 2.4-7 lists the likely pyrethroids and neonicotinoids used by growers. Alternatives are all, on average, lower cost than chlorpyrifos, which suggests that growers using chlorpyrifos face higher pest pressure, multiple pests, or other constraints that make these alternatives less useful than chlorpyrifos. For example, esfenvalerate, one of the cheaper alternatives, can cause outbreaks of mites, so some growers might instead prefer to use chlorpyrifos despite the higher cost.

Table 2.4-7. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Tart Cherries.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternative ($/acre)	Difference in Cost ($/acre)
Cherries (tart)	$23	Green Fruitworm	Permethrin	$6	($17)
			Esfenvalerate	$5	($18)
			Phosmet [1]	$20	($3)
			Zeta-cypermethrin	$6	($17)
		Plum Curculio	Esfenvalerate	$5	($18)
			Phosmet [1]	$20	($3)
			Thiamethoxam	$18	($5)
		Lesser Peachtree Borer	Phosmet	$20	($3)
			Mating Disruption	$65	$42

Source: Kynetec 2016; years 2010-2014. Numbers may not add due to rounding.
Footnote:
1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos.

For this assessment, EPA assumes that one application of chlorpyrifos ($23/acre) is used to control both green fruitworm and plum curculio simultaneously in tart cherries. The alternative scenario consists of one application of phosmet ($20/acre) to control green fruitworm and another application of phosmet ($20/acre) to control plum curculio. The baseline scenario of using chlorpyrifos is $23/acre and the cost of the alternative scenario is $40/acre. Therefore, the alternative scenario is about $17/acre more expensive than chlorpyrifos. Average gross revenue is about $1,695 per acre (Appendix A), implying impacts of about 1.1% of gross revenue per acre. On average, about 13,700 acres of tart cherries are treated with chlorpyrifos.

EPA received comments indicating that borers, particularly the lesser peach tree borer, are not effectively controlled by available insecticides (Korson, 2016). EPA agreed with the conclusion that this pest seems to be a growing problem for which effective alternatives to chlorpyrifos are not available. Michigan extension publications mention that mating disruption is a possible control strategy for lesser peachtree borer, at an additional cost of $42 per acre over chlorpyrifos. There is concern, however, that mating disruption may not be fully effective. For acreage where lesser peachtree borer is uncontrolled, EPA assumes 10% yield loss. This is based on surveys of heavily infested orchards from Michigan Extension experts reported to EPA by the USDA OPMP (USDA OPMP 2017). These surveys indicate that heavily infested orchards have about 20% of trees affected by borers, and half of those are in serious decline, with essentially no yield. The lesser peachtree borer actually reduces lifetime yield and shortens the life of infested trees, but EPA has been unable to find reliable quantitative estimates for yield losses and shortened tree lifetime. The 10% loss estimate may be on the low end, as over time borers could colonize a larger percentage of the trees in an infested orchard. Gross revenue from tart cherries averaged $2,005 per acre from 2010 – 2014, so 10% yield loss would be $201 per acre. An average of 1,389 acres were treated with chlorpyrifos targeting borers in Michigan cherries. This average is from 2012 – 2014, since there were no treatments for borers with chlorpyrifos in 2010 or 2011 according to the available usage data. This is consistent with the lesser peachtree borer emerging as an important pest in Michigan cherries. This estimate is sensitive to the assumptions about yield loss and the share of treated acreage that will suffer those yield losses, and these are a source of substantial uncertainty. This additional cost is specific to Michigan production, and is in addition to the estimate in the previous paragraph, because this cost is specific to Michigan cherry. Cherry production in other regions east of the Rocky Mountains may also have peachtree borer problems sporadically, in which case similar economic impacts would be expected.

The tart cherry low benefits estimate is $291,900, which assumes that 11,800 acres are treated with alternatives for plum curculio and green fruitworm at an additional cost of $17 per acre, and 1,400 acres also are treated with mating disruption for lesser peachtree borer at $65 per acre. The high-end estimate is $481,500 which assumes that 11,800 acres are treated with alternatives for plum curculio and green fruitworm at an additional cost of $17 per acre, and 1,400 suffer 10% yield loss instead of mating disruption for acreage treated for borers acreage. This is based on current chlorpyrifos use patterns against borers and will understate the costs if the problem continues to grow. This estimate is sensitive to the assumptions about yield loss and the share of treated acreage that will suffer those yield losses. These are a source of substantial uncertainty; higher affected acreage or greater yield loss could increase the losses substantially.

Cotton

Chlorpyrifos use on cotton nationally is relatively low – the national average for 2010 to 2014 was about five percent of all acres treated with foliar applications and about one percent treated with seed treatments (Kynetec 2016; years, 2010 - 2014). An average of one application per year was made during those years. There is considerable year to year variation in chlorpyrifos use, likely reflecting fluctuating levels of many insect pests. Use, as measured by percent of the crop treated, is higher in California, at 28% (Kynetec 2016; years, 2010 - 2014).

Chlorpyrifos foliar use in cotton most often targets the cotton aphid, silverleaf whitefly, and stinkbugs (various species). Stinkbugs refers to several species of this type of insect and the importance of one or other individual species varies across the country. Widely distributed members of this complex include the green stinkbug, the brown stinkbug, and the southern green stinkbug. All had historically been relatively minor pests until cotton genetically modified to control insects became widespread (Stevenson and Matcoha 2005, Hebert *et al.* 2009), which reduced application of insecticides targeting other pests. Stinkbugs damage plants by attacking developing cotton bolls directly (UGA 2019).

The cotton aphid and the silverleaf whitefly not only reduce yield by their feeding activity, but also reduce the quality of harvested cotton lint by leaving sticky honeydew on it. Honeydew is the sugary excretion these insects produce from the plant sap they feed on (UC IPM 2015e, MSU 2015). Sticky or discolored lint can result in entire fields' harvests becoming unsaleable not only in the pest-heavy year but in subsequent years, because cotton mills refuse to buy from that area again (UC IPM 2015).

Seed treatments appear to target thrips, although soil pests are often difficult to identify and growers may use seed treatments because they are observed to improve stand establishment, not because of a specific pest problem. Neonicotinoid seed treatments are the most common method for thrips control. At-plant applications of imidacloprid and acephate are also possible control strategies. Aldicarb has not been available for use in cotton in recent years. However, it is registered on cotton, so it may be available for use again in the future.

Based on the available pesticide usage data and extension guidance for pest management, EPA expects that a neonicotinoid seed treatment would be used in place of a chlorpyrifos seed treatment. Dicrotophos or acephate (both organophosphates), in combination with bifenthrin (a synthetic pyrethroid) could substitute for chlorpyrifos for the control of stinkbugs. Likely alternatives for the cotton aphid are imidacloprid, thiamethoxam, or acetamiprid, and for whiteflies, they might include either acetamiprid or pyriproxyfen.

Table 2.4-8. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Cotton.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternative ($/acre)	Difference in Cost ($/acre)
Cotton, seed treatment	$2	Thrips	Thiamethoxam	$6	$4
			Imidacloprid	$9	$7
			Clothianidin	$11	$9
			Acephate	$2	<$1
Cotton, foliar	$5	Cotton Aphid	Acetamiprid	$11	$6
			Flonicamid	$11	$6
			Imidacloprid	$5	$0
			Thiamethoxam	$6	$1
		Silverleaf Whitefly	Acetamiprid	$11	$6
			Pyriproxyfen	$15	$10
		Stinkbug	Dicrotophos [1]	$4	($1)
			Acephate	$3	($2)
			Bifenthrin	$4	($1)
			Imidacloprid	$5	$0
			Novaluron	$8	$3

Source: Kynetec, 2016; years 2010-2014. Numbers may not add due to rounding.
Footnote:
1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos. An application of chlorpyrifos is assumed to target a single pest, given the sporadic nature of use.

The alternative scenarios depend on the application method and pests; the pests targeted by foliar applications generally appear sporadic in nature and will not frequently occur simultaneously. However, since whiteflies and aphids have been emphasized as particularly damaging to both yield and quality of the harvest (UC IPM 2015), there may be situations where simultaneous control of both pests using two alternative insecticides are needed, at least in California.

For seed treatments, acephate could be used at no increase in costs. Neonicotinoids are more likely, implying an increase in insecticide cost of $4 to $9 per acre. Average gross revenue is about $668 per acre (Appendix A), implying impacts of 0% up to 1.3% of gross revenue per acre. About 482,000 acres of cotton are planted with chlorpyrifos-treated seeds (Kynetec 2016; years, 2010-2014), which implies from $0 to as much as $4.3 million in benefits for chlorpyrifos.

One foliar application of chlorpyrifos ($5/acre) could be replaced with one application of imidacloprid or thiamethoxam at approximately the same cost to control cotton aphid or with acetamiprid ($11/acre). Acetamiprid could also be used to control silverleaf whitefly. One application of dicrotophos and bifenthrin to control stinkbugs would cost about $8/acre in total. Thus, alternative control scenarios for foliar applications cost about the same to $6/acre more than chlorpyrifos. Costs could be up to $19/acre for control of stinkbug with whitefly or aphid together assuming use of acetamiprid; the combination would be about $14/acre more than chlorpyrifos. Average gross revenue is about $668 per acre (Appendix A), implying impacts from 0% up to 2.1% of gross revenue per acre. On average, 126,000 acres of cotton are treated with a foliar application of chlorpyrifos. Total benefit estimates range from almost nothing to as much as $1.8 million per year for replacing foliar chlorpyrifos applications.

Cranberry

Chlorpyrifos is used in cranberry to control lepidopteran (caterpillar) pests and cranberry weevil (Humfeld 2016). Public comments from the cranberry industry indicate that diazinon is an alternative to chlorpyrifos for control of both pests. Chlorantraniliprole is an alternative to control only lepidopteran pests, and cranberry weevil can be controlled with thiamethoxam. According to the industry information, chlorpyrifos treatments in cranberry control both pests with an average cost of $22 per acre, while diazinon treatments cost $36 per acre. Chlorantraniliprole treatments cost $51 per acre (Humfeld, 2016). Industry information did not identify the cost of thiamethoxam, and cranberry is not surveyed in the available market research data. Therefore, EPA estimated the cost of thiamethoxam use by taking the average cost of thiamethoxam used in all available crops in Washington and Wisconsin, the two biggest cranberry producing states (Kynetec 2016, years 2010-2014). The estimated cost of a treatment of thiamethoxam is $6 per acre.

The information on pests, alternatives, and costs is summarized in Table 2.4-9. Currently the cost of control with chlorpyrifos is $22/acre, which provides control of both lepidopterans and cranberry weevil. The alternatives scenario consists of replacing one application of chlorpyrifos with one application of chlorantraniliprole ($51/acre) to control lepidopterans and one application of thiamethoxam ($6) per acre to control cranberry weevil. The scenario is about $35/acre more expensive than chlorpyrifos. If targeting a single pest, the difference in cost between a chlorpyrifos treatment and an alternative treatment for one of the pests will be no more than $29/acre and could be as little as $14/acre with diazinon. Gross revenue averages $7,864 per acre (Appendix A), implying impacts of under 0.5% of gross revenue. According to the Census of Agriculture, there are 40,000 acres of cranberry grown in the United States (USDA 2014); the Cranberry Institute says that 31% of acres are treated with chlorpyrifos, which means about 12,400 acres would be affected. At an additional cost of $14 - $35 per acre, the estimated total benefit to the cranberry industry from chlorpyrifos is $174,000 - $434,000 annually.

Table 2.4-9. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Cranberry.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternative	Cost of Alternative ($/acre)	Difference in Cost ($/acre)

Cranberry	$22	Cutworms	Chlorantraniliprole [1]	$51	$29
			Diazinon	$36	$14
		Cranberry weevil	Thiamethoxam [1]	$6	($16)
			Diazinon	$36	$14

Sources: Cranberry Institute, 2016; Kynetec 2016; years, 2010-2014. Numbers may not add due to rounding.
Footnote:
1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos.

Grapefruit

In terms of pest management importance, chlorpyrifos is most likely important for control of citrus mealybug in grapefruit. University of Florida extension recommendations (Diepenbrock *et al.* 2019a) indicate that these pests are often controlled by natural enemies. However, when populations get exceedingly large, chlorpyrifos is the most efficacious material, and treatment is warranted "only in cases of severe infestations" (Diepenbrock *et al.* 2019a, b). Mealybugs are difficult to control on citrus due to feeding in concealed locations, such as crevices between foliage and fruit, that are difficult to cover with insecticides applied with airblast sprayers. Spraying is recommended immediately prior to spring flush or periods of peak egg-hatch after the flush (UF, 2012). Given the limited efficacy of alternatives, yield losses could occur under heavy outbreak situations without the use of chlorpyrifos.

While chlorpyrifos usage is reported on grapefruit for control of citrus leafminer and rust mites, it accounts for a minor proportion of all pesticide applications against these pests, with other market leaders surpassing chlorpyrifos in importance. For applications against adult Asian citrus psyllid (mainly in Florida), there are numerous alternatives and growers are currently making use of any and all insecticides at their disposal to contain outbreaks of this pest, which vectors the critical Huanglongbing disease in citrus. Use of chlorpyrifos against red scale is also reported.

EPA's projected upper bound cost scenario consists of one application of chlorpyrifos ($19/acre) per season being replaced by one application of zeta-cypermethrin ($4/acre) to control Asian citrus psyllid; one application of abamectin ($13/acre) to control citrus rust mite/mites; and one application of spirotetramat ($46/acre) to control citrus mealybug. In total, the alternatives would cost about $63/acre, which is about $44/acre more than one application of chlorpyrifos (Table 2.4-10). Lower cost scenarios would occur if only a single pest was to be targeted. For the psyllid, diflubenzuron ($31/acre) or spinetoram ($28/acre) might be used at additional insecticide cost of $9-$12/acre. Alternatives for citrus rust mites or citrus mealybug are $12-$16/acre more expensive than chlorpyrifos. Average gross revenue is about $3,731 per acre, implying impacts of about 1.2% of gross revenue per acre at the upper bound. On average, about 22,400 acres of grapefruit are treated annually with chlorpyrifos (Kynetec 2016; years, 2010-2014). Estimated total benefit for chlorpyrifos ranges from $202,000 to $987,000 per year. As discussed above, in the absence of chlorpyrifos, yield and/or quality losses could occur under heavy outbreaks of citrus mealybug.

Table 2.4-10. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Grapefruit.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternatives ($/acre)	Difference in Cost ($/acre)
Grapefruit	$19	Asian Citrus Psyllid	Zeta-cypermethrin [1]	$4	($15)
			Imidacloprid	$17	($2)
			Abamectin	$13	($6)
			Petroleum Oil	$16	($3)
			Thiamethoxam	$13	($6)
			Diflubenzuron	$31	$12
			Spinetoram	$46	$27
		Citrus Rust Mite/ Mites	Sulfur	$12	($7)
			Abamectin [1]	$13	($6)
			Petroleum Oil	$16	($3)
			Spirodiclofen	$32	$13
			Diflubenzuron	$31	$12
		Citrus Mealybug	Spirotetramat [1]	$46	$27
			Petroleum Oil	$16	($3)
			Imidacloprid	$17	($2)

Source: Kynetec, 2016; years 2010-2014. Numbers may not add due to rounding.
Footnote:
1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos.

Grapes

In all grapes, the available pesticide usage data indicate that chlorpyrifos was applied once per year on average (Kynetec 2016; years 2010-2014). In table grapes, an average of 41% of the crop was treated; area treated in wine and raisin grapes was much lower (4% and 6%, respectively).

The major pests targeted by chlorpyrifos in table, wine, and raisin grape production are the vine mealybug and the grape mealybug (Kynetec 2016; years 2010-2014). These insects contaminate grape clusters by excreting sticky honeydew that allows black sooty mold, a secondary contaminant, to develop. In addition, these insects can transmit viruses (i.e., grapevine leafroll-associated viruses) that stunt plant growth and reduce yields (UC IPM 2019). Table grapes are particularly vulnerable to mealybug damage because cluster contamination results in buyer rejection. Therefore, treatment for mealybugs in table grapes is recommended at a much lower threshold (about half the mealybug infestation in samples) as compared to wine and raisin grapes.

Table 2.4-11 shows the primary target pests for chlorpyrifos in grapes, as well as likely alternatives and the difference in cost between the alternatives and chlorpyrifos. The alternatives identified for both grape and vine mealybugs are generally more expensive than chlorpyrifos. For vine mealybug, buprofezin or spirotetramat along with a subsequent application of clothianidin are the alternatives likely to be used because of the high degree of control that is probably needed. For grape mealybug, buprofezin or spirotetramat, plus imidacloprid would be the likely option of choice to replace chlorpyrifos. Grape growers would experience an increased cost in chemical control for vine and grape mealybugs as a result of switching to this method and are likely to face some economic losses.

Table 2.4-11. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Table Grapes.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternative ($/acre)	Difference in Cost ($/acre)
Grapes (raisin)	$18	Mealybug	Imidacloprid [1]	$10	($8)
			Spirotetramat [1]	$48	$30
Grapes (table)	$18	Vine Mealybug	Buprofezin	$25	$7
			Clothianidin [1]	$14	($3)
			Spirotetramat [1]	$54	$36
		Grape Mealybug	Imidacloprid [1]	$26	$7
			Spirotetramat [1]	$54	$36
			Buprofezin	$25	$7
Grapes (wine)	$23	Vine Mealybug	Imidacloprid [1]	$14	($9)
			Buprofezin	$27	$4
			Spirotetramat [1]	$50	$27
		Grape Mealybug	Spinosyn	$36	$13
			Imidacloprid [1]	$14	($9)
			Spirotetramat [1]	$50	$27

Source: Kynetec, 2016; years 2010-2014. Numbers may not add due to rounding.
Footnote:
[1] Chemicals used to estimate the cost of control in the absence of chlorpyrifos.

For raisin grapes, the alternative is to apply spirotetramat, which costs about $30/acre more than chlorpyrifos. Average gross revenue is about $3,942/acre (USDA, 2010 – 2014), implying per-acre impacts of less than one percent of gross revenue. About 11,000 acres of raisin grapes are treated with chlorpyrifos annually (Kynetec 2016; years 2010-2014). The estimate of total benefits from chlorpyrifos are $331,000 per year.

The alternatives scenario for table grapes consists of one application of chlorpyrifos ($18/acre) per season being replaced by one application each of spirotetramat ($54/acre) and clothianidin ($14/acre) to control vine mealybug; and one application each of spirotetramat ($54/acre) and imidacloprid ($26/acre) to control grape mealybug. The baseline scenario of using chlorpyrifos is $18/acre and the cost of the alternative scenario is $148/acre. Therefore, the alternative scenario is about $130/acre more expensive than chlorpyrifos (the difference may not be exact due to rounding). This could overestimate the cost of an alternative control regime because a single application of buprofezin or spirotetramat could potentially control both vine and grape mealybugs with an increase in control cost of $7 to $36 per acre. Average gross revenue is about $11,435 per acre, implying impacts of about 1.1% of gross revenue per acre using the upper bound estimate of per-acre costs. On average, chlorpyrifos is used on 41,800 acres of table grape (Kynetec 2016; years 2010-2014) implying total benefits of $293,000 to $5.4 million annually.

The alternatives scenario for wine grape consists of one application of chlorpyrifos ($23/acre) per season being replaced by one application each of imidacloprid ($14/acre) and spirotetramat ($50/acre) to control vine mealybug and one application each of imidacloprid ($14/acre) and spirotetramat ($36/acre) to control grape mealybug. The baseline scenario of using chlorpyrifos is $23/acre and the cost of the alternative scenario is $114/acre. Therefore, the alternative scenario is about $91/acre more expensive than chlorpyrifos (the difference may not be exact due to rounding). This may overestimate the cost of an alternative control regime if both the vine and grape mealybug can be controlled simultaneously, as is assumed with a single application of chlorpyrifos, with a single application of spirotetramat. Increased costs in the absence of chlorpyrifos could be as low as $4/acre with use of buprofezin to control vine mealybug alone. Average gross revenue is about $4,876/acre (Appendix A), implying impacts of about 1.9% of gross revenue per acre with an increase of $91/acre in control costs. The total benefit of chlorpyrifos is estimated to be between $90,000 and $2.1 million per year, given an average of 22,600 acres of wine grapes treated annually with chlorpyrifos (Kynetec 2016; years 2010-2014).

Hazelnuts

Chlorpyrifos use on hazelnuts (also called filberts) is limited to three applications per year, including dormant/delayed dormant sprays and in-season foliar sprays. Usage data, however, indicates that only about two percent of hazelnut acres are treated more than once. While a large share of chlorpyrifos usage is targeted against the leafroller complex, filbert worms, and filbert aphids, numerous alternatives are available (Wiman and Bell 2020, Pscheidt *et al.* 2015). Imidacloprid, spirotetramat, acetamiprid, and cyfluthrin are all alternatives used for aphids (Table 2.4-12). Diflubenzuron, emamectin, *Bacillus thuringiensis* (*Bt*), methoxyfenozide and spinetoram are recommended alternatives for leafrollers (Wiman and Bell 2020, Pscheidt *et al.* 2015). There is very little reported use of methoxyfenozide, and there is no use of the other alternatives (Kynetec 2016, years 2010-2014). The alternative scenario used is based on alternatives shown to target leafrollers in usage data (Kynetec, 2016; years 2010 -2014).

The alternatives scenario consists of replacing an application of chlorpyrifos ($11/acre) with an application of esfenvalerate ($9/acre) or other synthetic pyrethroid, and an application of imidacloprid ($5/acre) for season-long control of the filbert aphid, leafrollers, and filbert worms. The total cost of the alternative regime is $14/acre, or $3/acre more than using chlorpyrifos alone. Impacts could be negligible, particularly for growers that face a single pest. Gross revenue for hazelnuts averages $3,224/acre (Appendix A), implying impacts per acre well below one percent of gross revenue. On average, about 3,300 acres of hazelnut are treated with chlorpyrifos (Kynetec 2016; years 2010-2014). Total benefits to hazelnut growers could be up to $10,000 per year.

Table 2.4-12. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Hazelnuts.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternatives ($/acre)	Difference in Cost ($/acre)
Hazelnuts	$11	Filbert Aphid	Esfenvalerate [1]	$9	($2)
			Cyfluthrin	$4	($7)
			Imidacloprid [1]	$5	($6)
		Leafrollers Complex	Esfenvalerate [1]	$9	($2)
			Cyfluthrin	$4	($7)
			Imidacloprid [1]	$5	($6)
		Filbert Worm	Esfenvalerate [1]	$9	($2)
			Cyfluthrin	$4	($7)
			Imidacloprid [1]	$5	($6)

Source: Kynetec, 2016; years 2010-2014. Numbers may not add due to rounding.

[1] Chemicals used to estimate the cost of control in the absence of chlorpyrifos.

Lemons

Chlorpyrifos is used in lemons to control several scale species, citrus bud mite and citrus mealybug. In some parts of Southern California, the soft scale species, citricola scale is controlled naturally (called biocontrol) by parasitic wasps (parasitoids) and is thus rarely a pest. However, in the Central Valley biocontrol is not effective, necessitating broad-spectrum insecticide usage. Petroleum oil can reduce populations as a stand-alone tactic but will not control large outbreaks. UC recommendations state that applications of chlorpyrifos at high rates can control populations for two to three years (UC IPM, 2015b). Alternatives such as neonicotinoids and buprofezin have moderate efficacy but can only control populations for one year. Because citricola scale is mostly susceptible to broad spectrum OP and carbamate applications, outbreaks are therefore most likely to occur in groves that have stopped using such tactics – *i.e.*, it is possible that the impact of this pest will grow over time if chlorpyrifos is removed from the system. In addition to the alternatives listed, UC IPM also recommends acetamiprid for applications in the fall following applications of other neonicotinoids in the spring via soil drench applications (UC IPM, 2015b).

For two armored scale species, California red Scale and yellow Scale, biocontrol is a viable option. UC IPM (2015c) recommends that growers should release rates of 5,000-10,000 parasitoid wasps per acre. Some areas of the state do not see outbreaks due to biocontrol. Applications of chlorpyrifos are timed to correspond with trap captures of the crawler lifestage, and efficacy is very good. Unlike citricola scale, it does not appear that OPs and carbamates confer multiple year suppression, so for comparison with alternatives, it might make more sense to consider one for one substitution of applications. In addition to the listed alternatives in the usage data, UC IPM also recommends buprofezin and carbaryl; each of these would be a one for one substitution with chlorpyrifos. However, if applications are already being made to target citricola scale, it is unlikely that additive applications would be made to also target other scale species.

The citrus bud mite has historically been a pest mainly of coastal-grown lemons but has recently been found on interior regions as well (UC IPM 2019b). Feeding damage distorts developing flower buds which can lead to lower yields and/or reduced fruit quality. While usage data indicate that chlorpyrifos has been used to an appreciable extent to manage this pest, recent extension guidelines from the University of California do not mention this insecticide as an option recommended for use in an IPM program targeting this mite pest. Several alternatives are recommended instead, often mixed with horticultural (petroleum or narrow-range) oils. These include cyantraniliprole in combination with abamectin, fenbutatin oxide, and spirotetramat (UC IPM 2019b).

University of Florida extension recommendations indicate that citrus mealybugs are often controlled by natural enemies, but that when populations get exceedingly large, chlorpyrifos is the most efficacious material and treatment is warranted 'only in cases of severe infestations' (Diepenbrock *et al.* 2019a, b). Mealybugs are difficult to control due to feeding in concealed locations, such as crevices between foliage and fruit that are difficult to cover with insecticides applied by airblast equipment, which is the typical broadcast treatment method for citrus crops. Spraying is recommended immediately prior to spring flush or during periods of peak egg-hatch after the flush (UF 2012). Given limited efficacy of alternatives (Diepenbrock *et al.* 2019b), this pest warrants consideration for yield loss analysis under heavy outbreak situations.

Table 2.4-13 shows the difference in cost between the alternatives and chlorpyrifos for the target pests. Based upon available information for control of citricola scale, one application of chlorpyrifos applied in a given year is assumed to be effective for three years. Thus, the chlorpyrifos cost of $36/acre is divided by three to obtain the annual cost of $12/acre. The alternatives scenario consists of two applications of buprofezin ($176/acre) to control citricola scale each year, and one application of a tank mix of petroleum oil ($35/acre), abamectin ($20/acre), and spirotetramat ($71/acre) to control citrus bud mite and mealybugs. In total, the alternatives would cost about $302/acre (the total is not exact due to rounding), which is about $290/acre more expensive than chlorpyrifos ($12/acre). Citricola scale accounts for about ten percent of the 15,600 acres treated with chlorpyrifos. Red and yellow scale account for over 40% of chlorpyrifos treated acres and mealybugs around 20 to 25%. Use of spirotetramat in place of chlorpyrifos to target red and yellow scale would add about $36/acre to production costs. If only the other scale (“scale complex") were targeted, cost increases might be as low as $10/acre with the use of thiamethoxam. The average gross revenue of lemon is $8,268, implying an impact of about 4% of gross revenue for citricola scale and less than 0.5% for other pests. The total benefit ranges from $156,000 to $4.5 million, but the upper bound assumes all acres are impacted by citricola scale.

Table 2.4-13. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Lemons.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternatives ($/acre)	Difference in Cost ($/acre)
Lemons	$36	Scale Complex [2]	Petroleum Oil	$35	<$1
			Thiamethoxam [1]	$45	$10
			Dimethoate	$22	($13)
		CA Red/Yellow Scale	Petroleum Oil	$35	<$1
			Spirotetramat [1]	$71	$36
			Pyriproxyfen	$63	<$1
		Citricola Scale	Petroleum Oil	$35	<$1
			Buprofezin [1]	$88	$53
			Acetamiprid	$20	($15)
			Dimethoate	$22	($13)
		Citrus Bud Mite	Petroleum Oil [1]	$35	<$1
			Abamectin [1]	$20	($15)
			Spirotetramat [1]	$71	$36
		Citrus Mealybug	Petroleum Oil [1]	$35	<$1
			Imidacloprid	$33	<$1
			Spirotetramat [1]	$71	$36
			Abamectin [1]	$20	($15)

Source: Kynetec, 2016; years 2010-2014. Numbers may not add due to rounding.
Footnotes:
1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos. Chlorpyrifos is assumed to be used once every three years when used for citricola scale, for an average annual cost of about $12/acre. Buprofezin is expected to be used twice each year to obtain similar control.
2 “Scale complex” does not include red scale and citricola scale

However, as discussed above, using the alternatives might result in yield/quality losses under heavy citrus mealybug outbreak situations, leading to revenue impacts in addition to chemical cost increases.

Mint

Chlorpyrifos is used in mint to control cutworms, mint root borer, and symphylans, according to comments from the Mint Industry Research Council submitted to the chlorpyrifos regulatory docket in 2015 (Salisbury 2015). EPA's earlier Small Business analysis of the petition to revoke chlorpyrifos tolerances (EPA, 2015a) did not include mint. EPA reviewed extension pest management recommendations from states with mint production (e.g., Washington, Oregon, California), and confirmed that the pests mentioned by the mint industry are potentially major problems for the crop. In addition, these recommendations suggested that chlorantraniliprole is an effective alternative for control of two of these pests (cutworms and borers) and that either 1,3-dichloropropene or ethoprop are effective alternatives for symphylan management (UC IPM 2012, Rinehold 2016). Because mint is not surveyed in the market research data that EPA uses to estimate prices, insecticide prices were estimated from national level data on pesticide costs in all crops, averaged from 2010 – 2014 (USDA, 2016b). The cost of chlorpyrifos was estimated at $10 per acre, which may be low for mint if application rates are higher than the national average. Chlorantraniliprole was estimated to cost $29 per acre, for a difference of $19 per acre (Table 2.4-14). If treatment for symphylans is needed, the cost of ethoprop would be about $19 per acre or 1,3-dichloropropene about $166 per acre with a difference in cost of $9 or $156 per acre (Table 2.4-14).

Using information from the USDA on yield and price received for peppermint and spearmint (USDA, 2016b), gross revenue is calculated at $2,080 per acre, implying impacts of 0.9% of gross revenue (Table 2.4-14). According to the Census of Agriculture, there are 92,400 acres of spearmint and peppermint grown in the United States (USDA, 2016b). In the absence of information on the share of the crop treated with chlorpyrifos, we conservatively assume that half to all acreage is treated with chlorpyrifos, and the more expensive alternative chlorantraniliprole would be applied to all the acreage. At an additional cost of $19 per acre for control of cutworms and borers, the estimated total benefits to the mint industry is $876,000 to $1.8 million annually. If the same acreage needed control of symphylans, the estimated total benefits, the additional cost of chlorantraniliprole plus ethoprop is $28, resulting in net benefits for chlorpyrifos of $1.3 to $2.6 million. The actual acreage that needs treatment for symphylans or the other mint pests is unknown.

Table 2.4-14. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Mint.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternative	Cost of Alternative ($/acre)	Difference in Cost ($/acre)
Mint	$10	Cutworms, Mint root borer	Chlorantraniliprole [1]	$29	$19
		Symphylans	Ethoprop	$19	$9
			1,3-dichloropropene	$166	$156

Source: Kynetec, 2016; years 2010-2014; Salisbury 2015. Numbers may not add due to rounding.
Footnote:
1 Chemical used to estimate the cost of control in the absence of chlorpyrifos.

Onions

Chlorpyrifos is applied to onions as a soil application at or before planting to control a complex of maggot species, including onion maggots, seedcorn maggots, *etc.*, which are problematic pests nationally, and of particular importance in the eastern U.S.

Seed treatments with neonicotinoids, spinosad, and cyromazine are available with demonstrated efficacy (Hoepting and Nault, 2012). Neonicotinoid-treated seeds are known to be used and are effective in controlling the soil pest complex, including maggots. Since seed treatments are done before planting, a grower could save the costs of actual application for chlorpyrifos pre-plant applications, *i.e.*, one less trip across the field. In the absence of seed treatments, preliminary indications are that maggot efficacy of chlorpyrifos is superior to alternatives (SEVEW 2019), so a yield loss might occur where neonicotinoid seed treatments are not viable or available. Applications of lambda-cyhalothrin and diazinon can be substituted one-for one with chlorpyrifos, but efficacy against the maggot complex is unclear.

Based upon available information on use, cost, and efficacy, EPA projects that the most likely alternative scenario to the use of chlorpyrifos is a seed treatment that costs from $20 to $75 per acre (Utah State University, Cooperative Extension, 2011). Due to variability in available packages (*i.e.*, some seed treatment systems are only available as a package treatment that also includes fungicides), pricing for this option is difficult to estimate. Using the upper bound of this range to estimate the impact, the alternatives scenario would cost $66/acre more than the current use of chlorpyrifos ($9/acre). Average gross revenue for onions is approximately $6,322 per acre, implying an impact of about 1% of gross revenue per acre. A low-cost estimate would be about $11/acre more for an application of diazinon instead of chlorpyrifos (Table 2.4-15). About 57,800 acres of onion are treated each year with chlorpyrifos, on average (Kynetec 2016; years 2010-2014). Total benefit for chlorpyrifos is estimated to be $636,000 to $3.8 million per year.

Table 2.4-15. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Onions.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternatives ($/acre)	Difference in Cost ($/acre)
Onions	$9	Maggot Complex (onion, seed, etc.)	Lambda-cyhalothrin	$5	($4)
			Diazinon [1]	$20	$11
			Spinetoram	$39	$30

Source: Kynetec, 2016; years 2010-2014. Numbers may not add due to rounding.
Footnote:
[1] Chemicals used to estimate the cost of control in the absence of chlorpyrifos. Data on seed treatment price from Utah State University, Cooperative Extension (2011).

Oranges (California)

The analysis for oranges was done separately for California and Florida due to significant differences in production practices and target pests for chlorpyrifos. California citrus production is driven by the sale of fresh produce, in contrast with Florida which mainly grows oranges for juice. California also has unique pest control challenges with citricola scale and katydids, which are not an issue for Florida growers. These considerations justify analyzing California oranges separately from Florida oranges. In addition, comments received on the tolerance revocation suggest that California growers need to control a complex of ant species frequently; no similar comments were received from Florida growers or crop experts (Grafton-Cardwell 2015, Morse 2015).

In some parts of Southern California, citricola scale is under biocontrol by parasitoids and is rarely a pest. In the Central Valley, however, biocontrol is not effective which necessitates broad-spectrum insecticide usage. Petroleum oil can reduce populations as a stand-alone tactic but will not control large outbreaks. UC recommendations state that applications of chlorpyrifos at high rates can effectively control or "re-set" populations for two to three years (UC IPM, 2015b). Alternatives such as neonicotinoids and buprofezin have moderate efficacy but can only control populations for one season. Each often requires more than one application per year. Because citricola scale is usually controlled with broad spectrum organophosphate and carbamate applications, outbreaks are most likely to occur in groves that have recently stopped using such tactics—i.e., it is possible that the impact of this pest will grow over time if chlorpyrifos is removed from the system. Certain ant species, such as the Argentine ant, tend to and protect phloem-feeding insects, such as citricola scale, in order to feed on the phloem-feeders' sugary honeydew excretions. If ant control is diminished with the use of alternatives, this scale-tending behavior would also contribute to an increase in scale populations and their damage to the crop. However, the cost estimates below are based on controlling pests that are tended by ants, not direct ant control. In addition to the alternatives listed, UC IPM also recommends acetamiprid for applications in the fall following applications of other neonicotinoids in the spring via soil drench applications for citricola scale (UC IPM, 2015b). As a result, an upper bound alternatives scenario could be two to four applications of acetamiprid plus two to four applications of imidacloprid as a soil drench, or two to four applications of buprofezin plus petroleum oil.

For two armored scale species, California red scale and yellow Scale, biocontrol is a viable option. UC IPM (2015c) recommends that growers should release parasitoid wasps at rates of 5,000-10,000 per acre. Some areas of the state do not see outbreaks of these scale species due to biocontrol. In groves where insecticide treatments are required, applications of chlorpyrifos are timed to correspond with trap captures of crawlers (immature scale) and efficacy is very good. Unlike citricola scale, it does not appear that organophosphates and carbamates confer multiple year suppression for California red scale. In addition to the listed alternatives in the usage data, UC IPM (2015c) also recommends buprofezin and carbaryl; each of these would also be a one for one substitution with chlorpyrifos. However, in years where applications are already being made to target citricola scale, it is unlikely that additive applications would be made to also target other scale.

Katydids are a significant pest problem in the absence of broad-spectrum pesticide options. Katydids (e.g., forktailed bush katydid) feed directly on fruit after petal fall, leading to either fruit drop or quality loss from scar tissue formation. Since California is a primarily fresh market producer, such quality losses would be significant. Beyond the listed insecticides in Table 2.4-16, diflubenzuron and naled are additional materials recommended for katydid control and would likely be used as a one for one substitution for chlorpyrifos (UC IPM, 2015d). On average, these chemicals cost just over $20/acre (Kynetec 2016; years 2010-2014).

Table 2.4-16. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, California Oranges.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternative ($/acre)	Difference in Cost ($/acre)
Oranges (CA)	$43	Citricola Scale	Petroleum Oil	$21	($22)
			Pyriproxyfen	$74	$31
			Acetamiprid	$61	$18
			Dimethoate	$14	($29)
			Buprofezin [1]	$93	$50
		CA Red/Yellow Scale	Petroleum Oil	$21	($22)
			Pyriproxyfen	$74	$31
			Spirotetramat	$65	$22
			Imidacloprid	$29	($14)
			Buprofezin [1]	$93	$50
			Acetamiprid	$61	$18
	$17	Katydids	Cyfluthrin	$9	($8)
			Fenpropathrin	$25	$18
			Cryolite [1]	$46	$29
			Chlorantraniliprole	$33	$16
			Dimethoate	$11	($6)

Source: Kynetec, 2016; years 2010-2014.
Footnote:
[1] Chemicals used to estimate the cost of control in the absence of chlorpyrifos. Chlorpyrifos is assumed to be used once every three years against scale, for an average annual cost of about $14/acre. Buprofezin is expected to be used twice each year.

Two applications of chlorpyrifos per year are permitted on California oranges. In practice, about 13% of acres are treated more than once. Based upon available information for control of scale insects, one application of chlorpyrifos applied in a given year is conservatively assumed to be effective for three years. Thus, the chlorpyrifos cost of $43/acre is divided by three to obtain the annual cost of about $14/acre. This might be replaced by two applications of buprofezin annually ($186/acre) for an increase in insecticide costs of $172/acre. For an application of chlorpyrifos to control katydids at about $17/acre, alternatives range in price from $25/acre for fenpropathrin to $46/acre for an application of cryolite, that is, $8 to $29/acre more than chlorpyrifos. An upper bound estimate of cost would be for an acre treated for both scales and katydids for a total increase in insecticide cost of $180 to $201 per acre. Average gross revenue is about $4,278 per acre, implying impacts of less than 0.5% to as much as 4.5% of gross revenue per acre. According to market research data (Kynetec 2016; years 2010-2014), 38,800 acres of oranges are treated, on average. Total benefits, therefore, are estimated to range from $310,000 to about $7.8 million per year.

However, in addition to being more expensive than chlorpyrifos, these alternative chemicals may also be less efficacious, leading to potential yield and/or quality losses for citricola scale.

Oranges, Florida

Florida orange production is driven by the processing (juice) market, in contrast with California, which mainly grows oranges for the fresh market. While chlorpyrifos usage is reported on Florida oranges for control of rust mites, it accounts for a minor proportion of all pesticide applications against these pests, with other market leaders far surpassing chlorpyrifos in importance. For applications against adult Asian citrus psyllids, there are numerous alternatives and growers are making use of any and all insecticides at their disposal to suppress outbreaks of this pest, which vectors the critical Huanglongbing disease in citrus.

EPA's alternative scenario consists of one application of chlorpyrifos ($13/acre) per season being replaced by one application of zeta-cypermethrin ($5/acre) to control Asian citrus psyllid and one application of a tank-mix of petroleum oil ($15/acre) and abamectin ($13/acre) to control citrus rust mites. In total, the alternatives would cost about $33/acre (the total is not exact due to rounding), which would be about $20/acre more expensive than one application of chlorpyrifos (Table 2.4-17). This may be an overestimate of cost because more than one application of chlorpyrifos may be needed to target multiple pests and here EPA assumes only one. A lower bound estimate would be applications of either imidacloprid or thiamethoxam to target either Asian citrus syllid or citrus rust mites for an increase of about $2/acre in insecticide cost relative to chlorpyrifos. Average gross revenue is about $3,352 per acre for Florida oranges, implying impacts of about 0.6% of gross revenue per acre for the more conservative substitution scenario. Given an average of 95,000 acres treated with chlorpyrifos each year (Kynetec 2016; years 2010-2014), total impact is estimated to be between $190,000 and $3.1 million annually.

Table 2.4-17. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Florida Oranges.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternatives ($/acre)	Difference in Cost ($/acre)
Oranges (FL)	$13	Asian Citrus Psyllid	Zeta-cypermethrin [1]	$5	($8)
			Abamectin	$13	<$1
			Petroleum Oil	$15	$2
			Imidacloprid	$15	$2
			Fenpropathrin	$16	$3
		Citrus. Rust Mite/ Mites	Petroleum Oil [1]	$15	$2
			Abamectin [1]	$13	<$1
			Sulfur	$12	($1)
			Spirodiclofen	$26	$13
			Thiamethoxam	$15	$2

Source: Kynetec, 2016; years 2010-2014. Numbers may not add due to rounding.
Footnote:
1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos.

According to USDA reports, from 2010-2014, an average of 24,700 acres of citrus crops (all citrus) were grown in Texas and 16,300 acres of tangelos and tangerines were cultivated in Florida (USDA 2016a). Approximately 22% of the orange crop is treated with chlorpyrifos in both Florida and California; it seems reasonable that a similar percentage of citrus in Texas and similar crops would be treated with chlorpyrifos as well. Thus, EPA estimates that almost 9,000 acres of other citrus are currently treated annually with chlorpyrifos, on average. Assuming per-acre impacts are similar to the Florida orange scenario, total benefits for these other citrus crops in Florida and all citrus in Texas are estimated to range from $18,000 to $296,000 per year.

Peaches/Nectarines

Chlorpyrifos use on peaches and nectarines is limited to one application per year. For airblast applications, only a dormant or delayed dormant season spray can be made to the canopy. For post-bloom (growing season) applications, only trunk and lower scaffold limb applications are permitted, with spray not allowed to contact fruit. Such trunk applications target the peachtree borer and lesser peachtree borer, both of which have similar biology. One application of chlorpyrifos to the trunk and lower limbs at the rate of 3.0 lbs/100 gal (dilute application) typically provides good to excellent season-long control against borers (PSU, 2013). For these pests, the main alternative is likely to be hand-applied mating disruption dispensers.

Pre-bloom dormant or delayed dormant applications to peaches typically target San Jose scale or white peach scale. Similar to apples, pears, and plums, while petroleum oil is listed as an alternative with a high percentage of crop treated for San Jose scale, oil is often not an efficacious stand-alone tactic. IPM recommendations suggest applications of oil with an insecticide during the dormant/delayed dormant period to target susceptible stages. For San Jose scale, growers may attempt to control the ‘crawler’ stage (immature scales) later in the growing season using spirotetramat, pyriproxyfen, or pyrethroids (PSU, 2013). Alternatives for these pests can be substitutes for chlorpyrifos on a one for one basis. A single application of one of these alternative chemicals is expected to have efficacy similar to chlorpyrifos.

Because of differences in the share of acreage treated with chlorpyrifos, Georgia and South Carolina peaches are modeled separately from the rest of the country. Chlorpyrifos use on peaches is limited to one application per year. Therefore, as in apples discussed above, two alternatives scenarios are possible. For states other than Georgia and South Carolina, chlorpyrifos applications targeting scale pests ($13/acre) would be replaced by one application of a tank mix of petroleum oil ($22/acre) and esfenvalerate ($6/acre) to control scale pests for a combined cost of about $28/acre or $15/acre more than using chlorpyrifos. For applications to control borers, one application of chlorpyrifos would be replaced with the use of mating disruption ($40/acre), which would cost about $27 per acre more than chlorpyrifos (Table 2.4-18). At the lower bound, applications of phosmet may be feasible at a cost of $8/acre in additional chemical cost. With average gross revenue per acre of about $5,916 per acre for states other than Georgia and South Carolina, this represents 0.1 to 0.5% of gross revenue per acre. Given that about 13% of peach acreage is treated with chlorpyrifos outside of Georgia and South Carolina, EPA estimates 11,100 acres are treated with leading to a benefit estimate of $88,000 to $297,000 in total.

Table 2.4-18. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Peaches and Nectarines.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternatives ($/acre)	Difference in Cost ($/acre)
Peaches/ Nectarines, GA and SC	$8	Peachtree and lesser peachtree borer	No effective alternatives		
			Mating Disruption [1]	$40	$32
			Petroleum Oil [1]	$15	7
			Phosmet	$20	$12

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternatives ($/acre)	Difference in Cost ($/acre)
		San Jose and white peach scale	Esfenvalerate [1]	$5	($3)
Peaches/ Nectarines, other states	$13	Lesser peachtree borer	Phosmet	$21	$8
			Esfenvalerate	$6	($7)
			Mating Disruption [1]	$40	$27
		San Jose and white peach scale	Petroleum Oil [1]	$22	$9
			Phosmet	$21	$8
			Esfenvalerate [1]	$6	($7)
			Pyriproxyfen	$42	$29
			Acetamiprid	$32	$19

Source: Kynetec 2016; years 2010-2014. Numbers may not add due to rounding.
Footnote:
1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos.

EPA received comments on the proposed tolerance revocation that discussed other pests of peach production in Georgia and South Carolina, specifically the lesser peachtree borer (Horton, 2016). EPA evaluated and verified the commenter's information about the pest and agreed with the conclusion that this pest is substantially more important in these states. Chlorpyrifos is used on a higher percentage of the peach acreage in Georgia and South Carolina, so these two states are considered separately. Information from state experts confirmed that alternatives were not effective, and usage data showed that only chlorpyrifos, not esfenvalerate or phosmet, was being used against this pest in this area. For acreage where lesser peachtree borer is uncontrolled, EPA assumes 10% yield loss for the purposes of cost estimation. Lesser peachtree borer reduces yield and shortens the life of the tree, but EPA has been unable to find reliable quantitative estimates for yield losses and shortened tree lifetime in peaches.

Based on information available for Michigan cherry (see the tart cherry section above), we model the yield loss at 10% for the affected acreage. The 10% loss estimate may be on the low end, as over time borers could colonize a larger percentage of the trees in an infested orchard. Gross revenue from peaches in Georgia and South Carolina averaged $4,178 from 2010 – 2014, so 10% yield loss would be about $418 per acre. An average of 17,900 acres were treated with chlorpyrifos in Georgia and South Carolina peaches for 2010 – 2014 (Kynetec, 2016). As a low-end estimate, we include treatments of petroleum oil ($15 per acre) and esfenvalerate ($5 per acre) to replace one treatment of chlorpyrifos at an increase $12 per acre for the control of scale pests. For the high-end estimate, we assume the same replacement at $12 per acre plus $418 per acre in lost revenue. For Georgia and South Carolina, the total benefit is from $215,100 to $7.8 million. This estimate is sensitive to the assumptions about yield loss and the share of treated acreage that will suffer those yield losses, and these are a source of substantial uncertainty. However, because most of the use of chlorpyrifos in these states seems to be targeting borer pests, the total benefit is likely to be in the higher end of this range.

Peanuts

Chlorpyrifos use in peanuts targets soil-dwelling insects: wireworms, rootworms, and borers (Kynetec 2016; years 2010-2014). The lesser cornstalk borer and the southern rootworms feed directly on the pegs and pods of the peanut plants (USDA, 2003b). Wireworms feed directly on the roots of transplanted peanuts and the seeds (USDA, 2003b). Based on the available data, over the last five years, chlorpyrifos was the most used chemical to control borers and rootworms (Kynetec 2016; years 2010-2014). However, the insecticides used for wireworm control have been more variable. In 2009, aldicarb was the most used chemical to control wireworms, but no use of aldicarb is reported after 2010, because manufacturing ceased. While production of aldicarb has resumed recently, wireworms are not on the current label as target pests in peanut. Phorate was the major chemical used for wireworms in 2010, but use has declined since, perhaps because it can no longer be used at pegging. In 2011 and 2012, chlorpyrifos was the major insecticide for wireworms.

In peanuts, on average chlorpyrifos is applied once per season (Kynetec 2016; years 2010-2014). Table 2.4-19 shows the primary target pests for chlorpyrifos in peanuts, as well as potential alternatives and the difference in cost between the alternatives and chlorpyrifos. For the primary pests targeted by chlorpyrifos, EPA considers phorate and chlorantraniliprole as alternatives, based on market research data (Kynetec 2016; years 2010 – 2014). Of the two, phorate (an organophosphate) is less expensive. Chlorantraniliprole (a member of the relatively new diamide class of insecticides) only controls borers, while phorate controls all three, but is less effective against borers. Chlorpyrifos users would most likely replace one application of chlorpyrifos with one application of phorate to control the pests targeted with chlorpyrifos. The cost of phorate or chlorantraniliprole is lower than chlorpyrifos, but we are assuming that growers will use both chemicals to replace chlorpyrifos. The earlier EPA analysis (EPA 2015) modeled a treatment of diflubenzuron instead of chlorantraniliprole, but information received in public comments lead to revision of the analysis. Cost estimates for chlorantraniliprole are based on only one year of usage data.

Table 2.4-19. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Peanuts.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternative ($/acre)	Difference in Cost ($/acre)
Peanuts	$21	Borers	Phorate	$14	($7)
			Chlorantraniliprole[1]	$17	($4)
		Rootworms	Phorate[1]	$14	($7)
		Wireworms	Phorate[1]	$14	($7)

Source: Kynetec 2016; years 2010-2014. Numbers may not add due to rounding.
Footnote:
1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos.

The alternatives scenario consists of replacing one application of chlorpyrifos ($21/acre) with an application of chlorantraniliprole ($17/acre) to control borers and an application of phorate ($14/acre) to control rootworms and wireworms. The total cost of the alternative regime is $10/acre more than the cost of chlorpyrifos. Gross revenue in peanut is $1,007 per acre, so the additional cost of chlorpyrifos alternatives is about 1% of gross revenue. EPA estimates that an average 114,000 acres of peanuts are treated from 2010 - 2014, implying total benefits of $1.1 million per year. However, as discussed above, using phorate in place of chlorpyrifos might result in yield loss if there is poor control of borers, leading to higher impacts.

Pears

Chlorpyrifos use on pears is limited to one application per year, made as a dormant/delayed dormant application. While applications against pear psylla are most common in terms of acres treated with chlorpyrifos (Kynetec 2016; years 2010-2014), chlorpyrifos plays a very small role relative to other active ingredients to control of this wide-spread pest. For San Jose scale, dormant/delayed dormant applications of chlorpyrifos with oil would target susceptible stages in the early season. While petroleum oil is listed as an alternative for San Jose scale, oil is often not an efficacious stand-alone tactic but is usually mixed with other insecticides, including chlorpyrifos (Murray and DeFrancesco 2014). When early season failures result, pear growers may attempt to control the crawler stage (immature scales) later in the growing season using spirotetramat, pyriproxyfen, buprofezin, and diazinon (Murray and DeFrancesco 2014).

Table 2.4-20 shows the primary target pest for chlorpyrifos in pears, San Jose and other scales, as well as potential alternatives and the difference in cost between the alternatives and chlorpyrifos. The alternative scenario for scale control consists of one application of a tank mix of petroleum oil ($14/acre) and pyriproxyfen ($40/acre). The baseline scenario of using chlorpyrifos is $17/acre and the cost of the alternative scenario is $54/acre. Therefore, the alternative scenario is about $37/acre more expensive than chlorpyrifos (difference may not be exact due to rounding). As chlorpyrifos may also be mixed with oil, the cost increase may only be the additional $23/acre incurred from switching to pyriproxyfen. Compared to chlorpyrifos alone, a combination of oil and lambda-cyhalothrin represents an increase in cost of $5/acre. Average gross revenue is about $8,060 per acre for pears (Appendix A), implying impacts of less than 0.5% of gross revenue per acre. EPA estimates that about 12% of pear acreage is treated with chlorpyrifos annually (Kynetec 2016; years 2010-2014) or about 6,000 acres. Thus, the benefits of chlorpyrifos is estimated to range from $30,000 to $223,000 per year.

Table 2.4-20. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Pears.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternative ($/acre)	Difference in Cost ($/acre)
Pears	$17	San Jose Scale/Scale Complex	Petroleum Oil [1]	$14	($3)
			Pyriproxyfen [1]	$40	$23
			Lambda-cyhalothrin	$8	($9)
			Spirotetramat	$44	$27

Source: Kynetec 2016; years 2010-2014. Numbers may not add due to rounding.
Footnote:
1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos.

Pecans

Chlorpyrifos use in pecans primarily targets the pecan nut casebearer (Kynetec 2016; years 2010-2014). The casebearer is a major pest of pecan nuts throughout the pecan growing regions (USDA, 2002). One larva will consume all the nuts in a cluster (USDA, 2003c). Since 2009, growers have chosen chlorpyrifos over other chemicals, in terms of acres treated, followed by methoxyfenozide. Other pests for which chlorpyrifos has been selected include a complex of aphids (Kynetec 2016; years 2010-2014). Aphids can be a problem, especially the black pecan aphid, which possesses a toxin that induces leaf loss, usually impacting the crop the following year (USDA, 2001). Pecan phylloxera are also targeted with chlorpyrifos, particularly in Georgia (James 2015).

Chlorpyrifos is applied as a foliar treatment to control pecan nut casebearer. Most applications in the past three years have been at application rates of 0.75 to 1 pounds (lb) of active ingredient (ai) per acre. However, the range of application rates extends up to 3.75 to 4 lbs ai/acre. An average of 1.75 chlorpyrifos applications are made per acre (Kynetec, 2016, years 2010 – 2014).

Proper timing of any effective insecticide at the first-generation larvae of pecan nut casebearer will usually prevent subsequent applications (Knutson and Ree, 2015; Mulder and Grantham, undated). Methoxyfenozide, an insect growth regulator, is effective against pecan nut casebearer larvae. Imidacloprid is the primary insecticide used to control aphids in pecans (Kynetec, 2016; years 2010-2014). Chlorpyrifos may be part of a resistance management program for aphids (USDA, 2001). The most common alternative to chlorpyrifos is imidacloprid (Kynetec 2016; years 2010 -2014).

Table 2.4-20 shows the primary target pests for chlorpyrifos in pecan production, as well as the potential alternatives and the difference in cost between the alternatives and chlorpyrifos. The alternatives scenario consists of one application of chlorpyrifos ($8/acre) being replaced by one application of methoxyfenozide ($10/acre) to control pecan nut casebearer and one application of imidacloprid ($9/acre) to control aphids and pecan phylloxera. The total cost of the alternative scenario is $19/acre, about $11/acre more expensive than chlorpyrifos (difference may not be exact due to rounding). However, if only one pest is targeted, the increase in insecticide cost may be only $1 to $2 per acre. Average gross revenue is about $1,127 per acre (Appendix A), implying impacts of less than 1% of gross revenue per acre. Annually, an average of 115,000 pecan acres are treated with chlorpyrifos. Per-acre costs range from $1 to $11, implying total benefits of $115,000 to $1.3 million per year.

Table 2.4-20. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Pecans

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Alternatives ($/acre)	Difference in Cost ($/acre)
Pecans	$8	Pecan Nut Casebearer	Methoxyfenozide [1]	$10	$2
		Aphids and Pecan Phylloxera	Imidacloprid [1]	$9	$1

Source: Kynetec 2016; years 2010-2014, James (2015). Numbers may not add due to rounding.
Footnote:
1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos.

Plums/Prunes

Chlorpyrifos use in plums and prunes is targeted for the control of San Jose scale. For San Jose scale, dormant/delayed dormant applications of chlorpyrifos with oil would target susceptible stages in the early season. While petroleum oil is listed as an alternative in Table 2.4-21, oil is often not an efficacious stand-alone tactic. For growers missing this early season control window, applications against crawlers later in the season would be made using a number of alternatives to chlorpyrifos.

Table 2.4-21. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Plums/Prunes

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternative ($/acre)	Difference in Cost ($/acre)
Plums/ Prunes	$16	San Jose Scale/Scale Complex	Petroleum Oil [1]	$17	$1
			Esfenvalerate [1]	$6	($10)
			Pyriproxyfen	$45	$29
			Spirotetramat	$49	$33

Source: Kynetec, 2016; years 2010-2014. Numbers may not add due to rounding.
Footnote:
1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos.

Table 2.4-21 shows the potential alternatives and the difference in cost between the alternatives and chlorpyrifos. Alternatives can be substituted on a one-for-one basis with chlorpyrifos. Both chlorpyrifos and its alternatives could be tank-mixed with oil for a dormant application, and efficacy would be comparable (UC IPM, 2009b). EPA's lower bound alternative, however, assumes that chlorpyrifos ($16/acre) is applied alone and would be replaced by a tank mix of petroleum oil ($17/acre) and esfenvalerate ($6/acre). The baseline scenario of using chlorpyrifos is $16/acre and the cost of the alternative scenario is $23/acre. Therefore, the alternative scenario is about $7/acre more expensive than chlorpyrifos (difference may not be exact due to rounding). An upper bound of per-acre costs would be for growers to switch to spirotetramat, at an increase in insecticide cost of $33/acre. Average gross revenue is about $3,646 per acre for plums/prunes (Appendix A), implying impacts of 0.2% to 0.9% of gross revenue per acre. Chlorpyrifos use is relatively low in plums and prunes; approximately 2,900 acres are treated annually. Total benefits for chlorpyrifos is estimated to range from $20,000 to $96,000 per year.

Sorghum (milo)

The analysis for sorghum was updated more recently than other crops, using usage data from 2014-2018. Sugarcane aphids are the primary target of chlorpyrifos applications in sorghum (Kynetec 2019; years 2014-2018). This species recently became a major problem in sorghum (EPA, 2015b), particularly in southern grain sorghum production areas. Sugarcane aphids insert their piercing-sucking mouthparts into leaves to remove plant sap. Their excrement is in the form of sticky honeydew. Black sooty mold forms on the honeydew, which potentially reduces photosynthetic efficiency. Severe sugarcane aphid infestations prior to flowering or during grain development can reduce yield (Bowling et al, 2016). Harvesting efficiency can also be affected because sticky honeydew that settles on foliage and grain heads causes material to build up in the separator of a combine (see reference in Bowling et al, 2016).

Chlorpyrifos is used early in the season due to a relatively long pre-harvest interval. During 2016, two new products were first registered in sorghum that contained the active ingredients sulfoxaflor and flupyradifurone (Sorghum Checkoff 2016). If these are used in place of chlorpyrifos, there is an additional cost of $3-4 per acre (Table 2.3.22).

Table 2.4-22. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Sorghum

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternative ($/acre)	Difference in Cost ($/acre)
Sorghum	$4	Sugarcane Aphid/Other Aphids	Sulfoxaflor[1]	$7	$3
			Flupyradifurone	$11	$7

Source: Kynetec, 2016; years 2014-2018. Numbers may not add due to rounding.
Footnote:
1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos.

Table 2.4-22 above shows the potential alternatives and the difference in cost between the alternatives and chlorpyrifos. Alternatives can be substituted on a one-for-one basis with chlorpyrifos. The cost of the baseline scenario using chlorpyrifos is $4/acre and the cost of the alternative scenario is $7/acre. Therefore, the alternative scenario is about $3/acre more expensive than chlorpyrifos (difference may not be exact due to rounding). An upper bound of per-acre costs would be for growers to switch to flupyradifurone, at an increase in insecticide cost of $7acre. Average gross revenue is about $245 per acre for grain sorghum (Appendix A), implying impacts of 1.2% to 2.9% of gross revenue per acre. Chlorpyrifos use averages about 108,000 acres are treated annually. Total benefits for chlorpyrifos is estimated to range from $324,000 to $756,000 per year.

Soybeans

Chlorpyrifos labels allow for multiple applications per year in this crop, including pre-plant soil and post-emergence foliar applications. On average, however, chlorpyrifos is applied once per year to soybeans; only about three percent of acres are treated twice (Kynetec 2016; years 2010-2014). Nationally, the average application rate is 0.36 lb ai/acre. The major pests targeted by chlorpyrifos in soybean production are shown in Table 2.4-23.

Soybean aphid is the leading target pest for chlorpyrifos applications to soybeans, by acres treated (Kynetec 2016; years 2010-2014). This invasive insect from Asia is a sap feeding pest that occurs sporadically over much of the United States, requiring applications of one or more foliar insecticides. Likely alternatives for this pest would be foliar applications of lambda-cyhalothrin, thiamethoxam, or imidacloprid. Thiamethoxam and imidacloprid have systemic activity, while lambda-cyhalothrin has broad-spectrum knockdown activity. Spider mites and bean leaf beetles are also targeted by applications of chlorpyrifos, with similar efficacy observed among the same alternatives listed for soybean aphid: lambda-cyhalothrin, thiamethoxam, and imidacloprid (Kynetec 2016; years 2010-2014). The most likely substitution scenarios for soybean growers in the absence of chlorpyrifos would be to apply any of these available alternatives, with substitution on a one-for-one basis with chlorpyrifos.

Table 2.4-23. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Soybeans

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternative	Cost of Alternative ($/acre)	Difference in Cost ($/acre)
Soybeans	$3	Soybean Aphid	Lambda-cyhalothrin	$4	$1
			Thiamethoxam [1]	$7	$4
			Imidacloprid	$8	$5
		Bean Leaf Beetle	Lambda-cyhalothrin	$4	$1
			Thiamethoxam [1]	$7	$4
			Imidacloprid	$8	$5
		Spider Mite	Lambda-cyhalothrin	$4	$1
			Thiamethoxam [1]	$7	$4
			Imidacloprid	$8	$5

Source: Kynetec, 2016; years 2010-2014. Numbers may not add due to rounding.
Footnote:
1 Chemical used to estimate the cost of control in the absence of chlorpyrifos. One application of thiamethoxam is expected to control either or both the soybean aphid and the bean leaf beetle.

EPA's alternatives scenario consists of one application of chlorpyrifos ($3/acre) per season being replaced by one application of thiamethoxam ($7/acre) to control soybean aphid and bean leaf beetle. The baseline scenario of using chlorpyrifos is $3/acre and the cost of the alternative scenario is $7/acre. Therefore, the alternative scenario is about $4/acre more expensive than chlorpyrifos (difference may not be exact due to rounding). However, costs could be as low as $1/acre with the use of lambda-cyhalothrin. Average gross revenue is about $526 per acre, implying impacts of about 0.2% to 0.8% of gross revenue per acre. EPA estimates that almost 3.1 million acres of soybean are treated annually with chlorpyrifos, so the total benefit ranges from $3.1 million to $12.2 million.

Strawberries

Chlorpyrifos use in strawberries targets a complex of lepidopteran larvae, including cutworms and various armyworms (Kynetec 2016; years 2010-2014). Early in the season, these pests will eat foliage and even the crown of young plants. Later in the season, these larvae feed directly on the berries (Mossler, 2012; UC IPM, 2014c). Chlorpyrifos is used early in the season, as there is a 21-day pre-harvest interval.

EPA received comments on pests specific to strawberry production in Oregon, specifically the soil pest, garden symphylan (Unger, 2016). Earlier usage data confirm that symphylans are the main pest targeted with chlorpyrifos in Oregon (Kynetec 2016; years 2010-2014), although usage data are no longer collected for Oregon strawberries. Furthermore, it appears that chlorpyrifos is the only pesticide used to control garden symphylans in this crop. Extension descriptions confirm that symphylans can sometimes be significant pests of newly planted strawberries and other crops in western Oregon (Jesse and Dreves 2020).

For the lepidopteran larvae, methoxyfenozide (an insect growth regulator) is the most likely alternative to chlorpyrifos but would not have any impact on other pests that might be present, such as the strawberry bud weevil. *Bacillus thuringiensis* (*Bt*) is a biopesticide with a very short pre-harvest interval (PHI). It is used multiple times during the harvest season, especially in organic production, but also in conventional strawberry production. Therefore, *Bt* may be applied to strawberries that have had chlorpyrifos applied earlier in the season. *Bt* is effective on only young lepidopteran larvae. As a conservative estimate, without chlorpyrifos, there may be three to five additional applications of *Bt*. There may be other pesticides needed for control of pests other than lepidopterans.

Table 2.4-24 shows the primary target pest for chlorpyrifos in strawberry as well as potential alternatives and the difference in cost between the alternatives and chlorpyrifos. For the primary pests targeted by chlorpyrifos, *Bt* and methoxyfenozide are the alternatives, as both control a variety of lepidopteran larvae. The reported cost for *Bt* represents five applications because multiple *Bt* applications that would be needed to replace one application of chlorpyrifos in strawberry. A single application of methoxyfenozide could replace one application of chlorpyrifos in strawberry to control lepidopteran larvae.

Table 2.4-24. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Strawberry.

Crop	Cost of Chlorpyrifos ($/Acre)	Target Pest	Alternatives to Chlorpyrifos	Cost of Alternatives	Difference in Cost ($/acre)
Strawberry, Other than Oregon	$10	Lepidopteran Larvae ("Worms")	*Bt* [1]	$75 ($15.50 up to 5x)	$65
			Methoxyfenozide [1]	$20	$10
			Spinetoram	$48	$38
			Chlorantraniliprole	$27	$17
Strawberry, Oregon	$12	Garden Symphylan	No Effective Alternatives		
		Weevil Complex	Carbaryl	$18	$6

Source: Kynetec 2016; years 2010-2014. Numbers may not add due to rounding.
Footnote:
[1] Chemicals used to estimate the cost of control in the absence of chlorpyrifos. *Bt* cost reflects multiple applications to achieve similar control.

The alternatives scenario consists of either five applications of *Bt* or one application of methoxyfenozide (states other than Oregon). The cost for one application of chlorpyrifos is $10 per acre. The cost for five applications of *Bt* to replace one application of chlorpyrifos is approximately $75 per acre while a single methoxyfenozide application is about $20 per acre. Therefore, the estimated alternative scenarios cost about $10 to $65 per acre more than chlorpyrifos. Average gross revenue is about $42,821 per acre (Appendix A), implying impacts of less than 0.1% of gross revenue per acre. On average, about 10,500 acres of strawberry are treated with chlorpyrifos outside Oregon. Total benefits for strawberry would cost growers in areas outside Oregon between $105,000 and $686,000 per year.

In Oregon, growers using chlorpyrifos to target multiple species of weevils might use carbaryl as an alternative. The average cost for chlorpyrifos is $12/acre while carbaryl averages $18/acre, an increase of $6/acre in chemical cost. Strawberry crown moth is another pest for which chlorpyrifos is recommended, but usage data show more use of carbaryl against this pest in Oregon (Kynetec 2016; years 2010 – 2014). Nearly all chlorpyrifos use, however, targets symphylans, for which there are no effective alternatives. Because there are no effective alternatives (Unger, 2016), yield loss estimates are 100% in the fields infested with symphylans without effective control. USDA yield and price data were used to calculate gross revenue per acre of $7,813 per acre in Oregon strawberry (USDA, 2016c). The affected acreage that is treated with chlorpyrifos averages 600 acres, annually, but 545 acres of chlorpyrifos acres are targeting symphylans annually (Kynetec 2016; years 2010 - 2014). The total incremental cost estimate for Oregon strawberry ranges from a low of $3,600, which assumes all acres are only targeting weevils, to about $4.3 million. Given the high proportion of acreage treated for garden symphylan, the cost is likely near the upper bound. This cost to Oregon growers is in addition to the cost estimated in the previous paragraph to growers outside of Oregon accounts for all affected strawberry acreage nationally. The total benefit in strawberry is estimated to be $109,000 to $5.0 million annually.

Sugarbeets

The analysis for sugarbeets was updated more recently than other crops, using usage data from 2014-2018. Nationally, chlorpyrifos use in sugarbeets primarily targets sugarbeet root maggot and leafminers (Kynetec 2016; years 2014-2018). Applications targeting root maggots are likely to be made at planting, while applications targeting leafminers would be foliar sprays or post crop emergence. Published extension recommendations (Hollingsworth 2019) indicate that there are several foliar insecticides that can control leafminer outbreaks, such as zeta-cypermethrin, azadirachtin, clothianidin, thiamethoxam, and spinosad, so substitution for alternatives with chlorpyrifos would be one-for-one to control that pest. For maggots, neonicotinoid seed treatments are registered, used widely, and known to be effective. For a seed treatment scenario, there would also be a potentially saving in the cost of applying chlorpyrifos (*i.e.*, no equipment and fuel costs for a separate at-planting application). For the other alternatives applied to soil, substitution would be one-for-one with chlorpyrifos.

Particularly important problems with sugarbeet root maggot were identified by industry experts in a few counties in the Minnesota counties of Clay, Kittson, Marshall, Norman, Polk and Wilkin, and the North Dakota counties of Grand Fork, Pembina, Traill and Walsh (Kahn, 2016). Experts estimate that without adequate control, infestation of sugarbeet root maggot in these areas can lead to yield losses of 45% (Boetel, 2016).

Outside Minnesota and North Dakota, an alternative scenario in the absence of chlorpyrifos consists of one application of a clothianidin seed treatment ($22/acre) at-planting to control sugarbeet root maggot and one foliar application of zeta-cypermethrin ($4/acre) to control leafminers, replacing two applications of chlorpyrifos ($6/acre each) (Table 2.4-25). The baseline scenario of using chlorpyrifos is $12/acre and the cost of the alternative scenario is $26/acre. Therefore, the alternative scenario is about $14/acre more expensive than chlorpyrifos. Per-acre cost would be similar for a single pest, with a clothianidin seed treatment costing $10 more than a single treatment of chlorpyrifos (Table 2.4-25). Average gross revenue from 2014 - 2018 outside of Minnesota and North Dakota is about $1,440 per acre (Appendix A), implying impacts of 0.9% of gross revenue per acre. On average, 140,000 acres are treated with chlorpyrifos in states other than Minnesota and North Dakota, implying total benefits of $1.8 million per year.

Table 2.4-25. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Sugarbeets.

Crop	Cost of Chlorpyrifos ($/Acre)	Target Pest	Alternatives to Chlorpyrifos	Cost of Alternatives	Difference in Cost ($/acre)
Sugarbeets, other states	$6	Leafminer	Zeta-cypermethrin [1]	$4	($2)
			Cyfluthrin (ST)	$4	($2)
			Clothianidin (ST)	$22	$16
		Sugarbeet Root Maggot	Clothianidin (ST) [1]	$22	$16
			Cyfluthrin (ST)	$4	($2)
			Terbufos	$17	$11
			Zeta-cypermethrin	$3	($3)
Sugarbeets, MN	$6	Cutworm	Clothianidin (ST)	$22	$16
			Cyfluthrin (ST)	$4	($2)
			Terbufos[1]	$17	$11
			Zeta-cypermethrin	$4	($2)
		Sugarbeet Root Maggot	Clothianidin (ST)	$22	$16
			Cyfluthrin (ST)	$4	($2)
			Terbufos	$17	$11
			Zeta-cypermethrin	$3	($3)
			No effective alternatives in heavily infested areas[1]	45% yield loss	
Sugarbeets, ND	$6	Sugarbeet Root Maggot	Clothianidin (ST)	$22	$16
			Cyfluthrin (ST)	$4	($2)
			Terbufos	$17	$11
			Zeta-cypermethrin	$3	($3)
			No effective alternatives in heavily infested areas[1]	45% yield loss	

Source: Kynetec 2016; years 2014-2018. Numbers may not add due to rounding. ST denotes a seed treatment. Kynetec no longer tracks the cost of seed treatments, so the seed treatment cost data are based on use from 2010 – 2014.
Footnote:
1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos.

In Minnesota and North Dakota, sugarbeet root maggot is the primary pest, and cutworm appears to be a target of chloropyrifos in MN. Alternatives to chlorpyrifos for maggot and cutworm control would be clothianidin seed treatments, costing $16 per acre more than chlorpyrifos, or a soil application of terbufos, costing about $11 acre more than chlorpyrifos (Table 2.4-25). To target adults of the root maggots, growers in heavily affected counties might use a foliar application of a pyrethroid, but instead we model yield losses of 45% from poor control, based on Boetel (2016). Gross revenues are calculated from USDA yield and revenue data, and average about $1,100 per acre in both states from 2014-2018 (USDA 2020), so yield losses are estimated at $498 per acre in North Dakota and Minnesota. The total estimated incremental costs from chlorpyrifos tolerances, given an average of 61,200 affected acres in Minnesota and North Dakota, is $900,000 to $30.5 million per year. However, acres in the counties identified as severely affected by root maggot account for less than 20% of chlorpyrifos-treated acres in Minnesota and about 10% of chlorpyrifos-treated acres in North Dakota (Kynetec 2016; years 2014-2018), so total annual costs are likely to be about $5.1 million annually. These costs are in addition to the costs in other states estimated in the previous paragraph. The total benefit of chlorpyrifos for all sugarbeet is estimated to be $2.6 to $32.2 million per year. However, the benefit is likely closer to $6.8 million when considering the limited extent of severe sugarbeet root maggot problems that would remain uncontrolled without chlorpyrifos.

Sunflowers

Chlorpyrifos use in sunflower targets a mix of lepidopteran larvae, or caterpillars (Kynetec 2016; years 2010-2014). There are several moth pests in the sunflower growing regions. Cutworms live in the soil and reduce the establishment of the stand (USDA, 1999b). Chlorpyrifos has been used as a soil treatment at plant for these soil pests, but in more recent years, neonicotinoid seed treatments are more likely to be used to control cutworms. Other moths that feed on foliage or sunflower heads are treated with foliar applications.

Table 2.4-26 shows the primary target pest for chlorpyrifos in sunflower as well as the potential alternatives and the difference in cost between the alternatives and chlorpyrifos. For the primary foliar pests targeted by chlorpyrifos, lambda-cyhalothrin and esfenvalerate, among other synthetic pyrethroids, are the alternatives used to control lepidopteran larvae. Costs are essentially the same but the synthetic pyrethroids are used more than chlorpyrifos in terms of acres treated.

Table 2.4-26. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Sunflower.

Crop	Cost of Chlorpyrifos ($/Acre)	Target Pest	Alternatives to Chlorpyrifos	Cost of Alternatives	Difference in Cost ($/acre)
Sunflower	$4	Lepidopteran Larvae	Lambda-cyhalothrin	$4	<$1
			Esfenvalerate [1]	$4	<$1

Source: Kynetec, 2016; years 2010-2014. Numbers may not add due to rounding.
Footnote:
[1] Chemicals used to estimate the cost of control in the absence of chlorpyrifos.

The alternatives scenario consists of one application of chlorpyrifos ($4/acre) being replaced with one application of esfenvalerate ($4/acre) to control lepidopteran larvae. The alternatives scenario costs approximately the same as, or about $1/acre more than, chlorpyrifos. Average gross revenue is about $352 per acre (Appendix A), implying impacts of less than 0.1% of gross revenue per acre. EPA estimates that about 123,000 acres of sunflower are treated annually with chlorpyrifos, which signifies a total benefit nationally of less than $123,000 per year.

Sweet Corn

Chlorpyrifos is used to control several sweet corn pests, primarily soil pests that include corn rootworms, seedcorn maggot, garden symphylan, and wireworms but also foliar pests such as cutworms and armyworms (Kynetec 2016; years 2010-2014). Most chlorpyrifos usage targets soil pests with pre-plant or at-planting applications to soil. Some small amount of usage are foliar applications, which could also control adult rootworms (beetles) during the growing season. About 10% of the treated area is treated more than once (Kynetec 2016; years 2010-2014).

Chlorpyrifos is also registered as a seed treatment use on sweet corn. Because seed treatment usage data were not available for sweet corn, the percent of the crop treated is underestimated and thus the benefits of chlorpyrifos may also be underestimated.

Garden symphylan is mainly a regional concern in the Pacific Northwest, particularly Oregon. While this pest accounts for a small amount of chlorpyrifos usage nationally, the data suggest that this is a significant pest targeted by chlorpyrifos applications in Oregon, again via soil applications at planting.

Substitution with other at-plant soil-applied materials would be one-for-one with chlorpyrifos. Besides other broad-spectrum insecticide applications, seed treatments with neonicotinoid insecticides provide control of the soil pest complex, though control of rootworm is highly rate-dependent. Usage of neonicotinoid seed treatments could potentially save the additional cost of an at-plant application. However, if growers are making soil applications, it is likely that they would substitute a soil application of bifenthrin, tefluthrin (except in California), or terbufos for chlorpyrifos (Table 2.4-27). For foliar pests, replacement of chlorpyrifos with a foliar alternative like methomyl or a synthetic pyrethroid would be likely. Neonicotinoid seed treatments are available as a possible replacement for chlorpyrifos-treated seed for sweet corn, but EPA does not have data on their use or any cost differences as compared to chlorpyrifos treatments.

Table 2.4-27. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Sweet Corn.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternatives ($/acre)	Difference in Cost ($/acre)
Sweet Corn	$15 (soil application)	Rootworm	Bifenthrin	$12	($3)
			Lambda-cyhalothrin	$5	($7)
			Tefluthrin [1]	$16	$1
		Seed Maggot/ Wireworm	Bifenthrin	$12	($3)
			Phorate	$15	<$1
			Tefluthrin [1]	$16	$1
		Garden Symphylan	Bifenthrin	$12	($3)
			Terbufos	$17	$2
			Chlorethoxyfos	$15	(<$1)
			Tefluthrin [1]	$16	$1
	$8 (foliar application)	Armyworm/ Cutworm	Methomyl [1]	$10	$2
			Lambda-cyhalothrin	$5	($3)
			Zeta-cypermethrin	$5	($3)

Source: Kynetec 2016; years 2010-2014. Numbers may not add due to rounding.
Footnote:
1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos. One application of tefluthrin is expected to control all soil pests. However, this insecticide is not registered in California.

EPA's projected alternatives scenario consists of replacing one soil application of chlorpyrifos ($15/acre) with one application of tefluthrin ($16/acre) to control corn rootworms, garden symphylan, seedcorn maggot, and wireworms. Replacing one foliar application of chlorpyrifos ($8) would entail one foliar application of methomyl ($10/acre) to control cutworms and/or armyworms. In total, the chlorpyrifos regime would cost $23/acre per year while the alternative strategy of tefluthrin and methomyl would cost about $26/acre per year. This implies an increase in pest control costs of about $3/acre per year. For any single application, increases in cost may range from $1 to $2/acre. Gross revenue in sweet corn, considering both fresh and processing, averages $1,890/acre. The increase in cost represents about 0.2% of gross revenue. An average of 54,300 acres of sweet corn are treated with chlorpyrifos each year. Total benefits are estimated to range from $54,000 to $163,000 annually. Tefluthrin is not registered in California, so growers there would need to use another alternative. As the other alternatives are less expensive, the national estimates are overestimates for California. There may be somewhat different impacts for growers replacing seed treatments, but they are unlikely to be significant. In field corn, neonicotinoid seed treatments are less expensive and much more widely used that chlorpyrifos, so they may be a viable alternative in sweet corn.

Tobacco

Chlorpyrifos use in tobacco is to control cutworm caterpillars and wireworms (beetle larvae), both soil insect pests (Kynetec, 2016; years 2010-2014). These insect pests occur more often when tobacco follows sod, tobacco, or corn (USDA, 2008). These insects are considered minor or occasional pests in most tobacco growing regions (USDA, 1999c). In past years, chlorpyrifos and acephate have been used as a soil treatment prior to transplant to control these pests. More recently, fumigations and ethoprop, applied for nematode control, also controls wireworms (USDA, 1999c; USDA, 2008). Newer chemicals, such as imidacloprid, that target major lepidopteran (caterpillar) pests will also control cutworms.

Currently one application of chlorpyrifos ($11/acre) is used to control cutworms and wireworms in tobacco. The alternatives scenario consists of replacing one application of chlorpyrifos with one application of imidacloprid ($15/acre) to control cutworms and/or wireworms. The scenario is about $4/acre more expensive than chlorpyrifos. Gross revenue averages $4,247 per acre (Appendix A), implying impacts of less than 0.1% of gross revenue. On average, about 37,300 acres of tobacco are treated annually with chlorpyrifos. The total benefit of chlorpyrifos tolerance is estimated to be $149,000 per year.

Table 2.4-28. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Tobacco.

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternative	Cost of Alternative ($/acre)	Difference in Cost ($/acre)
Tobacco	$11	Cutworms and Wireworms	Acephate	$7	($4)
			Imidacloprid [1]	$15	$4

Source: Kynetec 2016; years 2010-2014. Numbers may not add due to rounding.
Footnote:
1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos.

Walnuts

Chlorpyrifos use on walnuts is limited to two applications per year, including dormant/delayed dormant sprays and in-season foliar sprays. On average, about half the acreage treated with chlorpyrifos is treated once per year, and the other half is treated twice per year Chlorpyrifos is applied once on about half of the treated acreage, while the other half is treated twice per year (Kynetec 2016; years 2010-2014). Most chlorpyrifos usage, in terms of acres treated, is for walnut husk fly and/or codling moth. There are numerous effective alternatives available for both pests (Kynetec 2016; years 2010-2014). For walnut husk fly, a bait-based attract-and-kill strategy is recommended with a number of effective insecticide components mixed with a fly attractant (UC IPM, 2013a). For codling moth, early and mid-season foliar chlorpyrifos applications are made to target egg hatch, but several alternatives are available for effective control of this pest (UC IPM, 2013b). For navel orangeworm, another chlorpyrifos-target pest, cultural control tactics are recommended as a primary management strategy in walnuts, with insecticidal treatments mostly considered for applications targeting the third flight of adult moths (UC IPM, 2011a).

Table 2.4-29 shows the primary target pests for chlorpyrifos in walnuts as well as potential alternatives and the difference in cost between the two. EPA projects that one application of bifenthrin with bait ($16/acre) would replace one application of chlorpyrifos with bait ($19/acre) for control of walnut husk fly. A second application of bifenthrin would also replace one separate application of chlorpyrifos for control of codling moth at some point in the season. Since bifenthrin is less expensive than chlorpyrifos, no impact is projected, but EPA cannot explain why growers do not already follow this program. Given that usage data (Kynetec, 2016 years 2010 – 2014) indicates an overall preference by growers for chlorpyrifos over similarly priced or even less expensive pyrethroid and neonicotinoid alternatives, uncertainty remains as to whether efficacy or other IPM considerations may drive other potential benefits of chlorpyrifos usage on walnuts. More reasonable alternatives for walnut husk fly might be malathion ($2/acre more than chlorpyrifos – lower bound impact) or acetamiprid or spinosad at $18/acre more than chlorpyrifos. Methoxyfenozide ($6/acre more than chlorpyrifos) or chlorantraniliprole ($18/acre more than chlorpyrifos) could replace chlorpyrifos for control of codling moth or navel orangeworm. At the upper bound, one application each of acetamiprid and chlorantraniliprole could replace two chlorpyrifos applications for $36/acre increase in insecticide cost. Average gross revenue is about $5,591 per acre (Appendix A). EPA estimates that 124,000 acres of walnut are treated annually; the total benefit of chlorpyrifos for walnuts is estimated to range from $248,000 to $4.5 million per year.

Table 2.4-29. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Walnuts

Crop	Cost of Chlorpyrifos ($/acre)	Target Pest	Alternatives	Cost of Alternatives ($/acre)	Difference in Cost ($/acre)
Walnuts	$19	Walnut Husk Fly	Bifenthrin	$16	($3)
			Acetamiprid	$37	$18
			Esfenvalerate	$9	($11)
			Spinosyn	$37	$18
			Imidacloprid	$8	($11)
			Malathion[1]	$21	$2
			Spinetoram	$38	$19
		Codling Moth	Bifenthrin [1]	$16	($3)
			Chlorantraniliprole	$37	$18
			Esfenvalerate	$8	($11)
			Lambda-cyhalothrin	$6	($13)
			Acetamiprid	$37	$18
			Methoxyfenozide	$25	$6
			Imidacloprid	$8	($11)
			Spinetoram	$38	$19
		Navel Orangeworm	Chlorantraniliprole	$37	$18
			Bifenthrin	$16	($3)
			Permethrin	$6	($13)

Source: Kynetec 2016; years 2010-2014. Numbers may not add due to rounding. *Footnote*:

1 Chemicals used to estimate the cost of control in the absence of chlorpyrifos. Two applications of chlorpyrifos are permitted and bifenthrin could be used for either.

Other Crops
Chlorpyrifos is also registered on sites for which use is relatively small in terms of acres treated compared to acres grown. A low proportion of treated acres frequently indicates that cost-effective alternatives are available and/or that targeted pests are not particularly damaging. Table 2.4-30 presents information on the pests targeted by chlorpyrifos and some potential alternatives in order to estimate benefits for chlorpyrifos on these crops.

Table 2.4-30. Chlorpyrifos Target Pests, Alternatives, and Chemical Costs, Various Sites

Crop	Target Pest	Control method	Cost ($/acre)	Difference in Cost Between Control Method and Chlorpyrifos ($/acre)
Apricot	Borers	Chlorpyrifos	$7	
		Esfenvalerate	$5	($2)
		Methoxyfenozide	$21	$14
Beans, succulent	Symphylans, Maggots	Chlorpyrifos	$9	
		Ethoprop	$38	$29
		Bifenthrin	$3	($6)
Beans, dry	Red Spider Mite, Wireworms	Chlorpyrifos	$5	
		Malathion	$5	($<1)
		Zeta-cypermethrin	$2	($3)
		Ethoprop	$24	$19
Corn, field	Corn Rootworm	Chlorpyrifos	$9	
		Tefluthrin	$17	$8
		Tebupirimphos*	$15	$6
		Bifenthrin	$7	($2)
Peas, succulent	Maggots	Chlorpyrifos	$10	
		Esfenvalerate	$5	($5)
		Bifenthrin	$3	($7)
		Neonicotinoid Seed Treatment	$20-$75	$10-$65
Peppers	Aphids and Thrips	Chlorpyrifos	$8	
		Imidacloprid	$18	$10
		Spinetoram	$38	$30
Tomato	Caterpillars	Chlorpyrifos	$10	
		Methoxyfenozide	$17	$7
Wheat, Spring	Aphids	Chlorpyrifos	$3	
		Lambda-Cyhalothrin	$3	<$1
		Cyfluthrin	$3	(<$1)
		Thiamethoxam	$4	$1
		Imidacloprid	$2	($1)
Wheat, Winter	Aphids and Mites	Chlorpyrifos	$4	
		Imidacloprid	$4	(<$1)
		Thiamethoxam	$4	<$1

Source: Kynetec 2016; years 2010-2014. Numbers may not add due to rounding.
*Another common name for this active ingredient is phostebupirim; not available in California.

The benefits of chlorpyrifos in apricot are probably similar to other stone fruit, especially plums and prunes since most commercial production is in California. Insecticide costs in plums and prunes are expected to range between $7 and $33/acre more than with use of chlorpyrifos (Table

2.4-23). Borers are the primary chlorpyrifos target in apricot, but it is not a primary method of control (Kynetec 2016; years 2010-2014). Synthetic pyrethroids, such as esfenvalerate, tend to be less expensive than chlorpyrifos; methoxyfenozide is about $14/acre more expensive. EPA estimates that about 100 acres of apricot are treated each year, implying total benefits of $1,000 to $3,000 annually, using the range in cost estimated for plums and prunes.

Soil-dwelling pests are targeted by chlorpyrifos in green and other succulent beans (Kynetec 2016; years 2010-2014). Some of these pests, for example symphylans, are reported to be particularly problematic in other vegetables or in crops like strawberry. Symphylans appear to be a rare problem in beans, however; less than two percent of the crop is treated with chlorpyrifos. Alternatives may be expensive; ethoprop costs $29/acre more than a chlorpyrifos treatment. On average, about 4,700 acres of beans are treated annually, implying total benefits of chlorpyrifos in beans of $137,000 per year.

In dry beans, chlorpyrifos targets red spider mite and wireworms (Kynetec 2016; years 2010 – 2014). For both pests, there are multiple alternatives in use that are similar in cost to chlorpyrifos, although growers also use ethoprop to target wireworms at a cost of $19 per acre more than chlorpyrifos. On average, about 6,200 acres of dry beans are treated with chlorpyrifos annually, implying the total benefits of $0 to $118,000 annually.

Chlorpyrifos is mainly used for corn rootworm control in field corn (Kynetec 2016; years 2010-2014). Most of the acres treated with chlorpyrifos are treated at planting, but some are treated later in the season. Rootworm is mainly controlled at planting with plant incorporated protectants (PIPs) or seed treatments, including seed treated with chlorpyrifos. Chlorpyrifos may be used with PIPs, but it is often applied to conventional corn or herbicide-tolerant corn without traits for rootworm control. Due to restrictions on acreage planted to PIPs for resistance management purposes, they are unlikely to provide an alternative for chlorpyrifos. Neonicotinoid seed treatments may provide an option, but they tend to be less expensive, which implies chlorpyrifos is used in situations where neonicotinoids are inappropriate. As shown in Table 2.4-30, tefluthrin and tebupirimphos, as a soil application, are the most likely alternatives and cost $6 to $8 per acre more than chlorpyrifos. Either could also be used to replace a chlorpyrifos application later in the season. On average, 677,000 acres per year of corn are treated with chlorpyrifos. The total benefits for corn is estimated to be $4.1 to $5.4 million annually.

For green peas, the main target pests of chlorpyrifos use are seed maggots (Kynetec 2016; years 2010-2014). Alternative insecticides used in peas for control of seed maggots are synthetic pyrethroids, which are generally cheaper than chlorpyrifos. EPA assumes that chlorpyrifos is chosen in situations when pyrethroids would not provide adequate control. As with onion (Table 2.4-15), neonicotinoid-treated seeds may be a feasible option, implying an increase in control cost of $10 to $65 per acre. This assumes onion seed treatments are a reasonable approximation of seed cost. Maggots may be particularly damaging at crop germination, similar to *Brassica* crops, and control failure could lead to substantial losses. If yield loss is similar to the situation in *Brassica*, i.e., about 48%, impacts could be as high as $370 per acre. Less than 500 acres of green peas are treated annually, so total benefit to producers of green peas might range from $4,000 to $166,000 per year.

Chlorpyrifos is primarily used to control aphids and thrips in peppers (Kynetec 2016; years 2010-2014). As shown in Table 2.4-30, alternatives such as imidacloprid and spinetoram cost, on average, \$10 to \$30 per acre more than does chlorpyrifos. Given an average of about 500 acres of peppers treated each year with chlorpyrifos, estimates of the total benefit to pepper producers range from \$5,000 to \$15,000 per year.

Very little chlorpyrifos is used in tomato production; caterpillars, such as armyworms and cutworms, appear to be the primary target pests. There are numerous alternatives registered, with methoxyfenozide the most commonly used chemical control. As shown in Table 2.4-30, use of methoxyfenozide instead of chlorpyrifos may increase costs to the grower by about \$7/acre. As only about 1,600 acres of tomato are treated with chlorpyrifos per year, on average, the benefits of chlorpyrifos is about \$11,000 annually.

Chlorpyrifos is largely used for aphid control in spring and winter wheat (Kynetec 2016; years 2010-2014). There are several alternatives, particularly neonicotinoid insecticides like imidacloprid and thiamethoxam, that are similar in cost. Per acre, any increase in cost is likely to be under \$1/acre. About 783,000 acres of spring wheat and 549,000 acres of winter wheat are treated annually with chlorpyrifos. Total benefit, therefore, ranges from \$0 to \$783,000 for spring wheat and up to \$549,000 for winter wheat.

There are three sites for which chlorpyrifos is registered, figs, kiwifruit, and pistachio, that are primarily grown in California. California pesticide use reports show that less than 10 fields, covering just over 100 acres of these three crops, were treated with chlorpyrifos in the five years between 2010 and 2014. Similarly, market research data (Kynetec 2016; years 2010 – 2014) show negligible use of chlorpyrifos on celery and garlic (also primarily grown in California) from 2010 to 2014. Given the lack of consistent chlorpyrifos usage, EPA concludes that there is likely no significant benefit to growers of these crops.

Finally, chlorpyrifos is registered as a seed treatment for several vegetable crops, most notably cantaloupe, watermelon, cucumber, pumpkin, and squash. EPA does not have data as to the extent that chlorpyrifos-treated seeds are used and received no public comments regarding usage. In place of chlorpyrifos-treated seeds, growers could use seeds treated with other insecticides or make soil applications at planting. According to Kynetec (2016) years 2010-2014), there are numerous pesticides used for these vegetables at planting, ranging in cost from \$3 to \$36/acre. The most commonly used insecticide, imidacloprid, costs about \$18/acre (Kynetec 2016). These costs would overstate the incremental cost of the chemical replacing chlorpyrifos, since it does not account for the cost of the seed treatment. There may be some increase in application costs if growers switched from seed treatment to a soil application, but since the application would accompany the planting operation, additional labor and machinery costs may be small. EPA has no information regarding the acreage that might be affected.

In addition to these crops, EPA did not estimate costs of control for livestock uses of chlorpyrifos. Most livestock-related active registrations of chlorpyrifos are for treatment of housing and processing premises. The only direct use of chlorpyrifos in U.S. livestock production is for a cattle ear tag to repel and kill flies. The benefits of chlorpyrifos for this use are discussed qualitatively in a separate assessment by BEAD (US EPA, 2020c).

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Appendix A. Grower Revenue

EPA utilized data on area cultivated and value of production from the National Agricultural Statistics Service (NASS) of USDA to calculate average gross revenue per acre. A five-year (2010 – 2014) average is used unless recent price increases indicate substantially higher revenues currently.

Crop	Acres Harvested (Avg. Annual)	Gross Revenue (Avg. Annual)	Gross Revenue (Avg. Annual $ per acre)
ALFALFA (hay)	18,375,000	$10,038,403,600	$546
ALMONDS	822,000	$5,100,158,000	$6,205
APPLES	326,730	$2,892,088,600	$8,852
APRICOTS	11,404	$45,578,800	$3,997
ASPARAGUS	25,680	$86,513,000	$3,369
BEANS/PEAS (Dry)	1,533,180	989,730,200	$646
BEANS (Snap, Bush, Pole, String)	157,464	$249,372,100	$1,584
BROCCOLI[1]	124,920	$878,913,800	$7,036
CABBAGE[1]	57,434	$401,307,200	$6,987
CANOLA	1,400,560	$469,069,600	$335
CAULIFLOWER[1]	40,976	$396,934,600	$9,687
CELERY	28,580	$376,764,000	$13,183
CHERRIES (sweet)	87,378	$786,386,200	$9,000
CHERRIES (tart)	37,070	$74,307,600	$2,005
CORN (grain)	84,655,400	$66,043,095,400	$780
COTTON	9,274,520	$6,192,680,600	$668
CRANBERRIES	39,980	$314,384,800	$7,864
CUCUMBERS (fresh market)	39,980	$191,819,200	$4,877
CUCUMBERS (processing)	39,328	$174,862,000	$2,074
GARLIC	84,324	$255,807,200	$10,514
GRAPEFRUIT	24,330	$270,440,800	$3,731
GRAPES (raisin)	72,480	$792,405,000	$3,942
GRAPES (table)	201,000	$1,200,629,600	$11,435
GRAPES (wine)	105,000	$2,887,594,600	$4,876
HAZELNUTS	592,200	$94,470,000	$3,224
LEMONS	29,300	$454,421,000	$8,268
MINT	54,960	$191,789,600	$2,080
ONIONS	92,160	$919,155,000	$6,322
ORANGES (FL)	434,460	$1,456,223,400	$3,352
ORANGES (CA)	177,444	$759,065,600	$4,278
PEACHES	83,656	$493,190,600	$5,495
PEANUTS	1,261,020	$1,269,374,000	$1,007
PEARS	51,720	$416,869,800	$8,060
PEAS (Fresh/Green/Sweet)	179,700	$138,392,200	$770
PECANS (in shell)	4,938,401	$556,737,800	$1,127

Crop	Acres Harvested (Avg. Annual)	Gross Revenue (Avg. Annual)	Gross Revenue (Avg. Annual $ per acre)
PEPPERS (bell)	45,940	$589,605,400	$12,834
PEPPERS (chile)	20,920	$163,307,000	$7,806
PISTACHIOS	179,200	$1,389,330,000	$7,753
PLUMS / PRUNES	74,800	$272,710,000	$3,646
POTATOES	1,065,580	$3,990,486,000	$3,745
PUMPKINS	49,060	$133,716,800	$2,726
SORGHUM[1]	6,104,000	$1,497,555,800	$245
SOYBEANS	77,074,800	$40,578,872,000	$526
SQUASH	41,306	$218,161,600	$5,282
STRAWBERRIES	58,551	$2,507,214,000	$42,821
SUGARBEETS[1] (Except MN and ND)	498,260	718,550,000	$1,442
SUGARBEETS[1] (MN and ND)	627,400	693,810,400	$1,106
SUNFLOWER	1,629,260	$572,820,200	$352
SWEET CORN (fresh market)	223,326	$734,824,200	$3,290
SWEET CORN (processing)	330,912	$312,695,800	$945
SWEET CORN (combined)	554,238	$1,047,520,000	$1,890
TOBACCO	346,564	$1,471,710,200	$4,247
TOMATOES (fresh market)	100,302	$1,125,381,200	$11,220
TOMATOES (processing)	283,220	$1,093,076,600	$3,859
WALNUTS	272,000	$1,520,686,000	$5,591
WATERMELON	120,988	$488,717,800	$4,039
Wheat (Spring)	13,978,000	$4,377,700,800	$313
Wheat (Winter)	32,631,000	$9,772,478,200	$299

Sources: USDA NASS, 2010 – 2014

[1] USDA NASS, 2014 – 2018

Docket Number EPA-HQ-OPP-2008-0850
www.regulations.gov

Chlorpyrifos

Proposed Interim Registration Review Decision
Case Number 0100

December 2020

Approved by: ____________________________
Elissa Reaves, Ph.D.
Acting Director
Pesticide Re-evaluation Division

Date: 12-03-2020

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I. INTRODUCTION

This document is the Environmental Protection Agency's (the EPA or the agency) Proposed Interim Registration Review Decision (PID) for chlorpyrifos (PC Code 059101, case 0100), and is being issued pursuant to 40 CFR §155.56 and §155.58. A registration review decision is the agency's determination whether a pesticide continues to meet, or does not meet, the standard for registration in the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The agency may issue, when it determines it to be appropriate, an interim registration review decision before completing a registration review. Among other things, the interim registration review decision may determine that new risk mitigation measures are necessary, lay out interim risk mitigation measures, identify data or information required to complete the review, and include schedules for submitting the required data, conducting the new risk assessment and completing the registration review. Additional information on chlorpyrifos, can be found in the EPA's public docket (EPA-HQ-OPP-2008-0850) at www.regulations.gov.

FIFRA, as amended by the Food Quality Protection Act (FQPA) of 1996, mandates the continuous review of existing pesticides. All pesticides distributed or sold in the United States must be registered by the EPA based on scientific data showing that they will not cause unreasonable risks to human health or to the environment when used as directed on product labeling. The registration review program is intended to make sure that, as the ability to assess and reduce risk evolves and as policies and practices change, all registered pesticides continue to meet the statutory standard of no unreasonable adverse effects. Changes in science, public policy, and pesticide use practices will occur over time. Through the registration review program, the agency periodically re-evaluates pesticides to make sure that as these changes occur, products in the marketplace can continue to be used safely. Information on this program is provided at http://www.epa.gov/pesticide-reevaluation. In 2006, the agency implemented the registration review program pursuant to FIFRA § 3(g) and will review each registered pesticide every 15 years to determine whether it continues to meet the FIFRA standard for registration.

The EPA is issuing a PID for chlorpyrifos so that it can (1) move forward with aspects of the registration review that are complete and (2) implement interim risk mitigation (see Appendix A). EPA is currently working with the National Marine Fisheries Service (NMFS) under a reinitiated Endangered Species Act (ESA) consultation, and NMFS plans to issue a revised biological opinion for chlorpyrifos in June 2022. The U.S. Fish and Wildlife Service (FWS) has not yet completed a biological opinion for chlorpyrifos. EPA will complete any necessary consultation with NMFS and FWS for chlorpyrifos prior to completing the chlorpyrifos registration review. See section I. B. and Appendix B for more information. See Appendix C for additional information on the endocrine screening for the chlorpyrifos registration review.

Chlorpyrifos (O,O-diethyl O-(3,5,6-trichloro-2-pyridyl) phosphorothioate) is a broad-spectrum, chlorinated organophosphate insecticide used to control a variety of foliar and soil-borne insects. Pesticide products containing chlorpyrifos are registered for use on many agricultural crops, with the highest uses on corn, soybeans, alfalfa, oranges, wheat, and walnuts in terms of pounds of chlorpyrifos applied per year. Additionally, chlorpyrifos products are registered for use on non-food sites such as ornamental plants in nurseries, golf course turf, as wood treatment, and as an ear tag for cattle. There are also public health uses including aerial and ground-based mosquito adulticide fogger treatments, use as fire ant control in nursery stock grown in USDA-designated quarantine areas, and for some tick species that may transmit diseases such as Lyme disease.

The Reregistration Eligibility Document for chlorpyrifos was issued July 31, 2006.[1] In 1996, the Food Quality Protection Act set a more stringent safety standard to be especially protective of infants and children. After finalizing the chlorpyrifos risk assessments for reregistration, EPA identified the need to modify certain chlorpyrifos uses to meet the revised standard of safety, and to address health and environmental risks from chlorpyrifos exposure. In 1997, the registrant, Dow AgroSciences (now known as Corteva), voluntarily agreed to cancel chlorpyrifos registrations for indoor broadcast use and direct pet treatments, except pet collars. In December 2001, the majority of the remaining chlorpyrifos residential products were subject to voluntary phase out/cancellation. Further changes included label revisions such as buffer zones to ensure environmental and worker safety in 2002. Additional spray drift mitigation and reduced application rates were added in 2012 to be protective of bystanders in sensitive areas including schools and recreational areas. Current chlorpyrifos residential uses are limited to granular ant mound use (commercial applicator only) and roach bait in child-resistant packaging (for homeowner use). Chlorpyrifos can be applied as a seed treatment, by chemigation, airblast, and other ground applications (e.g., groundboom, tractor-drawn spreader), aerial applications, handheld applications (e.g., handwand, handgun, backpack sprayer, rotary spreader), and as an impregnated ear tag for some types of cattle. Products containing chlorpyrifos have almost every type of formulation including wettable powder, emulsifiable concentrate, flowable concentrate, water-soluble packets (WSP), and granules. There are currently four technical registrants. The first product containing chlorpyrifos was registered in 1965 and the Tolerance Reassessment and Risk Management Decision (TRED) was published in 2002. Reregistration was completed with the 2006 update to the Organophosphate Cumulative Risk Assessment.

This document is organized in five sections: the *Introduction*, which includes this summary; *Use and Usage*, which describes how and why chlorpyrifos is used and summarizes data on its use; *Scientific Assessments*, which summarizes the EPA's risk and benefits assessments, updates or revisions to previous risk assessments, and provides broader context with a discussion of risk characterization; the *Proposed Interim Registration Review Decision*, which describes the mitigation measures proposed to address risks of concern and the regulatory rationale for the EPA's PID; and, lastly, the *Next Steps and Timeline* for completion of this registration review.

[1] https://www3.epa.gov/pesticides/chem_search/reg_actions/reregistration/red_PC-059101_1-Jul-06.pdf

A. Summary of Chlorpyrifos Registration Review

Pursuant to 40 CFR § 155.50, the EPA formally initiated registration review for chlorpyrifos with the opening of the registration review docket for the case. The following summary highlights the docket opening and other significant milestones that have occurred thus far during the registration review of chlorpyrifos.

- March 2009 – The *Chlorpyrifos. Human Health Assessment Scoping Document in Support of Registration Review* and *Chlorpyrifos Summary Document* were posted to the docket for a 60-day public comment period.

- May 2009 – The *Preliminary Problem Formulation for the Ecological Risk and Environmental Fate, Endangered Species, and Drinking Water Assessments for Chlorpyrifos* was posted to the docket.

- October 2009 – The *Chlorpyrifos Final Work Plan* (FWP) was issued. The agency received nine comments on the *Chlorpyrifos Summary Document.* The comments received did not change the data and risk assessment needs or schedule for the chlorpyrifos registration review. The agency also published:
    - *Response to Comments on Preliminary Problem Formulation for Ecological Risk and Environmental Fate, Endangered Species and Drinking Water Assessments for Chlorpyrifos*
    - *Chlorpyrifos. Health Effects Division Response to Comments on the Registration Review Preliminary Work Plan*
    - *BEAD Response to Comments on Chlorpyrifos Preliminary Work Plan*

- September 2010 – The *Chlorpyrifos Generic Data Call (GDCI-059101-967)* was issued. There are no studies outstanding from the DCI that are needed to complete the registration review of chlorpyrifos.

- July 6, 2011 – The agency published the *Chlorpyrifos Preliminary Human Health Assessment for Registration Review,* as well as the following supporting materials, to the public docket for a 90-day comment period:
    - *Chlorpyrifos: Occupational and Residential Exposure Assessment*
    - *Revised Chlorpyrifos Acute and Chronic Dietary Exposure and Risk Assessments*
    - *Revised Chlorpyrifos Preliminary Registration Review Drinking Water Assessment*
    - *Chlorpyrifos. Registration Review Action for Chlorpyrifos. Summary of Analytical Chemistry and Residue Data.*
    - *Chlorpyrifos Carcinogenicity: Review of Evidence from the U.S. Agricultural Health Study (AHS) Epidemiologic Evaluations 2003-2009*
    - *Reader's Guide to the Preliminary Human Health Risk Assessment for Chlorpyrifos*
    - *Chlorpyrifos: Tier II Incident Report*

- July 15, 2011 – The agency published the *Revised Chlorpyrifos Preliminary Registration Review Drinking Water Assessment - Appendix D - Typical Use Data for Chlorpyrifos and Spray Drift Mitigation Decision for Chlorpyrifos* and *Occupational and Residential Appendices A* through *H*.

- July 2012 – The agency published *Chlorpyrifos – Evaluation of the Potential Risks from Spray Drift and the Impact of Potential Risk Reduction Measures*, *Spray Drift Mitigation Decision for Chlorpyrifos*, Appendices E, F, and G of the *Evaluation of the Potential Risks from Spray Drift and the Impact of Potential Risk Reduction Measures,* and the *Evaluation of Columbia University Epidemiology Study Claims Related to Brain Abnormalities and Pre-Natal Exposures to Chlorpyrifos.*

- February 2013 – The *Chlorpyrifos Preliminary Evaluation of the Potential Risks from Volatilization* was published for a 30-day public comment period.

- July 2014 – The agency published the *Chlorpyrifos: Reevaluation of the Potential Risks from Volatilization in Consideration of Chlorpyrifos Parent and Oxon Vapor Inhalation Toxicity Studies.*

- December 2014 – The agency published the *Chlorpyrifos: Revised Human Health Risk Assessment for Registration Review* and the following:
  - *Chlorpyrifos: Updated Drinking Water Assessment for Registration Review*
  - *Chlorpyrifos Updated DWA Attachment 12/23/2014*
  - *Chlorpyrifos Acute and Steady State Dietary (Food Only) Exposure Analysis to Support Registration Review*
  - *Chlorpyrifos: Updated Occupational and Residential Exposure Assessment for Registration Review*

- June 2015 – The agency published the *Chlorpyrifos: Quality Assurance Assessment of the Chlorpyrifos Physiologically Based Pharmacokinetic/Pharmacodynamic Model for Human Health Risk Assessment Applications.*

- April 2016 – The *Draft Biological Evaluations for Chlorpyrifos, Diazinon, and Malathion* were published for a 60-day comment period.[2]

- November 2016 – EPA issued the *Chlorpyrifos: Revised Human Health Assessment for Registration Review* along with the *Chlorpyrifos Refined Drinking Water Assessment for Registration Review.*

- January 2017 – The agency announced the availability of the following:
  - *Endangered Species Act Section 7 Formal Consultation Letter for Chlorpyrifos, Diazinon, and Malathion*
  - *Response to Comments on the Draft Biological Evaluations for Chlorpyrifos, Diazinon, and Malathion*

[2] https://www3.epa.gov/pesticides/nas/chlorpyrifos/draft-chlorpyrifos.pdf

  - *Final Biological Evaluations for Chlorpyrifos, Diazinon, and Malathion*[3]

- September 2020 – The agency issued the *Chlorpyrifos: Draft Ecological Risk Assessment for Registration Review* and *Chlorpyrifos: Third Revised Human Health Risk Assessment for Registration Review* in addition to the following:
  - *Updated Chlorpyrifos Refined Drinking Water Assessment for Registration Review*
  - *Evaluating the Impact of Removal of the 10X FQPA Safety Factor on Chlorpyrifos Drinking Water Concentrations*
  - *Usage of chlorpyrifos (PC# 059101) on alfalfa grown for alfalfa hay and seed, cotton, soybeans, sugar beets, spring and winter wheat, Michigan asparagus, Florida and Texas citrus, and Oregon strawberries by hydrologic region (two-digit HUC)*

- December 2020 – The agency is completing the PID for chlorpyrifos, in preparation for publication in the docket for a 60-day public comment period. The agency is also taking comments on the *Chlorpyrifos: Draft Ecological Risk Assessment for Registration Review* and *Chlorpyrifos: Third Revised Human Health Risk Assessment for Registration Review* issued September 21, 2020. In addition, the agency is also issuing:
  - *Benefits of Agricultural Uses of Chlorpyrifos (PC# 059101)*
  - *Chlorpyrifos (PC# 059101) Usage and Benefits Assessment for Non-crop Uses*
  - *Average and maximum application rates and average number of applications of chlorpyrifos (PC# 059101) used in cherries, corn, peaches, pecans, and peppers by hydrologic region (two-digit HUC)*
  - Chlorpyrifos (059101) National and State Summary Use and Usage Summary Matrix

B. Endangered Species Consultation

Chlorpyrifos was one of the first three pilot chemicals that EPA conducted a nationwide ESA consultation. EPA completed a biological evaluation and initiated consultation with the FWS and NMFS in January 2017. [4] Pursuant to a consent decree, at the end of December 2017, NMFS issued its Biological Opinion (BiOp) on chlorpyrifos, diazinon, and malathion.[5] In July 2019, EPA re-initiated formal consultation with NMFS on the December 2017 BiOp.[6] EPA re-initiated consultation because new information on how the pesticides were actually being used may show that the extent of the effects of the actions may be different than what was previously considered. As part of this re-initiation, EPA provided additional usage data it believes may be relevant to the consultation. In its transmittal of this information to NMFS, EPA also referenced usage data and information that had been recently submitted by the registrants of pesticide products containing chlorpyrifos, malathion, and diazinon. After reviewing information EPA provided to NMFS on the 2017 BiOp, NMFS determined that it was appropriate to revise the chlorpyrifos,

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[3] https://www.epa.gov/endangered-species/biological-evaluation-chapters-chlorpyrifos-esa-assessment
[4] https://www.epa.gov/endangered-species/biological-evaluation-chapters-chlorpyrifos-esa-assessment
[5] https://www.fisheries.noaa.gov/resource/document/biological-opinion-pesticides-chlorpyrifos-diazinon-and-malathion
[6] https://www.regulations.gov/document?D=EPA-HQ-OPP-2018-0141-0136

malathion, and diazinon BiOp. NMFS plans to issue a revised final BiOp for chlorpyrifos, diazinon, and malathion by June 2022. FWS has not yet issued a BiOp on chlorpyrifos. EPA plans to address risks to listed species and critical habitats from use of chlorpyrifos as part of the final registration review decision, pending completion of the nationwide consultation process.

C. Other Chlorpyrifos Actions

In September 2007, the Pesticide Action Network North America (PANNA) and Natural Resources Defense Council (NRDC) filed a Petition requesting that the EPA revoke all tolerances for chlorpyrifos under section 408(d) of the Federal Food, Drug and Cosmetic Act (FFDCA) and cancel all chlorpyrifos registrations under FIFRA. Public dockets were opened for the transmittal of public documents pertaining to this petition in EPA-HQ-OPP-2007-1005 and EPA-HQ-OPP-2015-0653.

The registration review of chlorpyrifos and the organophosphates (OPs) has presented EPA with numerous novel scientific issues that the agency has taken to multiple FIFRA Scientific Advisory Panel (SAP) meetings.[7] Many of these complex scientific issues formed the basis of the 2007 petition filed by PANNA and NRDC and EPA therefore decided to address the Petition on a similar timeframe to EPA's registration review schedule.

Throughout the development and revisions to the human health draft risk assessment, and after seeking the expertise of the SAP in 2016, the EPA issued the order to deny the petition in March 2017. The agency concluded that the science addressing neurodevelopmental effects remained unresolved and further evaluation of the science during the remaining time for completion of registration review was warranted. The agency specified it would continue to review the science addressing pre- and postnatal neurodevelopmental effects of chlorpyrifos, and those actions are described in further detail in this PID.

Petitioners and other parties filed objections to directly challenge the denial order. In July 2019, the EPA issued a final order denying objections to EPA's March 2017 order denying PANNA and NRDC's 2007 Petition to revoke all tolerances and cancel all registrations for chlorpyrifos.[8] That 2019 order has been challenged by the Petitioners in the Ninth Circuit, which heard oral arguments in that case in July 2020. *LULAC v. Wheeler*, No. 19-71979 (9th Cir.). To date, the Court had not yet issued a decision on the agency's decision to deny the petition to revoke chlorpyrifos tolerances.

Documents pertaining to the chlorpyrifos Petition to revoke all tolerances and cancel all registrations for chlorpyrifos (docket EPA-HQ-OPP-2007-1005) and chlorpyrifos tolerance rulemaking (docket EPA-HQ-OPP-2015-0653) may be found at www.regulations.gov.[9]

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[7] https://www.epa.gov/sap/fifra-scientific-advisory-panel-meetings
[8] https://www.regulations.gov/document?D=EPA-HQ-OPP-2007-1005-0527
[9] https://www.regulations.gov/docket?D=EPA-HQ-OPP-2007-1005 and https://www.regulations.gov/docket?D=EPA-HQ-OPP-2015-0653, respectively

D. Approach for Presenting Risk Estimates and Uncertainty Factors

As noted in the previous section, the registration review of chlorpyrifos and the OPs has presented EPA with numerous novel scientific issues, notably the potential for neurodevelopmental effects on the young (pre-natal, infants and children), that the agency has taken to multiple FIFRA SAP meetings since the completion of reregistration.[10] The agency completed a weight-of-the-evidence (WOE) analysis for neurodevelopmental effects using the "Framework for Incorporating Human Epidemiologic & Incident Data in Health Risk Assessment."[11] The WOE analysis integrated quantitative and qualitative findings from experimental toxicology studies, epidemiology studies, and physiologically-based pharmacokinetic-pharmacodynamic (PBPK-PD) modeling. [12] EPA has also considered the emerging new information from laboratory animal and mechanistic studies in addition to epidemiology studies that identified potential concern for increased sensitivity and susceptibility for the young from neurodevelopmental effects in the development of this PID. Despite several years of study, the science addressing neurodevelopmental effects remains unresolved. Due to this uncertainty, EPA has retained the FQPA 10X safety factor in its human health risk assessment in order "to take into account potential pre- and post-natal toxicity and completeness of the data with respect to exposure and toxicity to infants and children." FFDCA § 408(b)(2)(C). For consistency, EPA has also applied an additional 10X database uncertainty factor (UF_{DB}) in its assessment of occupational risks.

Notwithstanding, EPA recognizes that the science is evolving on this topic, and that there may be new information available prior to the completion of registration review that may impact the agency's conclusions about these effects. Most recently, EPA held a FIFRA SAP meeting from September 15 to September 18, 2020 to assess new approach methodologies that might be used to evaluate developmental neurotoxicity in EPA's assessment of risks to human health. EPA will consider the input and recommendations from the September 2020 FIFRA SAP once the SAP report is released in December 2020. In order to provide a fuller picture of the potential risk estimates and the evolving understanding of the potential for neurodevelopmental effects, EPA has also assessed the potential risks assuming a reduction to 1X of the FQPA SF and the UF_{DB}.

This PID presents the risk estimates as reflected in the 2020 human health risk assessment. EPA is proposing mitigation measures to mitigate risks estimated based on the retention of the 10X FQPA SF and UF_{DB}. EPA is also presenting measures to mitigate risks assuming a reduction to 1X. Depending on the recommendations of the SAP, EPA's conclusions about risk, and thus proposed mitigation measures, may be revised.

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[10] https://www.epa.gov/sap/fifra-scientific-advisory-panel-meetings

[11] U.S. Environmental Protection Agency. 2016. Framework for Incorporating Human Epidemiologic and Incident Data in Health Risk Assessment, December 28, 2016. Available at https://www3.epa.gov/pesticides/EPA-HQ-OPP-2008-0316-DRAFT-0075.pdf.

[12] The PBPK-PD model was used to derive toxicological points of departure (PoDs) and to determine the appropriate intra-species and inter-species uncertainty factors. https://www.regulations.gov/document?D=EPA-HQ-OPP-2008-0850-0941.

II. USE AND USAGE

Chlorpyrifos is a broad-spectrum insecticide and miticide registered for use for control of numerous insect pests and some mite pests. Products containing chlorpyrifos are registered for over 50 agricultural uses including fruit and vegetable crops, tree nuts, sorghum, wheat, and other food uses. Chlorpyrifos is also used to treat non-food uses such as cotton, nursery and landscape ornamentals, Christmas trees, golf course turf, greenhouse plants, as well as non-structural wood treatments such as utility poles and fence posts, cockroach bait stations, and as a mosquito adulticide. Many commercially-applied pesticide products containing chlorpyrifos are classified as restricted use products (RUPs), which can only be applied by certified applicators or those under their supervision. There is only one product currently registered for homeowner use which is formulated as a child-resistant bait station for cockroach control (EPA Reg. No. 9688-67). There are over 60 FIFRA Section 3 registrations, including eight technical registrations, and over 30 FIFRA Section 24(c) Special Local Need registrations for products containing chlorpyrifos, which include co-formulated products (i.e., those with multiple active ingredients in addition to chlorpyrifos). Overall usage has declined in the past decade but increased for some specific uses, such as sorghum, sweet corn, sunflowers, tobacco and pears. Since 2019, several states, including California, Hawaii, New York, Maryland, and Oregon, have initiated state-level actions to phase out all or most uses of chlorpyrifos.

Chlorpyrifos products are available in a variety of formulations, including wettable powders, granules, emulsifiable concentrates, WSPs, cattle ear tags, and bait stations. Chlorpyrifos products may be applied via groundboom sprayer, aircraft, tractor-drawn spreader, hand-wand, backpack sprayer, mechanically-pressurized handgun, and belly grinder. Application may take place throughout the agricultural season or throughout the year for non-agricultural applications.

Approximately 5.1 million pounds of chlorpyrifos were used each year for agricultural purposes in the United States between 2014 and 2018. Soybeans, alfalfa and corn make up nearly 50% of the total volume of chlorpyrifos used in the United States each year, with soybeans alone accounting for nearly 25% of total pounds applied. Less than 6% of each crop (i.e., soybeans, alfalfa and corn), however, is treated with chlorpyrifos. In addition to soybeans, alfalfa, and corn, crops with relatively high usage of chlorpyrifos (i.e., those with 100,000 lbs applied per year or more) include almonds, apples, grapes (wine, table, and raisins combined), oranges, peanuts, pecans, sugar beets, walnuts, spring wheat, and winter wheat. At least 40%, of the total acreage planted with apples, grapefruit, and asparagus is treated with chlorpyrifos. There has been a general trend of decreased usage in terms of pounds applied per year from 1998-2018, although acres treated has remained relatively stable (Kynetec, 2019.)[13]

Chlorpyrifos is registered for a number of non-crop uses including turf and ornamentals, tree farms and forest trees, cattle ear tags, livestock housing, rights of way, building perimeters, wood protection treatments, general outdoor treatments for ants and other pests, and wide area mosquito adulticide treatments. The majority of chlorpyrifos products registered for residential treatments were voluntarily cancelled or phased out by the registrants between 1997 and 2001. While usage data is not available for all non-agricultural use sites, available data indicate that the

[13] Kynetec USA, Inc. 2019. "The AgroTrak® Study from Kynetec USA, Inc." Database Subset: 1998-2018.

majority of non-agricultural chlorpyrifos usage in terms of pounds of active ingredient were applied to ornamental lawns and turf. Within this market segment, turf farms account for the majority of usage, with 70,000 pounds of chlorpyrifos applied to approximately 64,000 acres. Nursery and greenhouse use on ornamentals are a close second, with 50,000 pounds applied to approximately 67,000 acres (Kline, 2012).[14] Far fewer pounds of chlorpyrifos were applied for wide area mosquito treatment, with only 10,000 pounds applied annually. However, due to very low application rates typically used for mosquito adulticides, treatments for mosquitos account for the vast majority of non-crop acres treated with chlorpyrifos, with over 1,000,000 acres reported to be treated for this purpose (Kline, 2017).[15] Chlorpyrifos is also registered for use on the following additional surveyed non-crop sites: wide area/general outdoor treatment (for ants and other miscellaneous pests), buildings/premises, rights of way/utilities, and trees. However, while Kline and Company does survey these sites, the surveys did not report any usage for these sites, indicating that chlorpyrifos is not widely used in these sectors (Kline, 2016[16] and Kline, 2017). Chlorpyrifos is also registered for use on livestock areas and animal quarters, but usage data on pounds applied are unavailable for these sites.

III. SCIENTIFIC ASSESSMENTS

A. Human Health Risks

A summary of the agency's human health risk assessment is presented below. The agency used the most current science policies and risk assessment methodologies to prepare a risk assessment in support of the registration review of chlorpyrifos. For additional details on the human health assessment for chlorpyrifos, see the *Chlorpyrifos: Third Revised Human Health Risk Assessment for Registration Review*, which is available in the public docket.

1. Hazard Characterization

Chlorpyrifos is known to form chlorpyrifos-oxon, 3,5,6-trichloro-2-pyridinol (TCP), and 3,5,6-trichloro-2-methoxypyridine (TMP). Chlorpyrifos undergoes desulfuration, reacting in bioactivation to degrade to the more toxic and potent acetylcholinesterase (AChE) inhibitor, chlorpyrifos oxon. Due to rapid deactivation through hydrolytic cleavage by a process called diarylation, the oxon is highly unstable and breaks down to release TCP, which is not a U.S residue of concern.

The hazard characterization for chlorpyrifos and its oxon degradate is based on adverse health effects in animals and humans related to AChE inhibition, and potential for neurodevelopmental effects. Guideline animal toxicity studies have historically been used in support of the 10% red

[14] Kline and Company. 2012. Professional Turf and Ornamental Markets for Pesticides and Fertilizers 2012: U.S. Market Analysis and Opportunities. [Accessed April 2020.]
[15] Kline and Company. 2017. Professional Pest Management Markets for Pesticides 2016: United States Market Analysis and Opportunities 2016. [Accessed April 2020.]
[16] Kline and Company. 2016. Mosquito Control Markets 2015: U.S. Market Analysis and Opportunities. [Accessed April 2020.]

blood cell (RBC) AChE inhibition point of departure (POD) for chlorpyrifos in EPA risk assessments.

Since the agency has used the PBPK-PD model for chlorpyrifos to simulate human RBC AChE inhibition, the default 10X inter-species uncertainty factor (to account for uncertainty in relying on animal toxicity data to estimate a human toxicity endpoint) is not warranted and is reduced to 1X. The PBPK-PD model also incorporates inter-individual variation in response to chlorpyrifos to estimate a distribution of administered doses that could have resulted in 10% RBC AChE inhibition in humans, meaning a data derived extrapolation factor (DDEF) can be applied in lieu of the default intraspecies uncertainty factor. The agency has selected the 99th percentile of the distribution to account for variation of sensitivity. The intra-species DDEF is 4X for chlorpyrifos and 5X for the oxon for all groups except females of reproductive age for whom the 10X intra-species factor was retained.

The 2020 revised human health risk assessment presents potential risks with the 10X FQPA Safety Factor (SF), reflecting the uncertainties around doses that may cause pre- and postnatal neurodevelopmental effects, as well as 1X to demonstrate the range of potential risk estimates.

The uncertainty factors and total level of concern (LOC) for each subpopulation is as follows:

Table 1: Uncertainty Factor Summary

Uncertainty Factor	FQPA 10X			FQPA 1X		
	Females	All other Subpopulations		Females	All other Subpopulations	
		Food (parent)	Drinking Water (oxon)		Food (parent)	Drinking Water (oxon)
Interspecies	1	1	1	1	1	1
Intraspecies	10	4	5	10	4	5
FQPA	10	10	10	1	1	1
Total LOC	**100**	**40**	**50**	**10**	**4**	**5**

2. Risk Summary and Characterization

Steady State

As with other OPs, chlorpyrifos exhibits a phenomenon known as steady state AChE inhibition. Following repeated exposure at the same level, the degree of inhibition reaches equilibrium with production of new, uninhibited enzyme and the amount of AChE inhibition in a given dose remains consistent across exposure duration. After reaching steady state, the amount of AChE inhibition at a select dose remains constant across exposure duration. It generally takes approximately 2 to 3 weeks for this class of chemicals to reach steady state (U.S. EPA, 2002); however, this timeframe can vary with select chemicals. As such, the agency evaluated potential risks from steady state exposure in lieu of chronic exposure.

Dietary (Food + Water) Risks

FOOD

Both the acute and steady state dietary (food only) exposure analyses for chlorpyrifos were highly refined and incorporated monitoring data for almost all foods. Most of the food residues used were based upon USDA's Pesticide Data Program (PDP) monitoring data except in a few instances where no appropriate PDP data were available. Chlorpyrifos is routinely included in PDP monitoring.

The only residue of concern for the dietary (food only) assessment is chlorpyrifos. Food exposures do not incorporate potential exposure from food handling establishment (FHE) uses since the agency did not identify any registered FHE uses. Therefore, food exposures are based only upon field use of chlorpyrifos. At the 99.9^{th} percentile of exposure the subgroup with the highest acute exposure was females (13-49 years old) at 3.2 % acute population adjusted dose for food ($aPAD_{food}$) with the 10X FQPA safety factor retained. For the steady state dietary (food only) exposure analyses, the population subgroup with the highest exposure was children (1 to <2 years old) at 9.7% of the $ssPAD_{food}$ at the 99.9^{th} percentile of exposure. No potential risks of concern were identified from exposure to chlorpyrifos in food only. With the FQPA SF reduced to 1X, acute and steady state dietary risk estimates are <1% of the $aPAD_{food}$ and $ssPAD_{food}$ for all populations.

WATER

Drinking Water Assessment and Refinements

The *Updated Chlorpyrifos Refined Drinking Water Assessment for Registration Review* builds upon refinements from the 2014 and 2016 assessments at the Tier 3 assessment level, which included a screening-level approach at the national, regional, and watershed level as well as monitoring data and effects from water treatment systems. Based on regional screening, the incidence of high exposures is expected to be highly localized. However, assessing exposure on a local scale is difficult without regional-specific data and considering several local characteristics including soil type(s) and weather conditions. To further account for exposure on a local scale, EPA examined the potential geospatial concentration differences between two Hydrological Unit Code (HUC 2) Regions. This method was developed to identify use patterns that may result in estimated drinking water concentrations (EDWCs) that exceed the Drinking Water Level of Comparison (DWLOC) on a regional basis.

Moreover, the 2020 assessment incorporates the following additional refinements:

- New surface water model scenarios (i.e., soil, weather, and crop data);
- Use of community water system percent cropped area (PCA) adjustment factors and state level percent crop treated (PCT) data; and
- Quantitative use of surface water monitoring data.

Quantitative use of surface water monitoring data underwent external review in November 2019 from the FIFRA SAP and the remaining refinements were open to public comment and external peer review. Utilization of the aforementioned factors and data elevates the drinking water assessment to a Tier 4 assessment level, the most highly refined assessment tier.[17] The *Framework for Conducting Pesticide Drinking Water Assessments for Surface Water (DWA Framework)* (USEPA, 2020) includes a description of how these methods fit into the overall tiered drinking water assessment process.

Drinking Water Level of Comparison (DWLOC) Approach

Given the potential drinking water risks of concern previously identified during the registration review of chlorpyrifos, the *Updated Chlorpyrifos Refined Drinking Water Assessment (DWA) for Registration Review* focuses on a subset of high-benefit[18] [19] and/or critical uses in defined areas of the country:

- Alfalfa
- Apple
- Asparagus
- Cherry
- Citrus
- Cotton
- Peach
- Soybean
- Sugar beet
- Strawberry
- Wheat (Spring and Winter)

For a drinking water assessment which utilizes a DWLOC, the calculated DWLOC is compared to the EDWC. When the EDWC is greater than the DWLOC, there may be a risk concern for exposures to chlorpyrifos and/or chlorpyrifos oxon. Conversely, when the EDWC is less than the DWLOC, there are no risks of concern.

Both chlorpyrifos and the chlorpyrifos oxon are residues of concern in drinking water. With the 10X FQPA safety factor, the lowest acute DWLOC and steady state DWLOC calculated were 23 ppb and 4 ppb, respectively, for the most sensitive population, infants (<1 year old). The DWLOCs are 230 ppb and 43 ppb, respectively, without retention of the 10X FQPA safety factor. Drinking water concentrations of chlorpyrifos oxon above the DWLOC indicate a potential risk concern.

Table 2: DWLOC Values for Chlorpyrifos-Oxon for Infants				
DWLOC (ppb) for infants				
	Chlorpyrifos		**Chlorpyrifos-oxon**	
Safety Factor	10X	1X	10X	1X
Steady State	17	180	**4**	**43**
Acute	100	1000	23	230

[17] https://www.epa.gov/sap/meeting-information-november-19-22-2019-scientific-advisory-panel

[18] A high benefit indicates that there are no alternative pesticides for a pest on a specific crop or alternatives products are expensive or less efficacious. Target pests in these crops include alfalfa weevil, lygus bugs, scale, and two spotted spider mites. Additional details are provided in Section III.C. of this document.

[19] https://www.regulations.gov/document?D=EPA-HQ-OPP-2008-0850-0943

As noted earlier, several refinements were considered in the *Updated Chlorpyrifos Refined Drinking Water Assessment (DWA),* including usage data, percent cropped area aggregation, and percent cropped area-percent crop treated aggregation. These refinements are reflected in the below EDWCs and discussed in detail in the *Updated Chlorpyrifos Refined Drinking Water Assessment (DWA).*

Table 3: Surface Water Sourced Estimated Drinking Water Concentrations Resulting from Different Refinements for a Subset of 11 High-Benefit Chlorpyrifos Uses (Assuming Upper Bound Application Parameters)

2-digit HUC Name Overlapping States[1]	2-digit HUC Uses	Maximum 1-in-10 Year Estimated Chlorpyrifos-oxon Concentrations in Source Surface Water (µg/L)			
		Maximum 2-digit HUC Use Site-Specific Percent Cropped Area[2]		Percent Cropped Area Aggregation[3]	Percent Cropped Area-Percent Crop Treated Aggregation[4]
		1-day Average	21-day Average	21-day Average	21-day Average
Mid-Atlantic VT, NY, PA, NJ, MD, DE, WV, DC, VA	HUC-02 Apple and Peach	1.0	0.8	-	-
South Atlantic-Gulf VA, NC, SC, GA, FL, TN, MS	HUC-03 Cotton, Citrus, Peach, and Soybean	3.1	1.8	-	-
Great Lakes WI, MN, MI, IL, IN, OH, PA, NY	HUC-04 Alfalfa, Sugar beet, Apple, Cherry, Peach, Soybean, and Asparagus	22.8	19.6	3.4	-
Ohio IL, IN, OH, PA, WV, VA, KY, TN	HUC-05 Apple and Soybean	5.3	4.0	-	-
Tennessee VA, KY, TN, NC, GA, AL, MS	HUC-06 Apple	0.4	0.2	-	-
Upper Mississippi MN, WI, SD, IA, IL, MO, IN	HUC-07 Alfalfa, Sugar beet, and Soybean	9.9	7.2	5.4	3.2
Souris-Red-Rainy ND, MN, SD	HUC-09 Alfalfa, Sugar beet, Soybean, Spring Wheat,	8.3	5.6	5.2[4]	3.3

	and Winter Wheat				
Missouri MT, ND, WY, SD, MN, NE, IA, CO, IA, KS, MO	HUC-10 Alfalfa, Soybean, Spring Wheat, and Winter Wheat	5.7	3.6	-	-
Arkansas-White-Red CO, KS, MO, NM, TX, OK, AR, LA	HUC-11 Alfalfa, Soybean, and Winter Wheat	3.9	3.9	-	-
Texas-Gulf NM, TX, LA	HUC-12 Citrus, Peach, and Winter Wheat	1.1	0.7	-	-
Pacific Northwest WA, ID, MT, OR, WY, UT, NV	HUC-17 Alfalfa, Sugar beet, Apple, and Strawberry	8.5	6.1	2.5	-

Green shading indicates concentrations are below the 10X DWLOC (1-day = 43 µg/L and 21-day = 4 µg/L) while red shading indicates concentrations are above the 10X DWLOC.
- indicates values are not calculated because the concentrations in the prior step were below the 10x DWLOC.
[1] Sites are listed that include any overlap with the HUC-2 region.
[2] Use site-specific PCA refers to the use of a percent cropped area adjustment factor to adjust EDWCs to account only for the potential use sites (e.g., for example for HUC-03 the PCA is the summation of individual percent cropped area for orchard, cotton, and soybean) within each individual community water system where chlorpyrifos is being considered (see column "2-digit HUC Uses").
[3] PCA aggregation refers to the use of individual percent cropped area adjustment factors to proportionally allocate pesticide residue contribution in the development of EDWCs based on potential chlorpyrifos use sites (i.e., land use data) for individual watersheds. This analysis was done using the model output 1-in-10 year values and does not account for temporal residue contributions.
[4] PCA-PCT aggregation refers to the use of individual percent cropped area adjustment factors to proportionally allocate pesticide residue contribution in the development of EDWCs based on known chlorpyrifos use for individual watersheds. This analysis was done using the model output 1-in-10 year values and does not account for temporal residue contributions.
[5] The use pattern specific PCA is higher (i.e., >1) than all-ag PCA (0.95). Therefore, the use pattern specific PCA is capped at all-ag value and the use pattern PCA should not exceed the all-agricultural PCA. However, when aggregating the individual use residue contributions results, this capping cannot be completed.

Based on the most refined EDWCs, concentrations of chlorpyrifos and chlorpyrifos-oxon in drinking water are not likely to exceed the drinking water level of comparison (DWLOC) for the subset of 11 uses considered with the retention of the 10X FQPA safety factor. The consideration of additional crops would likely result in exceedances of the DWLOC if the 10X FQPA SF is retained. Dietary risks of concern from public health uses, such as mosquito adulticide treatment, are not expected at either the 1X or 10X.

EDWCs from the 2016 drinking water assessment for agricultural uses were compared to the DWLOCs to assess currently labels uses at the 1X FQPA safety factor. With a 1X FQPA safety factor, most of the current labeled uses result in drinking water concentrations below the DWLOC. Uses with drinking water concentrations above the DWLOC include, peppers, trash storage bins, and wood treatment, in all areas of the country. Additionally, uses with 1-in-10 year

21-day average drinking water concentrations above the 21-day average DWLOC in certain HUCs include corn, tart cherries, citrus, pecan, and peach. For additional information on the chlorpyrifos EDWCs at the 1X, please see *Evaluating the Impact of Removal of the 10X FQPA Safety Factor on Chlorpyrifos Drinking Water Concentrations.*[20]

Cancer

Chlorpyrifos has also been evaluated for cancer and is classified as "not likely to be carcinogenic to humans." Guideline carcinogenicity studies and epidemiological data are available from the Agricultural Health Study (AHS). Preliminary associations with breast, lung, colorectal, and prostate cancer warrant monitoring follow-up and additional research. There is no compelling evidence of an association with other cancer sites (C. Christensen, 6/16/11, D388167). The AHS chlorpyrifos carcinogenicity studies have been summarized in the memorandum, *Chlorpyrifos Carcinogenicity: Review of Evidence from the U.S. Agricultural Health Study (AHS) Epidemiologic Evaluations 2003-2009* (Christensen, D388167, 6/16/2011).

Residential Exposure Risks

Currently, chlorpyrifos products registered for residential use are limited to roach bait products (EPA Reg. No. 9688-67) or ant mound treatments which may only be applied by commercial applicators. The active ingredient is contained within a bait station which eliminates the potential for human contact; therefore, residential exposure to chlorpyrifos via these products is considered negligible. The majority of products registered for residential treatment were voluntarily cancelled or phased out by the registrants between 1997 and 2001.

There is a potential for exposure to the general population from use on golf courses following treatment with chlorpyrifos products or from exposures which occur following aerial or ground-based ultra-low volume (ULV) mosquito applications made directly in residential areas. Risk estimates for dermal and inhalation exposure were combined since the toxicological endpoint, RBC AChE inhibition, is the same for each of these exposure routes. With retention of the 10X FQPA SF, the residential post-application LOC for children is 40 and the adult residential post-application LOC is 100. Regardless of whether the FQPA SF is retained at 10X or reduced to 1X, there are no residential post-application risk estimates of concern for the registered uses of chlorpyrifos. The assessment of steady state golfer post-application exposures (dermal only) to chlorpyrifos treated turf resulted in no risks of concern to children/youth 6 to <16 years old (Margin of Exposure (MOEs) = 1,200 to 9,900) or adults (MOE = 1,000 to 5,400). With minimum MOEs of 400, there were no combined risks of concern identified for children 1 to <2 years old (dermal, inhalation, and incidental) or adults (dermal and inhalation) from post-application exposures following public health mosquito applications.

Aggregate Risk Assessment

A DWLOC approach was used to calculate the amount of exposure that could occur without exceeding the level of concern for acute and steady state aggregate assessments. This was to

[20] https://www.regulations.gov/document?D=EPA-HQ-OPP-2008-0850-0942

account for the available space in the "total aggregate risk cup" for exposures to chlorpyrifos oxon in drinking water after accounting for exposures to parent chlorpyrifos from food and residential uses. The calculated DWLOCs were then compared to the EDWCs of chlorpyrifos and chlorpyrifos oxon modeled under a variety of conditions.

With residential exposures considered negligible, the acute aggregate assessment includes only food and drinking water. The steady state aggregate assessment includes exposures from food, drinking water, and residential uses (golf courses). As previously mentioned, the drinking water assessment is highly refined incorporating multiple screening exercises and comparing modeling results to monitoring data.

When considering all currently registered agricultural and non-agricultural uses of chlorpyrifos, aggregate exposures are of concern. If considering only the uses that result in DWLOCs below the EDWCs, aggregate exposures are not of concern.

Non-Occupational Spray Drift Risks

Spray drift from ground or aerial applications can be a potential source of non-occupational exposure to chlorpyrifos. The potential risks from spray drift exposure and the impact of potential risk reduction measures were assessed in a July 2012 memorandum.[21] To increase protection for children and other bystanders, chlorpyrifos technical registrants voluntarily agreed to spray drift mitigation measures including lower application rates, increased droplet sizes, and buffer zones.

There are no risk estimates of concern incorporating the agreed-upon buffer distances and droplet sizes/nozzle types by the EPA and the technical registrants in 2012 with or without the 10X FQPA SF for aerial or groundboom applications. There were no combined (dermal + incidental oral) risks for children 1 to < 2 years old at the field edge from indirect spray drift exposure to chlorpyrifos and there were no dermal risk estimates of concern at the field edge for adults (females 13 - 49 years old). Aerial applications are not permitted at rates higher than 2.0 lb a.i./ except for treatment of Asian Citrus Psyllid (citrus use) at application rates up to 2.3 lbs a.i./A. For aerial applications at this highest rate, MOEs of concern were identified within 10 feet from the edge of the field. However, current buffer distances required on the label mitigate these potential risks of concern.

The EPA assessed post-application exposures to residential bystanders from spray drift and volatilization. This assessment focuses primarily on individuals who live on, work in, or frequent areas adjacent to chlorpyrifos-treated agricultural fields. In June 2014, a re-evaluation of the 2013 preliminary volatilization assessment was conducted to present the results of two new vapor studies and their impact (MRIDs 49119501 and 49210101). These studies demonstrated that no toxicity occurred even at the saturation concentration, which is the highest physically achievable concentration. As such, there are no anticipated risks of concern from exposure to the volatilization of either chlorpyrifos or chlorpyrifos oxon with or without retention of the 10X FQPA SF.

[21] https://www.regulations.gov/document?D=EPA-HQ-OPP-2008-0850-0103

Cumulative Risks

Chlorpyrifos is a member of the OP class of pesticides. EPA considers OPs to express toxicity through a common biochemical interaction with cholinesterase which may lead to several potential cholinergic effects and, consequently, the OPs should be considered as a group when performing cumulative risk assessments. The agency first completed a cumulative risk assessment for the OPs in 2001, a revised cumulative risk assessment for the OPs was completed in 2002[22], and an updated OP cumulative risk assessment was completed in 2006.[23] The cumulative effects of exposure to multiple OPs, including chlorpyrifos, are evaluated in those documents. Prior to the completion of registration review, the agency will update the OP cumulative risk assessment to incorporate any toxicity and exposure information available since 2006.

Occupational Handler Risks

Occupational handlers mixing, loading, and/or applying pesticide products containing chlorpyrifos may be exposed to chlorpyrifos dermally or by inhalation. PBPK-PD model-derived PODs (dermal and inhalation), which were specifically set up for occupational exposure scenarios, were used to estimate handler risks. The steady state approach accounts for short-term exposure duration, as well as for workers that are exposed over longer periods of time (i.e., intermediate-term exposures). The dermal and inhalation risk estimates were combined since the toxicological endpoint, RBC AChE inhibition, is the same for each of these exposure routes.

The human health risk assessment presents estimates assuming both that the database uncertainty factor (UF_{DB}) has been retained at 10X and has been reduced to 1X. If the database uncertainty factor is retained, the total LOC for occupational exposure assessment is 100X for adults (represented by females 13-49). If the database uncertainty SF is reduced to 1X, the total LOC for occupational exposure assessment is 10X for adults (represented by females 13-49).

Two hundred eighty-eight steady state occupational handler scenarios were assessed for non-seed treatments. Assuming a 10X database uncertainty factor is retained (LOC = 100), 119 scenarios are of concern with label-specified personal protective equipment (PPE; baseline attire, chemical resistant gloves, coveralls, and a protection factor (PF) 10 respirator) (MOEs < 100). Risks of concern for 45 additional exposure scenarios could potentially be mitigated if engineering controls are used. Without retention of the 10X database uncertainty factor (UF_{DB}) (LOC = 10), 19 non-seed treatment scenarios are of concern with baseline attire, chemical resistant gloves, coveralls, and an elastomeric half mask (PF 10) respirator (MOEs < 10). If

[22] US EPA, 2002. https://nepis.epa.gov/Exe/ZyNET.exe/9100BFLL.TXT?ZyActionD=ZyDocument&Client=EPA&Index=2000+Thru+2005&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C00thru05%5CTxt%5C00000023%5C9100BFLL.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL

[23] US EPA, 2006. https://www regulations.gov/document?D=EPA-HQ-OPP-2006-0618-0002

engineering controls are used, risks of concern for 15 additional scenarios could potentially be mitigated. The changes to the inputs are not expected to result in significant changes to the risk estimates and have not been updated at this time.[24]

A total of 93 commercial seed treatment scenarios were assessed for chlorpyrifos. The revised human health risk assessment identified 22 seed-treatment scenarios of concern with the assumption that the 10X UF_{DB} is retained. Seed treatment uses include corn, cotton (delinted), cucumber, pumpkin, sorghum grain, triticale (wheat), and a variety of beans. No potential risks of concern were identified with scenarios assessed for cucumber, pumpkin, sorghum grain and triticale or for planting seeds previously treated with chlorpyrifos. If the 10X UF_{DB} is reduced to 1X, there are no seed-treatment scenarios of concern for chlorpyrifos. Potential risks of concern were found for the following with retention of the 10X UF_{DB}:

Table 4: Occupational Risks of Concern from Seed Treatment at the 10X UF_{DB}[1]				
Formulation and PPE	**Loader/Applicator[2]**	**Sewer**	**Bagger**	**Multiple Activities Worker**
Liquid (with double layer PPE (coveralls), gloves, and an elastomeric half mask respirator (PF 10)	Corn = 67 - 95 Cotton = 33 - 46	Cotton = 50-71	Corn = 96 - 140 Cotton = 46 - 65	Beans = 61 - 86 Corn = 50 - 71 Cotton = 24 - 34
Liquid (microencapsulated)	Beans only: 59 - 83	Beans only: 91 - 130	Beans only: 84 - 120	Beans only: 44 - 62
Wettable Powder via WSP	Beans = 75 – 110 Corn = 62 - 88	Corn = 96 - 140	Corn = 89 - 130	Beans 57 – 79 Corn = 47 - 66

[1] LOC with 10X = 100
[2] Maximum MOEs with listed PPE

<u>NON-SEED TREATMENT</u>

<u>Aerial and/or Chemigation applications</u>

Several chlorpyrifos formulations may be applied by aerial or chemigation application. These include liquids, wettable powders, granule formulations, and water dispersable granules. The maximum application rate for aerial application is 2.3 lbs a.i./A for use on citrus.

Even with the use of engineering controls (closed systems), mixing and loading resulted in risks of concern to workers at the 1X UF_{DB} for four uses: corn (pre-plant), peanut, sweet potato, and sunflower. These risks of concern were limited to granular formulations for these uses. The MOE for aerial application of granular formulations of chlorpyrifos on peanuts is 5. MOEs for other

[24] Some occupational handler exposure inputs have changed since the previous ORE assessments were completed in 2011 (W. Britton, D388165, 06/27/2011), 2014 (W. Britton, D424484, 12/29/2014), and 2016 (W. Britton, D436317, 11/03/2016) (e.g., amount of seed treated per day, seed planted per day).

aerial granular applications are 9.4 (sweet potato), 9.5 (sunflower, tobacco), and 9.6 (corn). Without the 10X UF_{DB}, MOEs for mixing and loading for aerial applications ranges from 0.61 to 6.7 for uses with risks of concern with baseline PPE (long-sleeved shirt, long pants, socks and shoes). Use of the highest 2 tiers of refinement (double layer (coveralls), gloves, and an elastomeric half mask respirator or engineering controls result in MOEs of 4.7 to 66 for mixing and loading granular formulations.

For mixing/loading liquids and wettable powders (WP), nearly all scenarios resulted in MOEs below the LOC of 100 (with retention of the 10X UF_{DB}). With the exception of ornamental shade trees and herbaceous plants (MOE = 130 with engineering controls), the risk estimates for mixers and loaders for all remaining formulations were below the LOC of 100 with a range of 9.6 to 71 for citrus, tree nuts (almonds, filberts, hazelnuts), tree fruit (apple, cherries), cole crops (excludes Brussels sprouts and cauliflower), Christmas tree plantations, and nursery stock (pre-plant). Potential risks to aerial or chemigation applicators were found for all starting formulations of spray applications and granules for the following uses with MOEs from 5 to 94: peanut, sweet potato, sunflower, tobacco, sod farms (turf), corn (pre-plant and post-emergence), alfalfa, cotton (except Mississippi), soybean, wheat, sorghum, and Christmas tree plantations. All remaining aerial applications were above the LOC of 100 and, therefore, not of concern.

Airblast applications

Chlorpyrifos may be applied by airblast application at rates from 1.0 to 6.0 lbs a.i./acre to citrus, tree nuts, tree fruits, grapes, asparagus, and to shade trees, herbaceous plants, Christmas tree plantations, and ornamental woody shrubs and vines. Formulations that may be applied by airblast include liquid/soluble/emulsifiable concentrate (L/SC/EC), WP in WSP, and dry flowable/water dispersable granule (DF/WSG) in WSP. Risk estimates for mixing, loading, and applying airblast applications were mostly above the LOC of 100 with the use of engineering controls. At a rate of 6.0 lbs a.i./acre (California and Arizona citrus), MOEs ranged from 64 to 67 for mixing and loading WSP formulations. MOEs for mixing, loading, and applying citrus outside of California and Arizona were 98. Mixing, loading, and applying all formulations for tree nuts (pecans) ranged from 89 to 91. MOEs for remaining uses ranged from 98 to 390 with engineering controls. All airblast application scenarios without engineering controls, even those with use of chemical resistant headgear, resulted in potential risks of concern with MOEs from 0.55 to 4.2, which is below the LOC with or without retention of the 10X UF_{DB}.

There were no risks of concern for occupational handlers mixing and loading WSP formulations except and as mentioned above for citrus and tree nuts (pecans). However, with the use of double layer (coveralls), gloves, and an elastomeric half mask respirator, only the following uses resulted in MOEs above the agency's LOC of 100 for all other formulations (L/SC/EC):

- Cherries, tree fruits (pear, plum/prune (dormant, delayed dormant), tree nuts (almonds, filberts, hazelnuts, pecans, walnuts); MOE = 110
- Ornamental and/or shade trees, ornamental woody shrubs and vines, herbaceous plants, Christmas tree plantations, grapes; MOEs = 220

Risk estimates for all levels of PPE for the remaining uses were from 4.6 to 71 for mixers and loaders and were, therefore, of concern with retention of the 10X UF_{DB}.

<u>Groundboom applications</u>

Groundboom application is one of the most widely used application methods for chlorpyrifos. Nearly every use resulted in potential risks of concern from mixing, loading, or applying without the use of PPE above baseline levels (long-sleeved shirt, long pants, socks and shoes) for mixers, loaders, and applicators with retention of the 10X UF_{DB}. Risk estimates of concern were still identified for groundboom applicators with engineering controls on corn (pre-plant, MOE = 67) and cotton (except in Mississippi, MOE = 99) and mixers and loaders for the following uses:

Table 5: Groundboom Risk Estimates with MOEs < 100 with Engineering Controls

Formulation	Crop/Target Category	MOE with baseline PPE	MOEs with double layer (coveralls), gloves and respirator	MOE with engineering controls
Mixers and Loaders				
Liquid/Soluble Concentrate/Emulsifiable Concentrate (L/SC/EC)	Corn (pre-plant)	1.9	14	39
	Cotton (except MS)	2.7	22	58
	Tree nut orchard floors (pecans, almonds, walnuts)	3.2 - 3.5	25 - 26	68 - 73
	Ornamental lawns and turf, sod farms	3.7	28	77
	Radish (pre-plant)	4.6	35	96
Wettable powder in water-soluble packet (WSP)	Ornamental lawns and turf, sod farms	N/A	N/A	51
	Ornamental woody shrubs and vines (pre-transplant)	N/A	N/A	67
Dry flowable/water-soluble granule in WSP	Tree nut orchard floors (pecans, almonds, walnuts)	N/A	N/A	46 - 48
	Corn, sorghum grain, soybean	N/A	N/A	79
	Rutabaga	N/A	N/A	80
	Turnip	N/A	N/A	86
	Sweet potato	N/A	N/A	92
	Cole crops (excludes Brussels sprouts and cauliflower), mint (peppermint and	N/A	N/A	98

	spearmint), peanut, sunflower			
Applicator Risk Estimates with MOEs < 100 with Engineering Controls or Maximum PPE				
Spray (all starting formulations)	Corn (pre-plant), cotton (except Mississippi)	4.8 – 7.2	31 - 47	67 - 99
	Corn (post-emergence), tree nut orchard floors (pecans, almonds, walnuts), ornamental lawns and turf, sod farms (turf)	8.3 - 9.8	54 - 62	110 - 130
	Radish, alfalfa, cotton, sorghum grain, soybean, wheat,	12 - 15	78 - 94	170 - 210
	Rutabaga	15	94	210

Use of engineering controls resulted in mixer/loader risk estimates above the LOC of 100 for mixing and loading for the following uses (MOEs = 120 – 190):

- At a rate of 4.0 lbs a.i./acre: nursery stock (pre-plant)
- At a rate of 2.0 to 2.4 lbs a.i./acre: Brussels sprouts (at plant and post-emergence), cauliflower, cole crops, figs (only in California), grapes (foliar, dormant, delayed dormant), mint, peanut, pineapple, rutabaga, strawberries (pre-plant), sunflower (pre-plant) sweet potato (pre-plant and soil broadcast), and tobacco (preplant).
- At a rate of 1.9 lbs a.i./acre: beets (table, sugar, at plant), clover (grown for seed, foliar), hybrid cottonwood and polar plantations
- At a rate of 1.5 lbs a.i./acre: cranberry
- At a rate of 1.0 lbs a.i./acre: alfalfa, cotton, sorghum grain, soybean, and wheat

Mixer and loader risk estimates for these crops with double layer (coveralls), gloves, and an elastomeric half mask respirator range from 42 to 71. Applicator risks estimates with this level of PPE ranged from 31 to 470 with risks of concern identified for use on corn (pre-plant and post-emergence) and cotton (except MS), rutabaga, alfalfa, soybean, sorghum grain, wheat, radish (preplant), tree nut orchard floors (pecans, almonds, walnuts) and ornamental lawns and turf with MOEs up to 94.

With the exception of microencapsulated formulations for ornamental non-flowering plants and wettable powder for citrus orchard floors and cole crops (excluding Brussels sprouts and cauliflower), all remaining uses present potential risks of concern to mixers, loaders, and applicators with baseline PPE (long-sleeved shirt, long pants, socks, and shoes). MOEs for mixers and loaders range up to 27 and up to 72 for applicators. Use of double layer (coveralls), gloves, and an elastomeric half mask respirator results in risk estimates up to 220 for mixers and loaders and 470 for applicators and are not of concern.

Flaggers

Although the use of global positioning systems (GPS) has vastly replaced the use of flaggers to guide aerial applications, the agency continues to assess exposure as use of flaggers is not explicitly prohibited on pesticide products containing chlorpyrifos. At the 1X UF_{DB}, all risk estimates were above the LOC of 10 and, therefore, are not of concern. Nearly all applications of chlorpyrifos products results in potential risks of concern for flaggers with the maximum amount of PPE (double layer (coveralls), gloves, and PF10 respirator) at the 10X UF_{DB}; risk estimates of concern ranged from 15 to 88 with the maximum PPE (where the LOC with the 10X UF_{DB} is 100). No risks of concern were identified for flaggers with granule application to turf nor for applications to sweet potato, corn (pre-plant), sunflower, and tobacco with the maximum amount of PPE.

Handheld application methods[25]

Assessment of handheld application methods typically assumes mixer, loader, and applicator exposure to the same occupational handler.

Manually-pressurized handwand and handgun

Manually-pressurized handwand application is limited to mostly non-food uses such as ornamental plants, nursery stock, poultry litter, and industrial and commercial areas. Food uses include select tree nuts and tree fruits. With the use of single layer (long-sleeved shirt and long pants) and gloves, most uses are above the EPA's LOC of 10 at the 1X UF_{DB} (MOEs = 3.9 – 9,000) No risks of concern were identified at the 1X UF_{DB} from spot treatment applications (0.023 lbs a.i./Acre). Without gloves, MOEs ranged from 2.6 – 110 with risks of concern for use on applications that were not considered spot treatments (i.e., applications of 40 gallons or to 1,000 square feet). MOEs were below the LOC of 100 at the 10X UF_{DB} for the following handwand applications with maximum PPE (double layer (coveralls)) gloves, and an elastomeric half mask respirator:

- Wood protection treatment (MOE = 82)
- Nursery, pine seedlings (MOE = 90)
- Indoor commercial, institutional, industrial premises, food processing plant premises (MOE = 16)

Risks of concerns were found for nearly all scenarios with manually-pressurized handgun applications and formulations with the exception of:

- WSP application to ornamental woody shrubs and vines (MOEs = 440 to 2100); and
- All formulations registered for use on seed orchard tree (MOEs = 1800 – 8300).

Remaining risk estimates with use of double layer (coveralls), gloves, and an elastomeric half mask respirator ranged from 11 to 83. An MOE of 83 was determined for ornamental and/or shade trees, herbaceous plants, and grapes (WSP formulation only).

[25] Assessment assumes mixing, loading, and application are conducted by some the same individual and does not include use of engineering controls.

Tractor-drawn spreader

At the 10X UF_{DB}, no occupational handler risks of concern were identified with use of tractor-drawn spreaders. Nor were risks of concern found with use of a SmartBox®. SmartBox® systems are closed application systems that are considered to be protective as engineering controls. Retention of the 10X UF_{DB} resulted in risks of concern with use of only baseline PPE. MOEs range up to 71 except for use of golf course turf, rights of way, and road medians where the MOE is 120. Application to most uses are above the LOC of 100 with use of gloves, respirator, and coveralls or engineering controls. Even with engineering controls (excluding SmartBox systems), risk estimates are below 100 for application to soybean, corn, and ornamental woody shrubs and vines for mixers, loaders, and applicators (MOEs = 53 – 89).

Backpack Sprayers

Risks of concern from backpack sprayers without retention of the 10X UF_{DB} were limited to use on ornamental and/shade trees, herbaceous plants, ornamental woody shrubs and vines, wide-area general outdoor treatment, and outdoor commercial/institutional/industrial premises, non-agricultural outdoor buildings and structures.

MOEs for liquid concentrate application by backpack sprayer ranged from 1.5 – 76 and exceeded the agency's LOC of 100 for all levels of PPE except as follows:

Table 6: Risk Estimates for Backpack Sprayer Applications[1]

Formulation	Application type	Crop/Targeted Use	PPE	MOE
Dry flowable/water-dispersable granule in WSP	Broadcast (foliar)	Grapes (pre-bloom)	Double layer (coveralls), gloves, and an elastomeric half mask respirator	94
	Trunk spray/Drench	Tree fruits (apple)		100
	Drench/Soil-Ground-directed	Grapes (pre-bloom)		130
Liquid/soluble concentrate/emulsifiable concentrate	Broadcast (foliar)	Golf course turf		94
	Spot treatment applications (0.023 A treated)	Ornamental and/or Shade Trees, herbaceous plants	Baseline	320
		Ornamental lawns and turf, sod farms (turf)		350
		Outdoor commercial/institutional/industrial premises, non-agricultural buildings and structures, golf course turf		1300
Microencapsulated formula	Broadcast (foliar)	Ornamental woody shrubs and vines	Double layer	94

		Ornamental non-flowering plants	(coveralls), gloves, and an elastomeric half mask respirator	130
	Directed broadcast	Outdoor commercial/institutional/industrial premises	Baseline	230
	Broadcast	Agricultural farm premises	Baseline	400
	Broadcast	Poultry litter	Baseline	1100
WSP	Spot	Ornamental woody shrubs and vines (pre-transplant)	Baseline	330
	Spot	Outdoor lawns and turf, Sod Farms (turf)	Baseline	350
	Broadcast	Ornamental woody shrubs and vines	Baseline	930

[1]Select uses with risk estimates below the LOC of 100 were included if chlorpyrifos was considered a high benefit.

Granule formulations

Application of chlorpyrifos granule formulations by hand is limited to non-agricultural uses. Applications by spoon resulted is risk estimates from 1400 to 5700 and were not of concern. Regardless of PPE, all applications with a belly grinder with retention of the 10X UF_{DB} resulted in potential risks of concern with a maximum MOE of 43. Hand dispersal resulted in potential risks on concern with or without retention of the 10X UF_{DB} and regardless of PPE for treatment of commercial/institutional/industrial premises and utilities with MOEs from 0.49 to 1.4. Treatment of golf courses and sod farms by the same method were of concern with baseline PPE (MOE = 90; long-sleeved shirt, long pants, no gloves and no respirator). Hand dispersal and rotary spreader application resulted in MOEs below the LOC of 100 with retention of the 10X UF_{DB} for ornamental woody shrubs and vines regardless of PPE with MOEs up to 53. With baseline PPE, MOEs for all other remaining uses treated by rotary spreader were 63 to 70. Use of maximum PPE (double-layer (coveralls), gloves, and an elastomeric half mask respirator) results in MOEs of 290 to 320.

Non-Food and Other Application Methods:

Application of cattle eartags, bait stations, and total release foggers (greenhouses) are considered to have negligible exposure; therefore, there were no risks of concern identified to occupational handlers for these treatment methods. However, potential risks of concern were identified for all levels of personal protective equipment using paint brushes and rollers for wood protection treatment. Regardless of PPE, all applications with a brush roller resulted in potential risks of concern with retention of the 10X UF_{DB} with a maximum MOE of 45.

Wide-area Mosquito Abatement

With label required single layer (long-sleeved shirt and long pants) and gloves, MOEs for mixing and loading wide area mosquito applications were below the agency's LOC of 100 for aerial applications and above the LOC for ground applications. Aerial applications were assessed assuming only engineering control and were not of concern. With the retention of the 10X UF_{DB}, ground applications were only above the LOC of 100 with the use of engineering controls. Without engineering controls, ground applicator MOEs were of concern. Ultra-low volume (ULV) wide-area applications by airblast were below the LOC of 10 without retention of the 10X UF_{DB} with MOEs ranging from 4.4 to 5.6.

Occupational Post-Application Risks

Most crops and activities require a restricted entry interval (REI) of 24 hours on current chlorpyrifos labels. However, in some cases such as citrus fruits, REIs are up to 5 days after application. Occupational post-application risks have been updated to incorporate PBPK-derived steady state PODs based on 10% RBC AChE inhibition. Assuming the UF_{DB} is reduced to 1X, most post-application risk estimates are not of concern 1 day after application. Likewise, the majority of the post-applications scenarios are not of concern 1 day after application (REI = 24 hours) assuming the UF_{DB} of 10X is retained. However, for some activities result in risks of concern up to as many as 10 days following application for the non-microencapsulated formulations and > 35 days for the microencapsulated formulation.

The residue of concern for occupational post-application exposures is the chlorpyrifos parent compound, although it may be possible that the formation of chlorpyrifos oxon is greater and its degradation slower in greenhouses when compared to the outdoor environment. Dermal exposure to the oxon on foliar surfaces from reentry into an outdoor environment previously treated with chlorpyrifos is not anticipated and, therefore, has not been assessed.

The agency has numerous dislodgeable foliar residue (DFR) studies for several chlorpyrifos registered uses. Specifically, the DFR studies examined the use of 1) granular formulations on turf and sweet corn; 2) emulsifiable concentrate formulations on citrus, sugar beets, sweet corn, pecans, cotton, and turf; 3) a microencapsulated liquid formulation on ornamentals; 4) a total release aerosol formulation on ornamentals; and 5) wettable powder formulations on pecans, almonds, apples, tomato, cauliflower, and turf. These studies varied in location and calculations using each of these studies yield different risk estimates. The agency is presenting the full range of post-application risk estimates in Appendix D1 of this PID.

Dermal exposure assessment on outdoor foliar surfaces was limited to chlorpyrifos exposure only. Exposure to chlorpyrifos oxon on foliar surfaces from reentry into an outdoor environment (e.g., field crops and orchards) previously treated with chlorpyrifos is not anticipated and, therefore, was not assessed. Occupational post-application assessments were performed for: 1) exposures to the parent compound chlorpyrifos in outdoor environments (all uses), 2) exposures to the parent chlorpyrifos indoors (e.g., greenhouses) and 3) exposures to both the parent and chlorpyrifos oxon in greenhouses. Occupational dermal post-application exposures were assessed in greenhouses using conservative assumptions of oxon formation.

A quantitative occupational post-application inhalation risk assessment is not required for chlorpyrifos or chlorpyrifos oxon due to the lack of toxicity from the vapor phase of these chemicals, even at the saturation concentration. Post-application exposure from seed treatment is not expected.

The agency's LOC for occupational post-application risks is 100 at the 10X UF_{DB} and 10 at the 1X UF_{DB}. Post-application exposure to agricultural workers from commercial seed treatment is not expected. The agency has identified potential risks of concern for the following uses and activities. The comprehensive list of REIs by crop, post-application activity, and study location yielding those risk estimates are presented in Appendix D1.

Greenhouse

Chlorpyrifos may be applied to food and non-food uses in greenhouses. Chlorpyrifos formulations used in greenhouses include emulsifiable concentrate, microencapsulated liquid, wettable powder in WSP, and total release foggers. The chlorpyrifos parent compound is the residue of concern for occupational post-application dermal exposures; however, available exposure data indicate chlorpyrifos oxon may form in indoor environments.[26] It is uncertain if the formation of the oxon is greater and its deactivation slower in greenhouses when compared to the outdoor environment. Workers reentering indoor environments (i.e., greenhouses) previously treated with chlorpyrifos could potentially be exposed to the more toxic oxon as chlorpyrifos degrades. Risks for reentry into treated greenhouses for the parent chlorpyrifos plus chlorpyrifos oxon were estimated using a total toxic residue approach for all four formulations used in greenhouses.[27] A conservative assumption of 5% (0.05) of the total chlorpyrifos was estimated as present as DFR in greenhouses and available for contact during post-application activities. Five percent is the high-end value for the percent of parent that metabolized during the course of the residue studies. Risk estimates after treatment for total release fogger and liquid concentrate formulations were not of concern 0 to 6 days. For the microencapsulated formulation, MOEs are not of concern 3 to > 35 days after treatment (the completion of the monitoring period), depending on the exposure activity considered.

3. Human Incidents

Chlorpyrifos incidents were previously reviewed in 2011.[28] The human incident databases that were reviewed are:

- Office of Pesticide Programs Incident Data System (OPP IDS);
- National Pesticide Information Center (NPIC);
- NIOSH's Sentinel Event Notification System for Occupational Risks (SENSOR);
- California Pesticide Illness Surveillance Program Incident Data (CA PISP).

Incident information from each of these databases follows.

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[26] J.L. Martinez Vidal, et al. 1998. Diminution of Chlorpyrifos and Chlorpyrifos Oxon in Tomatoes and Green Beans Grown in Greenhouses. J. of Agric. and Food Chem. 46 (4), 1440–1444.
[27] Total DFR ($\mu g/cm^2$) = [Chlorpyrifos DFR ($\mu g/cm^2$) * TAF] + [Chlorpyrifos DFR ($\mu g/cm^2$)]
[28] Chlorpyrifos: Tier II Incident Report https://www.regulations.gov/document?D=EPA-HQ-OPP-2008-0850-0032

IDS
The IDS consists of the Aggregate IDS and Main IDS. In Aggregate IDS, queried from January 1, 2002 to May 27, 2010, there are 745 incidents involving chlorpyrifos. Prior to 2011, there are 247 cases reported that involve the active ingredient chlorpyrifos for the Main IDS. Of these cases, 141 cases are reported for the single chemical chlorpyrifos in the database. Most of these incidents were categorized as Human Moderates (HCs); 12 were categorized as Human Majors (HBs); and one was categorized as fatality (HA). Fifteen of these incidents were reported as affecting children 6 years old or under (2 HBs and 13 HCs). These latter incidents appear to be due to accidental ingestion and post application exposure to cancelled products. Main IDS-reported chlorpyrifos incidents appear to have decreased substantially in this period from 43 incidents in 2002, to 2 incidents in 2010. The initial large reductions generally coincide with the dates for which regulatory actions were taken.

NPIC
Similar to Poison Control Centers, NPIC's primary purpose is to provide information on a variety of pesticide topics and direct callers for pesticide incident investigation and emergency treatment. While NPIC does collect information about incidents, it generally receives fewer reports than IDS. From 2002 to 2010, 178 cases were reported for chlorpyrifos in the NPIC database. Of these cases, 88 were reviewed because, in these cases, chlorpyrifos was used as a single chemical and had a certainty classification of probable, possible, or unclassified. Eight of the chlorpyrifos cases were associated with children six years old or younger.

NIOSH SENSOR
The NIOSH SENSOR database is not national in scope and is limited to participation of 13 states.[29][30] For the 2011 human incident report, the agency analyzed NIOSH SENSOR data from 1998-2007. SENSOR focuses on occupational pesticide incidents, although both occupational and non-occupational incidents are included in the database. For NIOSH SENSOR from 1998 to 2007, there were 635 cases reported for chlorpyrifos in the database. Of these cases, 348 involved chlorpyrifos use as a single chemical only and had a certainty classification of definite, probable, or possible. There was one death due to suicide. Eight cases were classified as high severity; 60 cases, as moderate severity; and 279 cases, as low severity. Of the 348 chlorpyrifos-only cases, 18 cases involved children six years old or younger. These latter incidents were mostly due to accidental ingestions, misapplications around the home, and drift from nearby properties. Generally, chlorpyrifos incidents involved workers in agricultural or professional application occupations, homeowners and individuals at work but their job was not related to pesticide application, and to individuals exposed through drift.

California PISP
One hundred and sixty-four cases are attributable to chlorpyrifos-only exposures were reported to the California PISP between 1999 and 2008. Of these cases, 87 were occupational incidents and 77 were non-occupational incidents. A number of these incidents appear to be due to accidents and misuse. Drift of chlorpyrifos from adjacent fields appears to be the cause of the

[29] https://www.cdc.gov/niosh/topics/pesticides/overview html
[30] Only twelve states had participated between 1998- 2007.

most incidents in PISP accounting for 56% of the cases reported to PISP from 1999 to 2008. In the NIOSH SENSOR database, chlorpyrifos application appears to lead to the most incidents, being responsible for 46% reported to NIOSH SENSOR from 1998 to 2007. The chlorpyrifos incidents reported have declined substantially (95%) among residential users from 2002 to May 27, 2010; however, the rate of occupational incidents reported remained the same during this reporting period.

Overall, the incident data suggest that incidents associated with chlorpyrifos are declining over time. IDS incident reports decreased by 95% from 2002 to 2010, and NPIC incident reports have decreased by 92% from 2002 to 2010. The decrease in the number of chlorpyrifos incidents can be temporally associated with the phase out/cancellation of most residential chlorpyrifos products.

Health effects reported include neurological (e.g., tremors, headaches, dizziness, seizures), gastrointestinal (e.g., nausea, abdominal pain), respiratory (e.g., choking, coughing, shortness of breath), ocular (e.g., pain, itchiness), dermal (e.g., rash, lesions), and cardiovascular symptoms. Patients could exhibit multiple symptoms. The incidents reported have been reviewed and the agency will continue to monitor these incidents and remain alert for any changes in trend or patterns.

4. Tolerances

The 2020 revised chlorpyrifos human health risk assessment recommended changes to various tolerance levels to conform with the agency's rounding practice (*i.e.*, adding a trailing zero) at that time. Since the 2020 risk assessment was issued, the agency has decided to follow the Organization for Economic Coordination and Development (OECD) rounding class practice, which does not recommend adding a trailing zero. The EPA notes that the tolerance expression for chlorpyrifos in the 40 CFR§180.342 will be updated to comply with the S. Knizner 5/27/09 memo as follows:

> Tolerances are established for residues of chlorpyrifos, including its metabolites and degradates, in or on the commodities in the table below. Compliance with the tolerance levels specified below is to be determined by measuring only chlorpyrifos (*O,O* -diethyl *O* -(3,5,6-trichloro-2-pyridyl) phosphorothioate.

Based on data indicating that residues of chlorpyrifos may be present, EPA is recommending that tolerances be established for chlorpyrifos on the following: cotton, gin byproducts (15 ppm); grain, aspirated fractions (30 ppm); corn, field, milled byproducts (0.1 ppm); and wheat, milled byproducts (1.5 ppm). These recommendations, along with recommendations for revisions to current tolerances based on the (OECD rounding class practice, commodity definition revisions, crop group conversions/revisions, and harmonization with Codex, are presented in Tables 7 and 8.

Table 7: Summary of Tolerance Revisions for Chlorpyrifos (40 CFR §180.342(a)).[1]			
Commodity/ Correct Commodity Definition	**Established Tolerance (ppm)**	**Recommended Tolerance (ppm)**	**Comments**
Alfalfa, forage	3.0	3	Corrected values to be consistent with OECD Rounding Class Practice.
Grain, aspirated fractions	--	22	Recommended tolerance based on submitted residue data.
Beet, sugar, dried pulp	5.0	5	Corrected values to be consistent with OECD Rounding Class Practice.
Beet, sugar, roots	1.0	1	Corrected values to be consistent with OECD Rounding Class Practice.
Beet, sugar, leaves [2]	--	8	Commodity definition revision. Corrected values to be consistent with OECD Rounding Class Practice.
Beet, sugar, tops	8.0	remove	
Brassica, leafy greens, subgroup 4-16B	--	1	Crop group conversion/revision.[3,4]
Cherry, sweet	1.0	1	Corrected values to be consistent with OECD Rounding Class Practice.
Cherry, tart	1.0	1	Corrected values to be consistent with OECD Rounding Class Practice.
Fruit, citrus, group 10-10, dried pulp	--	5	Crop group conversion/revision. Corrected values to be consistent with OECD Rounding Class Practice.
Citrus, dried pulp	5.0	remove	
Fruit, citrus, group 10-10, oil	--	20	Crop group conversion/revision.
Citrus, oil	20	remove	
Corn, field, forage	8.0	8	Corrected values to be consistent with OECD Rounding Class Practice.
Corn, field, stover	8.0	8	Corrected values to be consistent with OECD Rounding Class Practice.
Corn, milled byproducts	--	0.1	Recommended tolerance based on submitted residue data.
Corn, sweet, forage	8.0	8	Corrected values to be consistent with OECD Rounding Class Practice.
Corn, sweet, stover	8.0	8	Corrected values to be consistent with OECD Rounding Class Practice.
Cotton, gin	--	15	Recommended tolerance based on

byproducts			submitted residue data.
Cotton, undelinted seed	0.2	0.3	Harmonization with Codex.
Cranberry	1.0	1	Corrected values to be consistent with OECD Rounding Class Practice.
Fruit, citrus, group 10-10	--	1	Crop group conversion/revision. Corrected values to be consistent with OECD Rounding Class Practice.
Fruit, citrus, group 10	1.0	remove	
Kohlrabi	--	1	Crop group conversion/revision.[3,4]
Kiwifruit, fuzzy	--	2	Commodity definition revision. Corrected values to be consistent with OECD Rounding Class Practice.
Kiwifruit	2.0	remove	
Milk	--	0.01	Commodity definition revision. Corrected values to be consistent with OECD Rounding Class Practice.
Milk, fat	--	0.3	
Milk, fat (Reflecting 0.01 ppm in whole milk)	0.25	remove	
Pepper, bell	--	1	Commodity definition revision. Corrected values to be consistent with OECD Rounding Class Practice.
Pepper, nonbell	--	1	
Pepper	1.0	remove	
Peppermint, fresh leaves	--	0.8	Commodity definition revision.
Peppermint, tops	0.8	remove	
Peppermint, oil	8.0	8	Corrected values to be consistent with OECD Rounding Class Practice.
Radish, roots	--	2	Commodity definition revision. Corrected values to be consistent with OECD Rounding Class Practice
Radish	2.0	remove	
Rutabaga, roots	--	0.5	Commodity definition revision.
Rutabaga	0.5	remove	
Spearmint, fresh leaves	--	0.8	Commodity definition revision.
Spearmint, tops	0.8	remove	
Spearmint, oil	8.0	8	Corrected values to be consistent with OECD Rounding Class Practice.
Sorghum, grain, stover	2.0	2	Corrected values to be consistent with OECD Rounding Class Practice.
Strawberry	0.2	0.3	Harmonization with Codex.
Sweet potato, tuber	--	0.05	Commodity definition revision.
Sweet potato, roots	0.05	remove	

Turnip, roots	1.0	1	Corrected values to be consistent with OECD Rounding Class Practice.
Turnip, leaves	--	0.3	Commodity definition revision.
Turnip, tops	0.3	remove	
Vegetable, brassica, head and stem, group 5-16	--	1	Crop group conversion/revision.[3] Corrected values to be consistent with OECD Rounding Class Practice.
Vegetable, brassica, leafy, group 5	1.0	remove	
Wheat, forage	3.0	3	Corrected values to be consistent with OECD Rounding Class Practice.
Wheat, milled byproducts	--	1.5	Recommended tolerance based on submitted residue data.
Wheat, straw	6.0	6	Corrected values to be consistent with OECD Rounding Class Practice.

[1] This table only includes recommended revisions to established tolerances and recommended establishment of new tolerances. For a complete list of all established tolerances see the International Residue Level Summary (IRLS) in Appendix 4.
[2] Sugar beet leaves/tops are no longer considered a significant livestock feed item. Commodity/tolerance may be removed.
[3] The recommended conversion of existing tolerance in/on **Vegetable, brassica, leafy, group 5** is to the following: **Vegetable, brassica, head and stem, group 5-16; Brassica, leafy greens, subgroup 4-16B;** and **Kohlrabi** (**"**Crop Group Conversion Plan for Existing Tolerances as a Result of Creation of New Crop Groups under Phase IV (4-16, 5-16, and 22)" dated 11/3/2015).
[4] HED is recommending for individual tolerances of 1 ppm for Kohlrabi based on the currently established tolerance for this commodity as part of crop group 5 (Vegetable, brassica, leafy). Kohlrabi is displaced by the crop group conversion noted in the footnote 3 above.

Table 8: Tolerance Revisions for Chlorpyrifos (40 CFR §180.342(c))[1, 2]

Commodity/ Correct Commodity Definition	Established Tolerance (ppm)	Recommended Tolerance (ppm)	Comments
Asparagus	5.0	5	Corrected values to be consistent with OECD Rounding Class Practice.

[1] This table only includes recommended revisions to established tolerances. For a complete list of all established tolerances see the IRLS in Appendix 4.
[2] Regional registrations.

The agency intends to undertake these tolerance actions pursuant to its Federal Food, Drug Cosmetic Act (FFDCA) authority. The agency will consider the input and recommendations from the September 2020 FIFRA Scientific Advisory Panel (SAP) on new approach methodologies for neurodevelopmental toxicity once the SAP report is released. After receiving the SAP's conclusions, EPA will examine the need for further tolerance actions.

5. Human Health Data Needs

The following residue chemistry data deficiencies were identified for chlorpyrifos. These data are not required to support this PID.

- 860.1500:
  - Separate magnitude of the residue studies for lemons are needed after application of Lorsban 4E and 75% WDG formulations in order to reevaluate the existing tolerance for chlorpyrifos for the citrus fruit crop group.
  - Magnitude of the residue studies are needed to establish a tolerance for residues of chlorpyrifos on wheat hay.

- 860.1520:
  - Processing studies are needed for soybean meal, hulls and refined oil.

B. Ecological Risks

A summary of the agency's ecological risk assessment is presented below. As stated earlier in this document, as part of the EPA's responsibility under the ESA, the agency completed a nationwide biological evaluation for chlorpyrifos initiated consultation with the NMFS in January 2017. In July 2019, EPA re-initiated formal consultation. NMFS is planning to issue a revised final BiOp for chlorpyrifos, diazinon, and malathion by June 2022. FWS has not yet issued a BiOp on chlorpyrifos.

Because the EPA's assessment of listed species is contained in its biological evaluation mentioned above, only the potential risks for non-listed species are described below.

The agency used the most current science policies and risk assessment methodologies to prepare a risk assessment in support of the registration review of chlorpyrifos. The agency has compiled an evaluation of risks to non-listed species for registration review in the document *Chlorpyrifos Draft Ecological Risk Assessment for Registration Review*. That document is based in part on the agency's biological evaluation for chlorpyrifos.[31] For additional details on the ecological assessment for chlorpyrifos, see the *Chlorpyrifos Draft Ecological Risk Assessment for Registration Review* (September 15, 2020), which is available in the public docket.

1. Risk Summary and Characterization

Chlorpyrifos prevents the natural breakdown of various cholines by inhibiting cholinesterase activity and ultimately causing the neuromuscular system to seize. Chlorpyrifos will initially enter the environment via direct application and may move off-site via runoff, spray drift, or volatilization. As it degrades, chlorpyrifos forms chlorpyrifos-oxon, TCP, and TMP. Further discussion on the consideration of residues of concern, the fate of chlorpyrifos, and study

[31] https://www.epa.gov/endangered-species/biological-evaluation-chapters-chlorpyrifos-esa-assessment

information may be found in the biological evaluation[32] and the previously issued drinking water assessments.[33] [34]

Terrestrial Risks

Mammals

The streamlined ecological risk assessment identified acute and chronic risks of concern from most uses for chlorpyrifos. Acute risk estimates for mammals from chlorpyrifos exposure ranged from 0.01 to 10. Half of the uses assessed resulted in acute RQs of 5 or greater (LOC = 0.5). Chronic risks in animals based on reproductive effects, a 30% loss of pups, ranged from 0.66 to 625. All chronic RQs based on a 4 to 5% decrease in body weight resulted in potential exceedances to the agency's LOC of 1 with a range of 2.01 to 1900. Fifty percent of uses resulted in RQs greater than 148 based on a reproductive endpoint and over 450 based on body weight loss.

Birds, Reptiles, and Terrestrial-Phase Amphibians

Acute RQs ranged from 0.07 to 380 with over half of all uses resulting in RQs greater than 93 (LOC = 0.5). Risk estimates for birds were based on significant reproductive effects, an 83% reduction in eggs laid. More than half of uses assessed resulted in chronic RQs above 14 with a total range of 0.60 to 58 (LOC = 1). As a result, there may be adverse effects to birds, as well as to terrestrial-phase amphibians and reptiles for which birds serve as surrogates.

Terrestrial Invertebrates (honeybees)

Consistent with its use as an insecticide, chlorpyrifos is highly toxic to adult honeybees on an acute exposure basis. The 2017 biological evaluation did not include the review of one acute larval honeybee study from Corteva. MRID 49960301 was submitted on the effects of chlorpyrifos to honeybee larvae after acute *in vitro* exposure. This study resulted in an LD_{50} of 0.0165 µg a.i./larva. This represented the most sensitive endpoint available for effects to honeybee larvae and was used as the endpoint for risk estimation. Acute RQs range from 820 to 4900 with exceedances for all uses (LOC = 0.4). Chronic toxicity data is not available for chlorpyrifos; therefore, the risk picture for terrestrial invertebrates is incomplete.

After EPA issued the problem formulation and registration review DCI for chlorpyrifos, EPA released its June 2014 *Guidance for Assessing Pesticide Risks to Bees*[35]. This 2014 guidance lists additional pollinator studies that were not included in the chlorpyrifos registration review DCI. Due to the timing of the chlorpyrifos DCI being issued before the guidance came out, EPA is not requiring any additional studies for assessing pollinators as part of registration review, although EPA continues to consider whether additional pollinator data are needed for chlorpyrifos. If the

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[32] https://www.epa.gov/endangered-species/biological-evaluation-chapters-chlorpyrifos-esa-assessment
[33] https://www.regulations.gov/document?D=EPA-HQ-OPP-2008-0850-0198
[34] https://www.regulations.gov/document?D=EPA-HQ-OPP-2015-0653-0437
[35] Available at https://www.epa.gov/sites/production/files/2014-06/documents/pollinator_risk_assessment_guidance_06_19_14.pdf

agency determines that additional pollinator exposure and effects data are necessary for chlorpyrifos, then the EPA will issue a DCI to obtain these data. The pollinator studies that could be required are listed in Table 9 below.

Table 9: Potential Pollinator Data Requirements	
Guideline #	**Study**
Tier 1	
850.3020	Acute contact toxicity study with adult honey bees
850.3030	Honey bee toxicity of residues on foliage
Non-Guideline (OECD 213)	Honey bee adult acute oral toxicity
Non-Guideline (OECD 237)	Honey bee larvae acute oral toxicity
Non-Guideline	Honey bee adult chronic oral toxicity
Non-Guideline	Honey bee larvae chronic oral toxicity
Tier 2†	
Non-Guideline	Field trial of residues in pollen and nectar
Non-Guideline (OECD 75)	Semi-field testing for pollinators
Tier 3†	
850.3040	Full-Field testing for pollinators

† The need for higher tier tests for pollinators will be determined based upon the results of lower tiered tests and/or other lines of evidence and the need for a refined pollinator risk assessment.

<u>Terrestrial and Aquatic Plants</u>

Risk quotients for aquatic vascular, non-vascular, and terrestrial plants did not exceed EPA's LOC of 1 with a total range of < 0.01 to 0.42. In addition, there were no vegetative vigor effects seen for either monocots or dicots and no seedling emergence effects were observed for monocots. There are some incidents involving plants from chlorpyrifos exposure, but potential risks to terrestrial or aquatic plants from chlorpyrifos exposure is considered limited.

Aquatic Risks

<u>Fish and Aquatic-Phase Amphibians</u>

The acute and chronic effects of chlorpyrifos exposure have been studied extensively in aquatic organisms. The acute LC_{50} for estuarine/marine and freshwater fish were 0.37 and 1.7 μg a.i./L, respectively. The chronic NOAEC was 0.28 μg a.i./L for estuarine fish but was not determined for freshwater fish which had a LOAEC of 0.251 μg a.i./L. Endpoints for fish were based on a 52% in fecundity for freshwater fish with a LOAEC of 0.251 μg a.i./L, lower than that of 0.48 μg a.i./L, for estuarine fish with 32% reduction in fecundity.

As with mammals, the majority of acute and all chronic RQs exceeded EPA's LOC of 0.5 for acute risks and 1 for chronic risks. Over 50% of uses assessed resulted in acute RQs above 33 with a range of .42 to 160. Chronic RQs reached a maximum of 135. Given the many use patterns affiliated with chlorpyrifos use, potential risks to fish and aquatic-phase amphibians from chlorpyrifos exposure can be expected.

Aquatic Invertebrates

All RQs for aquatic invertebrates were well above the agency's LOC of 0.5 for acute risks and 1 for chronic risks. Maximum acute and chronic RQs were 4300 and 8600, respectively, with 50% of all uses having RQs over 880 and 1540, respectively. Since chlorpyrifos is registered for a number of uses patterns across the United States, there exists the potential for risks to aquatic invertebrates.

2. Ecological Incidents

Numerous notable ecological incidents (e.g., significant fish kills, bee kills, large number of bird deaths) have been reported for all taxa for chlorpyrifos, including plants. These incidents summarized herein are based on the incidents reported for the chlorpyrifos Biological Evaluation and were reported with a high certainty level that chlorpyrifos was the associated causative agent. The biological evaluation on chlorpyrifos provided an extensive analysis of reported incidents broken down by individual taxa. Chlorpyrifos was reported as the 'possible,' 'probable,' or 'highly probable' causative agent for 110 adverse aquatic incidents (e.g., fish kills), 64 incidents involving birds, and 43 terrestrial plant incident reports. Some of the terrestrial plant incident reports were associated with spray drift, but most involved damage to the crop treated.

Additionally, 36 bee incidents were classified with a certainty index of 'possible', 'probable' or 'highly probable'. All of the terrestrial invertebrate incident reports involve honeybees, with bees being exposed via foraging on treated plants or by spray drift.

On August 14, 2020, an updated incident report was generated from the Incident Data System (IDS) for the time period from approximately January 1, 2015 to August 14, 2020. There were 20 unique incidents reported associated with nontarget organism in IDS. All of these incidents were associated with bee kills, except for one where the organism impacted was not specified. Two aggregate incidents, one presumed to involve bees, and one involving non-specified wildlife, were additionally reported.

EPA will continue to monitor ecological incident information as it is reported to the agency. Detailed analyses of these incidents are conducted if reported information indicates concerns for risk to non-target organisms.

3. Ecological and Environmental Fate Data Needs

No additional ecological or environmental fate data are required to support this registration review decision. EPA will consider requiring submission of pollinator data as a separate action.

C. Benefits Assessment

Based on a recent analysis[36] conducted by the agency for agricultural uses of chlorpyrifos, the total annual economic benefit of chlorpyrifos to crop production is estimated to be $19 - $130 million. These estimates are based on the additional costs of alternative pest control strategies likely to be used in the absence of chlorpyrifos or reduced revenue for some crops that do not have effective alternatives to chlorpyrifos for some pests. In some cases, effective alternatives could not be found; for those crops, the benefit of chlorpyrifos was estimated by yield or quality losses if chlorpyrifos were no longer available for use.

The high benefits are reflected in the wide use of chlorpyrifos on many different crops. However, despite this widespread usage, the majority of the benefits are concentrated in specific crops and regions that rely on chlorpyrifos without available effective alternatives to control pests. In particular, there are potentially high total benefits of chlorpyrifos usage in the production of sugar beets in Minnesota and North Dakota, oranges in California, peaches in the Southeastern U.S., and soybeans and apples throughout the U.S. The high-end total benefit for each of these crops is estimated to be in excess of $7 million per year. High total benefits are driven by high per-acre cost of production without chlorpyrifos in the case of sugar beets, orange, apple, and peach, and by the extent of acres treated in the case of large field crops like soybean despite relatively low benefits per acre.

For most non-crop uses, the agency's assessment[37] concluded that, chlorpyrifos is no longer recommended or heavily used for critically important insect pests. However, there a few exceptions to this overall conclusion. For pests of public health concern, such as mosquitoes and certain ticks, chlorpyrifos is one of a limited set of effective options available for wide area or broadcast use in specific use settings, such as government agency mosquito control districts (when suppressing adult mosquitoes), and golf courses (for ticks). For mosquitoes, chlorpyrifos also has value as one of a few insecticides that can be used against pyrethroid-resistant populations or to delay the onset of such resistance. While effective alternatives are available, due to the consequences to public health posed by the serious diseases transmitted by these pests, chlorpyrifos provides an important resistance management tool to sustain the effectiveness of non-organophosphate alternatives.

Similarly, for the protection of certain types of cattle livestock from horn flies, chlorpyrifos confers a benefit to control fly populations that have developed tolerance to pyrethroids, a widely used class of insecticides. In addition, for horn fly populations that have not yet developed pyrethroid resistance, chlorpyrifos is an active ingredient that, when used in rotation with pyrethroids, could mitigate, delay or even avoid insecticide resistance. Finally, for producers of outdoor-grown nursery plant stock, chlorpyrifos is one of a very limited set of insecticide options that qualify producers' products for pest-free certification in southeastern U.S. states that are currently under a USDA quarantine intended to prevent the spread of imported fire ants.

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[36] Mallampalli, N., Waterworth, R., and Berwald, D. 2020. Benefits of Agricultural Uses of Chlorpyrifos (PC# 059101). Biological and Economic Analysis Division memorandum to the Pesticide Re-Evaluation Division. Official record available through the chlorpyrifos docket at www.regulations.gov.
[37] Mallampalli, N. and C. Paisley-Jones. 2020. Chlorpyrifos Benefits Assessment for Non-crop Uses. Biological and Economic Analysis Division memorandum to the Pesticide Re-Evaluation Division. Official record available through the chlorpyrifos docket at www.regulations.gov.

IV. PROPOSED INTERIM REGISTRATION REVIEW DECISION

A. Proposed and Considered Risk Mitigation and Regulatory Rationale

Chlorpyrifos poses potential dietary and aggregate risks associated with drinking water exposure for currently labelled uses with and without the 10X FQPA safety factor, and mitigation is being proposed to reflect the range of potential risks. With the exception of seed-treatment uses, both occupational handler and post-application risks of concern were identified with and without the 10X UF_{DB}. PPE, use restrictions, and REI extensions are being considered to address these potential risks. The agency is also proposing spray drift management label language, pesticide resistance management label language, and other labeling updates consistent with those which are being required for other pesticides in registration review.

The agency will consider the input and recommendations from the September 2020 FIFRA Scientific Advisory Panel (SAP) on new approach methodologies for neurodevelopmental toxicity once the SAP report is released. After receiving the SAP's conclusions, EPA may further revise the human health risk assessment and proposed/considered mitigation. The agency is currently in discussions with the registrants regarding the proposed/considered mitigation measures.

1. Use Cancellations

To mitigate potential dietary exposure to chlorpyrifos, the agency is proposing to limit application to select uses in certain regions of the U.S. where the EDWCs for those uses are lower than the DWLOCs. Table 10 provides a list of the high-benefit agricultural uses that the agency has determined will not pose potential risks of concerns with an FQPA safety factor of 10X and may be considered for retention. In addition to the agricultural uses listed below, the agency may also retain use on public health pests such as mosquitos, ticks, and fire ants. The agency will consider registrant and stakeholder input on the subset of crops and regions from the public comment period and may conduct further analysis to determine if any other limited uses may be retained.

Table 10: Agricultural Uses Proposed for Retention in Chlorpyrifos Labels with an FQPA Safety Factor of 10X

Use Site	State for retention at the 10X[1]
Alfalfa	AZ, CO, IA, ID, IL, KS, MI, MN, MO, MT, ND, NE, NM, NV, OK, OR, SD, TX, UT, WA, WI, WY
Apple	AL, DC, DE, GA, ID, IN, KY, MD, MI, NJ, NY, OH, OR, PA, TN, VA, VT, WA, WV
Asparagus	MI
Cherry (tart)	MI
Citrus	AL, FL, GA, NC, SC, TX
Cotton	AL, FL, GA, NC, SC, VA
Peach	AL, DC, DE, FL, GA, MD, MI, NC, NJ, NY, OH, PA, SC, TX, VA, VT, WV

Soybean	AL, CO, FL, GA, IA, IL, IN, KS, KY, MN, MO, MT, NC, ND, NE, NM, OH, OK, PA, SC, SD, TN, TX, VA, WI, WV, WY
Strawberry	OR
Sugar beet	IA, ID, IL, MI, MN, ND, OR, WA, WI
Wheat (spring)	CO, KS, MO, MT, ND, NE, SD, WY
Wheat (winter)	CO, IA, KS, MN, MO, MT, ND, NE, OK, SD, TX, WY
[1]Only specific uses in specific 2-digit HUCs were assessed as described in the 2020 drinking water assessment. These specific uses are based on usage data and may not reflect maximum label rates on current labels.	

With a 1X FQPA safety factor, the majority of labeled chlorpyrifos uses result in drinking water concentrations below the DWLOC. Uses with drinking water concentrations above the DWLOC include, 1) peppers, 2) trash storage bins, and 3) wood treatment. In addition, six uses as noted in Table 11 below, can only be retained in certain states. Otherwise, all labeled chlorpyrifos uses can be retained nationwide.

Table 11: Regional Restrictions for Corn, Tart Cherries, Citrus, Pecan, and Peach with an FQPA Safety Factor of 1X	
Use Site	**State for retention at the 1X[1]**
Corn	AL, AR, FL, GA, IA, IL, IN, KS, KY, LA, MN, MO, MS, MT, NC, ND, NE, NY, OH, OK, PA, SC, SD, VA, VA, WI, WV, WY
Cherries (tart) 3 lb a.i./A	WA, OR, ID, MT (Deer Lodge, Flathead, Granite, Lake, Lincoln, Mineral, Missoula, Powell, Ravalli, Sanders, and Silver Bow counties)
Cherries (tart) 2 lb a.i./A	MI, WA, OR, ID, MT (Deer Lodge, Flathead, Granite, Lake, Lincoln, Mineral, Missoula, Powell, Ravalli, Sanders, and Silver Bow counties)
Citrus	AL, FL, GA, NC, SC, TX
Pecan	AL, FL, GA, NC, NM, OK, SC, TX
Peach	AL, DC, DE, FL, GA, MD, MI, NC, NJ, NY, OH, PA, SC, TX, VA, VT, WV
[1]Only specific uses in specific states listed above were assessed as described in the 2020 supplemental document. These specific uses were assessed based on actual application rates from reported usage data and may not reflect maximum label rates on current labels. If usage data were not available no additional refinement was possible, therefore, the state would not be listed.	

Stakeholders and registrants identified to EPA particular crops they considered to be important chlorpyrifos uses.[38] EPA estimated the benefits of chlorpyrifos in these, and many other crops

[38] https://www.regulations.gov/document?D=EPA-HQ-OPP-2008-0850-0938

with chlorpyrifos use.[39] Uses that were identified by stakeholders and registrants as important were alfalfa, citrus, cotton, soybean, sugar beet, and wheat. The estimated per acre benefits for alfalfa were low, at around $1 per acre, but over 1 million acres are treated annually, so total benefits were over $1 million. For citrus, there are potential high benefits for California lemons in some cases, with benefits of $290 per acre. The high-end benefit estimate for California oranges was similar. However, chlorpyrifos use is already restricted in California, with almost all uses banned after 2020.[40] Estimated benefits of chlorpyrifos in cotton are up to $14 per acre, with total benefits of up to $6.1 million annually. The benefit of chlorpyrifos in soybean is up to $4 per acre, and with over 3 million acres treated annually, the total benefit could be about $12 million. Sugar beets had potentially very high per acre benefits of almost $500 per acre in parts of Minnesota and North Dakota, leading to high-end estimated benefits over $30 million overall. Per acre benefits in wheat are estimated to be low, about $1 per acre in both spring and winter wheat, with a total benefit for both crops of about $1.3 million. In addition to these crops, EPA estimated high per-acre economic benefits to growers.

Crops that EPA concluded have potentially high benefits per-acre were: apples (nationwide), where alternatives for some pests could cost up to $51 per acre more than chlorpyrifos; asparagus, where the lack of alternatives in Michigan specifically could lead to yield losses of up to $450 per-acre; tart cherries in Michigan, where uncontrolled pest pressure could lead to yield losses of up to $201 per-acre; peaches in the southeastern U.S., where uncontrolled pest pressure could lead to yield losses of up to $430 per acre in Georgia and South Carolina; strawberries in Oregon, where uncontrolled soil pests (garden symphylans) could lead to abandonment of strawberry acreage, with a loss that corresponds to over $7,800 per acre.

2. PPE

The agency is providing the details for all currently labelled uses that would require additional PPE should those uses be retained. Given the current proposal in Section IV.A.1., should cancellation of uses be pursued, only the subset of remaining uses will be identified as requiring the additional PPE described below.

As specified in Section III.A.2., of the 288 steady state occupational handler scenarios assessed for non-seed treatments, 119 scenarios are of concern with label-specified personal protective equipment (PPE; baseline attire, chemical resistant gloves, coveralls, and an elastomeric half mask respirator) assuming the 10X UF_{DB} (MOEs < 100). Risks of concern for 45 additional exposure scenarios could potentially be mitigated if engineering controls are used.

If the 10X database uncertainty factor is reduced to 1X (LOC = 10), 19 scenarios are of concern with label-specified PPE (MOEs < 10). Risks of concern for 15 additional scenarios could potentially be mitigated if engineering controls are used.

[39] Mallampalli, N., Waterworth, R., and Berwald, D. 2020. Benefits of Agricultural Uses of Chlorpyrifos (PC# 059101). Biological and Economic Analysis Division memorandum to the Pesticide Re-Evaluation Division. Official record available through the chlorpyrifos docket at www.regulations.gov.
[40] https://www.cdpr.ca.gov/docs/chlorpyrifos/pdf/chlorpyrifos_action_plan.pdf

a. PPE Requirements – potential risks with the 10X UF_{DB}

Airblast applications

With the exception of citrus and tree nuts (pecans), risk estimates for mixing and loading formulations in WSP were above the LOC of 100. The agency is considering reducing the rate of citrus from 6.0 lbs a.i./Acre to 4.0 lbs a.i./Acre due to occupational risks identified to airblast applicators. Although the MOEs for tree nuts (pecans) and citrus at the lower rate do not meet the LOC of 100, chlorpyrifos is regarded as a high benefit to these uses.

For the remaining formulations (L/SC/EC), risk estimates for mixers and loaders are below the LOC with the following PPE:

Table 12: Considered engineering controls and PPE for risks of concern from airblast applications

Crop/Use	PPE/Engineering controls	MOE
Citrus, Non-bearing Fruit and Nut Trees (Nursery)	Engineering controls	140
Tree Fruits (Nectarine, Peach - Dormant, Delayed Dormant)		190
Cherries, tree fruits (pear, plum/prune (dormant, delayed dormant), tree nuts (almonds, filberts, hazelnuts, pecans, walnuts)	Double layer (coveralls), gloves, and either a particulate filtering facepiece (PF5)	110
Ornamental and/or shade trees, ornamental woody shrubs and vines, herbaceous plants, Christmas tree plantations, grapes	Single layer (long pants and long sleeve shirt), gloves	150

To address potential risks of concerns from mixing and loading L/SC/EC formulations for airblast application, the agency is considering engineering controls or PPE as listed for the uses in Table 12.

MOEs for mixing and loading airblast applications for citrus at an application rate of 6.0 lbs a.i./acre (CA and AZ) are 67 for WSP formulations and 96 for L/SC/EC formulations. Given other risks of concern from this rate, the agency is considering reducing this application rate for Arizona to 4 lbs a.i./acre. Exposures in California are considered negligible after 2020. See Section IV.3. below for additional details regarding proposed application rate reductions.

All airblast application scenarios without engineering controls (i.e., enclosed cabs) resulted in risk estimates of concern without retention of the 10X UF_{DB}. MOEs for these scenarios ranged from 0.55 to 4.2. With engineering controls, MOEs were below the LOC of 100 for tree nuts (pecans) and citrus at 89 and 98, respectively, however, chlorpyrifos provides high benefits for use on these food crops. EPA, as a result, is considering requiring engineering controls for all airblast applications.

Groundboom applications

With the retention of the 10X UF_{DB}, EPA is considering requiring engineering controls (closed systems) to address potential risks of concerns to occupational handlers mixing and loading L/SC/EC chlorpyrifos formulations for groundboom applications for the following uses:

- Nursery stock (pre-plant)
- Brussels sprouts (at plant and post-emergence), cauliflower, cole crops, grapes (foliar, dormant, delayed dormant), mint (peppermint, spearmint), peanut, pineapple, rutabaga, strawberries (pre-plant), sunflower (pre-plant) sweet potato (pre-plant and soil broadcast), and tobacco (pre-plant).
- Beets (table, sugar, at plant), clover (grown for seed, foliar), hybrid cottonwood and polar plantations
- Cranberry
- Alfalfa, cotton, sorghum grain, soybean, and wheat
- Radishes (pre-plant).

Addition of engineering controls (closed systems) for mixing and loading L/SC/EC formulations for radishes is 96 and below the LOC of 100. Chlorpyrifos, however, is considered a high benefit for this use.

For the remaining groundboom applications that may be mitigated with additional PPE, EPA is considering the following measures for mixers and loaders in Table 13 and measures for applicators in Table 14:

<table>
<tr><th colspan="3">Table 13: Considered PPE for Mixing and Loading Groundboom applications: L/SC/EC</th></tr>
<tr><th>Crop/Use</th><th>Proposed PPE</th><th>MOE[1]</th></tr>
<tr><td>Carrots</td><td>Double layer (coveralls), gloves, and a particulate filtering facepiece (PF 5)</td><td>110</td></tr>
<tr><td>Carrots</td><td rowspan="3">Double layer (coveralls), and gloves</td><td>92</td></tr>
<tr><td>Ornamental and/or shade trees, herbaceous plants, ornamental woody shrubs and vines</td><td>91</td></tr>
<tr><td>Asparagus, beets (table, sugar; at plant), citrus orchard floors, forest plantings (reforestation, plantation, tree farm), grass (forage/fodder/hay), legume vegetables, nonagricultural outdoor buildings and structures, onions</td><td>91</td></tr>
<tr><td>Conifers and deciduous trees, seed orchard trees</td><td></td><td>96</td></tr>
</table>

Golf course (fairways, tees, greens)	Single layer (long-sleeved shirt and long pants) and gloves	150

[1]MOE < LOC; however, chlorpyrifos is considered to be a high benefit to this use.

Table 14: Considered PPE or Engineering Controls for Groundboom Applicators		
Crop/Use	**Considered PPE or considered engineering controls**	**MOE[1]**
Alfalfa, sorghum grain, soybean, and wheat	Engineering controls	200
Ornamental lawns and turf, sod farms (turf)		130
Radish (pre-plant)		170
Turnip		86
Alfalfa, sorghum grain, soybean, and wheat	Double layer (coveralls), gloves, and an elastomeric half mask respirator	92
Nursery stock (pre-plant)	Double layer (coveralls), gloves, and a particulate filtering facepiece respirator	110
Brussels sprouts (at plant and post-emergence), cauliflower, cole crops, grapes (foliar, dormant, delayed dormant), mint (peppermint, spearmint), peanut, pineapple, strawberries (pre-plant), sunflower (pre-plant) and tobacco (pre-plant		110
Brussels sprouts (post-plant), grapes (foliar)		96
Clover (grown for seed, foliar), hybrid cottonwood and polar plantations		110
Rutabaga		88
Alfalfa, Sorghum Grain, Soybean, Wheat		87
Sweet potato (pre-plant and soil broadcast)	Single layer, gloves, and an elastomeric half mask respirator	88
Cranberry	Single layer, gloves, and a particulate filtering facepiece respirator	120
Beets (table, sugar; at plant), clover (grown for seed; foliar), hybrid cottonwood/poplar plantations		90

<table>
<tr><td>Asparagus, beets (table, sugar; at plant), citrus orchard floors, cole crops (excludes Brussels sprouts and cauliflower), cotton, forest plantings (reforestation, plantation, tree farm), grapes (dormant, delayed dormant), grass (forage/fodder/hay), legume vegetables, nonagricultural outdoor buildings and structures, onions, peppers, and strawberries</td><td rowspan="6">Single layer (long-sleeved shirt and long pants) and gloves</td><td>120</td></tr>
<tr><td>Ornamental and/or shade trees, herbaceous plants, ornamental woody shrubs and vines</td><td>120</td></tr>
<tr><td>Carrots</td><td>130</td></tr>
<tr><td>Conifers and deciduous trees, seed orchard trees</td><td>170</td></tr>
<tr><td>Forest trees (softwoods and conifers)</td><td>200</td></tr>
<tr><td>Golf course (fairways, tees, greens)</td><td>250</td></tr>
</table>

[1]MOE < LOC; however, chlorpyrifos is considered to be a high benefit to this use.

Handheld and Tractor-drawn Spreader applications

The agency is considering requiring the use of double layer PPE (coveralls), gloves, and an elastomeric half mask respirator, for mixers, loaders, and applicators applying chlorpyrifos liquid concentrate formulations via manually-pressurized handwand for wood protection treatment and to pine seedlings in a nursery. Although the MOEs are 82 and 90, respectively, and therefore are of concern at the 10X UF_{DB}, the agency considers chlorpyrifos to be of high benefit for these uses.

To increase MOEs to the LOC of 100, the agency is considering requiring additional PPE for manually-pressurized handwand application on the following uses:

- Single layer (long-sleeved shirt, long pants, socks, and shoes), gloves, and a particulate filtering facepiece for wide area/general outdoor treatment
- Single layer (long-sleeved shirt, long pants, socks, and shoes) and gloves for: Christmas tree plantations, conifers and deciduous trees; plantation nurseries, grapes, seed orchard trees, forest trees (softwoods, conifers), golf course turf, mounds/nests, non-agricultural outdoor buildings and structures, ornamental woody shrubs and vines, ornamental non-flowering plants, outdoor commercial/institutional/industrial premises (see master label description), agricultural farm premises, poultry litter, tree fruits (cherries, nectarines, peaches, plum/prunes), tree nuts (almonds) - pre-plant, tree nuts (apple) - pre-plant, and fruits and nuts (non-bearing, see master label description).

Regardless of PPE, risk estimates for application with mechanically pressurized handgun were below EPA's LOC of 100 for all uses except ornamental woody shrubs and vines and seed orchard trees (MOEs = 440 to 8,300); MOEs of concern ranged from 2.1 to 83 for all other uses and were therefore of concern.

For the following backpack sprayer applications and formulations, the PPE listed below is being proposed in Table 15:

Table 15: Considered Mitigation for Backpack Sprayer Applications

Formulation	Application type	Crop/Targeted Use	PPE[1]	MOE
Dry flowable/water-dispersable granule in WSP	Broadcast (foliar)	Grapes (pre-bloom)	Double layer (coveralls), gloves, and an elastomeric half mask respirator	94[2]
	Trunk spray/Drench	Tree fruits (apple)		100
	Drench/Soil-Ground-directed	Grapes (pre-bloom)		150
L/SC/EC	Broadcast (foliar)	Golf course turf		94[2]
	Spot treatment applications (0.023 A treated)	Ornamental and/or Shade Trees, herbaceous plants	Baseline	320
		Ornamental lawns and turf, sod farms (turf)		350
		Outdoor commercial/institutional/industrial premises, non-agricultural buildings and structures, golf course turf		1300
Microencapsulated formula	Broadcast (foliar)	Ornamental woody shrubs and vines	Double layer (coveralls), gloves, and an elastomeric half mask respirator	94[2]
		Ornamental non-flowering plants		130
	Directed broadcast	Outdoor commercial/institutional/industrial premises	Baseline	230
	Broadcast	Agricultural farm premises	Baseline	400
	Broadcast	Poultry litter	Baseline	1100
WSP	Spot	Ornamental woody shrubs and vines (pre-transplant)	Baseline	330
	Spot	Outdoor lawns and turf, Sod Farms (turf)	Baseline	350

	Broadcast (foliar)	Ornamental woody shrubs and vines	Baseline	930

[1]Baseline PPE includes long-sleeved shirt, long pants, shoes, no gloves, and no respirator.
[2] Although additional PPE does not result in MOEs above the LOC of 100 with the retention of the 10X UF_{DB}, chlorpyrifos is considered a high benefit for these uses.

The above-mentioned uses are the only uses which meet the agency's LOC of 100 with retention of the 10X UF_{DB}. All remaining uses treated by backpack sprayer applications are considered below in section IV.A.3 for possible application method prohibitions.

Tractor-drawn spreader applications

To address risks of concern to occupational handlers applying chlorpyrifos by tractor-drawn spreader, EPA is considering use of additional PPE. Most MOEs for mixers, loaders, and applicators are above the LOC of 100 with use of a SmartBox®, which is considered an engineering control. The EPA is considering additional PPE as follows for the uses in Table 16:

Table 16: Considered mitigation for tractor-drawn applications		
Crop/Targeted Use	**PPE**	**MOE[1]**
	Mixers/Loaders	
Ornamental woody shrubs and vines	Double layer (coveralls), gloves, and an elastomeric half mask respirator	91
Alfalfa	Single layer (long-sleeved shirt and long pants) and an elastomeric half mask respirator	98
Rutabaga	Single layer (long-sleeved shirt and long pants), gloves, and a particulate filtering facepiece	100
Sweet potato		120
Brussels	Single layer (long-sleeved shirt and long pants) and a particulate filtering facepiece	92
Asparagus		120
Nursery stock		220
Citrus orchard floors, onions, ornamental lawns and turf, sod farms (turf)		180
	Applicators	
Peanut	Double layer (coveralls), gloves, and an elastomeric half mask respirator	110
Sorghum grain		110
Ornamental woody shrubs and vines		96
Radish		85

Rutabaga	Single layer (long-sleeved shirt and long pants), gloves, and a particulate filtering facepiece	97
Alfalfa		92
Cauliflower (post-plant), Turnip	Single layer (long-sleeved shirt and long pants) and a particulate filtering facepiece	86
Brussels Sprouts (post-plant)		86
Sweet potato		92
Cole crops (except cauliflower), ginseng, sugar beets, sunflower, tobacco		98
Asparagus		130
Nursery stock	Single layer (long-sleeved shirt and long pants), gloves	98
Citrus orchard floors, onions, ornamental lawns and turf, sod farms (turf)	Double layer (coveralls), gloves	87

[1] Although additional PPE does not result in MOEs above the LOC of 100 with the retention of the 10X UF_{DB}, chlorpyrifos is considered a high benefit for these uses.

Hand dispersal application

At baseline PPE, MOEs for the following uses are below the EPA's LOC of 100 when treated by rotary spreader or hand dispersal application. Therefore, the agency is considering requiring the following PPE:

Table 17: Considered Mitigation for Applications by Rotary Spreader or Hand Dispersal				
Crop/Target Category	**Application Equipment**	**Application Type**	**PPE**	**MOEs**
Nursery stock	Rotary spreader	Broadcast	Double layer (coveralls) and gloves	110
Golf course turf, ornamental and/or shade trees, herbaceous plants, ornamental lawns and turf, sod farms (turfs)			Single layer (long sleeved shirt, long pants) and gloves	100
Golf course (turf) sod farms (turf)	Hand dispersal	Spot		130

Risk estimates for all other uses (ornamental woody shrubs and vines, commercial/institutional/industrial premises, utilities (pad)) fall below the LOC of 100 with maximum PPE (double layer (coveralls), gloves, and an elastomeric half mask respirator) and with retention of the 10X UF_{DB}. Therefore, the remaining uses are considered for possible application method prohibitions as addressed below in section IV.A.3.

Wide Area Mosquito Abatement

Risk estimates of concern were found for occupational handlers mixing, loading, and applying for wide-area mosquito treatment. Chlorpyrifos is not the primary pesticide used for the majority of wide-area mosquito treatment programs. However, given the public health concern for mosquito as vectors for a number of pathogens, there are high benefits for maintaining chlorpyrifos to treat adult mosquitos, particularly in areas with high pest pressure.

Without engineering controls, MOEs for applying wide area treatments of mosquito adulticide by ground are of concern. Thus, EPA is considering requiring engineering controls (enclosed cab) for airblast and aerial application of wide area mosquito treatment and double layer (coveralls), gloves, and an elastomeric half mask respirator for mixing and loading airblast and aerial applications.

b. PPE Requirements – potential risks without the 10X UF_{DB}

Aerial and Chemigation Application

Due to potential risks of concern to mixers and loaders for aerial application even without retention of the 10X UF_{DB}, EPA is considering requiring the following:

Table 18: Considered Mitigation for Mixing and Loading for Aerial and Chemigation Applications at the 1X FQPA Safety Factor

Crop/Target Category	Formula	Considered Engineering Controls or PPE	MOE
Aerial, Chemigation			
Citrus	L/SC/EC	Double layer (coveralls), gloves, and either a particulate filtering facepiece or an elastomeric half mask respirator	11
Non-bearing fruit and nut trees (nursery), radish (pre-plant), turfgrass (sod or seed)			12
Cherries, hybrid cottonwood/poplar plantations, mint (peppermint and spearmint), peanut, rutabaga, strawberries			12

(pre-plant), sunflower (pre-plant), sweet potato, tobacco, tree fruits (apple,), nectarine, peach, pear, plum/prune), tree nuts (almonds, filberts, hazelnuts, pecans, walnuts), turfgrass (ornamental and sod farms)			
Clover (grown for seed), cranberry, sunflower (post-emergence/ foliar)			13
Asparagus, Brussels sprouts, cauliflower, cole crops, strawberries, sugar beets, radish	L/SC/EC	Single layer (long-sleeved shirt and long pants), gloves, and a particulate filtering facepiece	13
Aerial Application			
Corn (post-emergence)	L/SC/EC	Engineering Controls	13
Corn (pre-plant)	Granule	Double layer (coveralls), gloves, and either a particulate filtering facepiece or an elastomeric half mask respirator	13
Alfalfa, corn (pre-plant), cotton (except Mississippi), sorghum, soybean, wheat	L/SC/EC	Single layer (long-sleeved shirt and long pants), gloves, and a particulate filtering facepiece	13
Christmas tree plantations			18
Carrots			19
Peanut	Granule		10
Sweet potato			20
Chemigation Application			
Tree nuts, orchard floors, (pecans)	L/SC/EC	Engineering controls	15
Tree nut orchard floors (almonds, walnuts)			17

Corn (pre-plant)			22
Corn (post-emergence)		Single layer (long-sleeved shirt and long pants), gloves, and a particulate filtering facepiece	13
Alfalfa, corn (pre-plant), cotton (except Mississippi), sorghum, soybean, wheat			18

Groundboom Application

Mixing and loading all formulations in WSP resulted in MOEs above 10 and are not of concern at the UF_{DB} of 1X. Mixing and loading most L/SC/EC formulations with single layer (long-sleeved shirt, long pants) and a particulate filtering facepiece results in risks of concern for most uses. MOEs ranged from 1.9 to 28 with risks of concerns for the following uses: Corn (pre-plant and post-emergence), radish (pre-plant), rutabaga, Brussels sprouts (at-plant, post-plant), grapes (foliar, dormant, delayed dormant), sweet potato (pre-plant, soil broadcast), cotton (except Mississippi), cole crops, cauliflower, mint (peppermint, spearmint), peanut, pineapple, strawberries (pre-plant), sunflower (pre-plant), tobacco (pre-plant), cranberry, alfalfa, cotton, sorghum grain, soybean, wheat, beets (table, sugar; at plant), clover (grown for seed; foliar), hybrid cottonwood/poplar plantations, tree nut orchard floors (pecans, almonds, walnuts), nursery stock (pre-plant), ornamental lawns and turf, and sod farms.

With the addition of gloves for these uses, the range of MOEs increases to 11 – 56 and are no longer of concern at the UF_{DB} of 1X.

Groundboom application risks of concern were identified for corn (pre-plant), tree nut orchard floors (pecans, almonds, walnuts), and cotton (except Mississippi) (MOEs = 5.3 – 9.9). With the use of single layer (long-sleeved shirt, long pants) and gloves, all risk estimates for groundboom applicators are greater than 10 are not of concern at the UF_{DB} of 1X.

Airblast and Handheld Applications

For mixing and loading L/SC/EC for airblast applications, EPA is considering single layer (long-sleeved shirt and long pants) and gloves for the following uses:

- Citrus (CA and AZ); MOE = 24
- Citrus, Non-bearing Fruit and Nut Trees (Nursery); MOE = 36
- Tree Fruits (Nectarine, Peach - Dormant, Delayed Dormant); MOE = 48

EPA is also considering requiring double layer (coveralls) and gloves for backpack application on wide-area general outdoor treatment, and outdoor commercial/institutional/industrial premises, non-agricultural outdoor buildings and structures. The MOEs with this additional PPE range from 12 to 19.

For handheld applications, EPA is considering requiring single layer (long-sleeved and long pants) and gloves for:

- Brush roller application to wood protection treatment (MOE = 16) and structural (e.g., warehouses, food handling establishments, and home bathrooms (MOE = 33)).
- Manually-pressurized handwand application to: Wood protection treatment, nursery (pine seedlings), wide area/ general outdoor treatment, Christmas tree plantations, conifers and deciduous trees; plantation nurseries, grapes, seed orchard trees, forest trees (softwoods, conifers), golf course turf, mounds/nests, non-agricultural outdoor buildings and structures, indoor commercial/institutional/industrial premises (see master label description), food processing plant premises, ornamental woody shrubs and vines, ornamental non-flowering plants, tree fruits (cherries, nectarines, peaches, plum/prunes), tree nuts (almonds) - pre-plant, and tree nuts (apple) - pre-plant.

c. Additional PPE Labeling Updates and Requirements

PPE Label Consistency Updates

In addition, the agency is considering updating the glove and respirator statements currently on labels. The proposed new glove and respirator language does not fundamentally change the PPE that workers need to use, and therefore should impose no impacts on users.

For gloves in particular, all statements that refer to the chemical resistance category selection chart are proposed to be removed from chlorpyrifos labels, as they might cause confusion for users. These statements are proposed to be replaced with specific chemical-resistant glove types, consistent with the Label Review Manual.[41]

Respirator Requirement for Chlorpyrifos Handlers

To mitigate potential inhalation risk to occupational handlers, the agency is considering requiring a respirator and, for pesticides covered by the Worker Protection Standard[42] (WPS), the associated fit test, training, and medical evaluation for the aforementioned formulations and uses.

The EPA has recently required fit testing, training, and medical evaluations[43] for all handlers who are required to wear respirators and whose work falls within the scope of the WPS.[44] If a chlorpyrifos handler currently does not have a respirator, an additional cost will be incurred by the handler or the handler's employer, which includes the cost of the respirator plus, for WPS-covered products, the cost for a respirator fit test, training, and medical exam.

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[41] https://www.epa.gov/pesticide-registration/label-review-manual
[42] 40 CFR 170
[43] Fit testing, training, and medical evaluations must be conducted according to OSHA regulations 29 CFR § 1910.134, 29 CFR § 1910.134(k)(1)(i) through(vi), and 29 CFR § 1910.134, respectively.
[44] 40 CFR 170 (see also Appendix A of Chapter 10 of the Label Review Manual, available at https://www.epa.gov/pesticide-registration/label-review-manual). [45] Economic Analysis of the Agricultural Worker Protection Standard Revisions. Biological and Economic Analysis Division, Office of Pesticide Programs, U.S. EPA. 2015. p. 205. Available at www regulations.gov, docket number EPA-HQ-OPP-2011-0184-2522.

Respirator costs are extremely variable depending upon the protection level desired, disposability, comfort, and the kinds of vapors and particulates being filtered. Based on available information that the EPA has, the cost of the respirators (whether disposable or reusable) is relatively minor in comparison to the fit-test requirement under the Worker Protection Standard. The agency expects that the average cost of a particulate filtering facepiece respirator is lower than the average cost of an elastomeric half mask respirator. The estimated cost of a respirator fit test, training and medical exam is about $180 annually.[45] The impact of the proposed respirator requirement is likely to be substantially lower for a chlorpyrifos handler who is already using a respirator because the handler or handler's employer uses other chemicals requiring a respirator in the production system or as part of the business (*i.e.*, the handler or employer will only incur the cost of purchasing filters for the respirator on a more frequent basis). Respirator fit tests are currently required by the Occupational Safety and Health Administration (OSHA) for other occupational settings to ensure proper protection.[46]

The EPA acknowledges that requiring a respirator and the associated fit testing, training, and medical evaluation places a burden on handlers or employers. However, the proper fit and use of respirators is essential to accomplish the protections respirators are intended to provide. In estimating the inhalation risks, and the risk reduction associated with different respirators, the EPA's human health risk assessments assume National Institute for Occupational Safety and Health (NIOSH) protection factors (*i.e.*, respirators are used according to OSHA's standards). If the respirator does not fit properly, use of chlorpyrifos may cause unreasonable adverse effects on the pesticide handler.

Engineering Requirement for Handlers

EPA is considering requiring that a closed pesticide delivery system be used for mixing and loading chlorpyrifos for applications to several uses as described above. Professional applicators likely have closed pesticide delivery systems because they handle multiple chemicals, some of which likely already require closed pesticide delivery systems. Thus, the impacts of this restriction would likely be small for situations where hired applicators are used. Individual or independent growers are much less likely to have closed pesticide delivery systems than commercial firms, so these restrictions could impede their ability to use chlorpyrifos. Users who do not already have the appropriate equipment would have to hire a commercial firm to make chlorpyrifos applications, probably at an increase in cost, or use an alternative insecticide, which (as described above) could be more expensive and (in some cases) less efficacious. Users could also invest in a closed pesticide delivery system. The cost of a closed pesticide delivery system varies and depends on the complexity of the system. Based on available information, the cost of the equipment may have been around $300.[47] It seems unlikely, however, that a grower would incur such an expense if chlorpyrifos is the only chemical applied to the field that requires a closed pesticide delivery system.

[45] Economic Analysis of the Agricultural Worker Protection Standard Revisions. Biological and Economic Analysis Division, Office of Pesticide Programs, U.S. EPA. 2015. p. 205. Available at www.regulations.gov, docket number EPA-HQ-OPP-2011-0184-2522.
[46] 29 CFR § 1910.134
[47] Giles K., & Billing, R. 2013. Designs and Improvements in Closed Systems. Report to: Ken Everett, Pesticide Enforcement Branch, California Department of Pesticide Regulation.

EPA is also considering the requirement of an enclosed cab for airblast applications of chlorpyrifos. Users that do not currently own a tractor with an enclosed cab could hire commercial applicators to apply chlorpyrifos, at an increased cost, or switch to alternative insecticides. As described above, users face increased costs using the available alternatives for some uses, and for some crops (i.e., California oranges, apples, and Southeastern peaches) effective alternatives are not available and yield and quality losses are possible. The characteristics of some orchards do not lend themselves well to enclosed cabs. In these situations, this requirement will most likely result in growers using alternatives insecticides.

3. Use Prohibitions, Application Method Restrictions, and Rate Reductions

For the following application methods, potential risk estimates of concern could not be resolved with additional PPE or engineering controls. For that reason, the EPA is considering additional options for mitigating these risks, including application method prohibitions, restricting use of particular application methods to select use sites, and/or application rate reductions.

The subset of uses that are ultimately retained to address potential dietary risk (discussed in section IV.A.1) will impact the mitigation approach taken to address potential occupational risk. At this time, the EPA is presenting use prohibitions and application restrictions for risk estimates that were below the LOC. Once the EPA considers the SAP's conclusions, the EPA may further revise the human health risk assessment and proposed/considered mitigation. This includes consideration of additional refinements to the occupational risk estimates where possible. The EPA will also consider the benefits of the crops that are ultimately retained, as well as public comments, prior to finalizing any use prohibitions and/or application restrictions.

The impacts of the prohibitions and restrictions on uses will depend on the use site. As described in Section III.C, there are alternatives available to chlorpyrifos for most use sites, at an increased cost to users in many cases. There are exceptions, and some chlorpyrifos users could see reductions in pest control using the alternatives, resulting in reduced yield or quality of some crops.

a. Use Prohibitions and Application Restrictions – with the 10X UF_{DB}

Aerial and chemigation applications

Even with engineering controls, risks of concern were identified for most uses from mixing and loading for aerial and chemigation applications. Most MOEs for mixers and loaders with engineering controls ranged from 9.6 to 71. Exceptions include mixing and loading for ornamental and/or shade trees, herbaceous plants (WP in WSP), ornamental non-flowering plants (microencapsulated formula) and mosquito/vector control (L/SC/EC). Therefore, EPA is considering limiting application to select uses or prohibit aerial and chemigation application of chlorpyrifos to all uses except chemigation application of microencapsulated formula on ornamental non-flowering plants and mosquito/vector control. See Appendix A for a complete list of considered prohibited uses.

Although the use of global positioning systems (GPS) has vastly replaced the use of flaggers to guide aerial applications, the agency continues to assess exposure as use of flaggers is not explicitly prohibited on pesticide products containing chlorpyrifos. All liquid applications of chlorpyrifos products results in potential risks of concern for flaggers with the maximum amount of PPE (double layer (coveralls), gloves, and an elastomeric half mask respirator). Potential risks of concern were identified for flaggers with granule application for treatment of peanuts regardless of PPE. Use of chlorpyrifos granule products also resulted in risks of concern without use of a respirator for application on sweet potato, corn (pre-plant), sunflower, and tobacco. No risks of concern were identified for flaggers with granule application to sod farms (turf). Therefore, the agency is considering prohibiting use of flagger for all applications except granule application to sod farms (turf).

Groundboom application

Risk estimates with engineering controls were still below EPA's LOC of 100 for mixing and loading the following formulations and respective uses (MOEs = 39 – 98):

- Liquid/Soluble Concentrate: Corn (pre-plant and post-emergence), cotton (except MS), tree nut orchard floors (pecans, almonds, walnuts), ornamental lawns and turf, and sod farms
- Wettable powder in WSP: Ornamental lawns and turf, sod farms (turf), ornamental woody shrubs and vines (pre-transplant)
- Dry flowable (DF) /water-soluble granule (WSG) in WSP: Tree nut orchard floors (pecans, almonds, walnuts), corn, sorghum grain, soybean, rutabaga, and turnip

Consequently, EPA is considering prohibiting chlorpyrifos application to the above uses and formulations by groundboom application. This would also address risks of concern to groundboom applicators for corn (pre-plant), cotton (except Mississippi).

WSP formulations are assessed having the protection factor of engineering controls. The DF/WSG in WSP formulations do not fully meet the LOC of 100 for sweet potato (pre-plant, soil broadcast), cole crops (excludes Brussels sprout and cauliflower), mint (peppermint and spearmint), peanut, sunflower, and tobacco with MOEs ranging from 92 to 98. Chlorpyrifos is regarded as a high benefit for these uses.

Airblast application

Risk estimates for mixing and loading with engineering controls for citrus (CA and AZ at a rate of 6.0 lbs a.i./Acre) resulted in MOEs of 96 (L/SC/EC) and 67 (wettable powder in WSP and DF/WDG in WSP). The MOE for airblast application to citrus at the highest rate was 64 with engineering controls. Given recent chlorpyrifos restrictions in the state of California, use in California is expected to be negligible after 2020. EPA is considering reducing the application rate applied to citrus in Arizona to 4.0 lbs a.i./acre. MOEs for this reduced rate are 98 and still below the EPA's LOC of 100. However, citrus is recognized as a high-benefit use for chlorpyrifos. Reducing this rate will also address potential post-application risks of concern for citrus (assuming retention the 10X UF_{DB}).

Tractor-drawn spreader

Use of double layer (coveralls), gloves, and a half face respirator results in the highest MOEs for mixing, loading, or applying chlorpyrifos by tractor-drawn spreader. MOEs for mixing and loading soybean and corn were 74 and 79, respectively. Engineering controls, excluding applications by SmartBox®, results in slightly lower risk estimates. Consequently, EPA is considering prohibiting tractor drawn spreader application on these uses.

Handheld application methods

Regardless of PPE, risk estimates for application with mechanically pressurized handgun were below EPA's level of concern for all uses except ornamental woody shrubs and vines and seed orchard trees (MOEs = 440 to 8300); MOEs of concern ranged from 2.1 to 83 for all other uses. As a result, EPA is considering limiting mechanically-pressurized handgun application only to ornamental woody shrubs and vines and seed orchard trees.

The agency is considering prohibiting manually pressurized handwand application to indoor commercial/institutional/industrial premises and food processing plant premises. The risk estimate for these uses is 16 with maximum PPE.

To address risks of concern to occupational handlers using backpack sprayers, the agency is considering prohibiting all uses with the retention of the 10X UF_{DB} except for the formulations, uses, and conditions listed in Section IV.A.2.

The highest MOEs with maximum PPE (double-layer (coveralls), gloves, and an elastomeric half mask respirator) for application of chlorpyrifos by belly grinder or brush roller are 43 and 45, respectively. Given the limited uses for this application method, none of which are food uses, the agency is considering prohibiting application of chlorpyrifos by these handheld methods.

EPA is also considering prohibiting application of granular formulation by hand dispersal to commercial/institutional/industrial premises and utilities (pad) and by belly grinder to ornamental wood shrubs and vine. Prohibiting application to sewer manholes by brush roller may also be considered. MOEs for these applications with double layer (coveralls), gloves, and an elastomeric half mask respirator ranged from 1.4 to 7.1.

Microencapsulated formulations on ornamentals in nurseries and in greenhouses (post-application)

Occupational post-application risks of concern from microencapsulated formulations extend up to >35 days for ornamentals in nurseries and greenhouses. Extending REIs beyond a week, even on the basis on select activities, is not considered practical. Other uses which have risk estimates below the agency's LOC of 100 at the FQPA safety factor of 10X include grape and cole crops. For these uses, EPA is in the process of determining the most appropriate DFR study to characterize risks for mitigation. Given the alternative formulations of chlorpyrifos available with significantly shorter REIs, EPA is considering prohibiting microencapsulated formulations for use on ornamentals in nurseries and greenhouses.

Seed Treatment

Occupational handlers applying chlorpyrifos for seed treatment may potentially conduct multiple tasks, such as sewing, bagging, loading, and applying. Additional activities increase the amount of potential exposure to these workers. These activities were assessed with the maximum amount of PPE available:

Table 19: Seed Treatment Activities and PPE

Activity	Maximum PPE assessed
Sewing seeds after seed treatment	Single layer (long sleeved shirt and long pants), no gloves and no respirator
Bagging seeds after seed treatment	
Loading/Applying liquid for seed treatment	Double layer (coveralls), gloves and PF10 respirator
Multiple activities for seed-treatment	

As a result, the agency is considering prohibiting use of chlorpyrifos as a seed treatment for the following formulations and crops based on risks to multiple activities workers or occupational handlers that conduct multiple activities for seed treatment (e.g., applying and bagging):

- Liquid formulation on beans, corn, cotton
- Microencapsulated formulation on beans
- Wettable powder in WSP on beans and corn

b. Use Prohibitions and Application Restrictions – without the 10X UF_{DB}

MOEs for aerial application of granular formulations of chlorpyrifos on peanuts is 5 with engineering controls. MOEs for other aerial granular applications range are 9.4 (sweet potato) and 9.5 (sunflower, tobacco) also with engineering controls. Therefore, EPA is considering prohibiting this application method on peanuts. Although the risk estimates are still below a LOC of 10 for sweet potato, sunflower, and tobacco, these uses are proposed to be retained given the benefits associated with the use of chlorpyrifos on these crops.

The agency is also considering prohibiting backpack sprayer application to ornamental and/shade trees, herbaceous plants, ornamental woody shrubs and vines. MOEs for application to these non-food sites are 3.8 with maximum PPE (double layer (coveralls), gloves, and an elastomeric half mask respirator) and therefore are of concern.

For handheld applications, EPA is considering prohibiting brush roller application for sewer manholes and hand dispersal to commercial/institutional/industrial premises and utilities (pad). With double layer (coveralls), gloves, and an elastomeric half mask respirator, the MOE is 1.4

for broadcast hand dispersal application to commercial/institutional/industrial premises and utilities (pad) and, therefore, is below the LOC. The agency is also considering prohibiting application with belly grinders on ornamental woody shrubs and vines. With maximum PPE, the MOE is 7.1 and below the LOC of 10 for these uses.

4. Re-Entry Interval

With retention of the 10X UF_{DB}, risk estimates exceed the LOC of 100 for over 30 activities/uses. These include: berries, field and row crops, tree fruit (deciduous, evergreen), forestry, tree nuts (almonds), ornamental nurseries (non-bearing fruit trees), fruiting vegetables, brassica vegetables, leafy vegetables, and grapes. As multiple DFR studies were submitted for many uses, the MOEs for chlorpyrifos on these crops may vary depending on activity and study location. EPA is in the process of determining the most appropriate DFR study to characterize risks for mitigation. Proposed REIs for uses with identified risks of concern may extend over one week. At the 1X UF_{DB}, the MOEs exceed the LOC for approximately 10 crop groups with proposed REIs extending from 2 to 5 days. See Appendix D2 for the mitigation being considered to address occupational post-application risks of concern. Mitigation measures for other risks of concern may impact the selection of uses that are maintained and, thus, how EPA addresses these post-application risks of concern.

5. Pesticide Resistance Management

Pesticide resistance occurs when genetic or behavioral changes enable a portion of a pest population to tolerate or survive what would otherwise be lethal doses of a given pesticide. The development of such resistance is influenced by a number of factors. One important factor is the repeated use of pesticides with the same mode (or mechanism) of action. This practice kills sensitive pest individuals but allows less susceptible ones in the targeted population to survive and reproduce, thus increasing in numbers. These individuals will eventually be unaffected by the repeated pesticide applications and may become a substantial portion of the pest population. An alternative approach, recommended by resistance management experts as part of integrated pest management (IPM) programs, is to use pesticides with different chemical modes (or mechanisms) of action against the same target pest population. This approach may delay and/or prevent the development of resistance to a particular mode (or mechanism) of action without resorting to increased rates and frequency of application, possibly prolonging the useful life of pesticides.

The EPA is proposing to include resistance-management labeling for insecticides/acaricides from PRN 2017-1, for products containing chlorpyrifos, in order to provide pesticide users with easy access to important information to help maintain the effectiveness of useful pesticides.[48] Resistance management label language for insecticides may be found at: https://www.epa.gov/pesticide-registration/pesticide-registration-notices-year.

[48] https://www.epa.gov/pesticide-registration/pesticide-registration-notices-year

Additional information on the EPA's guidance for resistance management can be found at the following website: https://www.epa.gov/pesticide-registration/prn-2017-1-guidance-pesticide-registrants-pesticide-resistance-management.

6. Spray Drift Management

EPA is proposing label changes to reduce off-target spray drift and establish a baseline level of protection against spray drift that is consistent across all chlorpyrifos products. Reducing spray drift is expected to reduce the extent of environmental exposure and risk to non-target plants and animals, including listed species whose range and/or critical habitat co-occur with the use of chlorpyrifos. These spray drift reduction measures, once finalized in the Interim Decision, will be considered in forthcoming consultation with the Services, as appropriate.

EPA is proposing the following spray drift mitigation language to be included on all chlorpyrifos product labels for products applied by liquid spray application. The proposed spray drift language includes mandatory, enforceable statements and supersede any existing language already on product labels (either advisory or mandatory) covering the same topics. EPA is also providing recommendations that allow chlorpyrifos registrants to standardize all advisory language on chlorpyrifos product labels. Registrants must ensure that any existing advisory language left on labels does not contradict or modify the new mandatory spray drift statements proposed in this PID, once effective.

- Applicators must not spray during temperature inversions.

- For aerial applications,
  - Do not apply when wind speeds exceed 10 mph at the application site.
  - The boom length must be 65% or less of the wingspan for fixed wing aircraft and 75% or less of the rotor diameter for helicopters. Applicators must use ½ swath displacement upwind at the downwind edge of the field.
  - The release height must be no higher than 10 feet from the top of the crop canopy or ground, unless a greater application height is required for pilot safety.

- For groundboom applications,
  - Do not apply when wind speeds exceed 10 mph at the application site.
  - Apply with a release height no more than 3 feet above the ground or crop canopy.

- Airblast applications:
  - Sprays must be directed into the canopy.
  - Do not apply when wind speeds exceed 10 miles per hour at the application site.
  - User must turn off outward pointing nozzles at row ends and when spraying outer row.

Buffers were required to mitigate potential spray drift risk to bystanders in the July 2012 *Spray Drift Mitigation Decision for Chlorpyrifos.* Buffer distances implemented as a result of that decision are not superseded by this PID, and are included below for reference:

Table 20: Buffer Distances				
Application rate (lb ai/A)	Nozzle Droplet Type	Required Setback (Buffer Zones) (feet)		
		Aerial	Airblast	Ground
>0.5 - 1	coarse or very coarse	10	10	10
>0.5 - 1	medium	25	10	10
>1 - 2	coarse or very coarse	50	10	10
>1 - 2	medium	80	10	10
>2 - 3	coarse or very coarse	80[1]	10	10
>2 - 3	medium	100[1]	10	10
>3 - 4	medium or coarse	NA[2]	25	10
>4	medium or coarse	NA	50	10

[1]Aerial application of greater than 2 lb ai/A is only permitted for Asian Citrus Psyllid control, up to 2.3 lb ai/A.
[2]NA is not allowed.

Spray drift mitigation for chlorpyrifos has the potential to decrease an applicator's flexibility to make timely applications for both ground and aerial applications (e.g., windspeed and temperature inversions). Applicators may see a decrease in flexibility of application timing and an increase in managerial effort for scheduling production activities, ultimately increasing costs for the user if chlorpyrifos applications are not made in a timely manner. Some users may be forced to use alternative insecticides, which may be more costly and/or less effective than chlorpyrifos. Fixed-wing aircraft will have reduction in usable boom length, which may necessitate more passes to complete an application, potentially increasing application costs. EPA has determined the changes in release height and swath displacement will have minimal impact on aerial applications. The agency anticipates little impact with residential buffers and considers that this size buffer corresponds to good application practices when applying near residential areas.

7. Updated Water-Soluble Packaging Language for Chlorpyrifos

EPA is proposing updated directions for use language be added to chlorpyrifos labels that are packaged in WSP, consistent with the language being proposed across WSP products in registration review. The improved clarity is expected to ensure proper use of these products and to minimize exposure to occupational handlers.

B. Tolerance Actions

The chlorpyrifos tolerance expressions established 40 CFR § 180.342 will be updated to incorporate newly revised crop group definitions, OECD rounding class practice, commodity definition revisions, crop group conversions/revisions, and harmonization with Codex. The agency will consider the input and recommendations from the September 2020 FIFRA Scientific Advisory Panel (SAP) on new approach methodologies for neurodevelopmental toxicity once the

SAP report is released. After receiving the SAP's conclusions which are anticipated in December 2020, EPA will examine the need for further tolerance actions. The agency will use its FFDCA rulemaking authority to make the needed changes to the tolerances. Refer to Section III.A.4 for details.

C. Proposed Interim Registration Review Decision

In accordance with 40 CFR § 155.56 and § 155.58, the agency is issuing this PID. The agency has made the following PID: (1) no additional data from registrants are required at this time and (2) changes to the affected registrations and their labeling are needed at this time, as described in Section IV. A and Appendix A.

The agency has concluded that there is no evidence demonstrating that chlorpyrifos potentially interacts with estrogen, androgen, or thyroid pathways. Therefore, EDSP Tier 2 testing is not recommended. For more information, see the *EDSP Weight of Evidence Conclusions on the Tier 1 Screen Assays for the List 1 Chemicals*[49] and Appendix C. The proposed mitigation described in this document is expected to reduce the extent of environmental exposure and may reduce risk to listed species whose range and/or critical habitat co-occur with the use of chlorpyrifos.

D. Data Requirements

The agency does not anticipate calling-in additional data for registration review of chlorpyrifos at this time. The EPA will consider requiring submission of pollinator and residue chemistry data as a separate action.

V. NEXT STEPS AND TIMELINE

A. Proposed Interim Registration Review Decision

A Federal Register Notice will announce the availability of this PID for chlorpyrifos and will allow a 60-day comment period. If there are no significant comments or additional information submitted to the docket during the comment period that leads the agency to change its PID, the EPA may issue an interim registration review decision for chlorpyrifos. However, a final decision for chlorpyrifos may be issued without the agency having previously issued an interim decision. A final decision on the chlorpyrifos registration review case will occur after: (1) an endangered species determination under the ESA and any needed § 7 consultation with the Services, and (2) the agency completes a revised cumulative risk assessment for OPs.

B. Implementation of Mitigation Measures

[49] https://www.regulations.gov/document?D=EPA-HQ-OPP-2008-0850-0849

Once the Interim Registration Review Decision is issued, the chlorpyrifos registrants must submit amended labels that include the label changes described in Appendix A. The agency will issue a label table after considering the input and recommendations from the September 2020 FIFRA Scientific Advisory Panel (SAP) on new approach methodologies for neurodevelopmental toxicity. The revised labels and requests for amendment of registrations must be submitted to the agency for review within 60 days following issuance of the Interim Registration Review Decision in the docket.

Appendix A: Summary of Proposed and Considered Actions for Chlorpyrifos

NOTE: The proposed and considered actions below reflect the suite of mitigation measures being considered for each of the currently labeled chlorpyrifos uses. If the agency moves forward with the use restrictions being proposed to reduce dietary exposure from drinking water, select occupational and post-application actions proposed below may not be needed. The agency will reexamine the proposed and considered mitigation after considering public input during the comment period and conclusions from the 2020 SAP.

Registration Review Case#: 0100 PC Code: 059101 Chemical Type: Insecticide Chemical Family: Organophosphate Mode of Action: Acetylcholinesterase inhibition						
Affected Population(s)	**Source of Exposure**	**Route of Exposure**	**Duration of Exposure**	**Potential Risk(s) of Concern**	**Proposed Actions with 10X FQPA SF**	**Proposed Actions with the 1X FQPA SF**
Infants and children	Dietary (drinking water)	Ingestion	Acute Steady state	Neurotoxicity	To reduce potential dietary exposure to chlorpyrifos, the agency is considering label amendments to limit use of chlorpyrifos to the 11 high-benefit and/or critical uses (alfalfa, apple, cherries (tart), asparagus, citrus, cotton, peach, soybean, strawberry, sugar beet, wheat (spring), and wheat (winter)) in select regions, as well as public health uses, as identified in Section IV.A.1. of this PID.	To reduce potential dietary exposure to chlorpyrifos, the agency is considering label amendments to prohibit the following uses: Peppers, trash storage bins, and wood treatment; and restrict the following uses to certain regions: corn, cherries (tart), citrus, pecans and peach; and reduce the application rate for cherries (tart) by region, as identified in Section IV.A.1. of this PID.
Females 13-49 years of age	Dietary (drinking water)	Ingestion	Acute Steady state	Neurotoxicity		
Considered mitigation for Occupational Risks of Concern						
Affected Population(s)	**Source of Exposure**	**Route of Exposure**	**Duration of Exposure**	**Potential Risk(s) of Concern**	**Mitigation Actions Considered with 10X UF_{DB}**	**Mitigation Actions Considered with the 1X UF_{DB}**
Occupational handler risks from mixing and loading most aerial and chemigation applications: Liquid/Soluble Concentrate/Emulsifiable	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider prohibiting aerial and chemigation application of chlorpyrifos to all uses except for aerial use on ornamental non-flowering	Consider prohibiting application of granules on peanuts. Consider use of double layer (coveralls), gloves, and an

Concentrate (L/SC/EC) and granule					plants and as a wide area mosquito adulticide (L/SC/EC). Consider requiring double layer (coveralls), gloves, and an elastomeric half mask respirator for mixing and loading aerial mosquito adulticide applications.	elastomeric half mask respirator, for: Citrus, non-bearing fruit and nut trees (nursery), radish (pre-plant), turfgrass (sod or seed), cherries, hybrid cottonwood/poplar plantations, mint (peppermint and spearmint), peanut, rutabaga, strawberries (pre-plant), sunflower (pre-plant), sweet potato, tobacco, tree fruits (apple, nectarine, peach, pear, plum/prune), tree nuts (almonds, filberts, hazelnuts, pecans, walnuts), turfgrass (ornamental and sod farms), clover (grown for seed), cranberry, sunflower (post-emergence/foliar). Consider single layer (long-sleeved shirt and long pants), gloves and a particulate filtering facepiece for: Asparagus, Brussels sprouts, cauliflower, cole crops, strawberries, sugar beets, and radish.
Occupational handler risks from mixing and loading aerial application only: L/SC/EC and granule	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider prohibiting all aerial application of chlorpyrifos on ornamental non-flowering plants and as a wide area mosquito adulticide (L/SC/EC). Consider requiring double layer (coveralls), gloves, and an elastomeric half mask respirator for mixing and loading aerial mosquito adulticide applications.	L/SC/EC: • Consider requiring engineering controls for mixing and loading corn (post-emergence). • Consider requiring single layer (long-sleeved shirt and long pants), gloves, and a particulate filtering facepiece for: Alfalfa, cotton (except Mississippi),

						sorghum, wheat, Christmas tree plantations, and carrots. Granule: • Consider double layer (coveralls), gloves, and either a particulate filtering facepiece or an elastomeric half mask respirator for corn (pre-plant). • Consider requiring single layer (long-sleeved shirt and long pants), gloves, and a particulate filtering facepiece for peanut and sweet potato.
Occupational handler risks from mixing and loading chemigation only applications: L/SC/EC	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider prohibiting all chemigation application of chlorpyrifos.	Consider requiring engineering controls for mixing and loading for use on: Tree nuts, orchard floors (pecans, almonds, walnuts), corn (pre-plant). Consider single layer (long-sleeved shirt and long pants), gloves, and a particulate filtering facepiece for mixing a loading for: Alfalfa, cotton (except Mississippi), sorghum, soybean, and wheat.
Occupational handler risks from mixing and loading most aerial and chemigation applications: Dry flowable/water-dispersable granules (DF/WDG) in WSP	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider prohibiting all aerial and chemigation application of chlorpyrifos DF/WDG in WSP formulations.	N/A

Occupational handler risks from mixing and loading most aerial and chemigation applications: Wettable Powder (WP), and Spray (all starting formulations	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider prohibiting application of WP to all uses except ornamental and/or shade trees, herbaceous plants. Consider prohibiting application of spray (all starting formulations) to the following uses: Citrus, carrots, corn (post-emergence), alfalfa, corn (pre-plant), Christmas tree plantations, cole crops, cotton (except Mississippi), sorghum, soybean, wheat, asparagus, Brussels sprouts, cauliflower, cole crops, strawberries, sugar beets, radish, clover (grown for seed; foliar), corn (post-emergence), cranberry, hybrid cottonwood/ poplar plantations grown for pulp, sunflower (post-emergence/ foliar), non-bearing fruit and nut trees (nursery), radish (pre-plant), sweet potato (pre-plant), cherries, mint (peppermint and spearmint), peanut, rutabaga, strawberries (pre-plant), sunflower (pre-plant), tobacco, tree fruits (apple, fig (CA only), nectarine, peach, pear, plum/prune), ornamental and/or shade trees, herbaceous plants, tree	N/A

					nuts (almonds, filberts/hazelnuts, pecans, walnuts), and turfgrass (ornamental and sod farms).	
Occupational handler risks from mixing and loading groundboom applications for: L/SC/EC	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider prohibiting application of L/SC/EC formulations by groundboom to: Corn (pre-plant, post-emergence), cotton (except Mississippi), tree nut orchard floors (pecans, almonds, walnuts), ornamentals lawns and turf, sod farms. Consider requiring engineering controls for mixing and loading L/SC/EC formulations for: Radish (pre-plant), alfalfa, cotton, sorghum grain, soybean, wheat, rutabaga, Brussels sprouts (at plant, post-plant), grapes (foliar, dormant, delayed dormant), sweet potato (pre-plant, soil broadcast), nursery stock (preplant), cole crops, cauliflower, mint (peppermint, spearmint), peanut, pineapple, strawberries (pre-plant), sunflower (pre-plant), tobacco (pre-plant), beets (table, sugar, at plant), clover (grown for seed; foliar), hybrid cottonwood/poplar plantations, and cranberry.	Consider requiring single layer (long-sleeved shirt, long pants), gloves, and a particulate filtering facepiece for: Corn (pre-plant and post-emergence), radish (pre-plant), rutabaga, Brussels sprouts (at-plant, post-plant), grapes (foliar, dormant, delayed dormant), sweet potato (pre-plant, soil broadcast), cotton (except Mississippi), cole crops, cauliflower, mint (peppermint, spearmint), peanut, pineapple, strawberries (pre-plant), sunflower (pre-plant), tobacco (pre-plant), cranberry, alfalfa, cotton, sorghum grain, soybean, wheat, beets (table, sugar; at plant), clover (grown for seed; foliar), hybrid cottonwood/poplar plantations, tree nut orchard floors (pecans, almonds, walnuts), nursery stock (pre-plant), ornamental lawns and turf, and sod farms.

					Consider requiring double layer (coveralls), gloves and particulate filtering facepiece for carrots. Consider requiring double layer (coveralls) and gloves for: Asparagus. beets (tables, sugar, at plant), citrus orchard floors, forest plantings (reforestation, plantation, tree farm), grass (forage/fodder/hay), legume, vegetables, nonagricultural outdoor buildings and structures, and onions. Consider requiring single layer (long-sleeved shirt and long pants) and gloves for: Conifers and deciduous trees, seed orchard trees, ornamental and/or shade trees, herbaceous plants, ornamental woody shrubs and vines, and golf course (fairways, tees, greens).	
Occupational handler risks from mixing and loading groundboom applications for: DF/WDG in WSP	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider prohibiting application of DF/WDG in WSP to: Tree nut orchard floors (pecans, walnuts, almonds), corn, sorghum grain, soybean, rutabaga, and turnip.	N/A
Occupational handler risks from mixing and loading	Air Residues	Dermal absorption	Acute Steady state	Neurotoxicity	Consider prohibiting application of WP (in WSP) to	N/A

groundboom applications for: WP (in WSP)		Inhalation			ornamental lawns and turf, sod farms (turf), and ornamental woody shrubs and vines (pre-transplant).	
Occupational handler risks from applying groundboom applications for: Spray (all starting formulations) considered for prohibition or engineering controls	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider prohibiting application of spray (in all starting formulations) to corn (pre-plant). Consider engineering controls for application on: Alfalfa, cotton, sorghum grain, wheat, radish, turnip, ornamental lawns and turf and sod farms (turf).	N/A
Occupational handler risks from applying groundboom applications for: Spray (all starting formulations) considered for additional PPE	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider double layer (coveralls), gloves, and an elastomeric half mask respirator for: Alfalfa, sorghum grain, soybean, and wheat. Consider double layer (coveralls), gloves, and particulate filtering facepiece for: Brussels sprouts (at plant, post-plant, and post-emergence), cauliflower, cole crops, , grapes (foliar, dormant, delayed dormant), mint (peppermint, spearmint), peanut, pineapple, rutabaga, strawberries (pre-plant), sunflower (pre-plant) sweet potato (pre-plant and soil broadcast), tobacco (pre-plant), nursery stock (pre-	Consider requiring single layer (long-sleeved shirt, long pants) and gloves for application to corn (pre-plant), tree nut orchard floors (pecans, almonds, walnuts), and cotton (except Mississippi).

					plant), rutabaga, clover (grown for seed, foliar), hybrid cottonwood and poplar plantations and potentially alfalfa, sorghum grain, soybean, and wheat. Consider single layer (long-sleeved shirt and long pants), gloves, and an elastomeric half mask respirator for: sweet potato (pre-plant and soil broadcast). Consider single layer, gloves, and particulate filtering facepiece for: Cranberry, beets (table, sugar; at plant), clover (grown for seed), and hybrid cottonwood and poplar plantations. Consider single layer and gloves for the following: Carrots, asparagus, beets (table, sugar, at plant), citrus orchard floors, cole crops (excludes Brussels sprouts and cauliflower), cotton, forest plantings (reforestation, plantation, tree farm), grapes (dormant, delayed dormant), grass (forage/fodder/hay), legume vegetables, nonagricultural outdoor buildings and structures, onions, peppers,	

					strawberries, ornamentals and/or shade trees, herbaceous plants, ornamental woody shrubs and vines, conifers and deciduous trees, seed orchard trees, forest trees (softwoods and conifers), and golf course (fairways, tees, and greens).	
Occupational handler risks from airblast applications: Mixing and loading L/SC/EC	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider requiring engineering controls for: Citrus, non-bearing fruit and nut trees (nursery), and tree fruits (nectarine, peach - dormant, delayed dormant). Consider requiring double-layer (coveralls), gloves, and an elastomeric half mask respirator (PF10) for: Cherries, tree fruits (pear, plum/prune (dormant, delayed dormant), and tree nuts (almond, filberts, hazelnuts, pecans, walnuts). Consider requiring single layer (long pants and long-sleeved shirt) and glove for: Ornamental and/or shade trees, ornamental woody shrubs and vines, herbaceous plants, Christmas tree plantations, and grapes.	Consider requiring single layer (long-sleeved shirt and long pants) and gloves for: Citrus, non-bearing fruit and nut trees (nursery), tree fruits (nectarine, peach - dormant, delayed dormant).
Occupational handler risks from airblast applications:	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider reducing application rate from 6.0 lbs a.i./Acre to 4.0 lbs a.i./Acre in Arizona.	N/A

Mixing and loading DF/WDG in WSP and WP (in WSP)						
Occupational handler risks from airblast applications: Applying spray (all starting formulations)	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider reducing application rate from 6.0 lbs a.i./Acre to 4.0 lbs a.i./Acre in Arizona. Consider requiring engineering controls for all uses.	N/A
Occupational handler: Seed treatment for liquid, microencapsulated, and wettable powder via WSP to multiple activities workers when applied on beans, corn, and cotton.	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider prohibiting seed-treatment for the following uses and formulations: • Liquid formulation on beans, corn, cotton • Microencapsulated formulation on beans • Wettable powder in WSP on beans and corn	N/A
Occupational handler: Mixing and loading, and applying by tractor-drawn spreader	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider prohibiting application on corn, soybean. Consider single layer (long-sleeved shirt and long pants) and an elastomeric half mask respirator for alfalfa. Consider single layer (long-sleeved shirt and long pants), gloves, and a particulate filtering facepiece for: Rutabaga and sweet potato.	N/A

					Consider single layer (long-sleeved shirt and long pants), and a particulate filtering facepiece for: Asparagus, cole crops, (excludes Brussels sprouts and cauliflower), ginseng, sugar beets, sunflower, citrus orchard floors, onions, tobacco, ornamental lawns and turf, sod farms (turf), and nursery stock.	
Occupational handler: Application by tractor-drawn spreader					Consider requiring double layer (coveralls), gloves, and an elastomeric half mask respirator for: Peanut and sorghum grain. Consider requiring double layer (coveralls) and gloves for: Citrus orchard floors, onions, ornamental lawns and turf, and sod farms (turfs). Consider requiring single layer (long-sleeved shirt and long pants), gloves, and a particulate facepiece for: Radish, rutabaga, and alfalfa. Consider requiring single layer (long-sleeved shirt and long pants) and a particulate facepiece for: Cauliflower (post-plant), turnip, Brussels sprouts (post-plant), sweet potato, cole crops (except	

					cauliflower) ginseng, sugar beets, sunflower, and tobacco.	
Occupational handler: Wide area mosquito adulticide applications from mixing, loading, and applying ground (airblast surrogate) and aerial applications.	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider requiring double layer (coveralls), gloves, and an elastomeric half mask respirator for mixers and loaders. Consider requiring engineering controls for applicators.	Consider requiring gloves and chemical resistant headgear for ground (airblast surrogate) applicators Consider requiring engineering controls for aerial applicators.
Occupational handler: Mechanically-pressurized handgun applications	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider prohibiting application by mechanically-pressurized handgun for all uses except on ornamental woody shrubs and vines and seed orchard trees.	Consider requiring double layer (coveralls), gloves, and a particulate filtering facepiece respirator
Occupational handler: Manually-pressurized handwand	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider prohibiting application to Indoor commercial, institutional, industrial premises, food processing plant premises. Consider requiring double layer PPE (coveralls), gloves, and an elastomeric half mask respirator (PF10) for wood treatment and nursery (pine seedlings). Consider requiring single layer (long-sleeved shirt and long pants), gloves, and a particulate filtering facepiece for wide area/general outdoor treatment.	Consider single layer (long-sleeved shirt and long pants) and gloves for Wood protection treatment, nursery (pine seedlings), wide area/ general outdoor treatment, Christmas tree plantations, conifers and deciduous trees; plantation nurseries, grapes, seed orchard trees, forest trees (softwoods, conifers), golf course turf, mounds/nests, non-agricultural outdoor buildings and structures, indoor commercial/institutional/industrial premises (see master label description), food processing plant premises, ornamental woody shrubs and vines, ornamental non-flowering plants, tree fruits

					Consider single layer (long-sleeved shirt and long pants) and gloves for: Christmas tree plantations, conifers and deciduous trees; plantation nurseries, grapes, seed orchard trees, forest trees (softwoods, conifers), golf course turf, mounds/nests, non-agricultural outdoor buildings and structures, ornamental woody shrubs and vines, ornamental non-flowering plants, outdoor commercial/institutional/industrial premises (see master label description), agricultural farm premises, poultry litter, tree fruits (cherries, nectarines, peaches, plum/prunes), tree nuts (almonds) - pre-plant, tree nuts (apple) - pre-plant, and fruits and nuts (non-bearing, see master label description).	(cherries, nectarines, peaches, plum/prunes), tree nuts (almonds) - pre-plant, and tree nuts (apple) - pre-plant.
Occupational handler: application by • Belly grinder • Brush roller • Rotary spreader • Hand dispersal	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider prohibiting application by brush roller and belly grinder. Consider prohibiting application to ornamental woody shrubs and vines by rotary spreader. Consider requiring single layer (long-sleeved shirt and long	Consider prohibiting brush roller application for sewer manholes. Consider requiring single layer (long-sleeved shirt and long pants) and gloves for brush roller application to wood protection treatment and structural (e.g., warehouses, food handling establishments, home bathrooms)

					pants) and gloves for rotary spreader application to nursery stock, golf course turf, ornamental and/or shade trees, herbaceous plants, ornamental lawns and turf, sod farms (turf). Consider prohibiting hand dispersal to commercial/ institutional/industrial/premises, utilities (pad). Consider requiring single layer (long-sleeved shirt and long pants) and gloves for hand dispersal (spo.t treatment) to golf course (turf), sod farm (turf).	Consider prohibiting belly grinder application for ornamental woody shrubs and vines Consider prohibiting hand dispersal to commercial/institutional/industrial premises and utilities (Pad)
Occupational handler risks from backpack sprayer applications: L/SC/EC	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider prohibiting application by broadcast (soil and foliar) and drench/soil-/ground-directed to: ornamental and/or shade trees, herbaceous plants, outdoor commercial/institutional/industrial premises, non-agricultural outdoor buildings and structures, wide area/ general outdoor treatment, wood protection treatment, Christmas tree plantations, tree fruit (cherries), seed orchard trees, grapes, and forest trees (softwoods, conifers)	Consider prohibiting broadcast (foliar) application with backpack sprayer of L/SC/EC on ornamental and/or shade trees, herbaceous plants. Consider double layer (coveralls) and glove for outdoor commercial/institutional/industrial premises, non-agricultural outdoor buildings and structures, and wide area/ general outdoor treatment.

					Consider limiting broadcast (foliar) application to golf course turf with double layer (coveralls), gloves, and an elastomeric half mask respirator. Consider limiting use on the following for only spot treatment with baseline PPE: ornamental and/or shade trees, herbaceous plants, ornamental lawns and turf, sod farms (turf), outdoor commercial/institutional/industrial premises, non-agricultural outdoor buildings and structures, and golf course turf.	
Occupational handler risks from backpack sprayer applications: DF/WDG in WSP	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider prohibiting broadcast (foliar) or drench/soil/ground-directed application to: ornamental woody shrubs and vines, Christmas tree plantations, tree fruits (cherries), tree nuts (almond), tree fruit (nectarine, peach, plum/prune), fruit and nut (non-bearing, nursery), tree fruits (apple). Consider requiring double layer (coveralls), gloves, and an elastomeric half mask respirator for broadcast	Consider prohibiting backpack sprayer of dry flowable/water-dispersible granules in WSP for broadcast (foliar) on ornamental woody shrubs and vines.

					(foliar) application to grapes (pre-bloom), trunk spray/drench to tree fruits (apple) and drench/soil-ground directed grapes (pre-bloom).	
Occupational handler risks from backpack sprayer applications: WSP	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider prohibiting broadcast use on ornamental and/or shade trees, herbaceous plants.	Consider prohibiting backpack sprayer broadcast application of WSP on ornamental and/or shade trees, herbaceous plants
Occupational handler risks from backpack sprayer applications: ME					Consider requiring double layer (coveralls), gloves, and an elastomeric half mask respirator for ornamental non-flowering plants and ornamental woody shrubs and vines.	N/A
Occupational handler: Flagging	Air Residues	Dermal absorption Inhalation	Acute Steady state	Neurotoxicity	Consider prohibiting flagging and require use of GPS or mechanical flagging systems with the exception of granule application to sod farms (turf).	N/A
Occupational post-application risks of concern	Residues	Dermal absorption	Acute Steady state	Neurotoxicity	Consider prohibiting use of microencapsulated formulations on ornamentals in nurseries and greenhouses. Considering extending REIs for select uses and activities. See Appendix D2 for potential REI extensions.	Considering extending REIs for select uses and activities. See Appendix D2 for potential REI extensions.
Proposed Ecological Mitigation						
Avian	Residues on treated site	Ingestion	Acute Chronic	Developmental Reproductive	Application method restrictions are expected to reduce risks to non-target organisms.	
Mammals	Residues on treated site	Ingestion	Acute Chronic	Developmental Reproductive		

Terrestrial Invertebrates	Residues on treated site	Dermal absorption Ingestion	Acute Chronic	Acute toxicity	Proposing label changes to reduce off-target spray drift and establish a baseline level of protection against spray drift that is consistent across all chlorpyrifos products.
Fish	Water	Dermal absorption Ingestion	Acute Chronic	Acute toxicity	
Aquatic Invertebrates	Water	Dermal absorption Ingestion	Acute Chronic	Acute toxicity	

Appendix B: Endangered Species Assessment

This Appendix provides general background about the agency's assessment of risks from pesticides to endangered and threatened (listed) species under the Endangered Species Act (ESA). Additional background specific to chlorpyrifos appears at the conclusion of this Appendix.

In 2013, the EPA, along with the Fish and Wildlife Service (FWS), the National Marine Fisheries Service (NMFS), and the United States Department of Agriculture (USDA) released a summary of their joint Interim Approaches for assessing risks to endangered and threatened (listed) species from pesticides. These Interim Approaches were developed jointly by the agencies in response to the National Academy of Sciences' (NAS) recommendations that discussed specific scientific and technical issues related to the development of pesticide risk assessments conducted on federally threatened and endangered species.

Since that time, EPA has conducted biological evaluations (BEs) on three pilot chemicals representing the first nationwide pesticide consultations (final pilot BEs for chlorpyrifos, malathion, and diazinon were completed in January 2017). These initial pilot consultations were envisioned to be the start of an iterative process. The agencies are continuing to work to improve the consultation process. For example, after receiving input from the Services and USDA on proposed revisions to the pilot interim method and after consideration of public comments received, EPA released an updated *Revised Method for National Level Listed Species Biological Evaluations of Conventional Pesticides* (i.e., Revised Method) in March 2020.[50] During the same timeframe, EPA also released draft BEs for carbaryl and methomyl, which were the first to be conducted using the Revised Method.

Also, a provision in the December 2018 Farm Bill included the establishment of a FIFRA Interagency Working Group to provide recommendations for improving the consultation process required under section 7 of the Endangered Species Act for pesticide registration and Registration Review and to increase opportunities for stakeholder input. This group includes representation from EPA, NMFS, FWS, USDA, and the Council on Environmental Quality (CEQ). Given this new law and that the first nationwide pesticide consultations were envisioned as pilots, the agencies are continuing to work collaboratively as consistent with the congressional intent of this new statutory provision. EPA has been tasked with a lead role in this group, and EPA hosted the first Principals Working Group meeting on June 6, 2019.

Chlorpyrifos was one of the first three pilot chemicals that EPA conducted a nationwide ESA consultation. EPA completed a biological evaluation and initiated consultation with the FWS and NMFS in January 2017.[51] Pursuant to a consent decree, at the end of December 2017, NMFS issued its Biological Opinion (BiOp) on chlorpyrifos, diazinon, and malathion.[52] In July 2019,

[50] https://www.epa.gov/endangered-species/revised-method-national-level-listed-species-biological-evaluations-conventional
[51] https://www.epa.gov/endangered-species/biological-evaluation-chapters-chlorpyrifos-esa-assessment
[52] https://www.fisheries noaa.gov/resource/document/biological-opinion-pesticides-chlorpyrifos-diazinon-and-malathion

EPA re-initiated formal consultation with NMFS on the December 2017 BiOp.[53] EPA re-initiated consultation because new information on how the pesticides were actually being used may show that the extent of the effects of the actions may be different than what was previously considered. As part of this re-initiation, EPA provided additional usage data it believes may be relevant to the consultation. In its transmittal of this information to NMFS, EPA also referenced usage data and information that had been recently submitted by the registrants of pesticide products containing chlorpyrifos, malathion, and diazinon. After reviewing information EPA provided to NMFS on the 2017 BiOp, NMFS determined that it was appropriate to revise the chlorpyrifos, malathion, and diazinon BiOp. NMFS plans to issue a revised final BiOp for chlorpyrifos, diazinon, and malathion by June 2022. FWS has not yet issued a BiOp on chlorpyrifos. EPA plans to address risks to listed species and critical habitats from use of chlorpyrifos as part of the final registration review decision, pending completion of the nationwide consultation process.

[53] https://www.regulations.gov/document?D=EPA-HQ-OPP-2018-0141-0136

Appendix C: Endocrine Disruptor Screening Program

As required by FIFRA and FFDCA, the EPA reviews numerous studies to assess potential adverse outcomes from exposure to chemicals. Collectively, these studies include acute, sub-chronic and chronic toxicity, including assessments of carcinogenicity, neurotoxicity, developmental, reproductive, and general or systemic toxicity. These studies include endpoints which may be susceptible to endocrine influence, including effects on endocrine target organ histopathology, organ weights, estrus cyclicity, sexual maturation, fertility, pregnancy rates, reproductive loss, and sex ratios in offspring. For ecological hazard assessments, the EPA evaluates acute tests and chronic studies that assess growth, developmental and reproductive effects in different taxonomic groups. As part of its most recent registration decision for chlorpyrifos, the EPA reviewed these data and selected the most sensitive endpoints for relevant risk assessment scenarios from the existing hazard database. However, as required by FFDCA § 408(p), chlorpyrifos is subject to the endocrine screening part of the Endocrine Disruptor Screening Program (EDSP).

The EPA has developed the EDSP to determine whether certain substances (including pesticide active and other ingredients) may have an effect in humans or wildlife similar to an effect produced by a "naturally occurring estrogen, or other such endocrine effects as the Administrator may designate." The EDSP employs a two-tiered approach to making the statutorily required determinations. Tier 1 consists of a battery of 11 screening assays to identify the potential of a chemical substance to interact with the estrogen, androgen, or thyroid (E, A, or T) hormonal systems. Chemicals that go through Tier 1 screening and are found to have the potential to interact with E, A, or T hormonal systems will proceed to the next stage of the EDSP where the EPA will determine which, if any, of the Tier 2 tests are necessary based on the available data. Tier 2 testing is designed to identify any adverse endocrine-related effects caused by the substance, and establish a dose-response relationship between the dose and the E, A, or T effect.

Under FFDCA § 408(p), the agency must screen all pesticide chemicals. Between October 2009 and February 2010, the EPA issued test orders/data call-ins for the first group of 67 chemicals, which contains 58 pesticide active ingredients and 9 inert ingredients. The agency has reviewed all of the assay data received for the List 1 chemicals and the conclusions of those reviews are available in the chemical-specific public dockets. Chlorpyrifos is on List 1 and the review conclusions are available in the chlorpyrifos public docket EPA-HQ-OPP-2008-0850.[54] A second list of chemicals identified for EDSP screening was published on June 14, 2013,[55] and includes some pesticides scheduled for Registration Review and chemicals found in water. Neither of these lists should be construed as a list of known or likely endocrine disruptors. For further information on the status of the EDSP, the policies and procedures, the lists of chemicals, future lists, the test guidelines and the Tier 1 screening battery, please visit the EPA website.[56]

[54] EDSP Weight of Evidence Conclusions on the Tier 1 Screening for the List 1 Chemicals https://www.regulations.gov/document?D=EPA-HQ-OPP-2008-0850-0849
[55] See http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPPT-2009-0477-0074 for the final second list of chemicals.
[56] https://www.epa.gov/endocrine-disruption

In this PID, the EPA is making no human health or environmental safety findings associated with the EDSP screening of chlorpyrifos. Before completing this registration review, the agency will make an EDSP FFDCA § 408(p) determination.

Appendix D1: Occupational Post-Application Risks of Concern[1]

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0[3]	DFR Study Location	MOE; Estimated REI Range (days)[4] for LOC >10	MOE; Estimated REI Range (days)[5] for LOC > 100
Berry: Low	Strawberry LC, WP Hand Harvesting	1.0	40	AZ	40 at Day 0	48 at Day 1 78 at Day 2 88 at Day 3 120 at Day 4
	Cranberry LC, WDG Hand Harvesting, Scouting	1.5	26	AZ	26 at Day 0	32 at Day 1 52 at Day 2 58 at Day 3 83 at Day 4 100 at Day 5
Mint	Peppermint/ Spearmint LC, WDG Irrigation	2.0	10	CA	10 at Day 0	86 at Day 1 120 at Day 2
			11	OR	11 at Day 0	110 at Day 1
			3.5	MN	110 at Day 1	110 at Day 1
Grapes	Grapes, LC Hand weeding, scouting	2.0	92	CA	92 at Day 0	390 at Day 1
	Grapes, LC Hand weeding, scouting		11	CA	11 at Day 0	46 at Day 1 100 at Day 2
	Grapes, LC Hand harvesting, leaf pulling, tying/training (wine grape)		6	CA	25 at Day 1	55 at Day 2 63 at Day 3 73 at Day 4 85 at Day 5 98 at Day 6 110 at Day 7
	Grape, LC Turning (table grape only)		3	CA	13 at Day 1	29 at Day 2 33 at Day 3 38 at Day 4 44 at Day 5 51 at Day 6 59 at Day 7 69 at Day 8 79 at Day 9 92 at Day 10 110 at Day 11

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0[3]	DFR Study Location	MOE; Estimated REI Range (days)[4] for LOC >10	MOE; Estimated REI Range (days)[5] for LOC > 100
Field and Row Crops: Tall	Corn: Sweet; Corn: Field, Including Grown for Seed WDG Detassling, hand harvesting)	1.5	0.8	IL	26 at Day 1	68 at Day 2 180 at Day 3
			1.0	MN	30 at Day 1	66 at Day 2 140 at Day 3
			1.4	OR	54 at Day 1	200 at Day 3
	Corn: Sweet; Corn: Field, Including Grown for Seed WDG Detassling, hand harvesting	1.0	1.2	IL	40 at Day 1	100 at Day 3
			1.5	MN	46 at Day 1	99 at Day 3 220 at Day 4
			2.1	OR	81 at Day 1	310 at Day 3
Tree Fruit: Deciduous	Apples, Cherries, Peaches, Pears, Plums, Prunes, Nectarines (Dormant and Delayed Dormant) LC for all, WDG for all, and WP for apples only Scouting, pruning, training	2.0	30	CA	480 at Day 1	480 at Day 1
			15	WA	63 at Day 2	180 at Day 3
			21	NY	50 at Day 2	110 at Day 3
	Apples, Cherries, Peaches, Pears, Plums, Prunes, Nectarines (Dormant and Delayed Dormant) LC for all, WDG for all, and WP for apples only	2.0	13	CA	200 at Day 1	200 at Day 1
			6	WA	26 at Day 2	76 at Day 3 130 at Day 4
			9	NY	21 at Day 2	45 at Day 3 96 at Day 4 180 at Day 5

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0[3]	DFR Study Location	MOE; Estimated REI Range (days)[4] for LOC >10	MOE; Estimated REI Range (days)[5] for LOC > 100
	Hand harvesting					
	Apples, Cherries, Peaches, Pears, Plums, Prunes, Nectarines (Dormant and Delayed Dormant) LC for all, WDG for all, and WP for apples only Thinning fruit	2.0	5	CA	78 at Day 1	110 at Day 2
			2	WA	10 at Day 1	30 at Day 2 50 at Day 3 83 at Day 4 140 at Day 5
			3	NY	8 at Day 1 18 at Day 2	37 at Day 3 69 at Day 4 130 at Day 5
	Nectarine (WDG and emulsifiable concentrate (EC)) & Peaches (EC) (Dormant and Delayed Dormant) Transplanting	3.0	51	CA	51 at Day 0	810 at Day 1
			25	WA	110 at Day 1	110 at Day 1
			35	NY	35 at Day 1	84 at Day 1 180 at Day 2
	Nectarine (WDG and emulsifiable concentrate (EC)) & Peaches (EC) (Dormant and Delayed Dormant) Scouting, pruning, training	3.0	20	CA	20 at Day 0	320 at Day 2
			10	WA	10 at Day 0	42 at Day 1 120 at Day 2
			14	NY	14 at Day 1	33 at Day 2 73 at Day 3 160 at Day 4
	Nectarine (WDG and emulsifiable concentrate	3.0	8.4	CA	130 at Day 1	130 at Day 1
			4	WA	17 at Day 1	51 at Day 2 85 at Day 3 140 at Day 4

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0[3]	DFR Study Location	MOE; Estimated REI Range (days)[4] for LOC >10	MOE; Estimated REI Range (days)[5] for LOC > 100
	(EC)) & Peaches (EC) (Dormant and Delayed Dormant) Hand harvesting		6	NY	14 at Day 1	33 at Day 2 73 at Day 3 160 at Day 4
	Nectarine (WDG and emulsifiable concentrate (EC)) & Peaches (EC) (Dormant and Delayed Dormant) Thinning fruit	3.0	3.3	CA	52 at Day 1	71 at Day 3 97 at Day 4 130 at Day 5
			2	WA	7 at Day 1 20 at Day 2	33 at Day 3 56 at Day 4 93 at Day 5 160 at Day 6
			2	NY	5 at Day 1 12 at Day 2	25 at Day 3 46 at Day 4 85 at Day 5 160 at Day 6
	Cherries (Sour) Transplanting	4.0	38	CA	38 at Day 0	610 at Day 1
			19	WA	19 at Day 0	80 at Day 1 230 at Day 2
			26	NY	26 at Day 0	140 at Day 2
	Cherries (Sour) Scouting, pruning, training		15	CA	15 at Day 0	240 at Day1
			7.5	WA	32 at Day 1	92 at Day 3 150 at Day 4
			10	NY	10 at Day 0	25 at Day 2 55 at Day 3 120 at Day 4
	Cherries (Sour) Hand harvesting		6.3	CA	100 at Day 1	100 at Day 1
			3.1	WA	13 at Day 1	38 at Day 2 64 at Day 3 110 at Day 5
			4.3	NY	10 at Day 1	23 at Day 2 48 at Day 3 89 at Day 4 160 at Day 5
	Cherries (Sour) Thinning fruit		2.4	CA	39 at Day 1	53 at Day 2 73 at Day 3 99 at Day 4 140 at Day 5
			1.2	WA	5.1 at Day 1 15 at Day 2	25 at Day 3 42 at Day 4 70 at Day 5 120 at Day 6

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0[3]	DFR Study Location	MOE; Estimated REI Range (days)[4] for LOC >10	MOE; Estimated REI Range (days)[5] for LOC > 100
			1.7	NY	4 at Day 1 8.8 at Day 2 19 at Day 3	35 at Day 4 64 at Day 5 120 at Day 6
Tree Fruit: Evergreen	Citrus LC, WDG Hand harvesting	4.0	21;	CA	21 at Day 0	89 at Day 1 200 at Day 2
	Citrus LC, WDG Transplanting	6.0 (CA and AZ)	86	CA	86 at Day 0	360 at Day 1
	Citrus LC, WDG Scouting, Hand pruning		34	CA	34 at Day 0	140 at Day 1
	Citrus LC, WDG Hand harvesting		14	CA	14 at Day 0	60 at Day 1 130 at Day 2
Forestry	Hybrid Cottonwood/ Poplar Plantations (Dormant and Delayed Dormant) LC Scouting	2.0	180	CA	180 at Day 0	180 at Day 1
			87	WA	87 at Day 0	370 at Day 1
			21	NY	21 at Day 0	50 at Day 1 110 at Day 2
	Hybrid Cottonwood/ Poplar Plantations (Dormant and Delayed Dormant) LC Irrigation	2.0	30	CA	30 at Day 0	480 at Day 1
			15	WA	15 at Day 0	63 at Day 1 180 at Day 2
			6.3	NY	15 at Day 1	33 at Day 2 71 at Day 3 130 at Day 4

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0[3]	DFR Study Location	MOE; Estimated REI Range (days)[4] for LOC >10	MOE; Estimated REI Range (days)[5] for LOC > 100
	Hybrid Cottonwood/ Poplar Plantations (Dormant and Delayed Dormant) LC Irrigation	2.0	9	CA	150 at Day 1	150 at Day 1
			4.6	WA	19 at Day 1	56 at Day 2 94 at Day 3 160 at Day 4
Tree Nuts[2]	Almonds (Dormant and Delayed Dormant) Harvesting Mechanical (Shaking)	4.0	37	CA	37 at Day 0	76 at Day 1 210 at Day2
			45	CA	45 at Day 0	730 at Day 1
			1700	TX	1700 at Day 0	1700 at Day 0
			280	LA	280 at Day 0	280 at Day 0
			160	GA	160 at Day 0	160 at Day 0
	Almonds (Dormant and Delayed Dormant) Transplanting	4.0	31	CA	31 at Day 0	63 at Day 1 180 at Day 2
			38	CA	38 at Day 0	27,000 at Day 1
			1400	TX	1400 at Day 0	1400 at Day 0
			230	LA	230 at Day 0	230 at Day 0
			130	GA	130 at Day 0	130 at Day 0
	Almonds (Dormant and Delayed Dormant) Scouting	4.0	12	CA	12 at Day 0	25 at Day 1 70 at Day 2 120 at Day 3
			15	CA	15 at Day 0	240 at Day 1
			560	TX	560 at Day 0	560 at Day 0
			92	LA	92 at Day 0	92 at Day 0 1300 at Day 1
			53	GA	53 at Day 0	480 at Day 1
Ornamental s/ Nurseries (Outdoor Only)	Non-bearing Fruit Trees (Peach, Nectarine) Container moving, hand pruning, tying/training	3.0	51	CA	51 at Day 0	810 at Day 1
			25	WA	25 at Day 0	110 at Day 1
			35	NY	35 at Day 0	84 at Day 1 180 at Day 2
Field and Row Crops	Alfalfa (LC, WDG), Soybean (LC, WDG) Scouting	1.0	26	CA	26 at Day 0	82 at Day 1 280 at Day 2
			12	TX	12 at Day 0	340 at Day 1
			10	MS	10 at Day 0	1500 at Day 1
			29	CA	29 at Day 0	380 at Day 1
			12	TX	12 at Day 0	340 at Day 1

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0[3]	DFR Study Location	MOE; Estimated REI Range (days)[4] for LOC >10	MOE; Estimated REI Range (days)[5] for LOC > 100
			38	AZ	38 at Day 0	210 at Day 1
	Alfalfa LC, WDG Irrigation		15	CA	15 at Day 0	47 at Day 1 160 at Day 2
			6.9	TX	6.9 at Day 0	200 at Day 1
			6	MS	6 at Day 0	890 at Day 1
			17	CA	17 at Day 0	220 at Day 1
			7	TX	370 at Day 1	370 at Day 1
			22	AZ	22 at Day 0	120 at Day 1
Vegetable: Fruiting	Pepper WDG Hand harvesting, tying	1.0	26	CA	26 at Day 0	82 at Day 1 280 at Day 2
			12	TX	12 at Day 0	340 at Day 1
			10	MS	10 at Day 0	1500 at Day 1
			29	CA	29 at Day 0	380 at Day 1
			12	TX	12 at Day 0	640 at Day 1
			38	AZ	38 at Day 0	210 at Day1
	Pepper WDG Irrigation		15	CA	15 at Day 0	47 at Day 1 160 at Day 2
			6.9	TX	200 at Day 1	200 at Day 1
			5.6	MS	890 at Day 1	890 at Day 1
			17	CA	17 at Day 1	220 at Day 1
			7	TX	370 at Day 1	370 at Day 1
Vegetable: Head and Stem Brassica	Broccoli (WP, WDG), Brussels sprouts (LC, WP, WDG), cabbage (WP, WDG), cauliflower (WP, WDG) Hand Weeding	1.0	40	AZ	40 at Day 0	48 at Day 1 78 at Day 2 88 at Day 3 120 at Day 4
	Broccoli (WP, WDG), Brussels sprouts (LC, WP, WDG), cabbage (WP, WDG), cauliflower (WP, WDG) Irrigation		23	AZ	23 at Day 0	28 at Day 1 45 at Day 2 51 at Day 3 72 at Day 4 89 at Day 5 110 at Day 6
	Broccoli (WP, WDG), Brussels sprouts (LC, WP, WDG), cabbage (WP, WDG),		10	AZ	10 at Day 0	13 at Day 1 20 at Day 2 23 at Day 3 33 at Day 4 40 at Day 5 49 at Day 6 61 at Day 7

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0[3]	DFR Study Location	MOE; Estimated REI Range (days)[4] for LOC >10	MOE; Estimated REI Range (days)[5] for LOC > 100
	cauliflower (WP, WDG) Scouting, hand harvesting					75 at Day 8 92 at Day 9 110 at Day 10
Vegetable: Leafy	Collards (WP, WDG), Bok Choy (WP), Kale (WP, WDG), Kohlrabi (WP, WDG) Hand harvesting	1.0	40	AZ	40 at Day 0	48 at Day 1 78 at Da y2 88 at Day 3 120 at Day 4
	Collards (WP, WDG), Bok Choy (WP), Kale (WP, WDG), Kohlrabi (WP, WDG) Irrigation		23	AZ	23 at Day 0	28 at Day 1 45 at Day 2 51 at Day 3 72 at Day 4 89 at Day 5 110 at Day 6
Vegetable, leafy	Cole Crops: Including Brussels sprouts (LC) and cauliflower (EC) Hand weeding	2.0	16	AZ	16 at Day 0	48 at Day 1 78 at Day 2 88 at Day 3 120 at Day 4
	Cole Crops: Including Brussels sprouts (LC) and cauliflower (EC) Irrigation		11	AZ	11 at Day 0	28 at Day 1 45 at Day 2 51 at Day 3 72 at Day 4 89 at Day 5 110 at Day 6
	Cole Crops: Including Brussels sprouts (LC) and cauliflower (EC) Hand weeding, topping		5	AZ	13 at Day 1	20 at Day 2 23 at Day 3 33 at Day 4 40 at Day 5 49 at Day 6 61 at Day 7 75 at Day 8 92 at Day 9 110 at Day 10
Cotton	Cotton	1.0	31	CA	31 at Day 0	100 at Day 1

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0[3]	DFR Study Location	MOE; Estimated REI Range (days)[4] for LOC >10	MOE; Estimated REI Range (days)[5] for LOC > 100
	LC, WDG Module builder operator		15	TX	15 at Day 0	420 at Day 1
			12	MS	12 at Day 0	1900 at Day 1
			36	CA	36 at Day 0	470 at Day 1
			14	TX	14 at Day 0	780 at Day 1
			47	AZ	47 at Day 0	260 at Day 1
	Cotton LC, WDG Picker operator, raker		12	CA	12 at Day 0	38 at Day 1 130 at Day 2
			6	TX	160 at Day 1	160 at Day 1
			4	MS	710 at Day 1	710 at Day 1
			14	CA	14 at Day 0	180 at Day 1
			5	TX	290 at Day 1	290 at Day 1
			18	AZ	18 at Day 0	98 at Day 1 420 at Day 2
	Cotton LC, WDG Tramper		6	CA	18 at Day 1	61 at Day 2 91 at Day 3 140 at Day 4
			3	TX	75 at Day 1	190 at Day 2
			2	MS	340 at Day 1	340 at Day 1
			6	CA	84 at Day 1	130 at Day 2
			3	TX	140 at Day 1	140 at Day 1
			8	AZ	46 at Day 1	200 at Day 2
Turfgrass	Turf grown for sod or seed LC, WP Maintenance, harvesting slab, transplanting/planting	3.76	40	CA (Very high exposure activities)	40 at Day 0	130 at Day 1
			56	IN (Very high exposure activities)	56 at Day 0	300 at Day 1
			34	MS (High exposure activities)	34 at Day 0	560 at Day 1
			21	CA (High exposure activities)	21 at Day 0	130 at Day 1
			8	IN (High exposure activities)	30 at Day 1	100 at Day 2
			14	MS (High exposure activities)	14 at Day 1	130 at Day 1
Microencapsulated Formulation Application						
Nursery (Microencap.	Ornamentals – Nurseries and Greenhouses	1.4	74	Ornamentals-smooth	74 at Day 0	120 at Day 0.33 40 at Day 1 29 at Day 2 260 at Day 3

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0[3]	DFR Study Location	MOE; Estimated REI Range (days)[4] for LOC >10	MOE; Estimated REI Range (days)[5] for LOC > 100
Formulation s)	Container moving, hand pruning, pinching, tying/training		50	Ornament als- hairy	50 at Day 0	140 at Day 1
	Ornamentals – Nurseries and Greenhouses Irrigation		9.0	Ornament als- smooth	5 at Day 1 4 at Day 2 32 at Day 3	Over 35 days; MOE = 30 or less at Day 35
			6	Ornament als- hairy	17 at Day 1	
	Ornamentals – Nurseries and Greenhouses Hand harvest, cut flower		3.6	Ornament als- smooth	2 at Day 1 1 at Day 2 12 at Day 3	Over 35 days; MOE = 12 or less at Day 35
			2	Ornament als- hairy	7 at Day 1 7 at Day 2 8at Day 3 13 at Day 4	
Greenhouse						
Greenhouse (Total Release Fogger and. Liquid Concentrate Formulation s)	Ornamentals – *Liquid Concentrates* Commercial Ornamentals, Greenhouse Production: Bedding Plants, Cut Flowers, Flowering Hanging Baskets, Potted Flowers, Ornamentals, Trees and Shrubs – *Total Release Foggers* Irrigation handset	2	10	CA	10 at Day 0	86 at Day 1 120 at Day 2
			11	OR	11 at Day 0	110 at Day 1
			3.5	MN	110 at Day 1	110 at Day 1
	Ornamentals – *Liquid Concentrates* Commercial Ornamentals, Greenhouse Production: Bedding Plants, Cut Flowers, Flowering Hanging		3.7	CA	34 at Day 1	48 at Day 2 69 at Day 3 98 at Day 4 140 at Day 5
			4.3	OR	42 at Day 1	350 at Day 2
			1.4	MN	44 at Day 1	68 at Day 2 100 at Day 3

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0[3]	DFR Study Location	MOE; Estimated REI Range (days)[4] for LOC >10	MOE; Estimated REI Range (days)[5] for LOC > 100
	Baskets, Potted Flowers, Ornamentals, Trees and Shrubs – *Total Release Foggers* Hand harvesting flowers					
	Ornamentals – *Liquid Concentrates* Commercial Ornamentals, Greenhouse Production: Bedding Plants, Cut Flowers, Flowering Hanging Baskets, Potted Flowers, Ornamentals, Trees and Shrubs Total release aerosol foggers Hand harvest cut flowers	0.29	18	Ornament als- hairy	18 at Day 0	44 at Day 1 140 at Day 2
Greenhouse - Oxon						
Greenhouse nursery	Greenhouse nursery Irrigation handset	2.0	5.0	CA	45 at Day 1	64 at Day 2 91 at Day3 130 at Day 4
			5.7	OR	56 at Day 1	460 at Day 2
			1.9	MN	59 at Day 1	90 at Day 2 140 at Day 3
	Greenhouse nursery Hand harvest		2.0	CA	18 at Day 1	25 at Day 2 36 at Day 3 51 at Day 4 73 at Day 5 100 at Day 6
			2.2	OR	22 at Day 1	180 at Day 2
			0.7	MN	23 at Day 1	36 at Day 2 55 at Day 3 84 at Day 4

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0[3]	DFR Study Location	MOE; Estimated REI Range (days)[4] for LOC >10	MOE; Estimated REI Range (days)[5] for LOC > 100
						130 at Day 5

[1]Range of MOEs is dependent on study used. See Appendix 11 for full range of occupational post-application risk estimates.[57]
[2] Formulations: EC = emulsifiable concentrate, LC = liquid concentrate, WDG = water dispersed granular, WP = wettable powder
[3] Dermal LOC = 10
[4] Dermal LOC = 100

[57] https://www.regulations.gov/document?D=EPA-HQ-OPP-2008-0850-0958

Appendix D2: Considered Mitigation for Occupational Post-Application Risks of Concern[1]

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0	DFR Study Location	Considered REI (days) for LOC of 10[3]	Considered REI (days) for LOC of 100[3]
Berry: Low	Strawberry, LC, WP Hand Harvesting	1.0	40	AZ	N/A	Day 3: 88 Day 4: 120
	Cranberry LC, WDG Hand Harvesting (raking), scouting	1.5	26		N/A	Day 4: 83 Day 5: 100
Mint	Peppermint/Spearmint LC, WDG Irrigation	2.0	10	CA	N/A	Day 1: 86 Day 2: 120
			11	OR	N/A	N/A
			3.5	MN	N/A	N/A
Grapes	Grapes, LC Hand weeding, scouting	2.0	11	CA	N/A	Day 2: 100
	Grapes, LC Hand harvesting, leaf pulling, tying/training (wine grape)		6	CA	N/A	Day 4: 73 Day 5: 85 Day 6: 98 Day 7: 110
	Grape, LC Turning (table grape only)		3	CA	N/A	Day 9: 79 Day 10: 92 Day 11: 110
Field and Row Crops: Tall	Corn: Sweet; Corn: Field, Including Grown for Seed Sweet and Field Corn (including grown for seed) (LC), Sunflower, sorghum (LC, WDG)	1.5	0.8	IL	N/A	Day 3: 180
			1.0	MN	N/A	Day 3: 140
			1.4	OR	N/A	Day 2: 200

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0	DFR Study Location	Considered REI (days) for LOC of 10[3]	Considered REI (days) for LOC of 100[3]
	Detassling, hand harvesting (corn only)					
	Corn: Sweet; Corn: Field, Including Grown for Seed Sweet and Field Corn (including grown for seed) (LC), Sunflower, sorghum (LC, WDG) Detassling, hand harvesting (corn only)	1.0	1.2	IL	N/A	Day 2: 100
			1.5	MN	N/A	Day 2: 99 Day 3: 220
			2.1	OR	N/A	Day 1: 81 Day 2: 310
Tree Fruit: Deciduous	Apples, Cherries, Peaches, Pears, Plums, Prunes, Nectarines (Dormant and Delayed Dormant) LC for all, WDG for all, and WP for apples only Scouting, pruning, training	2.0	30	CA	N/A	N/A
			15	WA	N/A	Day 1: 63 Day 2: 180
			21	NY	N/A	Day 2: 110
	Apples, Cherries, Peaches, Pears, Plums, Prunes, Nectarines (Dormant and Delayed Dormant) LC for all, WDG for all, and WP for apples only Hand harvesting	2.0	13	CA	N/A	N/A
			6	WA	N/A	Day 2: 76 Day 3: 130
			9	NY	N/A	Day 3: 96 Day 4: 180
	Apples, Cherries, Peaches, Pears, Plums, Prunes, Nectarines (Dormant and Delayed Dormant)	2.0	5	CA	N/A	Day 2: 110

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0	DFR Study Location	Considered REI (days) for LOC of 10[3]	Considered REI (days) for LOC of 100[3]
	LC for all, WDG for all, and WP for apples only Thinning fruit		2	WA	N/A	Day 4: 83 Day 5: 140
			3	NY	Day 1: 8 Day 2: 18	Day 5: 130
	Nectarine (WDG and EC) & Peach (EC) (Dormant and Delayed Dormant) Transplanting	3.0	51	CA	N/A	N/A
			25	WA	N/A	N/A
			35	NY	N/A	Day 1: 84 Day 2: 180
	Nectarine (WDG and emulsifiable concentrate (EC)) & Peaches (EC) (Dormant and Delayed Dormant) Scouting, pruning, training	3.0	20	CA	N/A	Day 1: 320
			10	WA	N/A	Day 2: 120
			14	NY	N/A	Day 2: 73 Day 3: 160
	Nectarine (WDG and emulsifiable concentrate (EC)) & Peaches (EC) (Dormant and Delayed Dormant) Hand harvesting	3.0	8.4	CA	N/A	N/A
			4	WA	N/A	Day 3: 85 Day 4: 140
			6	NY	N/A	Day 3: 64 Day 4: 120
	Nectarine (WDG and emulsifiable concentrate (EC)) & Peaches (EC) (Dormant and Delayed Dormant) Thinning fruit	3.0	3.3	CA	N/A	Day 3: 97 Day 4: 130
			2	WA	Day 1: 7 Day 2: 20	Day 5: 93 Day 6: 160
			2	NY	Day 2: 12	Day 5: 85 Day 6: 160
	Cherries (Sour) Transplanting	4.0	38	CA	N/A	N/A
			19	WA	N/A	Day 1: 80 Day 2: 230
			26	NY	N/A	Day 2: 140
	Cherries (Sour)		15	CA	N/A	N/A

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0	DFR Study Location	Considered REI (days) for LOC of 10[3]	Considered REI (days) for LOC of 100[3]
	Scouting, pruning, training		7.5	WA	N/A	Day 2: 92 Day 3: 150
			10	NY	N/A	Day 3: 120
	Cherries (Sour) Hand harvesting		6.3	CA	N/A	N/A
			3.1	WA	N/A	Day 4: 110
			4.3	NY	N/A	Day 4: 89 Day 5: 160
	Cherries (Sour) Thinning fruit		2.4	CA	N/A	Day 3: 73 Day 4: 99 Day 5: 140
			1.2	WA	5.1 at Day 1 15 at Day 2	Day 5: 70 Day 6: 120
			1.7	NY	4 at Day 1 8.8 at Day 2 19 at Day 3	Day 6: 120
Tree Fruit: Evergreen	Citrus LC, WDG – not CA or AZ Hand harvesting	4.0	21	CA	N/A	Day 1: 89 Day 2: 200
	Citrus AZ and CA = LC, WDG; all states = WP Hand harvesting	6.0 (CA and AZ)	14	CA	N/A	Day 2: 130
Forestry	Hybrid Cottonwood (grown for pulp)/ Poplar Plantations (Dormant and Delayed Dormant) LC Hand weeding	2.0	180	CA	N/A	N/A
			87	WA	N/A	N/A
	Hybrid Cottonwood (grown for pulp)/ Poplar Plantations (Dormant and Delayed Dormant) LC Scouting	2.0	30	CA	N/A	N/A
			15	WA	N/A	Day 2: 180
			21	NY	N/A	Day 2: 110

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0	DFR Study Location	Considered REI (days) for LOC of 10[3]	Considered REI (days) for LOC of 100[3]
	Hybrid Cottonwood/ Poplar Plantations (Dormant and Delayed Dormant) LC Irrigation	2.0	6.3	NY	N/A	Day 3: 71 Day 4: 130
			9	CA	N/A	N/A
			4.6	WA	N/A	Day 3: 94 Day 4: 160
Tree Nuts	Almonds (Dormant and Delayed Dormant) Harvesting Mechanical (Shaking)	4.0	37	CA	N/A	Day 1: 76 Day 2: 210
			45	CA	N/A	N/A
			1700	TX	N/A	N/A
			280	LA	N/A	N/A
			160	GA	N/A	N/A
	Almonds (Dormant and Delayed Dormant) Transplanting	4.0	31	CA	N/A	Day 2: 180
			38	CA	N/A	N/A
			1400	TX	N/A	N/A
			230	LA	N/A	N/A
			130	GA	N/A	N/A
	Almonds (Dormant and Delayed Dormant) Scouting	4.0	12	CA	N/A	Day 2: 70 Day 3: 120
			15	CA	N/A	N/A
			560	TX	N/A	N/A
			92	LA	N/A	N/A
			53	GA	N/A	N/A
Ornamental s/ Nurseries (Outdoor Only)	Non-bearing Fruit Trees (Peach, Nectarine) Container moving, hand pruning, tying/training, transplanting	3.0	51	CA	N/A	N/A
			25	WA	N/A	N/A
			35	NY	N/A	Day 1: 84 Day 2: 180
Field and Row Crops	Alfalfa (LC, WDG), Soybean (LC, WDG) Scouting	1.0	26	CA	N/A	Day 1: 82 Day 2: 280
			12	TX	N/A	N/A
			10	MS	N/A	N/A
			29	CA	N/A	N/A
			12	TX	N/A	N/A
			38	AZ	N/A	N/A
	Alfalfa LC, WDG Irrigation		15	CA	N/A	Day 2: 160
			6.9	TX	N/A	N/A
			6	MS	N/A	N/A
			17	CA	N/A	N/A
			7	TX	N/A	N/A

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0	DFR Study Location	Considered REI (days) for LOC of 10[3]	Considered REI (days) for LOC of 100[3]
			22	AZ	N/A	N/A
Field and Row Crops: Low to Medium (Outdoor Only)	Pepper WDG Hand harvesting, tying	1.0	26	CA	N/A	Day 1: 82 Day 2: 280
			12	TX	N/A	N/A
			10	MS	N/A	N/A
			29	CA	N/A	N/A
			12	TX	N/A	N/A
			38	AZ	N/A	N/A
	Pepper WDG Irrigation		15	CA	N/A	Day 2: 160
			6.9	TX	N/A	N/A
			5.6	MS	N/A	N/A
			17	CA	N/A	N/A
			7	TX	N/A	N/A
Vegetable: Fruiting	Pepper WDG Hand harvesting, tying	1.0	26	CA	N/A	Day 1: 82 Day 2: 280
			12	TX	N/A	N/A
			10	MS	N/A	N/A
			29	CA	N/A	N/A
			12	TX	N/A	N/A
			38	AZ	N/A	N/A
	Pepper WDG Irrigation		15	CA	N/A	Day 2: 160
			6.9	TX	N/A	N/A
			5.6	MS	N/A	N/A
			17	CA	N/A	N/A
			7	TX	N/A	N/A
Vegetable: Head and Stem Brassica	Broccoli (WP, WDG), Brussels sprouts (LC, WP, WDG), cabbage (WP, WDG), cauliflower (WP, WDG) Hand Weeding	1.0	40	AZ	N/A	Day 2: 78 Day 3: 88 Day 4: 120
	Broccoli (WP, WDG), Brussels sprouts (LC, WP, WDG), cabbage (WP, WDG), cauliflower (WP, WDG) Irrigation		23	AZ	N/A	Day 4: 72 Day 5: 89 Day 6: 110
	Broccoli (WP, WDG), Brussels sprouts (LC, WP, WDG), cabbage (WP, WDG),		10	AZ	N/A	Day 8: 75 Day 9: 92 Day 10: 110

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0	DFR Study Location	Considered REI (days) for LOC of 10[3]	Considered REI (days) for LOC of 100[3]
	cauliflower (WP, WDG) Scouting, hand harvesting					
Vegetable: Leafy	Collards (WP, WDG), Bok Choy (WP), Kale (WP, WDG), Kohlrabi (WP, WDG) Hand harvesting	1.0	40	AZ	N/A	Day 2: 78 Day 3: 88 Day 4: 120
	Collards (WP, WDG), Bok Choy (WP), Kale (WP, WDG), Kohlrabi (WP, WDG) Irrigation		23	AZ	N/A	Day 4: 72 Day 5: 89 Day 6: 110
Vegetable, leafy	Cole Crops: Including Brussels sprouts (LC) and cauliflower (EC) Hand Weeding	2.0	16	AZ	N/A	Day 2: 78 Day 3: 88 Day 4: 120
	Cole Crops: Including Brussels sprouts (LC) and cauliflower (EC) Irrigation		11	AZ	N/A	Day 4: 72 Day 5: 89 Day 6: 110
	Cole Crops: Including Brussels sprouts (LC) and cauliflower (EC) Hand harvesting, topping		5	AZ	N/A	Day 8: 75 Day 9: 92 Day 10: 110
Cotton	Cotton LC, WDG Mechanical harvesting- Module builder operator	1.0	31	CA	N/A	N/A
			15	TX	N/A	N/A
			12	MS	N/A	N/A
			36	CA	N/A	N/A
			14	TX	N/A	N/A
			47	AZ	N/A	N/A
	Cotton LC, WDG		12	CA	N/A	Day 2: 130
			6	TX	N/A	N/A
			4	MS	N/A	N/A
			14	CA	N/A	N/A
			5	TX	N/A	N/A

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0	DFR Study Location	Considered REI (days) for LOC of 10[3]	Considered REI (days) for LOC of 100[3]
	Picker operator, raker		18	AZ	N/A	Day 1: 98 Day 2: 420
	Cotton LC, WDG Tramper		6	CA	N/A	Day 3: 91 Day 4: 140
			3	TX	N/A	Day 1: 75 Day 2: 190
			2	MS	N/A	N/A
			6	CA	N/A	Day 1: 84 Day 2: 130
			3	TX	N/A	N/A
			8	AZ	N/A	Day 2: 200
Microencapsulated Formulation Application						
Nursery (Microencap. Formulations)	Ornamentals – Nurseries and Greenhouses Container moving, hand pruning, pinching, tying/training	1.4	74	Ornamentals-smooth	N/A	Day 0.33: 120 Day 1: 40 Day 2: 29 Day 3: 260
			50	Ornamentals- hairy	N/A	N/A
	Ornamentals – Nurseries and Greenhouses Irrigation		9.0	Ornamentals-smooth	Day 1: 5 Day 2: 4 Day 3: 32	Proposed cancelling use of microencapsulated formulations in nurseries MOE = 30 or less at Day 35
			6	Ornamentals- hairy	Day 1: 17	
	Ornamentals – Nurseries and Greenhouses Hand harvest, cut flower		3.6	Ornamentals-smooth	Day 1: 2 Day 2: 1 Day 3: 12	Proposed cancelling use of microencapsulated formulations in nurseries MOE = 12 or less at Day 35
			2	Ornamentals- hairy	Day 1: 7 Day 2: 7 Day 3: 8 Day 5: 13	
Greenhouse						
Greenhouse (Total Release Fogger and. Liquid Concentrate Formulations)	Ornamentals – *Liquid Concentrates* Commercial Ornamentals, Greenhouse Production: Bedding Plants, Cut Flowers, Flowering Hanging	2	10	CA	N/A	Day 1: 86 Day 2: 120
			11	OR	N/A	N/A
			3.5	MN	N/A	N/A

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0	DFR Study Location	Considered REI (days) for LOC of 10[3]	Considered REI (days) for LOC of 100[3]
	Baskets, Potted Flowers, Ornamentals, Trees and Shrubs – *Total Release Foggers* Irrigation handset					
	Ornamentals – *Liquid Concentrates* Commercial Ornamentals, Greenhouse Production: Bedding Plants, Cut Flowers, Flowering Hanging Baskets, Potted Flowers, Ornamentals, Trees and Shrubs – *Total Release Foggers* Hand harvesting flowers		3.7	CA	N/A	Day 4: 98 Day 5: 140
			4.3	OR	N/A	Day 2: 350
			1.4	MN	N/A	Day 3: 100
	Ornamentals – *Liquid Concentrates* Commercial Ornamentals, Greenhouse Production: Bedding Plants, Cut Flowers, Flowering Hanging Baskets, Potted Flowers, Ornamentals, Trees and Shrubs Total release aerosol foggers Hand harvesting (flowers)	0.29	18	Ornament als- hairy	N/A	Day 2: 140
Greenhouse - Oxon						
Greenhouse nursery	Greenhouse nursery	2.0	5.0	CA	N/A	Day 3: 91 Day 4: 130

Crop Group	Crop, Formulation, Activity[2]	App. Rate (lbs ai/A)	MOEs at Day 0	DFR Study Location	Considered REI (days) for LOC of 10[3]	Considered REI (days) for LOC of 100[3]
	Irrigation handset		5.7	OR	N/A	Day 2: 460
			1.9	MN	N/A	Day 2: 90 Day 3: 140
	Greenhouse nursery Hand harvest		2.0	CA	N/A	Day 5: 73 Day 6: 100
			2.2	OR	N/A	Day 2: 180
			0.7	MN	N/A	Day 4: 84 Day 5: 130

[1]Risk estimates may be found: https://www.regulations.gov/document?D=EPA-HQ-OPP-2008-0850-0958
[2] Formulations: EC = emulsifiable concentrate, LC = liquid concentrate, WDG = water dispersed granular, WP = wettable powder
[3]N/A = REI of 24 hours is protective of risks of concern.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE ADMINISTRATOR

IN RE FIFRA SECTION 6(b) NOTICE)	
OF INTENT TO CANCEL PESTICIDE)	
REGISTRATIONS FOR CHLORPYRIFOS)	**DOCKET NO. EPA-HQ-OPP-2022-0417**
)	

GHARDA CHEMICALS INTERNATIONAL, INC.'S REQUEST FOR HEARING AND STATEMENT OF OBJECTIONS AND REQUEST FOR STAY

Gharda Chemicals International, Inc. ("Gharda") hereby requests a hearing pursuant to Section 6 of the Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. §§ 136-136y, "FIFRA") to contest the proposed cancellation of the following of its pesticide product registrations:

- EPA Reg. No. 93182-3 Chlorpyrifos Technical[1]
- EPA Reg. No. 93182-7 Pilot 4E Chlorpyrifos Agricultural Insecticide[2]
- EPA Reg. No. 93182-8 Pilot 15G[3]

These three registrations are referred to herein as the "chlorpyrifos registrations." A Notice of Intent to Cancel was issued by the U.S. Environmental Protection Agency ("EPA" or "the Agency") and published in the Federal Register on December 14, 2022. Chlorpyrifos; Notice of Intent to Cancel Pesticide Registrations, 87 Fed. Reg. 76,474 (Dec. 14, 2022), Ex. 1. Copies of the approved labels for the chlorpyrifos registrations, and Gharda's most recent proposed amendments to the labels (**submitted January 13, 2023**) for the chlorpyrifos registrations, are attached here. *See* Exs. 2 & 3.

[1] Product information on EPA Reg. No. 93182-3 can be found here.
[2] Product information on EPA Reg. No. 93182-7 can be found here.
[3] Product information on EPA Reg. No. 93182-8 can be found here.

In the NOIC, EPA is proposing to cancel the registrations of Gharda's chlorpyrifos products noted above. EPA alleges that the chlorpyrifos registrations should be cancelled because the Agency had revoked tolerances for all food uses of chlorpyrifos by way of a Final Rule dated August 30, 2021.[4] In the NOIC, EPA also challenges the sufficiency of voluntary cancellations and label amendments Gharda submitted in March 2022 and June 2022, which brought its chlorpyrifos registrations and labels in line with the Final Rule as to all but a subset of uses that are the subject of ongoing litigation. Gharda and other affected parties urged EPA to immediately stay or withdraw the NOIC in correspondence dated January 6, 2023, but EPA denied this request.

The NOIC states that "the affected registrant must request a hearing within 30 days from the date that the affected registrant receives EPA's NOIC, or on or before January 13, 2023, whichever occurs later." 87 Fed. Reg. at 76,474, Ex. 1. Gharda notes that the address for Gharda identified in the NOIC is incorrect[5] and states that Gharda has not received a copy of the NOIC from EPA. **Accordingly, Gharda submits that the 30-day time period for requesting a hearing on the NOIC has not yet begun to run and respectfully requests that EPA cure its defective notice promptly.**

While Gharda reserves all rights as to the ripeness of any further proceedings on the NOIC until it receives proper notice, Gharda hereby objects to the cancellation of the

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[4] *See* Chlorpyrifos; Tolerance Revocations, 86 Fed. Reg. 48,315 (Aug. 30, 2021) ("Final Rule"), Ex. 4.

[5] *Compare* 87 Fed. Reg. at 76,474, Ex. 1 (identifying Gharda's address of record as 4932 Crockers Lake Blvd., Suite 818, Sarasota, Florida 34238) *with* https://www3.epa.gov/pesticides/chem_search/ppls/033658-00026-20121220.pdf (Gharda submission of amended labeling to EPA identifying Gharda address as 4032 Crockers Lake Blvd., Suite 818, Sarasota, Florida 34238).

chlorpyrifos registrations and provides this notice of its objections and request for a hearing under 40 C.F.R. section 164.20(b) and request for a stay of the NOIC.

INTRODUCTION

This matter concerns the insecticide chlorpyrifos, a crop protection tool growers have relied upon for decades. After working with registrants in 2019 to identify key U.S. crop uses for chlorpyrifos, EPA used up-to-date science to determine that the tolerances for a subset of uses, on eleven crops in select geographic regions, meet the aggregate exposure safety standard in the Federal Food, Drug, and Cosmetic Act ("FFDCA") (the "Safe Uses"). Despite that finding, which EPA announced in its Proposed Interim Decision ("PID") [6] in 2020 and reaffirmed in the Final Rule and several times since, EPA elected to revoke ***all*** food tolerances, including those the Agency found safe, at the expense of farmers across the country. EPA's Final Rule disregarded Gharda's written commitment *before* the Final Rule to modify its registration and product labels consistent with the Agency's safety finding as to the Safe Uses. Indeed, Gharda was standing by before the Final Rule to submit amended labels to EPA narrowing uses to the Safe Uses, at EPA's instruction, when EPA abruptly ceased discussions with Gharda. Gharda and others submitted objections to and requested a stay of the Final Rule (incorporated by reference here), which EPA denied.[7]

Nineteen grower groups (representing thousands of farmers around the country who rely on chlorpyrifos) and the sole remaining technical registrant of chlorpyrifos (Gharda) (collectively "Petitioners") challenged the Final Rule as to the Safe Uses because it is arbitrary

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[6] Chlorpyrifos Proposed Interim Registration Review Decision, EPA-HQ-OPP-2008-0850 (Dec. 3, 2020) https://www.regulations.gov/document/EPA-HQ-OPP-2008-0850-0971, Ex. 5.
[7] Chlorpyrifos; Final Order Denying Objections, Requests for Hearings, and Requests for a Stay of the August 2021 Tolerance Final Rule, 87 Fed. Reg. 11,222 (Feb. 28, 2022), Ex. 6.

and capricious and contrary to the FFDCA in the lawsuit known as *Red River Valley Sugarbeet Growers Ass'n, et al. v. Regan, et al.*, Nos. 22-1422, 22-1530 (8th Cir.) (the "lawsuit"). In the lawsuit, Petitioners seek vacatur of the Final Rule as to the Safe Uses. The lawsuit has been fully briefed, and oral argument took place on December 15, 2022. The parties' principal briefs in the lawsuit are incorporated by reference here.[8]

As set forth below, the extreme and unprecedented action EPA has taken in issuing the NOIC is objectionable on numerous grounds. The NOIC is based on the Final Rule, which is arbitrary and capricious and contrary to law in its revocation of tolerances for the Safe Uses for all of the reasons set forth in Gharda's objections to the Final Rule and briefing to the Eighth Circuit; the NOIC is accordingly itself arbitrary and capricious, even more so based on the current record before the Agency, in which there can be no doubt that EPA has all available tools and information at its disposal showing that the chlorpyrifos registrations are consistent with the Agency's safety finding. EPA also improperly attempts to narrow the scope of the NOIC by contending that the propriety of EPA's Final Rule—the sole basis for the NOIC—cannot be a topic for the NOIC. What is more, EPA's NOIC blatantly disregards important FIFRA-mandated cancellation rights and processes. Indeed, EPA's NOIC fails to comply with requirements established by FIFRA regarding consideration of alternatives to registration cancellation and input from the U.S. Department of Agriculture ("USDA"). Further, EPA ignores Gharda's due process and property rights by, *inter alia*, failing to follow processes mandated by FIFRA for registration cancellation and failing to appropriately consider Gharda's

[8] Pet'rs' Opening Br. ("Pet'rs Br."), *Red River Valley Sugarbeet Growers Ass'n, et al. v. Regan, et al.*, Nos. 22-1422, 22-1530 (8th Cir. May 24, 2022), ID No. 5160660; Resp't Br., *Red River Valley Sugarbeet Growers Ass'n*, Nos. 22-1422, 22-1530 (8th Cir. July 26, 2022), ID No. 5180922; Pet'rs' Reply Br. ("Pet'rs Reply Br."), *Red River Valley Sugarbeet Growers Ass'n*, Nos. 22-1422, 22-1530 (8th Cir. Sept. 6, 2022), ID No. 5195044, Ex. 7.

efforts to make its registrations and product labels align with EPA's Final Rule. Finally, EPA in large part ignores the lawsuit, which could be decided any day and could make the NOIC moot. EPA waited 15 months after the Final Rule—until the day before oral argument in the lawsuit—to publish the NOIC. Based on EPA's own conduct, there is no urgent need or other basis for EPA to proceed with the NOIC before the Eight Circuit's decision. Accordingly, Gharda respectfully submits that the Administrative Law Judge should dismiss the NOIC. At a minimum, the NOIC should be delayed until after the Eighth Circuit's decision.

GHARDA'S OBJECTIONS

OBJECTION 1: The NOIC is improperly based on the Final Rule, which incorrectly revoked tolerances for the Safe Uses. Contrary to EPA's contention in the NOIC (87 Fed. Reg. at 76,476, Ex. 1), comments and arguments challenging EPA's actions in the Final Rule are very relevant to the NOIC and scope of the NOIC.

- The primary basis for the NOIC is that in its Final Rule, EPA revoked all food tolerances for chlorpyrifos and, therefore, uses set forth in Gharda's registrations for food uses cannot stand and must be cancelled. Similarly, the NOIC contends that Gharda's product registrations and amended labels are not consistent with the Final Rule because they include the Safe Uses.

- For all the reasons set forth in Gharda's objections to the Final Rule and the Petitioners' briefing in the lawsuit (incorporated by reference here), the Final Rule was arbitrary and capricious and contrary to law in its revocation of tolerances for the Safe Uses. *See* Pet'rs Br. at 23–26, 42–54 (ID No. 5160660); Pet'rs Reply Br. at 14-22 (ID No. 5195044), Ex. 7; Gharda Objs. to the Final Rule Revoking All Tolerances for Chlorpyrifos ("Gharda Objs."), EPA-HQ-OPP-2021-0523, at 9-11, 31-34 (Oct. 22, 2021), https://www.regulations.gov/comment/EPA-HQ-OPP-2021-0523-0028, Ex. 8. In the absence of a proper basis for revocation of tolerances for the Safe Uses, there is no basis for the NOIC, which seeks to cancel registered uses for the Safe Uses.

- The validity of the Final Rule as to the Safe Uses is currently under consideration by the Eighth Circuit. Oral arguments in the lawsuit occurred on December 15, 2022, and a decision is expected in the near future.

- If the Eighth Circuit vacates/remands the Final Rule as to the tolerances for the Safe Uses, the NOIC's purported basis for the cancellation action becomes moot.

<u>OBJECTION 2</u>: Action on the NOIC should be delayed until after the Eighth Circuit decides Petitioners' challenge to the Final Rule.

- Taking action on the NOIC is contrary to the exercise of jurisdiction by the Eighth Circuit regarding the tolerances for the Safe Uses. *See* Pet'rs Br. at 1-5 (ID No. 5160660), Ex. 7.

- If registration cancellation occurs and the Eighth Circuit subsequently rules in Petitioners' favor by either vacating or remanding the Final Rule as to the Safe Uses, EPA would likely argue that Gharda must nevertheless apply to EPA for a new registration as to the Safe Uses and proceed anew through the FIFRA registration and tolerance petition process. In other words, EPA may claim that, even if the Eighth Circuit vacates or remands the Final Rule as to the Safe Uses, if the registrations have been cancelled, the Eighth Circuit ruling is a pyrrhic victory because tolerances are meaningless for a cancelled registration. EPA should not be allowed, through the NOIC process, to evade a potential Eighth Circuit invalidation of the Final Rule, especially when the lawsuit has been fully briefed and argued, and the Eighth Circuit's decision is forthcoming at any time.

- In addition, (1) challenging registration cancellation through the FIFRA-established administrative and subsequent court process and/or (2) petitioning for a new registration are time consuming and expensive processes with uncertain outcomes. Forcing Gharda to undertake one or both of these alternatives prior to a decision by the Eighth Circuit would be overly burdensome and unfair and would abridge Gharda's right to have the tolerances for the Safe Uses decided in a meaningful way by the Eighth Circuit.

- In short, it would be improper and prejudicial to use the NOIC to circumvent judicial review and to force Gharda to pursue costly and time-consuming alternatives in parallel to the pending court proceeding. These inappropriate outcomes can be avoided simply by delaying the NOIC until after the Eighth Circuit's decision.

<u>OBJECTION 3</u>: The NOIC erroneously signals an urgent need for registration cancellation. To the contrary, there is no urgency for the NOIC to address because there are currently no chlorpyrifos products used on food in the stream of commerce, as EPA knows, and therefore no reason that the NOIC cannot be delayed until after the Eighth Circuit's decision.

- The NOIC makes statements implying that chlorpyrifos is currently being sold, distributed and/or used for food uses. *See, e.g.,* 87 Fed. Reg. at 76,477 ("It is a violation of FIFRA to sell and distribute pesticides that are misbranded…because the aforementioned [chlorpyrifos] products would result in pesticide residues in or on food…continued sale and distribution [of chlorpyrifos products] would not comply with the provisions of FIFRA."), Ex. 1. This is misleading.

- In correspondence dated March 1, 2022, EPA asked Gharda to voluntarily cancel its food use registrations for chlorpyrifos. Gharda responded on March 30, 2022. *See* Ex. 9. Gharda's response: (1) requested the voluntary cancellation of all of Gharda's food use registrations for chlorpyrifos except for the eleven Safe Uses currently in litigation (consistent with Gharda's commitment to the Agency well before the Final Rule); (2) recognized that "there can be no use, distribution, or sale of chlorpyrifos products for use on food by Gharda, its distributors and dealers, and other downstream uses"; and (3) "committed to working to ensure that its chlorpyrifos product does not enter the U.S. food supply while EPA's revocation order remains under review by the Eighth Circuit."

- EPA has never provided evidence contrary to Gharda's commitment to ensure that its chlorpyrifos product does not enter the U.S. food supply while EPA's Final Rule remains under review by the Eighth Circuit.

- There is no evidence of or reasonable basis to believe that chlorpyrifos is being distributed, sold, or otherwise placed in the stream of commerce for use on food, necessitating registration cancellation at this time. EPA's tolerance revocations made distribution or use unlawful. As noted above, in correspondence dated March 30, 2022, Gharda recognized that "there can be no use, distribution, or sale of chlorpyrifos products for use on food by Gharda, its distributors and dealers, and other downstream uses" and "committed to working to ensure that its chlorpyrifos product does not enter the U.S. food supply while EPA's revocation order remains under review by the Eighth Circuit."

- The NOIC alleges no facts inconsistent with Gharda's commitments or otherwise demonstrating that chlorpyrifos products are being distributed, sold, and/or used in a manner inconsistent with the Final Rule.

- Oral argument in the lawsuit took place on December 15, 2022. For the Agency to wait nine months after Gharda's commitment not to sell or distribute chlorpyrifos products to issue its NOIC and to do so one day before oral argument in the lawsuit, demonstrates an inappropriate attempt by the NOIC to create urgency where EPA's conduct demonstrates none exists. In sum, there is no urgent need based on the facts for the NOIC to proceed with actions as extreme as cancellations before the Eighth Circuit's decision.

OBJECTION 4: The NOIC violates FIFRA by ignoring several of the statutorily required steps that *must* precede registration cancellation, including the requirement to consider alternatives to cancellation, and by improperly attempting to narrow the scope of the Administrative Law Judge's review.

- FIFRA Section 6(b) provides that "*[i]n taking any final action under this subsection*, the Administrator *shall* consider restricting a pesticide's use or uses as an alternative to cancellation and shall fully explain the reasons for these restrictions, and *shall* include among those factors to be taken into account the impact of such final action on production and prices of agricultural commodities, retail food prices, and otherwise on the agricultural economy, and the Administrator shall publish in the Federal Register an analysis of such impact." 7 U.S.C. § 136d(b) (emphasis added).

- FIFRA does not permit EPA to ignore these statutory requirements simply because a tolerance action precedes a cancellation action. EPA is required to review the full record before the Agency in issuing a decision on a NOIC. *See* 40 C.F.R. § 164.90(b).

- EPA contends in the NOIC that only the Final Rule and the facts existing at the time of the Final Rule are relevant to the NOIC. The NOIC thus ignores FIFRA's requirement that alternatives to registration cancellation *must* be considered *in taking any final action under FIFRA Section 6(b)* and improperly attempts to limit the scope of the Administrative Law Judge's review.

- EPA did not consider the PID and the Safe Uses identified by the PID as an alternative to cancellation and therefore violated FIFRA's registration cancellation requirements.

- EPA did not consider Gharda's repeated written commitment to the Agency before the Final Rule to voluntarily cancel all food uses of chlorpyrifos except the Safe Uses as an alternative to cancellation and therefore violated FIFRA's registration cancellation requirements. *See* Decl. of Ram Seethapathi in Support of Gharda's Objs. to the Final Rule Revoking All Tolerances for Chlorpyrifos ("Seethapathi Decl."), EPA-HQ-OPP-2021-0523, ¶¶ 21–36 and Exhibits to Seethapathi Decl. A–H (Oct. 22, 2021), Ex. 8; *see also* Ex. 9.

- EPA has never provided evidence contrary to Gharda's commitment to ensure that its chlorpyrifos product does not enter the U.S. food supply while EPA's Final Rule remains under review by the Eighth Circuit.

- EPA did not consider Gharda's submission of its request to voluntarily cancel all food uses of chlorpyrifos except the Safe Uses pending the outcome of the Eighth Circuit litigation as an alternative to cancellation and therefore violated FIFRA's registration cancellation requirements.

- EPA did not consider Gharda's submission of amended labels, which eliminated all food uses for chlorpyrifos except the Safe Uses as an alternative to cancellation and therefore violated FIFRA's registration cancellation requirements.

- EPA did not consider the impact of cancellation compared to the alternative of maintaining the Safe Uses on production and prices of agricultural commodities, retail food prices, and otherwise on the agricultural economy and therefore violated FIFRA's registration cancellation requirements.

- The Administrator of EPA did not publish in the Federal Register an analysis of the impact of cancellation compared to the alternative of maintaining the Safe Uses on production and prices of agricultural commodities, retail food prices, and otherwise on the agricultural economy and therefore violated FIFRA's registration cancellation requirements.

- FIFRA Section 6(b) requires EPA to respond to USDA's comments with respect to the NOIC.

- EPA gave no meaningful consideration to USDA's request that EPA re-establish tolerances for the Safe Uses based on EPA's own scientific findings and therefore violated FIFRA's cancellation requirements. *See* Letter from Kimberly Nesci, Dir., Office of Pest Mgmt. Pol'y, United States Dep't of Agriculture to Edward Messina, Dir., Office of Pesticide Programs ("USDA Comments Letter"), EPA, EPA-HQ-OPP-2022-0417 (Sept. 11, 2022) at 2, https://www.regulations.gov/document/EPA-HQ-OPP-2022-0417-0002.

- EPA gave no meaningful consideration to USDA's comments that, *inter alia*, EPA was not following "historical precedent and legal procedures" with respect to the Final Rule and NOIC and that the EPA's actions constituted "harmful precedent" and therefore violated FIFRA's registration cancellation requirements. *Id*. at 1–3.

- It is illogical for EPA to contend in the NOIC that the Final Rule is irrelevant to the NOIC and then imply that it can ignore USDA's comments submitted pursuant to FIFRA because it did not submit objections to the Final Rule.

<u>OBJECTION 5</u>: The NOIC violates Gharda's due process rights.

- Once a pesticide registration is granted, it becomes the registrant's property interest, *see, e.g., Reckitt Benckiser Inc. v. EPA*, 613 F.3d 1131, 1133 (D.C. Cir. 2010), and cannot "be taken away without that procedural due process required by the Fourteenth Amendment," *Bell v. Burson*, 402 U.S. 535, 539 (1971). FIFRA protects these due process rights by establishing an elaborate scheme for EPA to follow before cancelling a pesticide registration. *See, e.g.*, 7 U.S.C. §§ 136d(b)(1), (2); 136d(d); 136a(g)(1)(v); *see also Reckitt Benckiser, Inc. v. Jackson*, 762 F. Supp. 2d 34, 42 (D.D.C. 2011) (FIFRA "establishes a detailed, multi-step process that EPA *must* follow when it wants to cancel or suspend a registration.").

- Due process is denied when the statutorily mandated process for taking away a property right is not followed.

- EPA has failed to provide Gharda with due process by, *inter alia*: (1) instructing Gharda, before the Final Rule, to be prepared to submit a voluntary cancellation letter narrowing uses consistent with the PID and then abruptly terminating discussions; (2) not considering as an alternative to registration cancellation maintaining the Safe Uses as registered uses in accordance with the PID and EPA's determination of Safe Uses; (3) not considering as an alternative to registration cancellation Gharda's repeated written commitment to the Agency before the Final Rule to voluntarily cancel all food uses of chlorpyrifos except the Safe Uses; (4) not considering as an alternative to registration cancellation Gharda's commitment to ensure that its chlorpyrifos product does not enter the U.S. food supply while EPA's Final Rule remains under review by the Eighth Circuit; (5) not considering as an alternative to registration cancellation Gharda's submission of its request to voluntarily cancel all food uses of chlorpyrifos except the Safe Uses pending the outcome of the Eighth Circuit litigation; (6) not considering as an alternative to registration cancellation Gharda's submission of amended labels which eliminated all food uses for chlorpyrifos except the Safe Uses; (7) not considering the impact of registration cancellation compared to the alternative of maintaining the Safe Uses on production and prices of agricultural commodities, retail food prices, and otherwise on the agricultural economy; (8) not publishing in the Federal Register an analysis of the impact of registration cancellation compared to the alternative of maintaining the Safe Uses on production and prices of agricultural commodities, retail food prices, and otherwise on the agricultural economy; (9) failing to await the decision from the Eighth Circuit before issuing the NOIC when chlorpyrifos cannot be sold or used and there is otherwise no urgency for registration cancellation proceedings at this time; (10) overburdening Gharda and other adversely affected parties with the necessity to spend resources to defend the NOIC when an Eighth Circuit decision vacating or remanding the Final Rule as to the Safe Uses would eliminate the need for the NOIC; (11) overburdening Gharda with the necessity to spend resources to challenge registration cancellation that may occur and be followed by a favorable Eighth Circuit decision vacating or remanding the Final Rule as to the Safe Uses; and, (12) failing to consider or meaningfully consider USDA's comments in response to the NOIC, including, as set forth above, that EPA should re-establish tolerances for the Safe Uses and did not follow "historical precedent and legal procedures" regarding the Final Rule and NOIC.

- EPA's actions in issuing the NOIC compound the Agency's due process violations in issuing the Final Rule. EPA violated the due process rights of Gharda and others by revoking all tolerances in disregard of the Agency's own scientific findings as to the Safe Uses and Gharda's written commitment in advance of the Final Rule to modify its registration in accordance with the Agency's safety finding. *See* Gharda Objs. at 31–37, Ex. 8.

OBJECTION 6: Under the circumstances of this matter, EPA's demand in the NOIC that Gharda amend its registration labels to voluntarily cancel food uses for the Safe Uses is overly burdensome, unrealistic, punitive, and improperly seeks to interfere with the exercise of jurisdiction by the U.S. Court of Appeals for the Eighth Circuit.

- As noted above, on March 30, 2022, Gharda submitted a letter to EPA seeking cancellation of all food uses of chlorpyrifos in Gharda's registrations except the eleven

Safe Uses. Gharda explained in its letter that EPA's revocation of tolerances for the Safe Uses was currently under review by the Eighth Circuit. Ex. 9. Gharda also submitted amended labels to EPA omitting all food uses but the Safe Uses on June 10, 2022. Ex. 10.

- The NOIC states that "[w]hile Gharda submitted requests for voluntary cancellation for some uses and some label amendments, that request does not fully align with the revocation of chlorpyrifos tolerances (*i.e.,* it does not result in the removal of all food uses from those registered products); therefore, Gharda's products identified [in the NOIC] are subject to this Notice." 87 Fed. Reg. at 76,476, Ex. 1. The NOIC misleadingly omits that the only way Gharda's registrations do not align with the Final Rule is as to the Safe Uses currently under review by the Eighth Circuit.

- To the extent Gharda's prior commitments before the Final Rule and submissions to EPA after the Final Rule are somehow insufficient to satisfy EPA that label changes consistent with EPA's safety finding can be accomplished (a position Gharda views as contrary to the law and facts, *see* Pet'rs Br. at 23–28 (ID No. 5160660)), Gharda has submitted amended labels to EPA (included with this submission at Ex. 3) that once again limit food uses to the Safe Uses in the permitted geographic regions (that are the subject of the ongoing litigation) and also add application rate changes consistent with the PID safety finding. Gharda submits these changes to further demonstrate its commitment to conform its registrations to EPA's safety finding in the PID, despite that the changes proposed are based on information the Agency developed and has had in its possession for years. *See* Updated Chlorpyrifos Refined Drinking Water Assessment for Registration Review, EPA-HQ-OPP-2008-0850-0941 at 33–34 (Sep. 22, 2020), https://www.regulations.gov/document/EPA-HQ-OPP-2008-0850-0941, Ex. 11.

- The NOIC states that the cancellation proposed in the NOIC shall become final unless "the registrant makes the necessary corrections to the registrations" or a hearing is requested. 87 Fed. Reg. at 76,475, Ex. 1.

- Thus, EPA demands that Gharda voluntarily cancel all remaining food uses, the tolerances for which are currently under review by the Eighth Circuit. EPA's actions appear to be punitive, and an attempt to undermine and thwart Gharda's justified attempt to obtain judicial review of EPA's Final Rule as to the Safe Uses.

- If registration cancellation occurs before an Eighth Circuit decision invalidating the Final Rule, EPA would likely contend that Gharda must nevertheless apply to EPA for a new registration as to the Safe Uses and proceed anew through the FIFRA registration and tolerance petition processes. In other words, EPA may claim that, even if the Eighth Circuit vacates or remands the Final Rule to the Agency as to the Safe Uses, if the registrations have been cancelled, the Eighth Circuit ruling is a pyrrhic victory because tolerances are meaningless for a cancelled registration. But (1) challenging cancellation through the FIFRA-established administrative and subsequent court process and/or (2) petitioning for a new registration are time consuming and expensive processes with uncertain outcomes. Forcing Gharda to undertake one or both of these alternatives would be overly burdensome and unfair, and would abridge Gharda's right to have the tolerances for the Safe Uses decided in a meaningful way by the Eighth Circuit. These outcomes can be avoided simply by delaying the NOIC until after the Eighth Circuit decision.

OBJECTION 7: The NOIC does not give due consideration to the USDA's views, contrary to FIFRA.

- FIFRA Section 6(b) requires EPA to respond to USDA's comments with respect to the NOIC. 7 U.S.C. § 136d.

- EPA gave no meaningful consideration to USDA's request that EPA re-establish tolerances for the Safe Uses in accordance with its scientific findings and therefore violated FIFRA's registration cancellation requirements. *See* USDA Comments Letter at 2.

- EPA gave no meaningful consideration to USDA's comments that, *inter alia*, EPA was not following "historical precedent and legal procedures" with respect to the Final Rule and NOIC and that the EPA's actions constituted "harmful precedent" and therefore violated FIFRA's registration cancellation requirements. *Id*. at 1–3.

- As noted by USDA, it is unprecedented for EPA to ignore FIFRA-mandated cancellation rights and processes in a situation where tolerance revocation occurs first.

- It is illogical for EPA to contend in the NOIC that the Final Rule is irrelevant to the NOIC and then imply that it can ignore USDA's comments submitted pursuant to FIFRA because it did not submit objections to the Final Rule.

OBJECTION 8: Issuance of the NOIC with a response deadline shortly after the holiday period is burdensome, unfair, and unnecessary.

- As set forth above, there is no urgency or any other good faith reason to force Gharda and other adversely affected parties to respond to the NOIC during the holiday period and to prepare for and go through a potentially costly NOIC process in light of the circumstances set forth above. Accordingly, Gharda respectfully requests that the Administrative Law Judge stay action on the NOIC until after the Eighth Circuit's decision in the lawsuit.

REQUEST FOR STAY OF NOIC

Based on the foregoing, Gharda respectfully requests that the Administrative Law Judge delay any action with respect to the NOIC, including but not limited to the conduct of the hearing requested herein, until after the Eight Circuit's decision in the lawsuit. A stay of the NOIC proceedings is warranted because proceeding with a potential registration cancellation now would prejudice the rights of Gharda and others to obtain judicial relief from the Final Rule underlying the NOIC in the ongoing litigation. Should a potential cancellation of the chlorpyrifos registrations precede a favorable ruling by the Eighth Circuit invalidating the Final Rule, EPA may nevertheless take the position that Gharda must initiate the FIFRA registration and tolerance petition processes for chlorpyrifos anew—destroying decades of investment, causing the needless expenditure of Agency and registrant resources, and further delaying access to a crop protection tool critical to U.S. growers. As discussed above, as there are no chlorpyrifos products approved for use on food currently in the stream of commerce, there are no public health concerns with simply delaying further action on the NOIC until the Eighth Circuit rules.[9]

CONCLUSION

For the reasons set forth above, EPA's unprecedented NOIC is contrary to FIFRA in many respects, violates the due process rights of Gharda, and is otherwise deficient. Moreover, there is no urgent need or other basis for the NOIC to proceed before the Eighth Circuit's decision in the lawsuit. Forcing Gharda to defend the NOIC before the Eighth Circuit's decision would be unfairly burdensome and unnecessary and is contrary to the Eighth Circuit's exercise of jurisdiction over the tolerances for the Safe Uses.

[9] In other administrative actions, EPA has applied the stay criteria set forth by the U.S. Food and Drug Administration at 21 CFR § 10.35(e)(1)–(4) ((1) petitioner will suffer irreparable injury; (2) petitioner's case is not frivolous and pursued in good faith; (3) sound public policy grounds support a stay; and (4) delay from a stay is not outweighed by public health or other public interests). For reasons outlined herein, Gharda has satisfied these criteria here.

Gharda respectfully requests a hearing on the NOIC and requests that the Administrative Law Judge find that the Administrator did not have a proper basis for issuing the NOIC and dismiss the NOIC. At a minimum, the Administrative Law Judge should delay action on the NOIC until after a decision from the Eighth Circuit in the lawsuit.

Respectfully submitted,

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Attorneys for Gharda Chemicals International, Inc.

Date: January 13, 2023

CERTIFICATE OF SERVICE

I hereby certify that on January 13, 2023, true and correct copies of the foregoing Request for Hearing and Statement of Objections and Request for Stay, and all associated Exhibits, were filed electronically with the EPA OALJ E-Filing System for the OALJ's E-Docket Database, with a copy (without attachments) via electronic mail to the following:

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*/s/ Donald C. McLean*__________________
Donald C. McLean

EXHIBIT CC

Florida Commercial Citrus Acreage as of
January 1996

USDA, NASS Florida Field Office
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U. S. CITRUS PRODUCTION

For many years Florida has been the nation's dominant state in production of citrus. During the last decade about 70 percent of all U.S. citrus was grown in Florida.

Production of U.S. Citrus by States

Season	FL [1]	CA	TX	AZ	U.S. total
	(1,000 tons)	(1,000 tons)	(1,000 tons)	(1,000 tons)	(1,000 tons)
2001-2002	12,824	2,907	310	153	16,194
2002-2003	11,206	3,530	292	152	15,180
2003-2004	13,045	2,855	298	162	16,360
2004-2005	7,597	3,511	339	127	11,574
2005-2006	7,832	3,460	277	185	11,745
2006-2007	7,236	2,743	368	120	10,467
2007-2008	9,119	3,312	317	90	12,838
2008-2009	8,470	2,954	282	133	11,839
2009-2010	7,132	3,477	294	97	11,000
2010-2011	7,427	3,860	335	112	11,734

[1] Does not include lemons. Limes and K-Early Citrus Fruit included through 2001-02.

FLORIDA'S OBJECTIVE CITRUS FORECAST

Advance knowledge of crop size permits early decisions for planning operations, marketing, and policy making, which are especially important to a crop which is harvested over several months and sold year round. The U.S. Department of Agriculture first made forecasts of Florida citrus production in 1918, based on survey opinions of crop observers and statisticians. The need for greater accuracy in these forecasts intensified as Florida's production increased. Florida's participation in world markets underlines the need for comprehensive and accurate information to successfully compete in these markets.

The interest in a statistically accurate forecast has led to the current system based on objective data including an early season limb count survey to establish actual fruit set, supplemented with monthly in-season measurements of fruit size and observations of fruit droppage. This system of the forecasts and estimates is possible through an industry-supported per-box assessment on all Florida production. The resulting trust fund is used to collect much of the objective survey data for the USDA forecast and estimates.

Florida's Citrus Production by Seasons

Season	Oranges	Grapefruit	Others	Total
	(million boxes)	(million boxes)	(million boxes)	(million boxes)
2001-2002	230.0	46.7	10.6	287.3
2002-2003	203.0	38.7	9.3	251.0
2003-2004	242.0	40.9	8.9	291.8
2004-2005	149.8	12.8	6.7	169.3
2005-2006	147.7	19.3	7.6	174.6
2006-2007	129.0	27.2	5.9	162.1
2007-2008	170.2	26.6	7.0	203.8
2008-2009	162.5	21.7	5.0	189.2
2009-2010	133.7	20.3	5.4	159.4
2010-2011	140.3	19.8	5.8	165.9

COMMERCIAL TREE INVENTORY

The commercial tree inventory, done every year, provides a complete record of trees and acreage by counties for each citrus type and variety, by year planted. In addition to its use for decisions on planting and future planning, the inventory provides a sampling frame for the objective forecasting surveys—the statistical sample of groves is drawn from the inventory records. Thus, resulting estimates from the same survey data may be used with statistical confidence obtainable only with a probability sample.

The inventory has previously used aerial photographs of about 14,000 square miles of the Florida peninsula covering virtually all citrus growing areas. Photos were taken at 15,000 feet on black and white panchromatic film. The resulting exposures with a scale of 1:30,000 cover a three-mile wide swath on the ground, and the same flight lines were followed for each inventory. The first such photos were taken in late 1965 and used for the January 1966 inventory. For that inventory, photo enlargements were obtained and every block of citrus was identified on the ground and mapped onto an enlargement. The resulting record of each planting has been updated, amended, and added to at every inventory since then, through the use of photo comparison and subsequent survey work in the groves.

Now, remotely sensed data allows for rapid replacement and maintenance of background images. Grove boundaries are digitized and saved in a geodatabase in our geographic information system (GIS). The software provides additional tools to enhance comparative photo interpretation for grove change detection. Field checking of new and altered acreage follows. Changes detected on images and in field observations are used to update the previous inventory. This technology provides current tree inventory data for evaluating Florida's potential citrus production in a shorter period of time and at less cost than by ground survey methods alone.

Florida Commercial Citrus Acreage as of January

Survey year	Oranges	Grapefruit	Others	Total
	(acres)	(acres)	(acres)	(acres)
1988	536,737	119,606	41,586	697,929
1990	564,809	125,300	42,658	732,767
1992	608,636	135,166	47,488	791,290
1994	653,370	146,915	53,457	853,742
1996	656,598	144,416	56,673	857,687
1998	658,390	132,817	54,053	845,260
2000	665,529	118,145	48,601	832,275
2002	648,806	105,488	43,009	797,303
2004	622,821	89,048	36,686	748,555
2006	529,241	63,419	28,713	621,373
2008	496,518	56,881	23,178	576,577
2009	492,529	53,863	22,422	568,814
2010	483,418	50,189	20,430	554,037
2011	473,086	48,990	19,252	541,328

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OBJECTIVE SURVEY METHODS

The annual citrus crop production forecast is based on estimates and projections from actual counts and measurements, avoiding observations based on opinion or judgment. These objective procedures are simple in concept but complex in planning, management for efficiency, and quality assurance.

The four basic parameters used in the forecast are (1) number of bearing trees, (2) number of fruit per tree, (3) fruit size, and (4) fruit loss from droppage. The first two of these parameters have the greatest influence on the forecast. The general model incorporates the estimated total fruit (bearing trees times average fruit per tree), divided by the number of fruit projected to make a standard box at harvest (using the fruit size survey), reduced for droppage (the fraction of fruit counted at survey time but lost to droppage before it is harvested).

$$\text{Production Indicator} = \frac{\text{Bearing Trees} \times \text{Fruit per Tree} \times \text{Percent Remaining at Harvest}}{\text{Pieces of Fruit per Box}}$$

The sample design used to obtain each parameter stratifies the State's citrus belt into five nearly homogeneous areas and the bearing trees into five age groups. Sample groves for surveying are selected from the citrus tree inventory using probability sampling procedures. The samples are mapped on copies of aerial photo enlargements and indexed for reference.

Developed during the mid-1950's, the Limb Count survey conducted from mid-to-late summer has become the basic tool for estimating the average number of fruit on Florida's citrus trees. Annually as many as 3,200 sample groves are drawn from the tree inventory data by type, to be representative of their population. Survey crews are then dispatched to these groves. At each sample site, two trees are chosen at random for sampling.

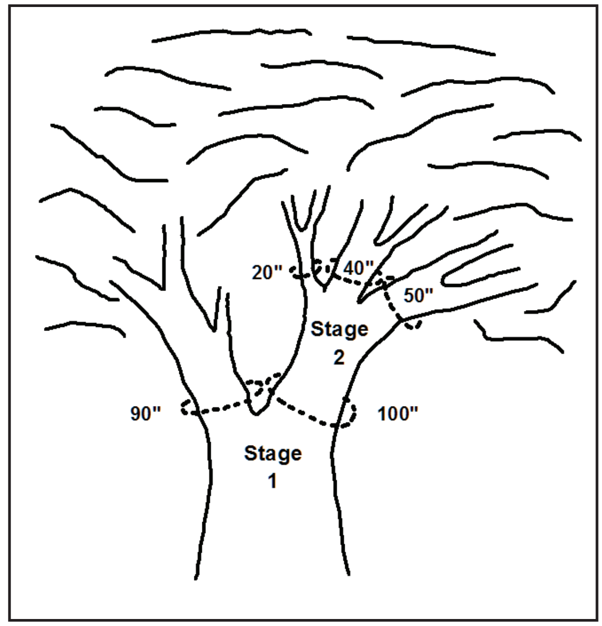
A sample limb representing approximately 10 percent of the bearing surface of each tree is randomly selected based on the cross sectional area measurements of limbs, starting at the trunk or scaffold and moving in successive stages up the tree. Fruit is then counted on this sample limb, with random recounts by supervisors to maintain quality control. The procedure utilizes the correlation between limb size and the fruiting ability of that limb—thus it is most efficient to sample more trees and count only a small part of each tree.

Fruit counts are then expanded by the reciprocal of the probability of selection to a total tree basis. This design results in the reliable estimates of average fruit per tree.

SIZE AND GROWTH OF FRUIT

Another important parameter in the forecast is the expected fruit size. Fruit size measurement surveys are conducted monthly from August to harvest on two trees in each of about 1,800 sample groves.

Circumference calipers, which have proven to be the most sensitive tool to measure subtle changes in size, are used for this survey. Fruit size is projected to harvest by use of growth charts, historical relationships of current survey data to final results, and other relationships to detect similar-year growth. Fruit circumference is converted to number of fruit per box to report the forecast in boxes.



FRUIT LOSS FROM DROPPAGE

Fruit droppage is the final factor which must be considered to develop a reliable forecast of production. This requires monthly observations of fruit loss from many sample branches. These sample branches are tagged and the fruit is counted at the same time as the Limb Count survey. Then at monthly intervals, the same branches are recounted. Cumulative fruit loss for the season and historical data from previous seasons are used to project fruit loss to harvest time.

The resulting October forecast is subject to change in later months due to weather conditions that affect fruit sizing and droppage rates.

CITRUS MATURITY AND YIELD SURVEY

Another feature of the Florida citrus forecasting program is the projected yield of frozen concentrated orange juice (FCOJ) for oranges, expressed in gallons of concentrate per box. This projection is important for fruit used in processing which is a major portion of the orange production.

Sample groves and trees remain relatively constant from year to year in order to assure the greatest continuity of data. Fruit samples are collected monthly throughout the season and tested for acid, solids, and unfinished juice. The projection of FCOJ yield per 90 pound box equivalent is based on a statistical regression of these unadjusted maturity and yield test results to actual yields at processing plants during past seasons. The level of maturity, weather, and harvest patterns all play a substantial part in the final result.

Prior to freezes in the mid-1980's, the Florida citrus industry annually produced approximately 90 percent of the nation's supply of frozen concentrated orange juice. In recent years, more fruit has been going to fresh squeezed products.

Florida's Frozen Concentrated Orange Juice (FCOJ)

Season	Boxes used	Average yield[1]	Product
	(1,000 boxes)		(1,000 gallons)
2001-2002	135,975	1.58	215,057
2002-2003	102,073	1.54	156,845
2003-2004	139,727	1.56	218,296
2004-2005	54,322	1.58	85,998
2005-2006	51,873	1.63	84,600
2006-2007	47,996	1.65	79,054
2007-2008	80,817	1.67	135,196
2008-2009	72,543	1.66	120,790
2009-2010	52,737	1.56	82,252
2010-2011	51,758	1.59	82,092

[1] Gallons per box at 42° Brix.

OTHER SURVEYS AND STATISTICS

From the objective surveys, estimates of production by counties and boxes of fruit per tree by types and ages are reported in the preliminary Production and Value release. It is followed by the annual Citrus Summary. From the annual tree inventory, tree and acreage changes are shown by fruit types, counties, and year set in the preliminary Tree Inventory release and the Commercial Citrus Inventory.

A monthly route survey is conducted during the season to estimate the percent of fruit harvested to date. Additional crop statistics are provided as the need arises. These include surveys following such disasters as hurricanes and freezes.

VALUE OF FLORIDA'S CITRUS CROP

Florida citrus production represents about one fifth of the total value of farm production in the State. Farm production value is the product of total units sold and the average price received by the producer.

Average prices received are estimated monthly for sales for fresh use and for processing, based on current sales information. These estimates are combined with sales volume to calculate a season average price. The price estimates, especially for processing, are subject to revision after the closing of cooperative pools, about one year later, since about one half of the orange crop is sold through cooperative and participation plans.

Price estimates are made and published for a 90-pound box equivalent of oranges and 85 pounds of grapefruit. The price received by growers for fruit processed is for pounds of sugar solids delivered to the processor. In recent years, over 95 percent of oranges and nearly 58 percent of grapefruit were processed.

Prices are reported at two levels: The on-tree value of sales, which excludes the cost per box for picking and hauling the fruit to the packinghouse, and the value per box delivered to the packinghouse.

On-Tree Value of Florida's Citrus

Season	Oranges	Grapefruit	Others	Total
	(1,000 dollars)	(1,000 dollars)	(1,000 dollars)	(1,000 dollars)
1991-1992	828,749	280,629	99,566	1,208,944
1992-1993	649,713	146,432	59,667	855,812
1993-1994	713,312	167,211	59,331	939,854
1994-1995	767,924	116,602	63,647	948,173
1995-1996	895,465	101,140	79,212	1,075,817
1996-1997	801,344	88,009	71,143	960,496
1997-1998	900,815	63,000	59,568	1,023,383
1998-1999	900,044	108,411	88,798	1,097,253
1999-2000	856,052	188,332	64,139	1,108,523
2000-2001	716,055	100,869	45,107	862,031
2001-2002	797,602	107,653	61,548	966,803
2002-2003	643,804	94,518	49,056	787,378
2003-2004	699,927	136,295	55,278	891,500
2004-2005	522,892	172,365	58,912	754,169
2005-2006	813,332	149,655	61,633	1,024,620
2006-2007	1,310,382	120,280	68,450	1,499,112
2007-2008	1,125,348	117,507	41,139	1,283,994
2008-2009	937,069	82,696	26,970	1,046,735
2009-2010	918,872	152,035	47,436	1,118,343
2010-2011 [1]	957,942	131,458	55,395	1,144,795

[1] Preliminary.

FORECAST ACCURACY

Each forecast is subject to inherent sampling errors, but during recent seasons without freezes or hurricanes, the average deviation from the October forecast to the final pickout has been under four percent for oranges and under five percent for grapefruit.

October Forecast Versus Final Production

Season	Oranges		Grapefruit	
	October	Final	October	Final
	(million boxes)	(million boxes)	(million boxes)	(million boxes)
1999-2000	211.0	233.0	50.0	53.4
2000-2001	240.0	223.3	50.0	46.0
2001-2002	231.0	230.0	48.0	46.7
2002-2003	197.0	203.0	42.0	38.7
2003-2004	252.0	242.0	42.0	40.9
2004-2005 [1]	176.0	149.6	15.0	12.8
2005-2006 [1]	190.0	147.7	24.0	19.3
2006-2007	135.0	129.0	26.0	27.2
2007-2008	168.0	170.2	25.0	26.6
2008-2009	166.0	162.5	23.0	21.7
2009-2010	136.0	133.7	19.8	20.3
2010-2011	146.0	140.3	20.0	19.8

[1] Hurricane-affected season.

FORECAST SECURITY

The citrus crop forecast is released by the USDA's National Agricultural Statistics Service in Washington, D.C., on or before the 12th day of the month, reflecting conditions as of the first of that month. The report is always released at 8:30 a.m., before the opening of business on the Futures Market. This is done to permit all concerned an equal opportunity to have access and review the statistics before trading resumes.

To insure absolute security of the information, all orange survey data is summarized in restricted areas and ultimately assembled for release in the lock-up area of the National Agricultural Statistics Service. An oath of loyalty is administered to all employees of the Department and they are subject to punishment for early release of information or for reporting erroneous data.

USDA, NASS, Florida Field Office

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Printed October 2011

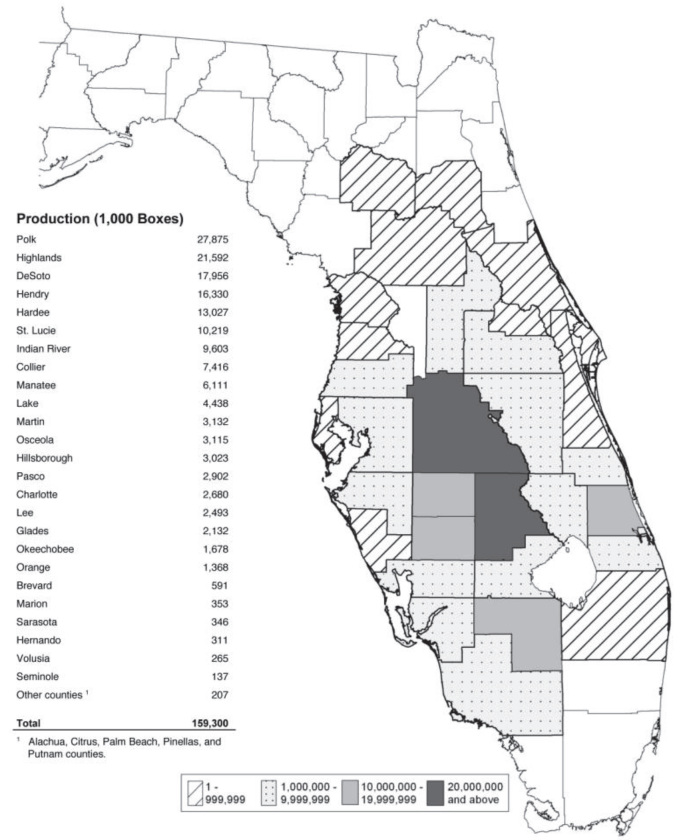
FORECASTING

FLORIDA'S

CITRUS

PRODUCTION

Citrus Production by County 2009-2010



FLORIDA'S CITRUS CROP STATISTICS

The USDA's National Agricultural Statistics Service Florida Field Office works cooperatively with the Florida Department of Agriculture and Consumer Services and the University of Florida. The office is responsible for gathering and reporting Florida's agricultural statistics. Major crop and livestock statistics are reported with various statistical methods used to prepare the information released. This brochure explains the process used to forecast citrus crop production.

EXHIBIT Z

Florida Agricultural Statistics
July 10, 1998

NASS Florida Agricultural Statistics Serv
1222 Woodward Street
Orlando, Florida 32803
407 / 648-6013
http://www.nass.usda.gov/fl

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FLORIDA AGRICULTURE

CITRUS

JULY FORECAST
FORECAST COMPONENTS

July 10, 1998

Citrus production, July 1, 1998
forecasts by varieties and States, with comparisons

Crop and State	Production		Forecast	
	1995-96 [1/]	1996-97 [2/]	Jun 12, 1998	Jul 10, 1998
	--- 1,000 boxes ---			
Early, Midseason, and Navel Oranges:				
FLORIDA	**121,200**	**134,200**	**140,000**	**140,000**
California	38,000	40,000	44,000	44,000
Texas	830	1,300	1,350	1,350
Arizona	700	400	450	350
Total Above Varieties	160,730	175,900	185,800	185,700
Valencias:				
FLORIDA	**82,100**	**92,000**	**108,000**	**104,000**
California	20,000	24,000	30,000	30,000
Texas	110	120	180	180
Arizona	950	600	550	650
Total Valencias	103,160	116,720	138,730	134,830
All Oranges:				
FLORIDA	**203,300**	**226,200**	**248,000**	**244,000**
California	58,000	64,000	74,000	74,000
Texas	940	1,420	1,530	1,530
Arizona	1,650	1,000	1,000	1,000
Total All Oranges	263,890	292,620	324,530	320,530
Grapefruit:				
FLORIDA-All	**52,350**	**55,800**	**49,500**	**49,500**
Seedless	**51,300**	**54,900**	**48,850**	**48,850**
White	**23,200**	**23,500**	**18,250**	**18,250**
Colored	**28,100**	**31,400**	**30,600**	**30,600**
Seedy (Other)	**1,050**	**900**	**650**	**650**
Texas	4,550	5,300	4,800	4,800
Arizona	1,200	900	800	800
California-All	8,100	8,200	9,000	9,000
Total Grapefruit	66,200	70,200	64,100	64,100
Lemons:				
California	21,000	20,000	22,000	22,000
Arizona	5,100	2,600	2,600	2,600
Total Lemons	26,100	22,600	24,600	24,600
Limes: Florida	**300**	**320**	**(Final) 440**	**(Final) 440**
Temples: Florida	**2,150**	**2,400**	**2,250**	**2,250**
Tangelos: Florida	**2,450**	**3,950**	**2,850**	**2,850**
K-Early: Florida	**160**	**150**	**40**	**40**
Tangerines:				
FLORIDA-All	**4,500**	**6,300**	**5,200**	**5,200**
Early [3/]	**2,900**	**4,500**	**3,200**	**3,200**
Honey	**1,600**	**1,800**	**2,000**	**2,000**
California	2,600	2,600	2,400	2,400
Arizona	1,000	550	500	600
Total Tangerines	8,100	9,450	8,100	8,200

[1/] Excludes 3.0 million boxes of economic abandonment of Florida colored seedless varieties. [2/] Excludes 6.0 million boxes of economic abandonment in Florida: 3.0 million white seedless and 3.0 million colored varieties. [3/] Robinson, Fallglo, Sunburst, and Dancy.

The first forecast of the 1998-99 season will be released at 8:30 A.M. October 9, 1998.

ALL ORANGES NOW 244.0 MILLION BOXES

The all orange forecast is decreased 4.0 million to 244.0 million boxes as reported by the USDA Agricultural Statistics Board. The decrease is in the Valencia portion which is now forecast at 104.0 million boxes. This decrease reflects certifications to June 21 and estimated utilization for the remainder of the season. Harvest is nearly complete with the last major processor scheduled to close today. Early and midseasons are final at 140.0 million boxes.

This all orange utilization is a record, eight percent above last season's previous record of 226.2 million boxes. The early and midseason crop exceeds last season by four percent and Valencias totaled 13 percent more.

ALL GRAPEFRUIT 49.5 MILLION BOXES

The all grapefruit forecast of utilized production (including 1.2 million boxes of non-certified and gift fruit usage) is unchanged from last month at 49.5 million boxes. White seedless is 18.25 million boxes, colored seedless varieties 30.6 million, and seedy 650,000, all unchanged from last month. There was limited utilization in June as the high heat curtailed usability of fruit.

SPECIALTY TYPES COMPLETE

Harvest is complete for all specialty types. Temple utilization at 2.25 million boxes is five percent below the average of the past five seasons. While down 28 percent from last season, the tangelo crop of 2.85 million boxes is 16 percent higher than in 1995-96. Tangerines varieties total 5.2 million, 55 percent above the average of the past 10 non-freeze seasons. The smallest crop of K-Early Citrus is recorded at 40,000 boxes.

FCOJ REMAINS 1.58 GALLONS PER BOX

The all orange FCOJ yield projection remains at 1.58 gallons per box. The Valencia projection continues at 1.72 gallons, a record high yield. The previous high of 1.69608 gallons per box occurred in 1991-92. The early and midseason portion is final at 1.492548 gallons per box, down from 1996-97 but higher than the two prior seasons.

U.S. Department of Agriculture
National Agricultural Statistics Service

Florida Department of Agriculture and Consumer Services
Division of Marketing and Development

University of Florida
Institute of Food and Agricultural Sciences

FORECAST COMPONENTS OF PRODUCTION FROM OBJECTIVE SURVEYS

The table shows the production components used for the 1997-98 forecast season with comparisons to the previous four seasons. Bearing trees are estimated at the beginning of each forecast season using the most recent Commercial Citrus Inventory with an allowance for normal attrition.

Fruit per tree is the weighted average obtained from the annual Limb Count Survey. This survey is conducted during a two-month period beginning in late July. Survey averages for each tree age group within an area are weighted by the estimated number of bearing trees for each age group.

Fruit size measurements and drop observations are obtained from monthly size and drop surveys. The average drop percentages are from the "cut-off" month survey which varies by variety according to the usual harvest period. Average fruit sizes were also obtained from the same survey period but have been converted in the table to estimated number of fruit needed to fill a box.

These four factors are the primary components used in the initial October forecast and in following months up to the "cut-off" for each fruit type. The first two have the greatest influence on the forecast.

Direct Expansion =

$$\frac{\text{Bearing Trees} \times \text{Fruit per Tree} \times \text{Percent Remaining at Harvest}}{\text{Pieces of Fruit per Box}}$$

Fruit type and crop year	Number bearing trees (millions)	Sample survey averages		
		Fruit per tree	Percent drop [1]	Fruit per box [1]
EARLY-MID ORANGES [2]				
1993-94	30.241	1,068	8	256
1994-95	33.495	973	14	215
1995-96	36.122	938	9	220
1996-97	37.132	999	7	238
1997-98	37.334	1,145	9	242
NAVEL ORANGES				
1993-94	2.465	292	17	136
1994-95	2.749	375	20	130
1995-96	2.945	313	13	130
1996-97	3.160	375	11	142
1997-98	3.184	431	16	135
VALENCIA ORANGES				
1993-94	29.569	584	13	210
1994-95	33.051	633	17	196
1995-96	36.061	555	11	198
1996-97	38.233	609	15	209
1997-98	39.019	708	15	209
WHITE SEEDLESS GRAPEFRUIT				
1993-94	4.579	533	8	92
1994-95	4.807	511	10	81
1995-96	5.005	427	9	75
1996-97	5.169	538	8	88
1997-98	4.900	462	10	81
COLORED SEEDLESS GRAPEFRUIT				
1993-94	6.493	428	8	94
1994-95	7.469	421	11	86
1995-96	8.312	382	7	83
1996-97	8.656	461	8	94
1997-98	8.200	410	14	89

[1] Averages at harvest month--January 1 for Early-mids, December 1 for Navels, April 1 for Valencias, and February 1 for grapefruit. [2] Excludes Navels.

After five days return to
UNITED STATES DEPARTMENT OF AGRICULTURE
National Agricultural Statistics Service
1222 Woodward Street, Orlando, Florida 32803

Official Business
PENALTY FOR PRIVATE USE $300

EXHIBIT EE

Ellsworth et al. 1999, The University of Arizona, Cooperative Extension IPM Series No. 13, Sticky Cotton Sources & Solutions

THE UNIVERSITY OF ARIZONA
Cooperative Extension
IPM Series No. 13
AZ1156 – 12/1999

Sticky Cotton Sources & Solutions

S U M M A R Y

From field to textile mill, all stages of the cotton industry are adversely affected by sticky cotton. Honeydew deposited by phloem-feeding insects such as whiteflies and aphids, and sugars produced by the plant itself may build up to levels that impede fiber handling. Typically, stickiness is first encountered when sugar-contaminated cotton lint is carded at the textile mill. Growers often sustain considerable costs in managing honeydew-producing insects. Further, if stickiness is found by textile processors, growers in regions associated with sticky cotton may suffer price reductions in future years. At present, no test for sugars contamination is as rapid as HVI testing. Moreover, no current test of sugars contamination has been directly calibrated with fiber processing efficiency. Because current measures for mitigating stickiness in the field and at the mill are unreliable, stickiness is best avoided by managing insect and plant sources. Well-implemented integrated pest and plant management plans are our best defenses against the stickiness problem. Having put such plans to work, cotton growers in the western United States have minimized the risks of sticky cotton.

What is Stickiness?

To growers, stickiness means higher costs for insect control and reduced cotton marketability. To ginners, stickiness may mean special handling and processing requirements. At the textile mill, stickiness means reduced processing efficiency, lower yarn quality, and in severe cases total shut down. For everyone concerned, stickiness means reduced profitability. Stickiness occurs when excessive sugars present on fibers are transferred to equipment and interfere with processing. Sugars may be insect- or plant-derived. Though sugars are ubiquitous in lint, they usually occur at levels that pose no processing difficulties. This bulletin details the sources and components of problem sugars on harvested lint, the processing and marketing impacts of stickiness, and strategies for avoiding or mitigating stickiness.

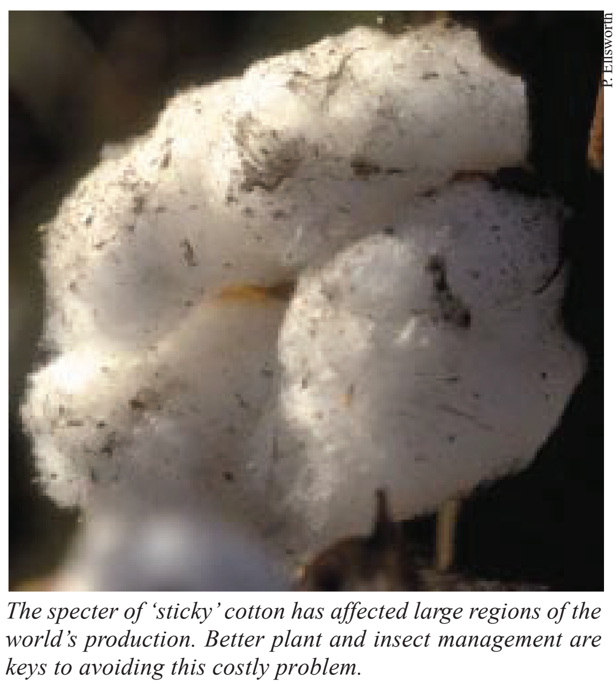
Honeydew, when present in sufficient quantity, is the main source of sugars that can result in sticky lint. Honeydew is excreted by certain phloem-feeding insects including such common pests of cotton as aphids and whiteflies. These insects are capable of transforming ingested sucrose into over twenty different sugars in their excreted honeydew. The major sugars in cotton insect honeydew are trehalulose, melezitose, sucrose, fructose and glucose.

Another source of stickiness is free plant sugars sometimes found in immature fibers. Cotton fiber is largely cellulose that is formed from sugars synthesized by the plant. Dry, mature cotton fibers contain little free sugar, while immature cotton fibers contain glucose, fructose, sucrose, and other sugars. If immature cotton fiber is subjected to a freeze, complex sugars may be broken down to release additional simple sugars. Less commonly, oils released by crushed seed coat fragments can also result in stickiness. In this case, raffinose is the characteristic sugar.

Sugars differ in their stickiness. For example, sucrose, melezitose, and trehalulose are all significantly stickier when deposited on fiber than are glucose or fructose. Further, trehalulose-contaminated fiber is stickier than fiber with an equivalent amount of melezitose. Mixtures of sugars, such as occur in honeydew, tend to be stickier than single sugars. Localized concentration of sugars like honeydew is at higher risk of causing stickiness than more evenly distributed sources like plant sugars.

Impact of Stickiness on Growers & the Marketplace

Between insect control costs and reduced cotton prices, sticky cotton is costly to growers. The major cost is in controlling the potential sources of stickiness. The costs of aphid control in TX and CA, and of whitefly control in TX, AZ and CA have all increased in the last decade. Insecticide treatment to specifically prevent stickiness has cost Southwestern cotton growers $47 million for aphids and $154 million for whiteflies from 1994–98 (Table 1). In AZ, the cost of controlling whiteflies increased from $12/acre in 1990 (the onset of the whitefly outbreak) to $145/acre in 1995. This cost accounted for 11% in 1990 and 68% in 1995 of the total spent on insect control. A new integrated system of whitefly management based on insect growth regulators began in 1996. Since then, AZ growers have reduced control costs to less than $35/A, while achieving excellent whitefly control. The 1996 AZ crop was found to be 98% free of stickiness as determined by random bale testing with SCT (see next section). In



The specter of 'sticky' cotton has affected large regions of the world's production. Better plant and insect management are keys to avoiding this costly problem.

Peter C. Ellsworth, Russell Tronstad, University of Arizona
James Leser, Texas A&M University
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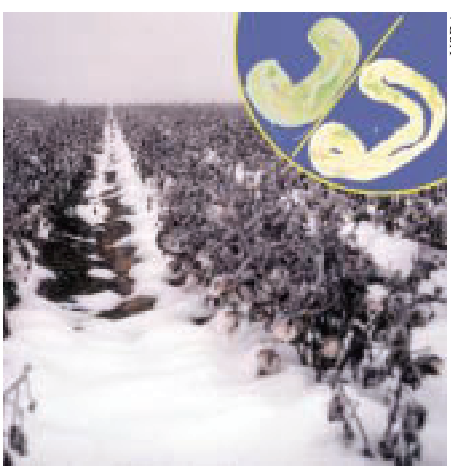
UC Statewide IPM Project
L. Forlow Jech

The cotton aphid, Aphis gossypii*, excretes honeydew rich in melezitose (ca. 30–40%). Their droplets (inset, 50X) tend to be larger than those produced by whiteflies.*

1997, CA cotton growers spent a statewide average of $7/A on whitefly control and $38/A on aphid control. Combined, these costs accounted for over half of their total insect control budget. In TX, aphid and plant sugars have been the largest sources of stickiness. TX cotton growers have spent up to $19/A (1995) on aphid control and $21/A (1991) on whitefly control. In addition to these immediate costs, excessive dependence on chemical control tactics carries with it increased frequency and risks of insecticide resistance with an incalculable cost to growers and the industry.

Sticky cotton can reduce cotton gin output (in bales/hr) by up to 25%. At the textile mill, excessive wear and increased maintenance of machinery may occur even with slightly sticky cotton. In severe instances mill shutdown with a thorough cleanup is required.


J. Supak
USDA

A preharvest freeze can set off a chain of events that leads to immature fibers and excessive plant sugars. Inset (250X) are cross sections of fibers, normal (left) & immature (right). Note wall thicknesses and lumen volume.

A reputation for stickiness has a negative impact on domestic sales, export orders, and prices for cotton from regions suspected of stickiness. The precise loss of sales due to stickiness is difficult to estimate, because cotton consumption and exports are affected by many factors every year. Cotton price is reduced for stickiness by the market at a rate proportional to the perception of risk. Reductions in the market value of lint are applied regionally and indiscriminately. Regional penalties are a consequence of the difficulty in measuring stickiness in cotton. Because there is currently no rapid method that is accepted as an industry standard for the measurement of stickiness, there can be no formal, bale-specific schedule of discounts for stickiness in the USDA-AMS cotton classification system. Estimates of the immediate effects of stickiness on regional cotton prices are reductions up to $0.03–0.05 / lb for AZ since the whitefly outbreak of 1992 (Fig. 1), and at least $0.03 / lb for West TX in 1995. Since 1992, growers in AZ may have lost as much as $21 million (1993–1995) and $36 million (1996–1998). In West TX, prices were affected primarily for the 1995 crop. A similar market penalty could be re-imposed in any region should the potential for stickiness be suspected.

In addition to causing price reductions for cotton lint, estimates of losses due to whitefly feeding in southwestern agricultural communities exceeded $200 million in 1991 and $500 million in 1992. In the Imperial Valley, CA alone, annual crop losses to the silverleaf whitefly from 1991 to 1995 have been estimated to be about $100 million. In 1992 and 1995, whitefly feeding directly reduced cotton yields in AZ, as did aphid feeding during the mid-season of 1995 and 1997 in CA.

Stickiness Detection & Measurement

'Stickiness' is the physical process of contaminated lint adhering to equipment (Fig. 2). The degree of stickiness depends on the chemical identity, quantity, and distribution of the sugars, the ambient conditions during processing—especially humidity—and the machinery itself. Stickiness is therefore difficult to measure. Nonetheless, methods for measuring sugars on fiber have been and are being developed. These measurements may be correlated with sticking of contaminated lint to moving machine parts. Currently, no generally recognized system of stickiness measurement is compatible with the speed of commercial cotton classing. The physical and chemical attributes of the lint and sugars that are correlated with stickiness have been measured in many ways, each with differing efficiency and precision.


S. Bauer (USDA)
L. Forlow Jech

Whiteflies, Bemisia *spp., also excrete honeydew, but as trehalulose-rich (ca. 40–50%) droplets (inset, 50X).*

Some textile mills use reducing-sugar tests based on reduction of the cupric ion to screen for sugar contamination. These tests are relatively quick and inexpensive. However, some insect sugars are not reducing sugars, and some others are measured at different levels of efficiency by various reducing-sugar methods. Thus conventional reducing-sugar tests are best reserved for screening lint that potentially has high levels of plant sugars. In these cases and with the potassium ferricyanide (KFeCN) test, lint with reducing sugar levels below 0.3% may be processed without difficulty.

High Performance Liquid Chromatography (HPLC) identifies and measures both reducing and nonreducing sugars. The main sugars of insect honeydew, trehalulose (from whiteflies) and melezitose (from aphids), and of plant sugars (glucose, fructose & sucrose) are all readily identified in this test. The benefit of HPLC analysis is the identification of the source of contamination (whitefly, aphid, or plant) which may help identify specific mitigation measures.

The physical interaction of all sugars on lint with equipment can be measured by several types of machines. The primary difficulty with these physical tests is in standardizing the stickiness measurement. As with chemical testing, these tests must be correlated with measures of fiber processing efficiency in order to interpret the results.

One of these tests, the minicard, is a physical test that measures actual cotton stickiness of the card web passing between stainless steel delivery rollers of a miniature carding machine. Modeled after a production carding machine, the minicard must be run under strict tolerances. A ‘0’ minicard rating indicates that no sticking was observed, while progressively higher numbers (on a 0–3 scale) indicate progressively greater amounts of sticking during the process. Cottons with high plant sugar contents evenly distributed along the fibers may fail to be measured as sticky in this test. The minicard test is slow and has been replaced as the international standard by the manual thermodetector (see next section).

The Sticky Cotton Thermodetector (SCT) measures the physical sticking points transferred to aluminum sheets by a conditioned lint sample that is squeezed and heated (to 82.5°C for 12 sec.). Levels of stickiness are categorized according to the number of specks left on the two sheets of foil. Lower numbers of specks are preferable to higher numbers; however, a specific threshold over which all cotton will result in processing problems has not been defined. The SCT takes about 5 minutes to process each sample, requires smaller initial investment costs than the minicard, is more mobile, and its results correlate well with predicted stickiness from the minicard.

The High Speed Stickiness Detector (H2SD) is a quicker, automatic version of the thermodetector. The cotton sample is pressed between a heated (54°C for 30 sec.) and an unheated pressure plate. Sticky points are counted and point size distribution determined by image-processing computer software. Plates are automatically cleaned between samples. The H2SD is able to analyze a sample in 30 seconds.

Like the thermodetector and H2SD, the Fiber Contamination Tester (FCT) measures physical sticking points (at 65% RH). The instrument feeds a thin web between two rollers. Contamination of the rollers interrupts a laser beam, resulting in a recording. Because the cleaning and recording is automated, samples may be processed as quickly as one per 45 seconds.

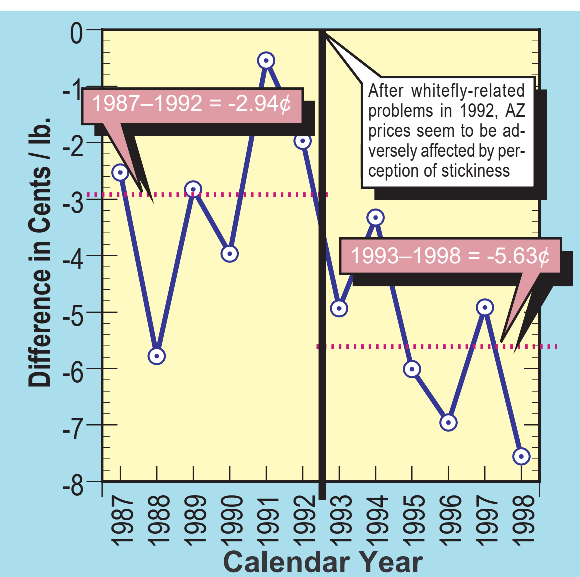


Figure 1. *Average† weekly spot price difference of Arizona (DSW) minus California (SJV) upland (31-3/35). Market forces other than stickiness may also be acting on these differences.*

† Source: USDA-AMS, Cotton Price Statistics, 1987–1998.

While there is no reliable in-field method for detection of stickiness predisposition, the insects responsible for honeydew deposits can be sampled and populations measured. Not all population levels of insects lead to sticky lint; however, chronic numbers of insects, especially during boll opening or an extended season, can lead to excessive insect sugars that result in stickiness. In addition, field factors associated with risk of excessive plant sugars are lateness of the crop, fiber immaturity, and freezing temperatures before harvest.

Table 1. Costs (in $US millions) of aphid and whitefly control in Arizona, California and Texas, 1994–1998 (for yield protection & stickiness prevention).

APHID						
State	1994	1995	1996	1997	1998	Sum
AZ	0.0	0.7	0.1	0.0	0.4	1.2
CA	33.4	25.5	4.8	40.3	2.3	106.3
TX	11.3	23.0	8.1	9.9	5.5	57.8
Sum	44.7	49.2	13.0	50.2	8.2	165.3
WHITEFLY						
AZ	27.5	58.1	18.7	17.3	8.9	130.5
CA	0.0	1.7	3.0	7.9	1.1	13.7
TX	0.0	9.5	0.0	0.0	0.2	9.7
Sum	27.5	69.3	21.7	25.2	10.2	153.9

Work is currently underway to determine methods for measuring insect sugars on field-collected lint as a tool for predicting stickiness. Such predictions would be complicated by various degradative processes that occur prior to processing such as rain and microbial activity that might reduce the potential for stickiness.

Managing the Sources

The most efficient way now to prevent stickiness is by managing sugar sources in the field. Detailed integrated pest management plans (see references) for both aphid and whitefly have been developed in AZ, CA, and TX. These honeydew-producing insects may be managed by avoiding conditions leading to outbreaks, carefully sampling pest populations, and using effective insecticides when populations reach predetermined thresholds.

The risk of having excessive plant sugars can be minimized by harvesting mature seed cotton. This may be accomplished through plant management tactics that include: early and uniform planting, nitrogen management according to plant growth and yield goals, high first-position boll retention, and timely chemical termination and harvest. If a freeze is imminent and immature bolls are present, the use of boll-opening chemicals can greatly diminish the problem of plant sugar contamination. All these measures work towards early harvest, before freezing conditions that contribute to excess plant sugars.

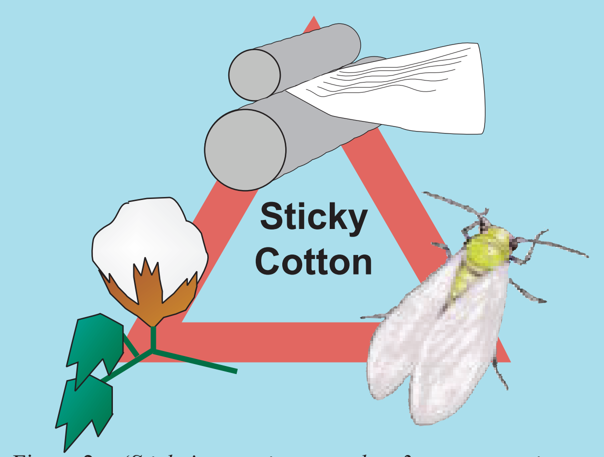


Figure 2. *'Sticky' cotton is a complex, 3-component interaction among source (insect or plant sugars), lint, and processing equipment.*

Mitigating the Problem

When field management of sugar sources is inadequate to prevent excess accumulation of sugars, mitigation tactics may be necessary to remove excess sugars from the lint. This mitigation may be achieved through both natural and managed processes; however, the specific impact of these processes on stickiness is variable and may depend on the initial level of contamination. Natural processes include weathering, rainfall, and degradation by microorganisms. Since sugars are water soluble, rainfall will wash some honeydew from lint. If sufficient moisture is available, bacteria and molds living on the plants will decompose many honeydew sugars. Complex sugars are broken down to simpler sugars, and the simpler sugars, given sufficient time and moisture, are further broken down to carbon dioxide and water. Unfortunately, microbial action also leads to discoloration and to a weakening of the fibers as well as heating of cotton in modules that may result in reduced seed viability and problems in ginning.

Potential in-field mitigation techniques include supplemental oversprays of enzymes or water. Certain carbohydrate degrading enzymes when sprayed on sticky cotton can reduce honeydew to simpler sugars. Microbial activity on the fibers then further degrades these simpler sugars, resulting in a significant decrease in fiber stickiness. However, these enzymes require water for activity, and metering the proper amount of water for activity is a problem yet to be solved. In some areas of the world, overhead and in-canopy irrigation has been used to remove honeydew from open bolls. The frequency of this type of irrigation may be more important than the volume applied. Use of sprinklers has been limited in the Western United States, where furrow irrigation is prevalent.

If stickiness is a problem while ginning, the ginning rate of honeydew contaminated cotton can be increased by increasing the heat of the drying towers to reduce humidity. The potential for stickiness can be further reduced by lint cleaning. Both of these practices, however, can result in shorter fibers. Conventional textile lubricants may also be used. Stickiness due to high levels of plant sugars can be reduced by storing the cotton for approximately six months. However, storage of baled cotton will not appreciably reduce stickiness from insect sugars. At the textile mill, stickiness may be managed by blending bales and by reducing humidity during carding. A lubricant in fog form may be introduced at the end of the hopper conveyor, and card-crush rolls may be sprayed sparingly with a lubricant to minimize sticking.

Conclusion

Lints contaminated with sugars from various sources (plant and insect) can result in stickiness. Yet stickiness is not an intrinsic property of the lint and therefore cannot be measured directly. Rather, stickiness is a complex, three-component interaction that involves the source sugars, harvested seedcotton, and processing equipment. The complexity of this interaction indicates the need for an integrated solution that includes prevention, in-field mitigation, and processing adjustments. Because currently our best means of eliminating stickiness is source sugar minimization in the field, US agricultural research and implementation agencies continue to emphasize successful insect and crop management plans.

Endorsing Organizations

The University of Arizona, The University of California, Texas A&M University, United States Department of Agriculture, Cotton Incorporated, National Cotton Council

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For more information about cotton stickiness and insect/crop management, including this publication, visit the internet site: **ag.arizona.edu/cotton**.

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EXHIBIT J

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Economic Contribution of the Sugarbeet Industry in Minnesota and North Dakota

AAE Report No. 688, February 2012

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MINN-DAK FARMERS COOPERATIVE

American Crystal Sugar Company

SMBSC

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The authors assume responsibility for any errors of omission, logic, or otherwise. Any opinions, findings, and conclusions expressed in this publication are those of the authors and do not necessarily reflect the view of the Department of Agribusiness and Applied Economics, North Dakota State University, or the study sponsors.

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Abstract

Agricultural industries in small geographical areas with limited acreage tend to be overlooked by those not associated with the growing region or industry. Sugarbeets continue to be produced in a relatively small geographic area and on relatively limited acreage in Minnesota and North Dakota. These factors, along with continued debate over policies affecting domestic sugar industries and recent industry expansions, help justify a continued assessment of the economic importance of the sugarbeet industry to the regional economy.

Revenues from sugarbeet production and expenditures by processors to Minnesota and North Dakota entities in fiscal 2011 represented the direct economic impacts from the industry. Expenditure information was provided by sugarbeet processing and marketing cooperatives. Secondary economic impacts were estimated using input-output analysis.

The sugarbeet industry, which included the growing regions and processing plants located in the Red River Valley of Minnesota and North Dakota and west central Minnesota planted 652,741 acres and processed 15.5 million tons of sugarbeets in fiscal 2011. Production and processing activities generated $1.7 billion in direct economic impacts. Gross business volume (direct and secondary effects) from the sugarbeet industry was estimated at $4.9 billion. Direct and secondary employment in the industry was 2,473 and 18,830 full-time equivalent jobs, respectively. The industry paid $15.4 million in property taxes and was estimated to generate another $105 million in sales and use, personal income, and corporate income taxes in Minnesota and North Dakota.

In real terms, gross business volume of the sugarbeet industry in Minnesota and eastern North Dakota has increased 185 percent since 1987. Increases in business activity from the industry have resulted from increased production, processing, and marketing activities, as well as relatively high sugar prices during fiscal 2011.

Key words: sugarbeet industry, North Dakota, Minnesota, economic impact

Highlights

Minnesota and North Dakota had nearly 57 percent of the nation's planted sugarbeet acreage and produced 55 percent of the nation's sugarbeet tonnage in 2010. Despite being the single largest sugarbeet producing region in the United States, sugarbeets are produced on relatively few acres and remain geographically limited within the Upper Midwest. The sugarbeet industry, as described in this report, included production and processing facilities in the Red River Valley of North Dakota and Minnesota and in west central Minnesota. The purpose of this report was to estimate the economic contribution of the sugarbeet industry in Minnesota and North Dakota.

Three sugarbeet cooperatives located in eastern North Dakota (Minn-Dak Farmers Cooperative) and Minnesota (American Crystal Sugar Company and Southern Minnesota Beet Sugar Cooperative) were surveyed to obtain estimates of expenditures made within Minnesota and North Dakota in fiscal 2011. In addition, United Sugars Corporation, which handles the marketing of sugar for American Crystal and Minn-Dak Farmers Cooperative, and Midwest Agri-Commodities, which handles the marketing of sugarbeet pulp and molasses, also were surveyed to obtain estimates of expenditures made within the two-state region.

Crop production budgets were developed to estimate the direct economic impacts from sugarbeet production. Total direct impacts from sugarbeet production in the two states were estimated to average $1,653 per acre or $1.08 billion. Direct impacts from processing and marketing activities were estimated at $601 million in fiscal 2011. About 65 percent of total direct impacts were generated in Minnesota.

Total direct economic impacts from the sugarbeet industry (i.e, sugarbeet production, processing, and marketing activities) were estimated at $1.7 billion in fiscal 2011. The North Dakota Input-Output Model was used to estimate the secondary economic impacts. The $1.7 billion in direct impacts generated another $3.2 billion in secondary economic impacts. Total economic activity (direct and secondary impacts, also termed gross business volume) was estimated at $4.9 billion in the two-state region. Total state and local tax revenues generated by the industry were estimated at $120.8 million, which included $15.4 million in property taxes and $105 million in combined sales and use, personal income, and corporate income taxes in Minnesota and North Dakota. The cooperatives also employed an equivalent of 2,473 full-time workers and indirectly supported an additional 18,830 full-time equivalent jobs in the two-state region.

The sugarbeet industry in Minnesota and eastern North Dakota has experienced substantial physical and economic growth over the past 20 years. Since 1987, planted acreage and tons processed have increased 42 percent and 121 percent, respectively. However, acreage planted in recent years has remained lower than levels found in the early 2000s, yet tons processed have continued to increase despite fewer planted acres. Correspondingly in real terms (effects of inflation removed), gross business volume generated by the sugarbeet industry in North Dakota and Minnesota has increased by 49 percent since 2003, 61 percent since 1997, 108 percent since 1992, and 185 percent since 1987. While real growth has occurred in the industry, some of the large percentage changes observed with fiscal 2011 figures can be attributable to unusually high sugar prices over the study period.

The characteristics of the sugarbeet-growing area suggest most of the industry's economic activity affects local economies because expenditures for crop inputs (*Retail Trade* sector) and returns to growers (*Households* sector), which represent a majority of the economic activity, are evenly distributed throughout the growing area. Although the sugarbeet industry in Minnesota and North Dakota is not large in terms of acres or geographic area, the magnitude of key economic measures (i.e., retail trade activity, personal income, and overall business activity) clearly indicates that the industry contributes substantially to Minnesota and North Dakota economies.

Economic Contribution of the Sugarbeet Industry to the Economy of Minnesota and North Dakota

Dean A. Bangsund, Nancy M. Hodur and F. Larry Leistritz*

INTRODUCTION

Agriculture has historically been a major component of the regional economy of North Dakota and Minnesota (Coon and Leistritz 2011, Senf et al. 1993). Despite the historical importance of agriculture, agriculture is no longer the single largest sector in either Minnesota or North Dakota (Lazarus 2002, Coon and Leistritz 2011). Generally, the agriculture sector has not decreased in magnitude in recent decades, rather other sectors of the economy have grown, and now surpass agriculture in terms of economic size. As a result, the relative share of agriculture to the states' economies has decreased over the past decade. While the role of agriculture in the regional economy may be, in relative terms, smaller than in the past decades, specific industries within the agriculture sector often find it advantageous to describe their activities in economic terms.

In the past decade, a number of studies have attempted to document the relative economic contribution of various commodities to the North Dakota and Minnesota economies. For example, economic contribution studies have been conducted for the wheat industry in North Dakota and Minnesota (Bangsund and Leistritz 2005, Bangsund et al. 1994), the barley industry in Minnesota, North Dakota, and South Dakota (Bangsund and Leistritz 1998a), and the soybean industry in North Dakota (Bangsund et al. 2011). In some cases, the studies take on a national focus, for example, an assessment of the economic size of the U.S. Sunflower Industry (Bangsund and Leistritz 1995) and the Sugar and Corn Sweetener Industry (LMC International Ltd. 2001).

The economic contribution of the sugarbeet industry in Minnesota and North Dakota has been periodically assessed since 1987. Coon and Leistritz (1988), Bangsund and Leistritz (1993), Bangsund and Leistritz (1998b), and Bangsund and Leistritz (2004) estimated the economic contribution of the sugarbeet industry in North Dakota and Minnesota in previous years. However, continued debate over the future of national sugar policies have prompted a re-evaluation of the industry's economic importance. A reassessment of the industry's economic importance to the region would be helpful to demonstrate the economic implications of future policy changes affecting domestic sugar industries and document the economic effect of recent industry expansions.

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OBJECTIVES

The purpose of the study was to estimate the economic contribution (direct and secondary effects) of the sugarbeet industry to the economies of Minnesota and North Dakota.

Specific objectives include:

1) quantify sugarbeet acreage and production in Minnesota and eastern North Dakota,

2) estimate the direct economic impacts of the sugarbeet industry to the state economies of Minnesota and North Dakota,

3) estimate the secondary economic impacts of the sugarbeet industry to the state economies of Minnesota and North Dakota.

PROCEDURES

An economic contribution analysis, as defined in this study, represents an estimate of all relevant expenditures and returns associated with an industry (i.e., economic activity from sugarbeet production, processing, transportation, and marketing). The economic contribution approach to estimating economic activity has been used for several similar studies (Bangsund et al. 2011, Bangsund and Leistritz 2010, and Bangsund and Leistritz 2005). The methods and analyses used in this report paralleled those used by Bangsund and Leistritz (2004).

Analysis of the sugarbeet industry required several steps. Discussion of the procedures used in the study was divided into the following sections: (1) sugarbeet production in Minnesota and North Dakota (2) sugarbeet production expenditures, (3) sugarbeet processor and marketing alliance expenditures, and (4) application of input-output analysis to generate secondary impacts.

Sugarbeet Production

Sugarbeet production and associated processing facilities are concentrated in the Red River Valley of North Dakota and Minnesota and west central Minnesota (Figure 1). Sugarbeet production is centered around processing plants operated by three producer-owned cooperatives: American Crystal Sugar Company with headquarters in Moorhead, Minnesota; Minn-Dak Farmers Cooperative located in Wahpeton, North Dakota; and Southern Minnesota Beet Sugar Cooperative located in Renville, Minnesota.

Generally, the growing conditions in the Red River Valley and west central Minnesota are conducive to sugarbeet production. Sugarbeets, unlike most traditional crops (e.g., small grains, corn, beans), are difficult and expensive to transport long distances. They also have unique storage problems not found with most crops (i.e., they are bulky, require specialized handling equipment, have limited storage life, and must be stored in cold conditions). As a result, processing facilities and sugarbeet production are located in close proximity to each other. The geographic concentration of sugarbeet production and processing accentuates the industry's economic impact on local economies.

Seven counties in eastern North Dakota collectively produced about 5.3 million tons of sugarbeets for American Crystal Sugar Company and Minn-Dak Farmers Cooperative in 2010 (Table 1). Minnesota had over 23 counties that collectively produced 11.7 million tons of sugarbeets in 2010 (Table 1). The combined growing regions in eastern North Dakota and Minnesota planted nearly 654,000 acres of sugarbeets in 2010 (National Agricultural Statistics Service 2011). About 31 percent of the region's planted acreage was in North Dakota and 69 percent in Minnesota. The three sugar cooperatives reported processing about 15.5 million tons of sugarbeets and 652,741 planted acres of sugarbeets in 2010.

Sugarbeet acreage in Minnesota and North Dakota has increased from 1970 through 2000s (Figure 2). Since 2000, national sugarbeet acreage has been trending lower. The trend in acreage in North Dakota and Minnesota also has declined slightly over the same period, but to a much lesser extent than the changes observed nationally. As a result, the share of national acreage grown in North Dakota and Minnesota has risen over the period and in recent years has approached 60 percent of national acreage.

Changes in sugarbeet tonnage mirrored changes in acreage from the 1970s through 2000 (Figure 3). U.S. sugarbeet tonnage declined gradually from 1970 through the early 1980s, increased through the 1980s, and has stabilized over the last decade. As a result of U.S. production remaining relatively stable since 1970 and production in Minnesota and North Dakota consistently increasing over the same period, the share of U.S. production in Minnesota and North Dakota has continued to increase (Figure 3). In 2010, Minnesota and North Dakota accounted for about 57 percent of U.S. planted acreage and 55 percent of total U.S. sugarbeet production.

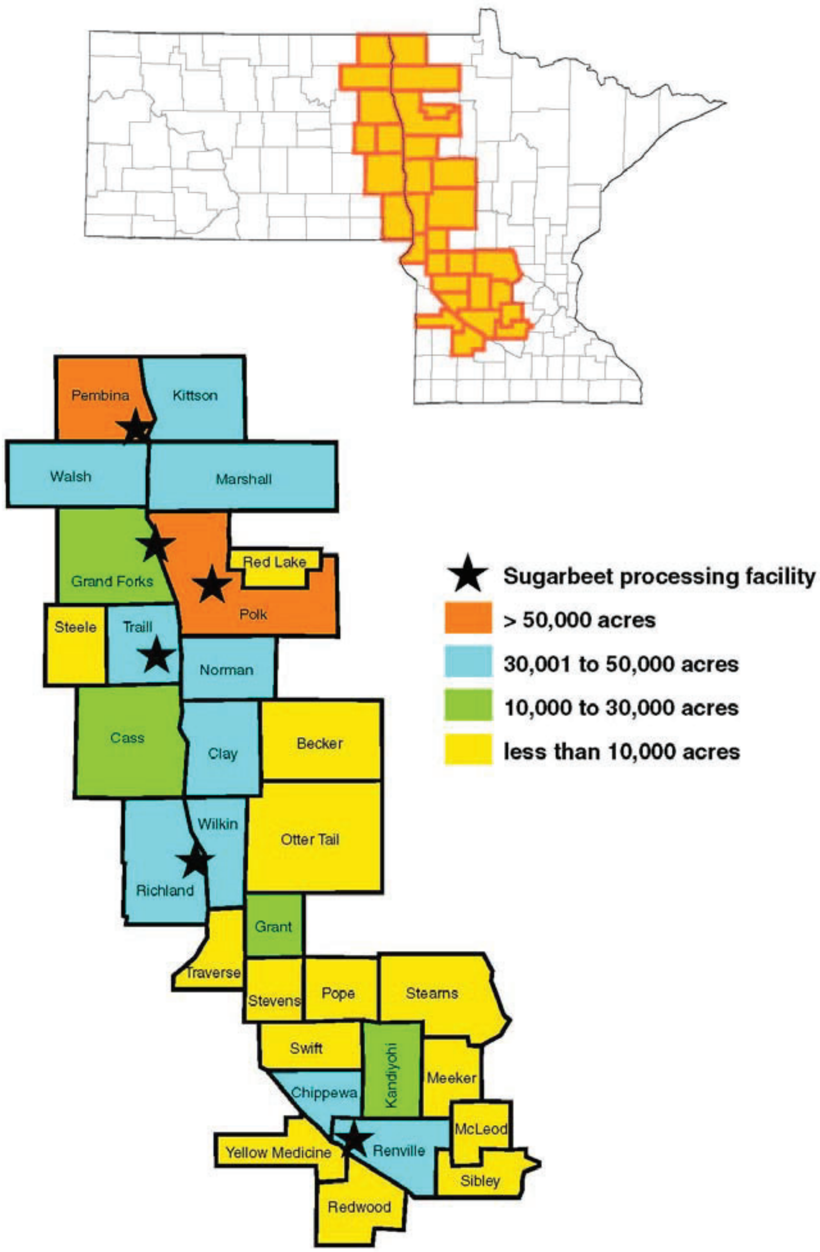

Figure 1. Distribution of Sugarbeet Production and Processing Facilities in Minnesota and Eastern North Dakota, 2010

Source: National Agricultural Statistics Service (2011).

Table 1. Sugarbeet Production, by County, Minnesota and Eastern North Dakota, 2010

State/County	Acreage Planted	Acreage Harvested	Yield[a]	Production
	-------------- acres -----------		- tons/acre -	------- tons -------
North Dakota				
Cass	14,900	14,700	26.85	400,000
Pembina	60,200	58,700	25.35	1,526,000
Richland	31,000	30,500	25.19	781,000
Steele	500	500	30.00	15,000
Traill	31,200	31,000	27.53	859,000
Walsh	39,100	38,700	25.22	986,000
Other Counties[b]	27,700	27,500	27.83	773,000
State	**204,600**	**201,600**	**26.09**	**5,338,000**
Minnesota				
Becker	7,500	7,400	26.00	195,000
Chippewa	30,100	30,000	25.32	762,000
Clay	43,600	42,900	27.55	1,201,000
Grant	12,200	12,100	27.30	333,000
Kandiyohi	14,400	14,400	26.67	384,000
Kittson	31,100	28,400	19.94	620,000
McLeod	2,300	2,300	25.48	58,600
Mahnomen	2,500	2,400	26.16	65,400
Marshall	42,100	40,800	22.78	959,000
Meeker	2,500	2,500	26.04	65,100
Norman	38,200	37,900	28.69	1,096,000
Otter Tail	3,300	3,100	25.33	83,600
Polk	91,200	90,600	26.59	2,424,000
Pope	2,600	2,600	29.50	76,700
Redwood	4,700	4,700	27.23	128,000
Renville	37,800	37,500	27.01	1,021,000
Sibley	2,600	2,500	25.65	66,700
Stearns	2,600	2,600	29.85	77,600
Stevens	4,500	4,500	32.44	146,000
Swift	7,600	7,500	28.95	220,000
Traverse	9,400	9,300	27.77	261,000
Wilkin	48,700	48,000	26.92	1,311,000
Yellow Medicine	3,700	3,600	23.68	87,600
Other Counties[b]	3,800	3,400	23.08	87,700
State		**441,000**	**26.13**	**11,731,000**

[a] Yield per planted acre.
[b] Included Grand Forks, Cavalier, and other counties.
Source: National Agricultural Statistics Service (2011).

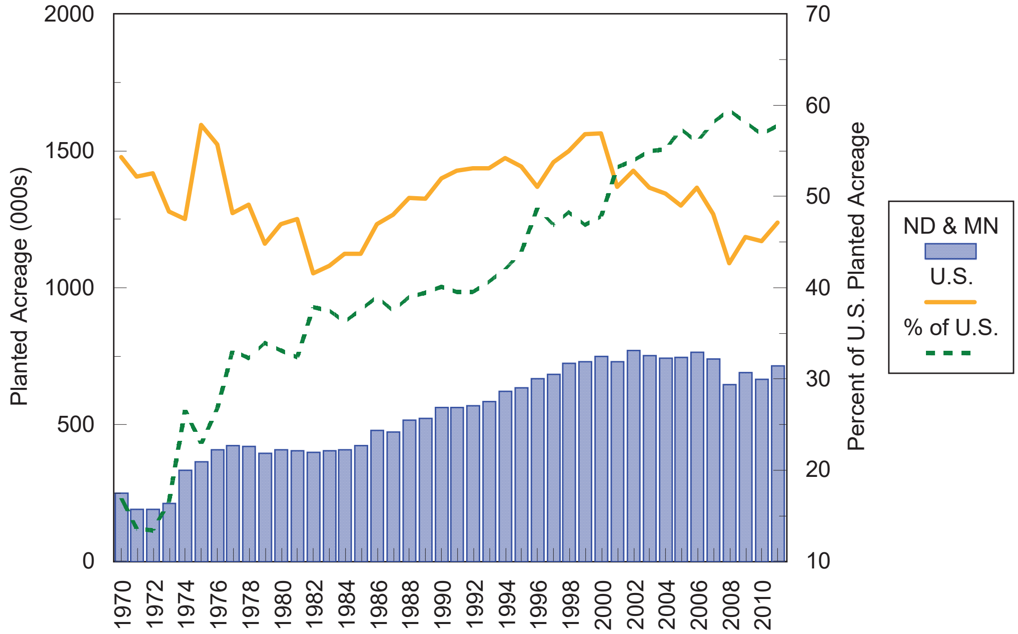

Figure
2. Planted Sugarbeet Acreage, United States, Minnesota and North Dakota, 1970 through 2011

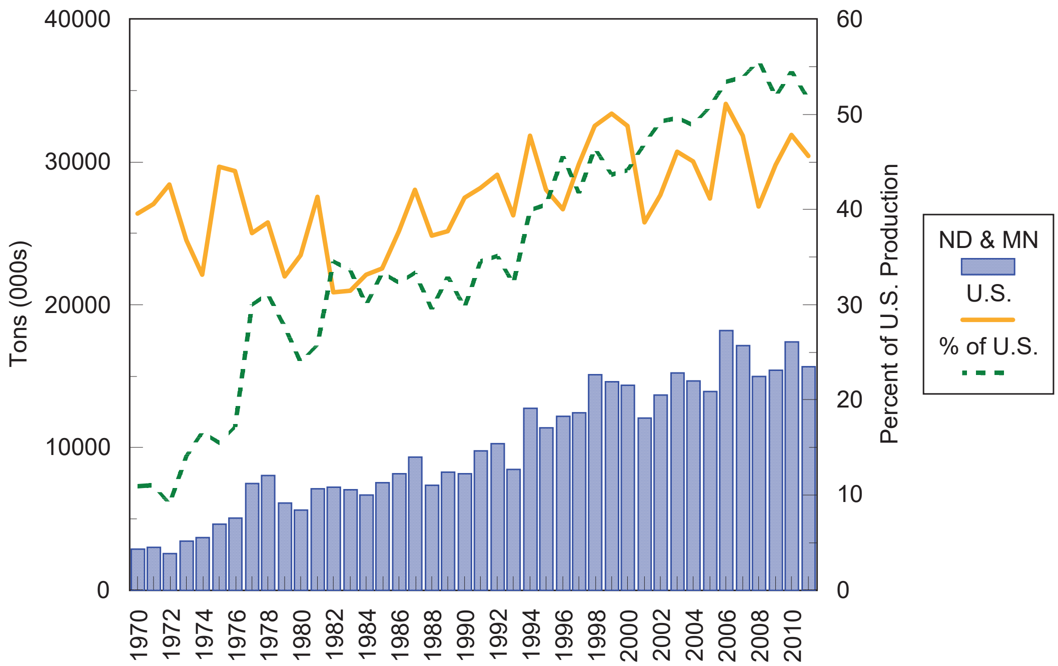

Figure 3. Sugarbeet Production, United States, Minnesota and North Dakota, 1970 through 2011

Sugarbeet Production Expenditures

Crop expenses were obtained from the Farm Business Management Programs in North Dakota and Minnesota (Minnesota Farm Business Management Education 2011, North Dakota Farm and Ranch Business Management Education 2011). Budgets obtained were for sugarbeet production on owned land and rented land in the Red River Valley in North Dakota and Minnesota, and for owned and rented land in west-central Minnesota. Expenses were averaged between budgets for sugarbeets produced on owned land and rented land by the ratio of owned and rented farm land in the sugarbeet producing counties (U.S. Department of Agriculture 2011a). Revenues from sugarbeet production were derived from the survey of processors, which listed payments made to producers.

Cash outlays by sugarbeet farmers represent money spent for fuel, seed, fertilizer, chemicals, machinery, and other items which impact local economies. The budget contained some noncash expenditures, which are considered appropriate production costs, but do not represent a cash expenditure. Non-cash expenditures were treated proxies for purchases of various production related inputs (e.g., machinery depreciation, building deprecation, management charges).

Sugarbeet Cooperative Expenditures

The three sugarbeet cooperatives located in eastern North Dakota (Minn-Dak Farmers Cooperative) and Minnesota (American Crystal Sugar Company and Southern Minnesota Beet Sugar Cooperative) were asked to provide the amount of processing, research, distribution, and administrative cash expenditures made within Minnesota and North Dakota in fiscal 2011 (Appendix B). Expenditures made in Minnesota and North Dakota by United Sugars Corporation and Midwest Agri-Commodities also were obtained. Non-cash outlays or expenditures made to entities outside of the two-state area were not included. Itemization of expenditures for each cooperative were not included due to confidentiality.

Input-output Analysis

Economic activity from a project, program, or policy can be categorized into direct and secondary impacts. Direct impacts are those changes in output, employment, or income that represent the initial or first-round effects of a project, program, or event. Secondary impacts (sometimes further categorized into indirect and induced effects) result from subsequent rounds of spending and respending within an economy. This process of spending and respending is sometimes termed the multiplier process, and the resultant secondary effects are sometimes referred to as multiplier effects (Leistritz and Murdock 1981).

Input-output (I-O) analysis is a mathematical tool that traces linkages among sectors of an economy and calculates the total business activity resulting from a direct impact in a basic sector (Coon et al. 1985). The North Dakota I-O Model has 17 economic sectors, is closed with respect to households (households are included in the model), and was developed from primary (survey) data from firms and households in North Dakota. Empirical testing has shown the North Dakota I-O Model is sufficiently accurate in estimating economic impacts in neighboring states (Coon and Leistritz 2011; Coon et al. 1984; Leistritz et al. 1990).

ECONOMIC IMPACTS

The economic contribution from the sugarbeet industry was estimated from production and processing expenditures. Both production and processing expenditures represent the direct economic impacts from the sugarbeet industry. Subsequently, the direct impacts were used with an input-output model to estimate the secondary impacts. Secondary impacts result from the turnover or respending of direct impacts within the area economy. The following section is divided into five major parts: (1) direct impacts, (2) secondary impacts, (3) tax revenue, (4) total economic impacts, and (5) previous industry impacts.

Direct Impacts

From an economic perspective, direct impacts are those changes in output, employment, or income that represent the initial or direct effects of a project, program, or event. The direct impacts from the sugarbeet industry on the local economies in Minnesota and North Dakota include (1) expenditures and returns from the production of sugarbeets, (2) expenditures from processing sugarbeets into refined sugar, and (3) expenditures incurred through marketing activities associated with the sugarbeet industry. The following sections describe these direct economic impacts.

Sugarbeet Production

Farmers and producers generate direct economic impacts to the area economy through (1) expenditures for production outlays and (2) net returns from production. Direct economic impacts from sugarbeet production (i.e., production outlays and producer returns) were estimated using cost-of-production budgets and payments to sugarbeet growers, as reported by the cooperatives. Separate budgets were developed for sugarbeet production in the Red River Valley and west central Minnesota. Each budget contained estimates of gross revenue, variable and fixed costs, and returns to unpaid labor, management, and equity (Appendix A). Gross revenue per acre was calculated by dividing sugarbeet payments (i.e., payments made by the cooperatives to the growers) by estimated planted sugarbeet acreage from each cooperative and adding farm program payments obtained on sugarbeet acreage (estimates obtained from the Farm Business Management Programs in North Dakota and Minnesota). Variable and fixed costs represented an average of actual production costs incurred on owned and rented land in calender year 2010 (North Dakota Farm and Ranch Business Management Education 2011 and Minnesota Farm Business Management Education 2011).

Cash and non-cash expenses (e.g., depreciation) from sugarbeet production represented direct impacts. Returns to invested resources (i.e., unpaid labor, management, and equity) also were considered direct impacts, even though net returns do not represent a cash expenditure. Net returns were considered retained by the producer, eventually resulting in personal or business purchases in the regional economy.

Total direct impacts per acre from sugarbeet production should be equal to the gross revenue per acre, providing all economic activity (production expenses and returns to unpaid labor, management, and equity) remains in the two-state economy. All expenses and returns associated with sugarbeet production in calendar year 2010 were assumed to initially be made to entities within the two-state economy. For example, sugarbeet growers are residents of the regional economy and production inputs are assumed to be made from entities located near the producer's residence or farming enterprise. Total direct impacts from sugarbeet production were estimated at $1,653 per acre or $1.079 billion (Table 2).

Total direct impacts of $1,653 per planted acre were further broken into variable costs, fixed costs, and returns to unpaid labor, management, and equity. Variable costs (i.e., outlays for seed, herbicide, fertilizer, chemical, custom hire, etc. that change with the level of production) were estimated at $722.57 per acre. Fixed costs (i.e., expenses that do not change with the level of production, such as interest on land debt payments, farm utilities, and machinery overhead) were estimated to be $221.60 per acre. Total expenses were estimated at $944.17 per acre. Net returns were estimated at $708.54 per acre (Table 2).

Table 2. Direct Economic Impacts from Sugarbeet Production in Minnesota and Eastern North Dakota, Fiscal 2011[a]

	Direct Impacts	
Expenses and Returns [b]	Per Acre	Total
Payments to Growers	--	$1,063,453,624
Misc Farm Program Payments	--	$9,685,382
Misc Revenue & Insurance Indemnities	--	$5,651,287
Planted Acreage	--	652,741
Revenue per Acre	--	$1,652.71
Variable Costs	$722.57	471,648,000
Fixed Costs	$221.60	144,650,000
Total Costs	$944.17	616,298,000
Net Returns	$708.54	462,492,000
Direct Impacts	$1,652.71	1,078,790,000

[a] While some production expenses occur in the spring of calendar year 2010, all expenditures were treated as part of the industry's economic contribution in fiscal 2011.
[b] See Appendix A for complete budgets.

Sugarbeet Processing and Marketing

Sugarbeet cooperatives and their processing facilities impact local economies through expenditures for production and processing inputs, labor, and investment in facilities and capital. American Crystal Sugar Company, Minn-Dak Farmers Cooperative, Southern Minnesota Beet Sugar Cooperative, United Sugars Corporation, and Midwest Agri-Commodities were surveyed to estimate their fiscal 2011 cash expenditures (Appendix B). Only cash expenditures and outlays made within the two-state economy were included.

Total cash expenditures made to entities in the two-state region by the processing cooperatives and sugar marketing alliances in Minnesota and North Dakota were $1.66 billion in fiscal 2011. However, over $1 billion represented payments to growers and was reflected in the direct impacts attributable to sugarbeet production. Direct economic impacts from the cooperatives were estimated at $601 million (Table 3). Approximately 58 percent of the direct impacts from the processing component of the industry were generated in Minnesota. North Dakota received about 42 percent of processor expenditures. The processing cooperatives and marketing companies also were directly responsible for 2,473 full-time equivalent jobs in fiscal 2011.

Direct Impacts by State

Total direct impacts from the sugarbeet industry (production, processing, and marketing) in Minnesota and North Dakota were estimated at $1.680 billion in fiscal 2011[1] (Table 4). Sugarbeet production accounted for 64 percent ($1.079 billion) of all direct impacts, while sugarbeet processing and marketing accounted for 36 percent ($601 million) of all direct impacts. Based on planted sugarbeet acreage in the study region, about 68 percent and 32 percent of the direct impacts from sugarbeet production were generated in Minnesota and North Dakota, respectively. Similarly, about 58 percent and 42 percent of the direct impacts from processing were captured in Minnesota and North Dakota, respectively, based on expenditures made in each state by the processing cooperatives and marketing companies (Table 4).

Total direct impacts in Minnesota were estimated at $1.087 billion ($348.8 million from processors and $739.0 million from growers). Total direct impacts in North Dakota were estimated at $592.3 million ($252.5 million from processors and $339.8 million from growers).

[1]While some production expenses occur in the spring of calendar year 2010, all expenditures relating to sugarbeet production were treated as part of the industry's economic contribution in fiscal 2011.

Table 3. Direct Economic Impacts from Sugarbeet Processing and Marketing Activities in Minnesota and North Eastern North Dakota, Fiscal Year 2011

Expenditure Category	Expenditures in Minnesota and North Dakota
	-- 000s $ --
Total payments to sugarbeet growers	1,034,635
Contract construction	53,669
Plant maintenance and overhaul	48,868
Transportation	73,523
Communication	1,121
Public Utilities	46,312
Miscellaneous Manufacturing	2,191
Wholesale trade	81,914
Retail trade	5,069
Finance, insurance, and real estate	14,649
Business and personal services	8,876
Professional and social services	19,475
Coal	6,740
State and local taxes[b]	9,646
Labor[c]	215,228
Other expenses	14,004
Total cash expenditures	1,664,739
Direct impacts from processors[d]	601,286

[a] Only expenditures made within the two-state region were included.
[b] Included sales and use, property, and miscellaneous taxes.
[c] Included wages and salaries and employee benefits.
[d] Direct impacts were calculated by subtracting payments to sugarbeet growers from total expenditures. Payments made to sugarbeet growers were considered direct impacts attributable to sugarbeet production.

Table 4. Total Direct Impacts of the Sugarbeet Industry, by State and Component of the Industry, Fiscal 2011				
Industry Component	Minnesota	North Dakota	Total[a]	
	---------- 000s $ ----------			
Processing/Marketing	348,774	252,510	601,284	35.8%
State Share	58.0%	42.0%		
Production[b]	739,035	339,757	1,078,792	64.2%
State Share	68.5%	31.5%		
Total (all activities)[a]	1,087,809	592,267	1,680,076	
State Share	64.7%	35.3%		

[a] Columns and rows may not sum due to rounding.
[b] Calendar year 2010 expenses treated as part of fiscal 2011 industry impacts.

Direct Impacts by Economic Sector

Sugarbeet production expenditures, returns to sugarbeet growers, and production outlays by sugarbeet cooperatives were allocated to various economic sectors of the North Dakota I-O Model. Seed, herbicide, fungicide, insecticide, fertilizer, fuel, lubrication, repairs, and machinery depreciation were allocated to the *Retail Trade* sector. Custom hire expenses were allocated to the *Business and Personal Services* sector. Crop insurance, interest expense, and machinery and building leases were allocated to the *Finance, Insurance, and Real Estate* sector. Property taxes were allocated to the *Government* sector. Utility expenses were allocated to the *Communication and Public Utilities* sector. Hired labor, land rent, beet stock charges, and net returns were allocated to the *Households* sector. Dues and fees were allocated to the *Professional and Social Services* sector.

The survey of processors was designed to collect information on expenditures made by processing and marketing activities in the tri-state region. Both individual expenditures and expenses that can be grouped together into broad categories, based on Standard Industrial Classification (SIC) codes, were included in the survey. Major expense types based on SIC codes were organized to match several existing sectors in the North Dakota I-O Model. Those expenditure categories were directly allocated to the same sectors in the North Dakota I-O Model (see Appendix B for more detail). The remaining expenses collected from the survey of processing and marketing activities were allocated to appropriate sectors of the North Dakota I-O Model in the same manner as production outlays.

Miscellaneous manufacturing, wholesale trade, and 40 percent of plant maintenance and overhaul expenses were allocated to the *Agricultural Processing and Miscellaneous Manufacturing* sector. Twenty percent of plant maintenance and overhaul expenses were allocated to *Business and Personal Services* sector. Forty percent of plant maintenance and overhaul expenses were allocated to the *Retail Trade* sector. Expenses for petroleum, natural gas, coal, and communications were allocated to the *Communications and Public Utilities* sector. Employee benefits, insurance, and interest expenses were allocated to the *Finance, Insurance, and Real Estate* sector. Sugarbeet research was allocated to the *Professional and Social Services* sector. All taxes, unemployment, and workman's compensation were allocated to the *Government* sector. Salary and wage expenses were allocated to the *Households* sector.

The *Households* and *Retail Trade* sectors collectively accounted for about 68 percent of all direct impacts (Table 5). The *Finance, Insurance, and Real Estate* sector accounted for 9 percent, while direct impacts in the *Construction* and *Transportation* sectors collectively accounted for 8 percent of all expenditures. Noticeable direct impacts also were generated in the *Communications and Public Utilities*, *Agricultural Processing and Miscellaneous Manufacturing*, and *Professional and Social Services* sectors (Table 5).

Table 5. Direct Economic Impacts of Sugarbeet Industry in Minnesota and North Dakota, by Economic Sector, Fiscal 2011

	Industry Activity		
Economic Sector	Production	Processing and Marketing	Total
	---------------------------- 000s $	----------------------------	
Construction	0	53,669	53,669
Transportation	4,593	73,523	78,116
Communication and Public Utilities	4,492	54,173	58,665
Ag Processing and Misc Mnfg	0	103,651	103,651
Retail Trade	362,451	24,616	387,067
Finance, Insurance, and Real Estate	60,769	93,616	154,685
Business and Personal Services	13,653	30,623	44,276
Professional and Social Services	2,896	21,068	23,964
Households (personal income)	619,200	135,960	755,160
Government	10,738	10,085	20,823
Total	**1,078,792**	**601,284**	**1,680,076**

Secondary Impacts

The secondary impacts of the sugarbeet industry were estimated using the North Dakota Input-Output Model. The North Dakota Input-Output Model traces linkages among sectors of an economy and calculates total business activity resulting from a direct impact in a basic sector (Coon et al. 1985). The model embodies interdependence coefficients or multipliers that measure the level of total gross business volume (gross receipts) generated in each sector of the regional economy from an additional dollar of sales to final demand in a given sector. The model was developed from primary data from North Dakota firms and households and is closed with respect to households (meaning that measurements of economy-wide personal income are included within the model). The input-output model applies the expenditures from the sugarbeet industry to these interdependence coefficients. Resulting levels of business activity were used to estimate secondary (indirect and induced) employment, based on historic relationships.

This process of spending and respending can be explained by using an example. A single dollar from an area sugarbeet producer (*Households* sector) may be spent for a bag of sugar at the local store (*Retail Trade* sector); the store uses part of that dollar to pay for the next shipment of sugar (*Transportation* and *Agricultural Processing* sectors), part to pay the store employee (*Households* sector) who shelved or sold the sugar, and part to pay operating expenses for the store (*Communications and Public Utilities*, *Business and Personal Services*, *Finance, Insurance, and Real Estate*); the sugar processor uses part of that dollar to pay for the sugarbeets used to make the sugar (*Agriculture-Crops* sector); the sugarbeet grower in turn uses a portion of the sugarbeet payment to purchase production inputs (*Retail Trade* and *Business and Personal Services* sectors)... and so on.

Total direct impacts of $1.680 billion from the sugarbeet industry in Minnesota and North Dakota generated about $3.239 billion in secondary impacts (Table 6). Secondary economic impacts were greatest in the *Households* ($1.04 billion), *Retail Trade* ($962 million), *Finance, Insurance, and Real Estate* ($214 million), *Communications and Public Utilities* ($152 million), and *Construction* ($114 million) sectors. The economic activity in the *Households* sector represents economy-wide personal income resulting from industry expenditures and their subsequent secondary effects. Each dollar of direct impacts generated $1.93 in secondary impacts.

Table 6. Direct, Secondary, and Total Economic Impacts of the Sugarbeet Industry in Minnesota and North Dakota, Fiscal 2011			
	Industry Impacts		
Economic Sector	Direct	Secondary	Total
	---------------------------- 000s $ ----------------------------		
Construction	53,669	114,113	167,782
Transportation	78,116	16,966	95,082
Communication and Public Utilities	58,665	151,976	210,641
Ag Processing and Misc Mnfg	103,651	143,181	246,832
Retail Trade	387,067	962,145	1,349,212
Finance, Insurance, and Real Estate	154,685	213,710	368,395
Business and Personal Services	44,276	80,906	125,182
Professional and Social Services	23,964	116,933	140,897
Households (personal income)	755,160	1,038,543	1,793,703
Government	20,823	156,007	176,830
Other sectors[a]	0	244,404	244,404
Total	**1,680,076**	**3,238,884**	**4,918,960**
Direct Employment (full-time jobs)	**2,473**	**--**	**--**
Secondary Employment (full-time jobs)	**--**	**18,830**	**--**

[a] Includes Agriculture and Mining sectors.

Tax Revenue

Tax collections are another important measure of the economic impact of an industry on an economy. Tax implications have become an increasingly important measure of local and state-level impacts. Some of the interest in estimating tax revenue generated by an industry has stemmed from public awareness of the importance of tax revenue to local and state governments. In an era of reduced federal funding, revenue shortfalls, and growing public demand on governments to balance their budgets while providing constant or increased levels of services and benefits, tax collections have become an important factor in assessing economic impacts.

Business activity alone does not directly support government functions; however, taxes on personal income, retail trade, real estate property, and corporate income are important revenue sources for local and state governments. Total economic impacts in the *Retail Trade* sector were used to estimate revenue from sales and use taxes. Economic activity in the *Households* sector was used to estimate personal income tax collections. Similarly, corporate income tax revenue was estimated from the economic activity in all business sectors (excluding the *Households*, *Government*, and *Agriculture* sectors). The sugarbeet cooperatives and growers paid an estimated $15.4 million in property taxes in Minnesota and North Dakota in 2011. Property taxes were included in the direct impacts.

Tax collections were estimated separately for Minnesota and North Dakota. Direct economic impacts, those from sugarbeet production and processing, were estimated for each state. I-O analysis was used to estimate total business activity in each state. Total business activity, which is comprised of personal income, retail trade, and other business activity, was used to estimate tax revenue. Tax revenue generated by the sugarbeet industry in North Dakota included $21.5 million in sales and use taxes, $8 million in personal income taxes, and $3 million in corporate income taxes in fiscal 2011 (Table 7). The sugarbeet industry in Minnesota generated $26.9 million in sales and use taxes, $40.4 million in personal income taxes, and $5.4 million in corporate income taxes in fiscal 2011 (Table 7). Total tax collections generated by the sugarbeet industry in fiscal 2011 from sales and use, personal income, and corporate income taxes in the two-state region were about $105.4 million (Table 7). Total tax revenue attributable to the industry was estimated at $120.8 million, which included property, sales and use, personal income, and corporate income taxes.

Table 7. Estimated Tax Collections and Direct Taxes Paid by the Sugarbeet Industry in Minnesota and North Dakota, Fiscal 2011

Tax	Minnesota	North Dakota	Total
Estimated Tax Collections	--- 000s $ ---		
Sales and Use	26,943	21,531	48,474
Personal Income	40,413	8,009	48,422
Corporate Income	5,413	3,054	8,467
Sub-total	72,769	32,594	105,363
Direct Tax Payments			
Property	11,528	3,892	15,420
Total	**84,297**	**36,846**	**120,783**

Total Economic Impacts

Total business activity from sugarbeet industry expenditures and returns in Minnesota and North Dakota was estimated at nearly $4.9 billion in fiscal 2011 (see Table 6). The sectors of the two-state economy with the greatest total economic impact included the *Households* (economy-wide personal income) ($1.8 billion), *Retail Trade* ($1.3 billion), *Finance, Insurance, and Real Estate* ($368 million), *Agricultural Processing and Manufacturing* ($247 million), *Communications and Public Utilities* ($211 million), *Construction* ($168 million), and *Government* ($177 million) sectors.

The North Dakota I-O Model also estimates secondary employment. Employment estimates represent the number of full-time jobs generated as a result of the secondary economic activity. The sugarbeet cooperatives and marketing alliances were directly responsible for 2,473 full-time equivalent jobs and indirectly supported an additional 18,830 full-time equivalent jobs. The sugarbeet industry generated about $36.8 million in tax revenue in North Dakota and another $84.3 million in tax revenue in Minnesota.

The number of jobs created directly from sugarbeet production is difficult to estimate because most sugarbeet farmers also raise other crops. This complicates the employment estimate since if they did not raise sugarbeets, they likely would remain employed raising other crops. Also, sugarbeet labor requirements are seasonal, requiring substantial additional labor during planting and harvesting. Thus, estimating full-time employment equivalents is difficult. Although full-time employment equivalents for additional part-time hired labor are unknown, most of the seasonal employment (i.e., migrant workers, harvest labor, and truck drivers) is captured in the input-output analysis. Secondary employment was calculated based on secondary business activity and expressed in full-time equivalents. Seasonal employment, measured in terms of individuals employed, would be higher than the number of full-time equivalents, since those workers are employed for short time periods.

Previous Industry Impacts

Previous estimates of the economic contribution of the sugarbeet industry were compared to analyze the changing economic importance of the industry (Table 8). Four prior studies examining the economic contribution of the sugarbeet industry in eastern North Dakota and Minnesota have employed similar methodologies at various points in time. Thus, comparisons of previous estimates can be made by adjusting previous industry estimates to reflect real dollars (effects of inflation removed). Previous estimates from Coon and Leistritz (1988), Bangsund and Leistritz (1993), Bangsund and Leistritz (1998b), Bangsund and Leistritz (2004) were adjusted using the Gross Domestic Product–Implicit Price Deflator (U.S. Department of Commerce 2011) to reflect 2011 equivalent dollars.

Using a survey of sugarbeet processors to obtain processing, research, and distribution expenditures and using crop budgets to estimate farmers' production expenditures, Coon and Leistritz (1988) estimated the overall business activity generated from the sugarbeet industry in eastern North Dakota and Minnesota in 1987. Using similar methodologies, Bangsund and Leistritz (1993) also surveyed sugarbeet processors to obtain their operating expenditures and producer payments in eastern North Dakota and Minnesota. Bangsund and Leistritz (1993) and Bangsund and Leistritz (2004) included producer (grower) net returns associated with sugarbeet production in their study, an item not included in the study by Coon and Leistritz (1988). Methodologies used by Bangsund and Leistritz (1998b, 2004) were similar to those of Bangsund and Leistritz (1993), except expenditures made by United Sugars Corporation and Midwest Agri-Commodities to entities in Minnesota and North Dakota were included. The methods used in this study are similar to those used by Bangsund and Leistritz (1993, 1998b, 2004).

Adjusting previous estimates of industry size for inflation revealed that the sugarbeet industry exhibited real growth (size has increased after adjusting for inflation) over the last 20 years. Since 1987, planted acreage and tons processed have increased 42 percent and 121 percent, respectively. Planted acreage in 1987 was about 460,000 acres, while planted acreage in 2010 increased to 652,741 acres. Correspondingly, in real terms, gross business volume generated by the sugarbeet industry in eastern North Dakota and Minnesota has increased by 49 percent since 2003, nearly 61 percent since 1997, 108 percent since 1992, and about 185 percent since 1987.

Changes in direct employment were mostly constant over the 1987 to 2010 period. Direct employment within the industry grew by nearly 11 percent from 1987 to 1992. Direct employment by the industry remained relatively constant from 1992 through 2010: 2,410 full-time equivalents (FTE) in 1992, 2,486 FTE in 1997, 2,377 FTE in 2003, and 2,473 FTE in 2010 (Table 8).

Changes in secondary employment over the same period were similar. The number of jobs supported by secondary business activity generated by the sugarbeet industry increased by nearly 45 percent from 1987 to 1992 and increased by 19 percent from 1992 to 1997. However, secondary employment decreased by 12 percent from 1997 to 2003. From 2003 to 2010, secondary employment increased by 18 percent.

The decrease in secondary employment from 1997 to 2003 was not due to less overall economic activity (e.g., secondary economic impacts increased by 10 percent in real terms over the same period), but rather the decrease was reflective of changes in productivity ratios[2] used to estimate secondary employment. The relative change in productivity ratios from 1997 to 2003 was greater than the relative change in the industry's secondary economic activity. For example, the average amount of economy-wide business activity required to support one secondary job rose from $104,398 (average of all sectors influenced by the sugarbeet industry) in 1997 to $124,476 in 2003, a 19 percent increase. Thus, even though the industry generated a 10 percent increase in inflation-adjusted secondary business volume, the number of secondary jobs supported by the industry decreased because, in percentage terms, the average amount of business activity required to support a secondary job increased by 19 percent.

[2] A measure of the amount of economic activity needed in an economic sector to support one full-time job within that sector.

Table 8. Economic Size of the Sugarbeet Industry in Minnesota and North Dakota, Selected Years

	Sugarbeet Industry Activity in Various Years[a]				
Economic Indicators	1987	1992	1997	2003	2010
Gross Business Volume (000s nominal $)	985,709	1,635,800	2,321,500	2,812,219	4,918,960
Gross Business Volume (000s 2010 $)[b]	1,726,800	2,367,000	3,062,700	3,304,900	4,918,960
Direct Employment (full-time jobs)	2,175	2,410	2,486	2,377	2,473
Secondary Employment (full-time jobs)	10,604	15,375	18,248	16,009	18,830
Tax Revenue Generated (000s 2010 $)	39,180	48,620	67,280	70,190	105,363
Planted Acreage	460,000	554,400	654,400	776,300	652,741
Economic Impact per Acre (2010 $)	3,835	4,452	4,681	4,494	7,536
Tons of Sugarbeets Processed[c]	7,000,000	9,273,819	11,690,823	14,525,889	15,487,498
Economic Impact per Ton (2010 $)	247	255.23	261.97	244.07	317.61
Gross Business Volume by State (000s 2010					
Minnesota	na	1,641,700	1,973,800	2,252,520	3,161,634
North Dakota	na	827,000	1,088,800	1,052,300	1,757,326

na--not available.

[a] Sources for previous studies: 1987, Coon and Leistritz (1988); 1992, Bangsund and Leistritz (1993); 1997, Bangsund and Leistritz (1998b); 2003, Bangsund and Leistritz (2004). Producer net returns and expenditures made by marketing activities were excluded from Coon and Leistritz (1988). Expenditures made by marketing activities were excluded from Bangsund and Leistritz (1993). Expenditures by marketing companies were included in Bangsund and Leistritz (2004) and included in the current study. Bangsund and Leistritz (2004) included the economic impacts from the Sidney, MT sugarbeet plant; however, the effects of that processing plant were removed for sake of comparison to past economic assessments.

[b] Adjusted for inflation using the Gross Domestic Product–Implicit Price Deflator (U.S. Department of Commerce 2011).

[c] Exact tonnage of sugarbeets processed was not available from Coon and Leistritz (1988).

Recent changes in the economic impact of the industry have not been proportional in North Dakota and Minnesota. The economic size of the sugarbeet industry in North Dakota increased 32 percent in real terms from 1992 to 1997, while the size of the industry in Minnesota increased 20 percent over the same period. However, the economic contribution of the sugarbeet industry in North Dakota decreased in real terms by 3 percent from 1997 to 2003. The economic size of the sugarbeet industry in Minnesota; however, increased over the same period by nearly 14 percent. By comparison, the economic size of the industry increased in real terms by nearly 67 percent in North Dakota and 40 percent in Minnesota from 2003 to 2010.

While changes in planted acreage from 1997 to 2003 between the two states were similar in percentage terms (16.7 percent increase in ND and 14.5 percent increase in Minnesota), in physical terms, increased acreage in Minnesota was nearly double that of North Dakota over the period (an increase of 35,700 acres in ND compared to 64,000 acres in MN). From 2003 to 2010, the industry decreased planted acreage. The decrease was greater in North Dakota (-18 percent) than in Minnesota (-11 percent). While some of the change in gross business volume between the two states can be attributed to planted acreage, the distribution of expenditures by processing and marketing activities also account for the differences in economic activity between the two states. About 65 percent of the industry-wide gross business volume was generated in Minnesota and 35 percent was generated in North Dakota in fiscal 2011. By comparison in 2003, about 32 percent of the industry's economic activity was generated in North Dakota and 68 percent in Minnesota.

The economic size and importance of the sugarbeet industry in eastern North Dakota and Minnesota has increased substantially in the last 20 years. However, the rate of change over time has not necessarily been equally distributed between North Dakota and Minnesota. Bangsund and Leistritz (1998b) showed subtle shifts in economic growth favoring North Dakota over Minnesota in the mid 1990s, while Bangsund and Leistritz (2004) showed shifts in economic growth favoring Minnesota over North Dakota. Currently, shifts in growth, albeit relatively subtle, have again favored North Dakota over Minnesota.

Subtle changes in physical measures (i.e., impact per ton, impact per acre) of the industry's impact occurred from 1987 to 2011. Gross business volume per planted acre increased in real terms from 1987 to 1992 and from 1992 to 1998. However, gross business volume per planted acre, after adjusting for inflation, decreased from 1997 to 2003 only to increase again from 2003 to 2010. The amount of business activity per planted acre was estimated at about $7,500 in 2010, a 68 percent increase from inflation-adjusted figures for 2003. Similarly, in real terms, the gross business volume per ton of sugarbeets processed went from $262 per ton in 1997 to $318 per ton in 2010. In previous studies, the gross business volume per ton (in real terms) of sugarbeets processed fluctuated between the studies. Both measures, gross business volume per ton processed and per acre planted, after correcting for inflation, showed increases from 2003 to 2010. Potential reasons for the change might be attributable to such things as annual differences in yield, shrink, and spoilage, varying levels of sugar content, spending patterns by the industry within the study region, and changes in sugar prices.

Physically, the sugarbeet industry in eastern North Dakota and Minnesota has decreased in size based on planted acreage, yet increased in size based on tons of sugarbeets harvested and processed, and volume of sugar marketed. Expansions and contractions have been varied over the last 20 years as sugarbeet acreage increased by 81,000 acres or by 12 percent in eastern

North Dakota and Minnesota from 1997 to 2003 while planted acreage decreased by nearly the same amount from 2003 through 2010 (82,600 acres or by 11 percent). Despite changes in acreage, tonnage of sugarbeets processed has shown steady increases over the 1987 to 2010 period. However, changes in tonnage of sugarbeets processed has not matched percentage changes in gross business volume. Physical growth, in percentage terms, has only contributed to a portion of the industry expansion.

Several reasons contribute to the situation where physical growth does not match economic growth. First, not all physical measures of the industry (acreage, tonnage) translate into linear changes in economic size, as processors do not incur proportional increases in all expenditures with proportional increases in processing activity. Second, the degree to which processors purchase inputs and services from entities outside of the study region can affect the impact of the industry since the primary mechanism used to measure the economic contribution of the sugarbeet industry is an assessment of expenditures made within the study region. If the volume of those purchases changes, or if additional inputs, once available locally, now require purchasing from entities outside of the study region, the net effect can lead to slippage in the amount of expenditures made in the regional economy. Third, changes in sugar prices can lead to changes in revenues for processors and growers.

The economic size of the industry over time has been adjusted to reflect changes in the purchasing power of the dollar (inflation). If the same correction for inflation is performed on wholesale prices of refined beet sugar in the Midwest, average annual sugar prices show a 16 percent decrease from 1997 to 2003 (U.S. Department of Agriculture 2011b). However, prices have increased 74 percent from 2003 through 2010. The dramatic rise in wholesale refined beet sugar prices in the Midwest is perhaps the largest single driver of the substantial increase in the sugarbeet industries gross business volume when comparing 2003 to 2010 figures.

Finally, yields can influence the economic and physical measures of the industry. The industry is processing greater volumes on sugarbeets from fewer acres over the last several years. Therefore, increased yields have contributed to the increase in the gross business volume, despite a reduction in planted acreage. Thus, future changes in the economic importance of the sugarbeet industry not only hinge on physical size, such as acreage and tonnage produced, but also will rely on prices received for industry outputs and spending patterns by industry processors within the regional economy.

SUMMARY and CONCLUSIONS

The sugarbeet industry analyzed in this study is geographically limited to the Red River Valley of North Dakota and Minnesota and west central Minnesota. Within these areas, sugarbeets are produced and processed into refined sugar. The industry is concentrated geographically and structurally, which boosts the economic effect of the industry on local economies. However because sugarbeets are produced in a relatively small area compared to other traditional crops and livestock within the two states and with relatively few acres, the economic impact generated by the industry can be overlooked or underestimated.

The purpose of this study was to estimate the economic contribution of the sugarbeet industry to the economies in Minnesota and North Dakota in 2010. An economic contribution analysis, as used in this study, represents an estimate of all relevant expenditures by a specific industry and the subsequent secondary effects of those expenditures.

Sugarbeet production budgets were developed to estimate costs of production and returns from growing sugarbeets in the each state. The sugarbeet processing cooperatives and joint marketing entities in Minnesota and North Dakota were surveyed to obtain estimates of their in-state expenditures. Expenditures from processing and marketing activities and combined expenditures and net returns from sugarbeet production in the two-state region were estimated at $1.7 billion in fiscal 2011. The $1.7 billion in direct impacts, based on input-output analysis, generated another $3.2 billion in secondary impacts. The sugarbeet industry employed 2,473 full-time equivalent workers and, based on secondary business activity, supported an additional 18,830 full-time equivalent jobs in the two-state region. Total economic activity (direct and secondary impacts) was estimated at $4.9 billion in 2010, including $1.8 billion in economy-wide personal income and $1.3 billion in annual retail sales. Also, the sugarbeet industry generated about $105.4 million in sales and use, personal income, and corporate income taxes and paid $15.4 in property taxes. Total tax collections were $84.3 million in Minnesota and $36.5 million in North Dakota. Minnesota had the largest share of the industry's gross business volume ($3.2 billion or 64 percent) with North Dakota having $1.7 billion in gross business volume.

For every dollar the sugarbeet industry spent in Minnesota and North Dakota an additional $1.93 in business activity was generated within the regional economy. Each acre of sugarbeets planted generated about $7,500 in total business activity (production, processing, marketing, and secondary impacts) or, expressed alternatively, each ton of sugarbeets processed generated about $318 in total business activity.

Examinations of previous studies of the economic contribution of the sugarbeet industry revealed that the industry has experienced substantial real growth (i.e., effects of inflation were removed) in the last 20 years. Planted acreage in eastern North Dakota and Minnesota increased by 60 percent from 1987 to 2003, but has decreased by 11 percent since 2003. Tons of sugarbeets processed increased by 121 percent from 1987 to 2010 and, more recently, by 14 percent from 2003 to 2010. In real terms, gross business volume generated by the industry in Minnesota and North Dakota has increased 49 percent since 2003 and 185 percent since 1987. Some of the increase can be attributable to substantial increases in wholesale refined beet sugar prices in fiscal 2010 and fiscal 2011, which have in the Midwest region of the U.S. increased about 74 percent from average prices received from 2005 through 2009.

The sugarbeet industry in Minnesota and North Dakota contributes substantially to the two-state economy. Not only was the dollar volume of business activity considerable, but most processing plants are located in rural areas of the two states. Even though the sugarbeet industry has processing plants located throughout the sugarbeet-growing area, the size of the sugarbeet-growing area suggests much of its economic activity affects local economies. Expenditures for crop inputs and returns to growers, which represent a majority of the economic activity, are evenly distributed throughout the growing area. Substantial impacts in two major sectors of the economy, *Households* and *Retail Trade*, help to support this conclusion. In contrast, economic activity in other sectors of the economy may represent a concentration of economic activity in one or two major cities or with a few large firms (e.g., *Communications and Public Utilities*).

Although the sugarbeet industry in Minnesota and North Dakota is not large in terms of acres or geographic area, if measured in terms of personal income, retail sales, total business activity, tax revenue collections, and employment (direct and secondary), its economic contribution is highly apparent. The industry is an important and substantial contributor to both local economies and the two-state regional economy.

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APPENDIX A

Sugarbeet Production Budgets

Budget Sources and General Composition

Sugarbeet production budgets were compiled for the two main growing regions: Red River Valley in North Dakota and Minnesota and west central Minnesota. Production budgets were used to estimate the economic contribution of sugarbeet production, and were used to allocate production expenses to various sectors of the North Dakota I-O Model.

Revenues

Payments to farmers and planted acreage in each major growing area were obtained from the survey of sugarbeet processors (Appendix B). Estimates of per-acre federal farm program payments, miscellaneous revenues, and crop insurance indemnities were obtained from the North Dakota Farm and Ranch Business Management Education (2011) and Minnesota Farm Business Management Education (2011). Payments from sugarbeet processors, farm program payments, and insurance indemnities were combined to estimate gross revenues from sugarbeet production.

Expenses

Expenses for sugarbeet production on owned and rented land in the North Dakota and Minnesota Red River Valley were obtained from Minnesota Farm Business Management Education (2011) and North Dakota Farm and Ranch Business Management Education (2011). Similarly, expenses for sugarbeet production in west central Minnesota were obtained from Minnesota Farm Business Management Education (2011). Expenses available from the Farm Business Management Education programs represented an average of actual production costs incurred by the farmers/producers who are enrolled in the program. Expenses for sugarbeet production in the Red River Valley and west central Minnesota represented an average of operating costs for both rented and owned land. The ratio of rented to owned land in the Red River Valley and west central Minnesota sugarbeet growing regions was obtained from the *2007 Census of Agriculture* (U.S. Department of Agriculture 2011a) and used to average production costs between owned and rented land.

Net Returns

Producer net returns from sugarbeet production were estimated by subtracting variable and fixed costs from gross revenue. All expenses represented cash costs, except depreciation charges, which were used a proxy for machinery purchases. As a result, the budgets excluded non-cash costs associated with owned land, return on invested equity, management charges, and income tax liability. The producer net returns estimated in the budgets should not be confused with economic profit. Instead, the returns to unpaid labor, management, and equity simply represent gross revenues less cash expenses. Economic costs of production were not estimated.

Sugarbeet Production Budget, North Dakota and Minnesota Red River Valley, 2010

	Owned Land	Rented Land	Average
Sugarbeet payments to growers			$874,266,309
Planted acreage in Red River Valley			537,332
Amount of land that is rented			54.7%
Farm program payments	$16.88	$16.19	$16.50
Miscellaneous income	6.29	6.71	$6.52
Insurance indemnities	2.06	0.94	$1.45
Payments from sugarbeet processors			$1,627.05
Gross Revenue ($/planted acre)			$1,651.52
Variable Expenses ($/planted acre)			
Seed	158.07	158.16	158.12
Fertilizer	81.88	79.73	80.71
Chemical	67.38	67.96	67.70
Insurance	23.94	24.31	24.14
Fuel and Lubrication	61.41	62.90	62.23
Repairs	89.51	90.16	89.86
Custom Hire	12.24	11.90	12.05
Hired Labor	28.59	25.77	27.05
Stock lease	120.26	163.78	144.05
Machinery and Building Lease	0.14	0.79	0.49
Hauling and trucking	7.71	5.47	6.49
Interest	16.86	17.84	17.39
Land Rent*	0	83.35	45.56
Miscellaneous	2.19	1.99	2.08
Total Variable Costs	670.20	794.10	737.92
Fixed Costs ($/planted acre)			
Custom Hire	3.23	2.67	2.93
Hired Labor	46.11	49.86	48.16
Machinery and Building Lease	5.98	11.78	9.15
Property Tax*	13.60	13.60	13.60
Farm Insurance	9.36	9.21	9.28
Utilities	6.20	6.54	6.38
Dues and Professional Fees	4.62	4.77	4.70
Interest	40.62	11.60	24.76
Machinery & Building Depreciation	92.62	81.69	86.65
Miscellaneous	6.51	8.21	7.44
Total Fixed Costs	228.85	199.94	213.05
Total Costs	899.04	994.04	950.97
Returns to Unpaid Labor, Management, and Equity	---	---	700.55

*Property tax expense on owned land was subtracted from cash rent on rented land. Property tax expense was not originally listed in the budget for rented land. By adding property tax expense on rented land, variable expenses were reduced by the amount of property tax and subsequently, fixed costs on rented land were increased by the same amount. This was done to account for property tax expense for all land used to produce sugarbeets.

Sugarbeet Production Budget, West Central Minnesota, 2010

Sugarbeet payments to growers			$189,187,315
Planted acreage in west central Minnesota			115,409
	Owned Land	Rented Land	Average
Amount of land that is rented			54.6%
Farm program payments	$6.03	$7.99	$7.10
Miscellaneous Income	15.59	2.83	$8.62
Insurance Indemnities	1.15	4.98	$3.24
Payments from Sugarbeet Processors			$1,639.28
Gross Revenue ($/planted acre)			$1,658.42
Variable Expenses ($/planted acre)			
Seed	146.56	143.45	144.86
Fertilizer	46.38	55.97	51.62
Chemical	90.46	87.99	89.11
Insurance	21.32	29.29	25.68
Packaging and supplies	4.85	0.52	2.48
Fuel and Lubrication	67.41	62.60	64.78
Repairs	69.97	70.23	70.11
Custom Hire	56.32	42.10	48.55
Hired Labor	2.52	16.30	10.05
Machinery and Building Lease	4.77	17.53	11.74
Hauling and trucking	10.38	8.91	9.58
Interest	35.93	24.07	29.45
Land Rent*	0	142.58	77.92
Miscellaneous	7.39	21.59	15.15
Total Variable Costs	564.26	723.13	651.08
Fixed Costs ($/planted acre)			
Hired Labor	49.46	26.49	36.91
Machinery and Building Lease	13.20	3.10	7.68
Property Tax*	29.72	29.72	29.72
Farm Insurance	19.57	13.98	16.52
Utilities	10.82	7.87	9.21
Dues and Professional Fees	4.32	2.29	3.21
Interest	70.17	12.67	38.75
Machinery & Building Depreciation	120.52	87.99	102.74
Miscellaneous	21.41	12.77	16.69
Total Fixed Costs	339.19	196.88	261.43
Total Costs	903.45	920.01	912.50
Returns to Unpaid Labor, Management, and Equity	---	---	745.73

*Property tax expense on owned land was subtracted from cash rent on rented land. Property tax expense was not originally listed in the budget for rented land. By adding property tax expense on rented land, variable expenses were reduced by the amount of property tax and subsequently, fixed costs on rented land were increased by the same amount. This was done to account for property tax expense for all land used to produce sugarbeets.

APPENDIX B

Sugarbeet Processor Expenditures Survey

Instructions for Sugarbeet Processor Expenditures Survey

Data provided from this survey will be used to estimate the contribution the sugarbeet industry makes to the economies of North Dakota and Minnesota. All the information you provide will be kept strictly confidential. The following general instructions are suggested for completing the questionnaire.

1. Use information for Fiscal Year 2011.

2. Information should be recorded in dollar terms.

3. Include information for all of the organization's processing facilities on this questionnaire.

4. Include relevant information from all business ventures and other cooperative arrangements (United Sugars, Midwest Agri-Commodities, Pro-Gold)

5. If you cannot identify whether expenditures were made to North Dakota or Minnesota entities, please include the expenditure but note the lack of breakdown between states.

6. Do not include expenditures for pre-paid inputs/services purchased this year for next year's campaign.

7. When exact information is not available, please estimate.

8. Definitions for selected expenditure items and their corresponding Standard Industrial Classification (SIC) code listing are included to help in determining allocation of expenditures.

9. Please complete the survey by **July 22** and mail the questionnaire to the address below.

10. If you have questions, please contact:

Dean Bangsund (701-231-7471)
d.bangsund@ndsu.edu

Dr. Nancy Hodur (701-231-7357)
nancy.hodur@ndsu.edu

Mailing Address
Dept # 7610
PO Box 6050
North Dakota State University
Fargo, ND 58108-6050

DEFINITIONS FOR EXPENDITURE CATEGORIES

The following definitions are derived from Standard Industrial Classification Manual (SIC codes) and have been provided to assist in allocating expenses into common categories. If needed, please refer to the following web site for additional examples of the expenses included in each category: http://www.osha.gov/pls/imis/sic_manual.html Each category has several Major Group numbers, which contain additional detail on the type of activities in each category.

Construction: Includes expenses for construction projects, such as construction (including new work, additions, alterations, remodeling, and repairs) of residential, industrial, public, office, warehouse, and other buildings and structures. (Major Groups 15, 16, and 17)

Transportation: Includes expenses for railroad, motor freight, water transportation, air transportation, and other transportation to include packing and crating services, and rental of transportation equipment. (Major Groups 40, 41, 42, 43, 44, 45, 46, and 47)

Communications: Includes expenditures for telephone, telegraph, radio, television, satellite services, Internet transactions, and other communication services. (Major Group 48)

Public Utilities: Includes expenses for natural gas, electricity, water supply, and sanitary (sewer & garbage) services. (Major Group 49)

Wholesale Trade: Expenses paid to establishments primarily engaged in selling merchandise to retailers; to industrial, commercial, institutional, or professional users; or to other wholesalers, or acting as agents in buying merchandise for or selling merchandise to such persons or companies. (Major Groups 50 and 51)

Retail Trade: Includes expenses for building materials, hardware, food, general merchandise, office supplies, automobile fuel, computers, eating and drinking establishments, work uniforms, and most other business and office-related supplies. (Major Groups 52, 53, 54, 55, 56, 57, 58, and 59)

Finance, Insurance, and Real Estate: Includes expenses for loan service, interest on loans, investment counseling, insurance, real estate transactions, brokerage fees, and any other financial service expenditures. (Major Groups 60, 61, 62, 63, 64, 65, 66, and 67)

Business and Personal Services: Examples of business and personal services include expenses for advertising, collection services, photocopying/duplication/printing services, equipment rental, computer services, computer software, security services, tax preparation, automotive/equipment/miscellaneous repairs, entertainment, janitorial services, and overnight lodging. (Major Groups 70, 72, 73, 75, 76, 78, 79, and 87)

Professional and Social Services: Includes expenses for health/pharmaceutical, medical, legal, educational, research and development, child care, vocational training, and other professional services. (Major Groups 80, 81, 82, 83, 84, 86, 88, and 89)

SUGARBEET PROCESSOR EXPENDITURES QUESTIONNAIRE

Cooperative: ____

Location: ____

Contact Person: ____

I. **Listing of expenditures made in FY 2011**

Expenditure Categories	**Estimated Annual Expenditure In** North Dakota	Minnesota
	dollars	
Payments to sugarbeet growers (sugarbeet production)		
Other payments to sugarbeet growers (capital returns, etc.)		
Construction		
Plant maintenance and overhaul		
Transportation		
Communications		
Public utilities		
Miscellaneous manufacturing		
Wholesale trade		
Retail trade		
Finance, insurance, and real estate		
Business and personal services		
Professional and social services		
Coal		
Wages and salaries		
Benefits		
Sugarbeet research funded		

Items For Which Expenditures were Made	Estimated Annual Expenditure In North Dakota	Minnesota
	dollars	
Government (taxes paid in ND and MN only)		
Property taxes		
Sales and use taxes		
Unemployment		
Other taxes (please specify)		
Other Expenses (please specify nature of expense)		

II. **Total annual revenue (from all ventures):** $_______________

III. **Number of employees in full-time equivalents:** ___________

IV. **Sugarbeets processed:** _____________ tons

V. **Sugarbeet acreage:** _____________ acres planted
_____________ acres harvested

VI. **Comments/further explanations (attach supporting material if needed):**

____

____

____

____

EXHIBIT W

2002 Census of Agriculture – Table 36

Excerpt Issued June 2004

Florida

State and County Data

Volume 1, Geographic Area Series
Part 9

AC-02-A-9

2002
CENSUS OF
AGRICULTURE

Issued June 2004

U.S. Department of Agriculture
Ann M. Veneman, Secretary
Dr. Joseph J. Jen, Under Secretary for
Research, Education, and Economics
NATIONAL AGRICULTURAL STATISTICS SERVICE
R. Ronald Bosecker, Administrator

Table 36. **Specified Fruits and Nuts by Acres: 2002 and 1997**

[For meaning of abbreviations and symbols, see introductory text]

Crop	Total		Bearing acres		Nonbearing acres	
	Farms	Acres	Farms	Acres	Farms	Acres
Apples ... 2002	53	54	28	19	38	35
1997	81	116	(NA)	(NA)	(NA)	(NA)
Avocados ... 2002	839	7,254	737	6,609	281	645
1997	632	7,104	(NA)	(NA)	(NA)	(NA)
2002 acres:						
0.1 to 0.9 acres	164	60	112	41	73	19
1.0 to 4.9 acres	377	846	338	665	132	180
5.0 to 14.9 acres	207	1,550	196	1,384	52	166
15.0 to 24.9 acres	34	607	34	556	7	51
25.0 to 49.9 acres	25	839	25	762	9	77
50.0 to 99.9 acres	19	1,253	19	1,143	4	110
100.0 acres or more	13	2,100	13	2,058	4	42
1997 acres:						
0.1 to 0.9 acres	95	32	(NA)	(NA)	(NA)	(NA)
1.0 to 4.9 acres	274	694	(NA)	(NA)	(NA)	(NA)
5.0 to 14.9 acres	168	1,264	(NA)	(NA)	(NA)	(NA)
15.0 to 24.9 acres	46	809	(NA)	(NA)	(NA)	(NA)
25.0 to 49.9 acres	30	(D)	(NA)	(NA)	(NA)	(NA)
50.0 to 99.9 acres	5	407	(NA)	(NA)	(NA)	(NA)
100.0 acres or more	14	(D)	(NA)	(NA)	(NA)	(NA)
Bananas ... 2002	81	120	36	40	47	80
1997	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Figs ... 2002	12	2	8	(D)	4	(D)
1997	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Grapes ... 2002	266	788	231	562	89	226
1997	327	777	(NA)	(NA)	(NA)	(NA)
Guavas ... 2002	112	362	63	186	60	176
1997	45	158	(NA)	(NA)	(NA)	(NA)
Mangoes ... 2002	400	1,373	301	1,205	167	168
1997	277	2,102	(NA)	(NA)	(NA)	(NA)
Nectarines ... 2002	22	23	13	13	20	10
1997	29	19	(NA)	(NA)	(NA)	(NA)
Papayas ... 2002	53	156	43	(D)	21	(D)
1997	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Passion Fruit ... 2002	5	12	1	(D)	4	(D)
1997	3	(D)	(NA)	(NA)	(NA)	(NA)
Peaches, All ... 2002	111	432	65	264	76	168
1997	153	516	(NA)	(NA)	(NA)	(NA)
Pears, All ... 2002	74	48	50	18	41	31
1997	116	102	(NA)	(NA)	(NA)	(NA)
Persimmons ... 2002	154	537	100	297	94	240
1997	174	466	(NA)	(NA)	(NA)	(NA)
Plums and prunes ... 2002	34	35	21	15	24	20
1997	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Other noncitrus fruit (see text) ... 2002	714	2,849	498	1,649	392	1,200
1997	370	1,520	(NA)	(NA)	(NA)	(NA)
Citrus fruit, All ... 2002	7,653	871,733	7,389	825,679	1,782	46,054
1997	8,968	971,577	(NA)	(NA)	(NA)	(NA)
2002 acres:						
0.1 to 0.9 acres	278	136	222	104	100	32
1.0 to 4.9 acres	1,294	3,163	1,227	2,786	308	377
5.0 to 14.9 acres	2,148	18,126	2,062	16,347	462	1,778
15.0 to 24.9 acres	945	17,922	922	16,333	207	1,589
25.0 to 49.9 acres	1,113	38,499	1,093	35,570	230	2,929
50.0 to 99.9 acres	800	54,647	788	50,816	185	3,831
100.0 or more acres	1,075	739,240	1,075	703,722	290	35,518
100.0 to 249.9 acres	584	86,627	584	82,269	144	4,359
250.0 to 499.9 acres	237	81,480	237	78,629	57	2,851
500.0 to 749.9 acres	56	32,653	56	30,527	18	2,126
750.0 to 999.9 acres	44	37,566	44	35,345	12	2,222
1,000.0 acres or more	154	500,914	154	476,952	59	23,961
1,000.0 to 1,999.9 acres	82	110,937	82	102,936	32	8,001
2,000.0 to 2,999.9 acres	24	58,459	24	(D)	13	(D)
3,000.0 acres or more	48	331,518	48	(D)	14	(D)
1997 acres:						
0.1 to 0.9 acres	299	137	(NA)	(NA)	(NA)	(NA)
1.0 to 4.9 acres	1,731	4,420	(NA)	(NA)	(NA)	(NA)
5.0 to 14.9 acres	2,398	20,448	(NA)	(NA)	(NA)	(NA)
15.0 to 24.9 acres	1,239	23,405	(NA)	(NA)	(NA)	(NA)
25.0 to 49.9 acres	1,322	45,602	(NA)	(NA)	(NA)	(NA)
50.0 to 99.9 acres	886	59,803	(NA)	(NA)	(NA)	(NA)
100.0 to 249.9 acres	539	82,845	(NA)	(NA)	(NA)	(NA)
250.0 to 499.9 acres	228	77,268	(NA)	(NA)	(NA)	(NA)
500.0 to 749.9 acres	82	49,060	(NA)	(NA)	(NA)	(NA)
750.0 to 999.9 acres	60	51,837	(NA)	(NA)	(NA)	(NA)
1,000.0 acres or more	184	556,754	(NA)	(NA)	(NA)	(NA)
Grapefruit, All ... 2002	1,861	119,364	1,740	113,929	390	5,435
1997	2,979	154,955	(NA)	(NA)	(NA)	(NA)
2002 acres:						
0.1 to 0.9 acres	361	118	291	91	113	28
1.0 to 4.9 acres	380	790	351	684	83	107
5.0 to 14.9 acres	453	3,719	444	3,525	63	194
15.0 to 24.9 acres	172	3,242	166	2,925	36	317
25.0 to 49.9 acres	198	6,657	194	6,295	33	363
50.0 to 99.9 acres	107	7,229	104	6,802	20	426
100.0 acres or more	190	97,609	190	93,608	42	4,001
100.0 to 249.9 acres	96	14,172	96	13,563	18	608
250.0 to 499.9 acres	48	15,572	48	(D)	13	(D)

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EXHIBIT Y

Singerman, A., M. Burani-Arouca, and S. Futch. 2018
The profitability of new citrus plantings in Florida in the era of HLB Hortscience. 53(11); 1655-1663

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The Profitability of New Citrus Plantings in Florida in the Era of Huanglongbing

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Additional index words. citrus economics, citrus greening, HLB

***Abstract*. The Florida citrus industry has been enduring the impact of citrus greening since 2005. The disease has been the main driver for the state's citrus production to plummet by 80% in the past 13 years, causing the industry to downsize drastically. Planting new groves is key to ensuring a supply of fruit for processors and packinghouses to stay in business. However, a key question is whether it makes economic sense to plant a new grove in the current environment. We estimate the establishment and production costs for a new grove under endemic Huanglongbing (HLB; citrus greening) conditions for three different tree planting densities under different market conditions and examine their profitability. Our results show that establishing a new grove with a tree density similar to that of the state's average is not profitable under current market conditions. However, greater tree densities are profitable despite the greater level of investment required.**

The Florida citrus industry has faced multiple challenges during the past 20 years. On the supply side, such challenges have included the expansion of urban development, resulting in a decrease in agricultural land (Hernandez et al., 2012; Kautz et al., 2007); the reduction of domestic labor supply availability with its consequent increase in cost (Emerson, 2007; Wu and Guan, 2016); as well as the introduction of exotic diseases (Gottwald et al., 2002). The industry has also seen challenges on the demand side. In Florida, ≈90% of the citrus crop is processed for juice (U.S. Department of Agriculture, National Agricultural Statistics Service, 2018), and the introduction of new and alternative beverages available to consumers has increased the competition among beverage products during the past few years (Terazono and Hume, 2016). In addition, consumer concerns and media reports about sugar content in orange juice (Barclay, 2014; Saner, 2014; *Time Magazine*, 2014) have likely affected demand negatively, which triggered a response from the industry to address them (Florida Department of Citrus, 2016). Changes in consumer lifestyles and diets have also conspired against orange juice consumption (Heng et al., 2018; Terazono and Hume, 2016). But, chief among all challenges, the industry has been dealing with HLB since 2005.

The finding of HLB in Florida in 2005 was at about the same time that the citrus canker eradication program ended. Despite government and growers' efforts to eradicate canker-affected trees in Florida, such disease became endemic across the state (Gottwald et al., 2002; Weaver, 2016). Thus, when plant pathologists recommended the eradication of HLB-affected trees as part of the disease management plan (Bové, 2006), many Florida growers were reluctant to adopt such a strategy and opted instead for keeping the trees. This was not only because of the futile efforts to try to eradicate canker, but also because fruit prices were high at the time. Therefore, the opportunity cost of removing trees that were producing fruit was too high for many growers. Without inoculum removal, HLB spread rapidly across Florida. In 2015, it was estimated that 90% of the area of a citrus operation in the state was affected by HLB (Singerman and Useche, 2017). To date, there is no cure or successful management strategy to deal with HLB. As trees become increasingly affected by the disease, they suffer premature fruit drop, the fruit harvested is smaller and misshapen, and the juice quality is compromised, all resulting in lower yield. In addition, tree mortality and cost of production also increase.

Production costs have increased significantly compared with pre-HLB levels. Figure 1 shows real cultural production costs for processed oranges in Southwest Florida. On a per-hectare basis and using 2017 as the base year, costs increased from $2869 in 2003–04 to $4804 in 2016–17, up 67% during that period. Such an increase in cost was mainly a result of growers using more foliar sprays and fertilizer (Singerman and Burani-Arouca, 2017). Figure 1 also shows that, on a per-box basis, real cultural production costs have increased from $2.71 in 2003–04 to $10.40 in 2016–17, which represents a 283% increase. The reason for the greater percentage increase on a per-box basis is a result of the simultaneous increase in cost per hectare and decrease

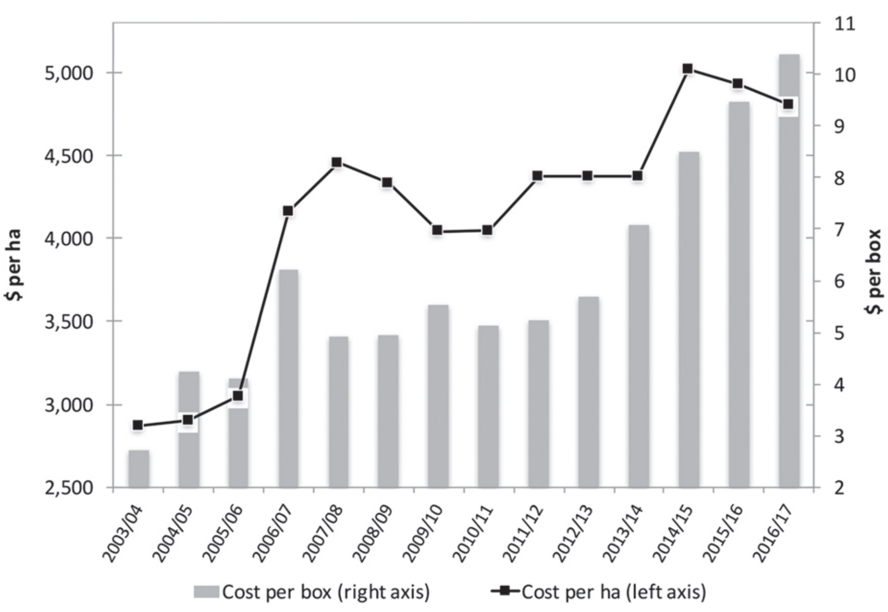

Fig. 1. Real cultural cost of production for processed oranges in Southwest Florida [Producer price index (PPI) 2017 = 100]; 40.82 kg/box. Source: University of Florida, Institute of Food and Agricultural Sciences; Citrus Research and Education Center; Multiple Annual Cost of Production reports. Revenue estimates are the authors' calculations.

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in yield per hectare. During the same period, as a result of the decrease in supply (and as economic theory predicts), on-tree prices per box increased. Such an increase in real prices was by 122% (U.S. Department of Agriculture, National Agricultural Statistics Service, 2018). Thus, the greater increase in cost per box relative to price has resulted in a lack of profitability for the average grower, particularly during the past few seasons (Fig. 2).

As a consequence of the challenges the industry has been facing, but in particular as a result of the lack of profitability, it is not surprising that the rate of area lost has been larger than that of area planted (Fig. 3). And, as shown in Fig. 3, the difference between the two rates has also been increasing during the past few years. Consequently, the bearing area for oranges in Florida has decreased from 229,000 ha in 2003–04 to 149,000 ha in 2016–17 (Fig. 4). Such a decrease in area also denotes the reduction in the number of citrus growers across the state. Figure 5 shows the number of operations by farm size through time. The number of citrus growers in all four categories decreased from 7167 in 2002 to 3122 in 2012. However, the two categories with a smaller area—0.4 to 19.9 ha and 20 to 100.9 ha—decreased by 59% and 52%, respectively, whereas the decrease in the two categories of growers with a larger area were 34% and 40%, respectively. Thus, the reduction in the number of growers has been greater in absolute and percentage terms for smaller operations. Operations with areas between 0.4 to 19.9 ha still represented 69% of the total number of citrus operations in Florida in 2012. However, they accounted for ≈6% of the citrus-bearing area. The representativeness of operations with am area greater than 303 ha increased by 4% from 2002 to 2012. The 2017 census data will be released by U.S. Department of Agriculture, National Agricultural Statistics Service in 2019, but given the impact of HLB, it is very reasonable to assume that such a trend has continued because, under current circumstances, it can be sensibly argued that smaller growers have had a harder time staying in business relative to larger growers.

The downsizing of the industry in recent years has not only occurred at the grower level, but also at the industry level. Figure 6 shows that the number of juice processing facilities decreased from 41 in 2003–04 to 14 in 2016–17, whereas the number of packinghouses decreased from 79 to 26 during the same period. The reduction in infrastructure is particularly troublesome. After a juice processing plant or packinghouse shuts down, the facility is put up for sale and is, therefore, unlikely to reopen. To prevent more growers and the infrastructure from going away, and to keep the Florida citrus industry afloat until a cure or management strategy for HLB is found, several public and private incentive programs for replanting have been made available to growers (Singerman, 2017; Spreen and Zansler, 2016). Such programs can incentivize growers to invest in a new citrus grove. However, and perhaps more important, a key question is whether current practices—in particular, the typical grove planting density—are still valid (i.e., profitable) in the current environment. Thus, the purpose of this study is 2-fold: first, to estimate the establishment and production costs for a new grove under endemic HLB conditions for three different tree planting densities; and second, to examine the profitability of those three different densities under different production and market conditions.

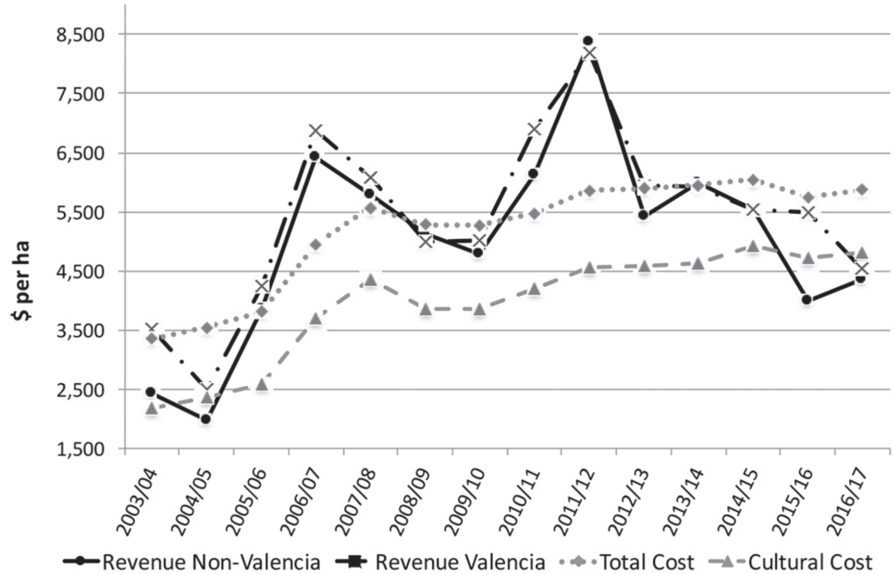


Fig. 2. Revenue and cost of production for processed oranges in Southwest Florida. Source: U.S. Department of Agriculture-Natural Agricultural Statistics Service. Revenue estimates are the authors' calculations.

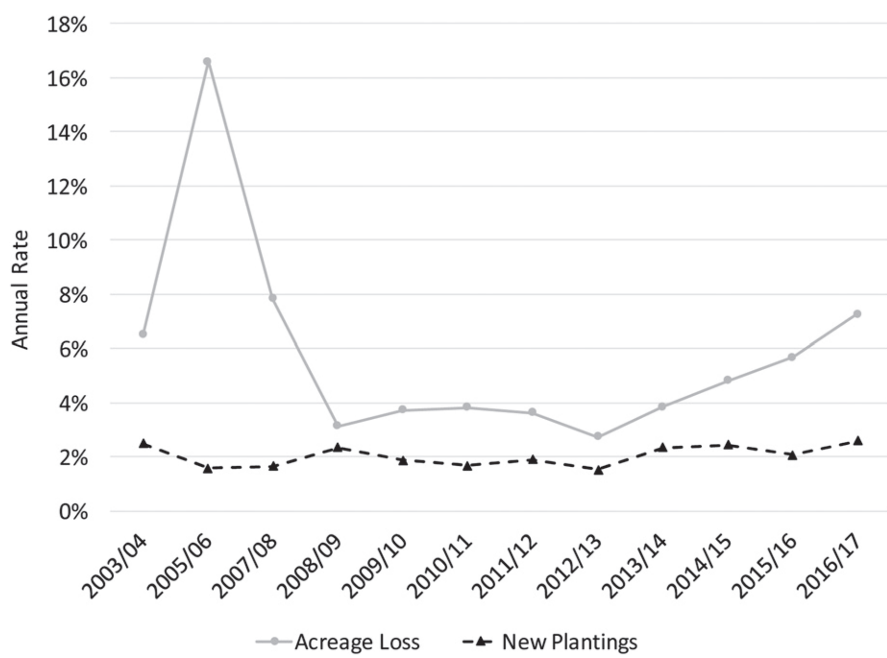


Fig. 3. Annual area loss and new plantings rates for oranges in Florida. Source: U.S. Department of Agriculture-Natural Agricultural Statistics Service, Florida Citrus Statistics. Authors' calculations.

Materials and Methods

The current analysis is for 'Valencia' oranges, which is the predominant late cultivar produced in Florida and has accounted for ≈55% of the bearing area of oranges grown in the state during the past few years. The choice of this cultivar determines the values for yields and prices used in our model. Our cost estimates, however, are also applicable to early cultivars. The annual cost of production is based on survey data collected in Southwest Florida in 2016–17 for growing processed oranges (Singerman, 2018). Although the sample of growers may not be representative of the entire citrus grower population in Southwest Florida, the data represent 14,730 ha, which is a sizable area in that region. Thus, such data are the most updated, credible, and detailed source

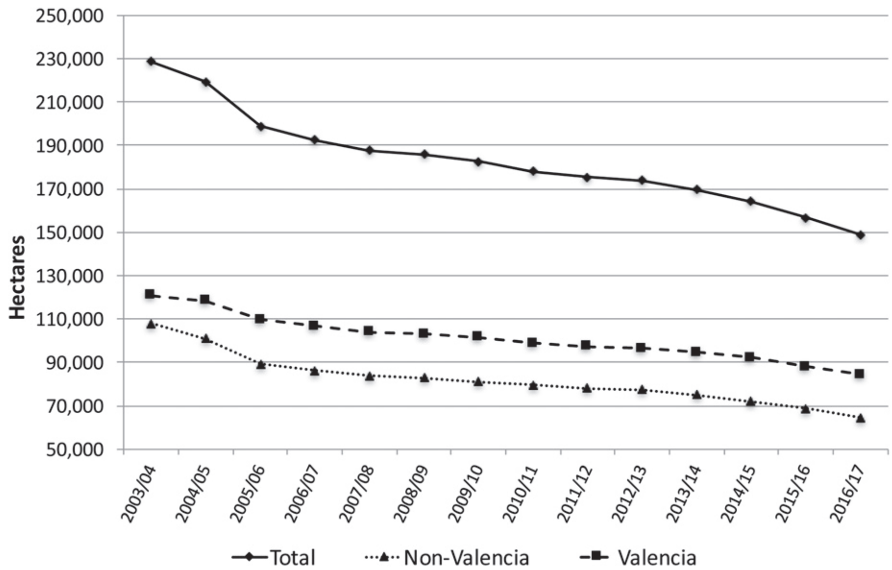


Fig. 4. Bearing area for oranges in Florida. Source: U.S. Department of Agriculture-National Agricultural Statistics Service, Florida Citrus Statistics.

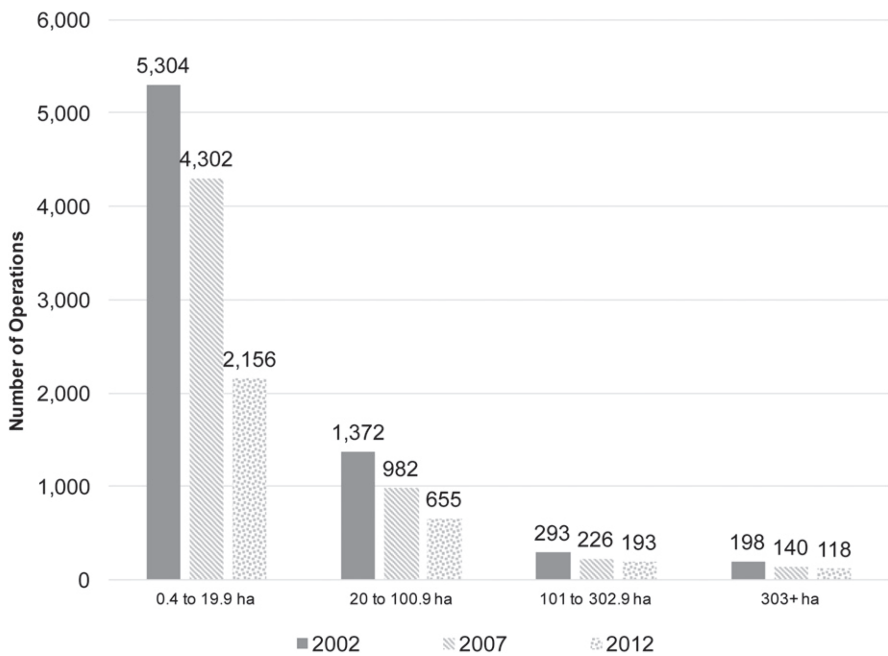


Fig. 5. Number of citrus operations in Florida by farm size (area). Source: U.S. Department of Agriculture-National Agricultural Statistics Service, Census of Agriculture data (2002; 2007; 2012).

available on the cost of production of citrus in Florida in the era of HLB. The estimates include both the costs of materials and the costs associated with their application (i.e., labor). The tree density baseline for our analysis is 358 trees/ha, which is the average tree density reported by growers participating in the survey, and it is also about the state average for a citrus grove in Florida, which is 339 trees/ha (U.S. Department of Agriculture, National Agricultural Statistics Service, 2018). The between-row and in-row tree spacing associated with 358 trees/ha is 7.6 × 3.7 m.

In addition to the tree density baseline of 358 trees/ha, we also analyzed two greater tree densities: 544 trees/ha (with between-row and in-row tree spacing of 6.7 × 2.7 m) and 749 trees/ha (with between-row and in-row tree spacing of 5.5 × 2.4 m). The choice for these two greater densities is based on the feedback we obtained from growers who had already planted greater density groves.

To estimate the necessary investment in irrigation and frost protection, the first step was to determine the quantity of water needed for each tree density. Parsons and Morgan (2017) reported the per-tree water needs for a grove with 346 trees/ha to be 53 and 148 $L{\cdot}d^{-1}$ for the winter and summer months, respectively. They also reported the per-tree water needs for a grove planted at 539 trees/ha to be 34 and 95 $L{\cdot}d^{-1}$ for the winter and summer, respectively. For computing the water required to irrigate a grove with 749 trees/ha, we extrapolated the water requirements based on the percentage of additional trees relative to 544 trees/ha, taking into account a reduction in per-tree water needs. To establish the volume of annual irrigation needed, we took into account the amount of water trees receive from rainfall. Thus, we estimated the historical average rainfall in three representative citrus-growing cities in Florida (Clewiston, Frostproof, and Immokalee) from 2010 to 2016 using data from the Florida Automated Weather Network. Then, based on the liters of water needed per day per tree for each tree density, we calculated the average amount of irrigated water needed each month to supplement rainfall.

To account for frost protection, we assumed four radiation frost events per year based on the work of Jackson et al. (2015). During each freeze event, the irrigation system was assumed to be run continuously for 12 h, resulting in 48 h/year in which the irrigation system would pump water for freeze protection. We assumed a 20-ha irrigation zone based on feedback from irrigation supply companies. We also assumed which type of microsprinkler would be used for each tree, which in turn affected the decision of the capacity of the water well and pump needed. Note that the choice of microsprinkler, water well, and pump is different for each tree density; we gathered appropriate quotes for the equipment that would meet the requirements of each tree density. We then computed the variable costs associated with the irrigation system, such as pumping hours, diesel consumption, repairs, and maintenance, using feedback from suppliers.

We assume that the average expected lifespan of a grove in Florida has decreased from 30 to 20 years as a consequence of the impact of HLB. The disease has also affected tree mortality, which we assume to be 3% in years 2 through 6 and 5% from years 7 through 20; these figures are based on growers' feedback. However, the tree replacement strategy for removed trees is based on a sensitivity analysis that maximizes profit. In our model, we also assume that the following cultural activities are contracted: land preparation and bedding, fertilization, hedging and topping, tree removal, and tree replacement. Regarding the land, we assume it is already owned.

Foliar sprays are the largest expense among the caretaking practices of the groves, accounting for 34% of the cultural cost of production (Singerman, 2018). Because we assume the use of tree sensing technology for the application of foliar sprays, we wanted to obtain the cost of materials on a per-tree basis by tree age. To calculate such cost per tree, we divided the cost per hectare of the foliar sprays program by the total number of trees in the year in which trees reach maturity. Taking into account the HLB stunting effect on citrus trees (HLB-affected trees do not grow as much as trees without HLB), we

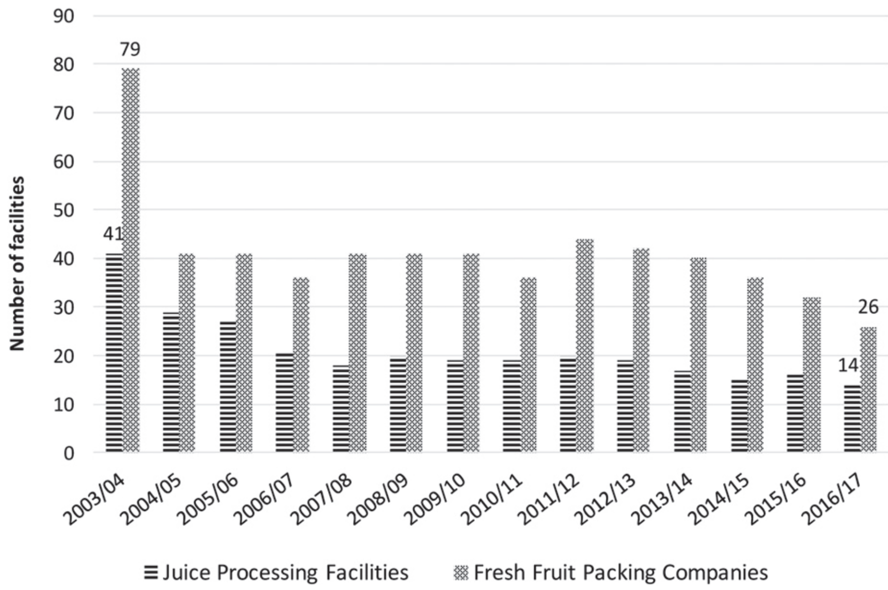


Fig. 6. Number of juice processing facilities and packinghouses in Florida. Source: Florida Department of Agriculture and Consumer Services (FDACS).

assumed it would take 12 years for them to reach full size (height). Thus, the material application rate for trees between 1 and 11 years old was computed by taking into account a percentage reduction relative to mature trees based on their age (and height). After we obtained the cost on a per-tree basis by age, we computed the foliar sprays costs per hectare for each year simply by multiplying the number of trees in each cohort by the associated foliar spray cost per tree.

Fertilizer is the second-largest expense in the caretaking of the groves, which accounted for 21% of the cultural cost of production in 2016–17 (Singerman, 2018). For computing the cost of the annual fertilizer program—similarly for foliar sprays—we also wanted to obtain fertilization rates on a per-tree basis. To calculate such rates per tree, we divided the cost per hectare of the program by the total number of trees that are 4 years old and older in year 12. Mature trees receive 100% of the rate associated with the survey cost data. To compute the cost of fertilizing younger trees, we did the following. For trees that are 1, 2, and 3 years old, we based fertilizer applications on University of Florida, Institute of Food and Agricultural Sciences recommendations (Morgan et al., 2017), which specify using three dry fertilizer applications and eight liquid fertilizer applications per year. For trees that are between 4 and 11 years old, we computed a reduction in their material application rate relative to a mature tree based on their height.

To compute the cost of the fertilizing program for tree densities of 544 and 749 trees/ha, we calculated the cost per tree in a similar fashion to that described earlier. However, because fertilizer recommendations are on a per-hectare basis, we applied a cap equal to the cost of the mature trees' program in the 358-tree/ha density. Regarding the annual application cost per hectare for dry fertilizer, we included an application cost upcharge of 11% and 44% for 544 and 749 trees/ha, respectively. Such upcharges are based on the extra cost of fuel and labor involved in the applications resulting from the additional number of rows per hectare in greater density groves relative to the 358-tree/ha density.

A summary of the annual variable costs throughout the grove lifetime is presented in Table 1 for each of the three tree densities analyzed.

Sensitivity analysis. To allow for the possibility of different types of growers planting a new grove, we also made assumptions regarding the level of investment needed in terms of machinery and irrigation. Such investment could be either full or partial to represent the cases of a new grower and that of a current grower, respectively. The difference between the scenarios is that, in the full-investment scenario, the grower needs to purchase all machinery and irrigation equipment required to manage the grove whereas, in the partial scenario, the grower only needs to make some investment in irrigation (the well and pumping station are assumed to be in place). However, in both scenarios we assume the grower needs to purchase a new tractor, ATV, and pickup truck in year 11. The rest of the machinery is assumed to be used beyond its accounting lifespan of 10 years.

Yield is a key parameter in the model, and we assume two possible scenarios for modeling it. In both scenarios, trees start to fruit 26 months after planting. In the first scenario, which we refer to as low, we assume that the boxes per tree for each of the different age cohorts are given by the U.S. Department of Agriculture, National Agricultural Statistics Service average for Southwest Florida during seasons 2013–14 through 2015–16. Their estimates represent about a 40% yield reduction compared with pre-HLB yield levels. Such a figure is in agreement with the average loss reported by growers (Singerman and Useche, 2017). In the second scenario, which we refer to as high, we assume trees yield more boxes relative to scenario 1 based on the feedback from growers with whom we visited, who attain yields greater than the state's average. Regarding quality yield, we assume that in both scenarios each box yields 6.24 pound solids (ps) (Florida Department of Citrus, 2017b).

Price is another key parameter in the model. The average delivered-in price for 'Valencia' oranges in 2016–17 was \$2.85/ps (Florida Department of Citrus, 2017a). To obtain the on-tree price (which is the price the grower receives, and the basis we use to compute profitability) from the delivered-in price, we subtract \$3.27/box (Singerman et al., 2017) for harvesting and \$0.07/box for Florida Department of Citrus assessment from delivered-in prices and obtain \$2.31/ps. We model three scenarios to represent possible market conditions: low, medium, and high prices. Thus, we use the on-tree price estimate as the medium-price scenario, and assume a 15% decrease (10% increase) with respect to such price to establish the low (high) scenario of \$1.97/ps (\$2.55/ps). These values translate to delivered-in estimates of \$2.50/ps and \$3.08/ps, respectively. These prices were chosen to represent a range of conservative current and future potential market conditions. We assume that fruit prices and input costs are constant throughout the investment period, which, in the case of the former, assumes away weather shocks derived from potential freezes and/or hurricanes. To the extent that prices and yield are a natural hedge, and taking into account that the main purpose of this analysis is to illustrate the profitability of different planting densities, we consider this assumption to be reasonable. We also assume the annual cash flows are expressed in real terms, so we do not need to adjust them for inflation. Thus, the resulting rate of return is in real terms as well.

Results

For each tree density, we computed the set of different scenarios described in the previous section by combining the investment requirement (full or partial), cost of production, yields, and prices to obtain the returns. We then compiled an annual financial budget, which is the basis for the investment analysis—the typical methodology for establishing the profitability of a long-term investment.

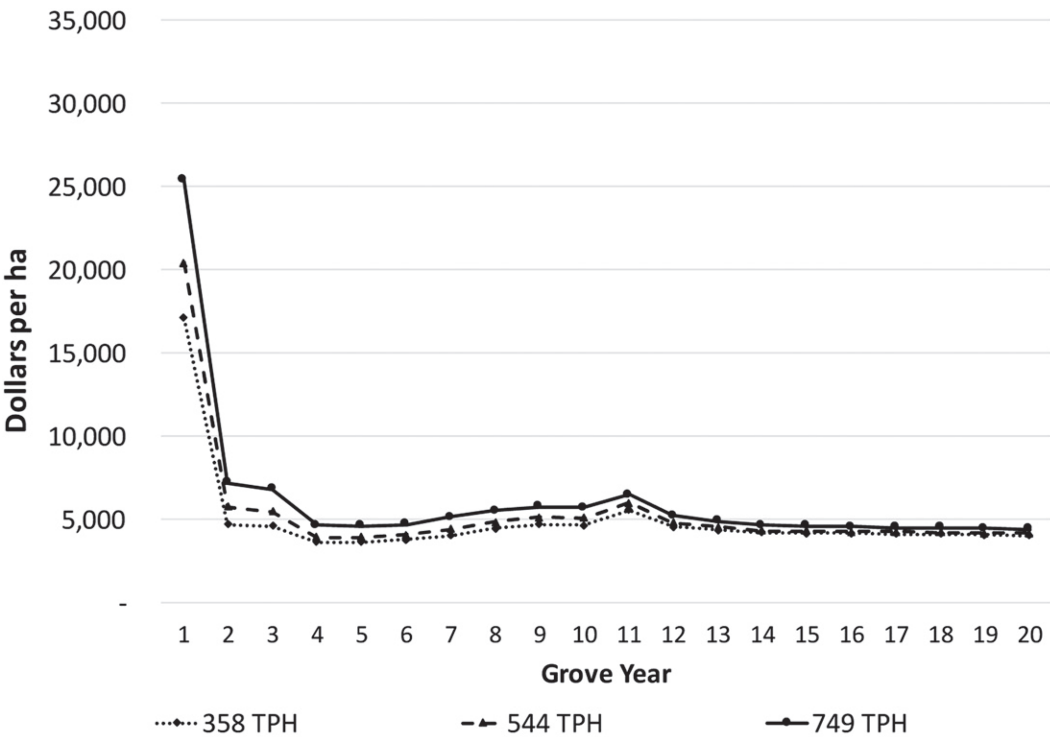
Figure 7 shows the cash expenses for each of the three tree densities throughout the 20-year investment period. Figure 7A denotes the expenses for the partial-investment scenario and Figure 7B shows the full-investment scenario. In the partial investment, expenses in year 1 are \$17,071, \$20,395, and \$25,366/ha in year 1 for 358, 544, and 749 trees/ha, respectively. The latter two are 19% and 49% greater relative to the 358-trees/ha baseline. In years 2 and 3, expenses for the 544- and 749-trees/ha densities decrease, but are still ≈20%

Table 1. Variable costs summary by cultural program per grove year on a per-hectare basis.

Item	Grove yr 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
358 trees/ha scenario																				
Land preparation	2,923																			
Solid-set planting costs	3,828																			
Fertilization materials	161	314	457	489	489	489	482	724	712	714	714	838	835	843	833	823	811	801	786	773
Fertilization application	106	106	106	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Weed management	598	598	598	598	598	598	598	598	598	598	598	598	598	598	598	598	598	598	598	598
Foliar sprays, insecticides	133	133	133	193	193	250	304	351	408	405	403	432	428	428	425	423	418	410	403	395
Foliar sprays, fungicides	37	37	37	52	52	67	82	96	111	109	109	116	116	116	116	114	114	111	109	106
Foliar sprays, nutritionals	94	94	94	136	136	175	213	247	287	287	284	304	301	301	299	299	294	289	284	279
Foliar sprays, bactericides	59	59	59	89	89	114	138	161	185	185	183	198	195	195	193	193	190	185	183	180
Foliar sprays application costs	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385
Neonicotinoid psyllid management	1,137	937	630	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHMAs sprays	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168
Irrigation and frost protection	2,713	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460
Sprouting/pruning	255	198	188	0	0	0	0	0	79	79	79	79	79	79	79	79	79	79	79	79
Tree removal	0	62	62	62	62	62	109	109	109	109	109	109	109	94	94	94	94	94	79	79
Tree replacement and care	0	217	348	479	479	479	576	615	652	613	603	326	163	0	0	0	0	0	0	0
Other costs[z]	1,292	786	731	259	259	267	279	299	311	309	309	304	294	287	287	284	284	282	279	279
Total variable costs	13,883	4,552	4,453	3,450	3,450	3,595	3,872	4,295	4,544	4,497	4,488	4,399	4,211	4,030	4,016	3,998	3,971	3,941	3,894	3,860
544 trees/ha scenario																				
Land preparation	2,923																			
Solid-set planting costs	5,807																			
Fertilization materials	161	311	452	484	487	487	479	722	714	714	714	838	840	845	833	823	813	808	791	776
Fertilization application	114	114	114	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89
Weed management	628	628	628	628	628	628	628	628	628	628	628	628	628	628	628	628	628	628	628	628
Foliar sprays, insecticides	131	131	131	193	193	247	301	348	405	405	403	432	428	425	423	420	415	413	405	395
Foliar sprays, fungicides	37	37	35	52	52	67	82	94	111	109	109	116	116	116	114	114	114	111	109	106
Foliar sprays, nutritionals	94	94	94	136	136	175	213	247	287	284	284	304	301	299	299	297	294	292	287	279
Foliar sprays, bactericides	59	59	59	86	86	114	136	158	185	183	183	195	195	193	193	190	190	188	183	180
Foliar sprays application costs	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415
Neonicotinoids psyllid management	1,725	1,416	946	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHMAs sprays	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168
Irrigation and frost protection	2,847	447	447	447	447	447	447	447	447	447	447	447	447	447	447	447	447	447	447	447
Sprouting/pruning	388	301	282	0	0	0	0	0	86	86	86	86	86	86	86	86	86	86	86	86
Tree removal	0	109	109	109	109	109	171	171	171	171	171	171	156	156	138	138	138	138	124	124
Tree replacement and care	0	366	514	682	652	652	811	897	979	927	899	452	222	0	0	0	0	0	0	0
Other costs[z]	1,727	1,080	986	272	272	279	297	319	334	329	329	316	304	292	289	289	289	287	284	284
Total variable costs	17,221	5,676	5,385	3,761	3,736	3,880	4,235	4,703	5,019	4,959	4,922	4,660	4,396	4,161	4,129	4,112	4,087	4,072	4,020	3,978
749 trees/ha scenario																				
Land preparation	2,923																			
Solid-set planting costs	7,996																			
Fertilization materials	161	311	455	499	502	504	497	744	734	729	727	848	845	848	833	820	808	801	783	764
Fertilization application	138	138	138	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
Weed management	717	717	717	717	717	717	717	717	717	717	717	717	717	717	717	717	717	717	717	717
Foliar sprays, insecticides	136	136	136	198	198	255	309	358	415	413	408	435	430	425	420	418	410	405	398	388
Foliar sprays, fungicides	37	37	37	54	54	69	84	96	114	111	111	119	116	116	114	114	111	111	109	104
Foliar sprays, nutritionals	96	96	96	138	138	180	217	252	292	292	289	306	304	301	297	294	289	287	282	272
Foliar sprays, bactericides	62	62	62	89	89	116	141	163	188	188	185	198	195	193	190	190	188	185	180	175
Foliar sprays application costs	512	512	512	512	512	512	512	512	512	512	512	512	512	512	512	512	512	512	512	512
Neonicotinoids psyllid management	2,375	1,955	1,315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHMAs sprays	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168
Irrigation and frost protection	3,640	591	591	591	591	591	591	591	591	591	591	591	591	591	591	591	591	591	591	591
Sprouting/pruning	534	415	393	0	0	0	0	0	114	114	114	114	114	114	114	114	114	114	114	114
Tree removal	0	138	138	138	138	138	232	232	232	232	232	232	217	200	200	185	185	171	171	171
Tree replacement and care	0	472	729	979	927	899	1,097	1,166	1,208	1,208	1,208	563	264	0	0	0	0	0	0	0
Other costs[z]	2,241	1,418	1,292	301	299	304	324	346	361	361	361	336	321	306	304	304	301	299	299	297
Total variable costs	21,731	7,164	6,776	4,497	4,446	4,564	4,997	5,461	5,755	5,743	5,733	5,254	4,903	4,604	4,574	4,537	4,510	4,470	4,431	4,384

[z]Chemical handling and grove care supervision of solid-set planting, machinery and equipment repairs, scouting for pests and diseases, and interest on operating (cultural) costs.
CHMA = Citrus Health Management Area.

A.



B.

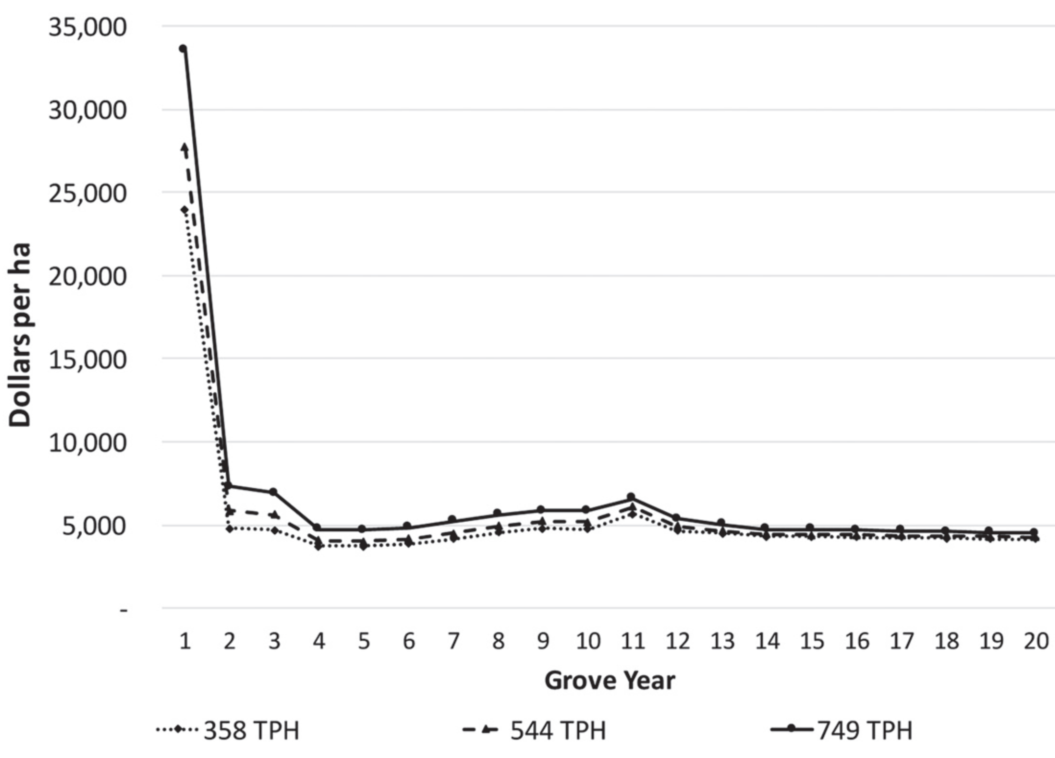


Fig. 7. Cash expenses by grove year for 358, 544, and 749 trees/ha (TPH). (**A**) Partial investment scenario: All machinery but only some irrigation equipment need to be purchased. The well and pumping station are assumed to be in place. (**B**) Full investment scenario: All machinery and irrigation equipment need to be purchased.

and 50% greater with respect to those of a grove planted at 358 trees/ha. However, in years 4 through 11, expenses are about between 7% to 10% greater for the 544-trees/ha density, and 16% to 28% greater for the 749-trees/ha density compared with the baseline density. Starting in year 12, expenses are up to 6% and 15% greater for the 544- and 749-trees/ha density, respectively, compared with the 358-trees/ha density baseline. As shown in Fig. 7B, results for the full-investment scenario are similar. As Fig. 7 and the comparisons here illustrate, annual expenses for greater tree densities do not increase proportionally with the number of trees planted.

Figure 8 shows yield per hectare by grove year for each of the three tree densities. It can be seen from the figure that for tree densities of 544 and 749 trees/ha, yield per hectare does increase proportionally to the greater number of trees planted relative to the 358-tree/ha density baseline. Such proportional increase is imposed by assumption because, as described earlier, we use data on yield per tree from the U.S. Department of Agriculture, National Agricultural Statistics Service (2018) for our calculations. However, starting in year 10, the proportional change decreases slightly as a result of the effect of the penalty we impose for canopy closure and resetting strategy for the greater densities. The assumptions on yield we made are feasible under current conditions. Note, for example, the maximum yield of 922 boxes/ha is achieved in year 9 for the 749-trees/ha density. As a reference, the average yield per hectare for 'Valencia' oranges in Florida in 2003–04 was 961 boxes/ha with an average tree density of 329 trees/ha.

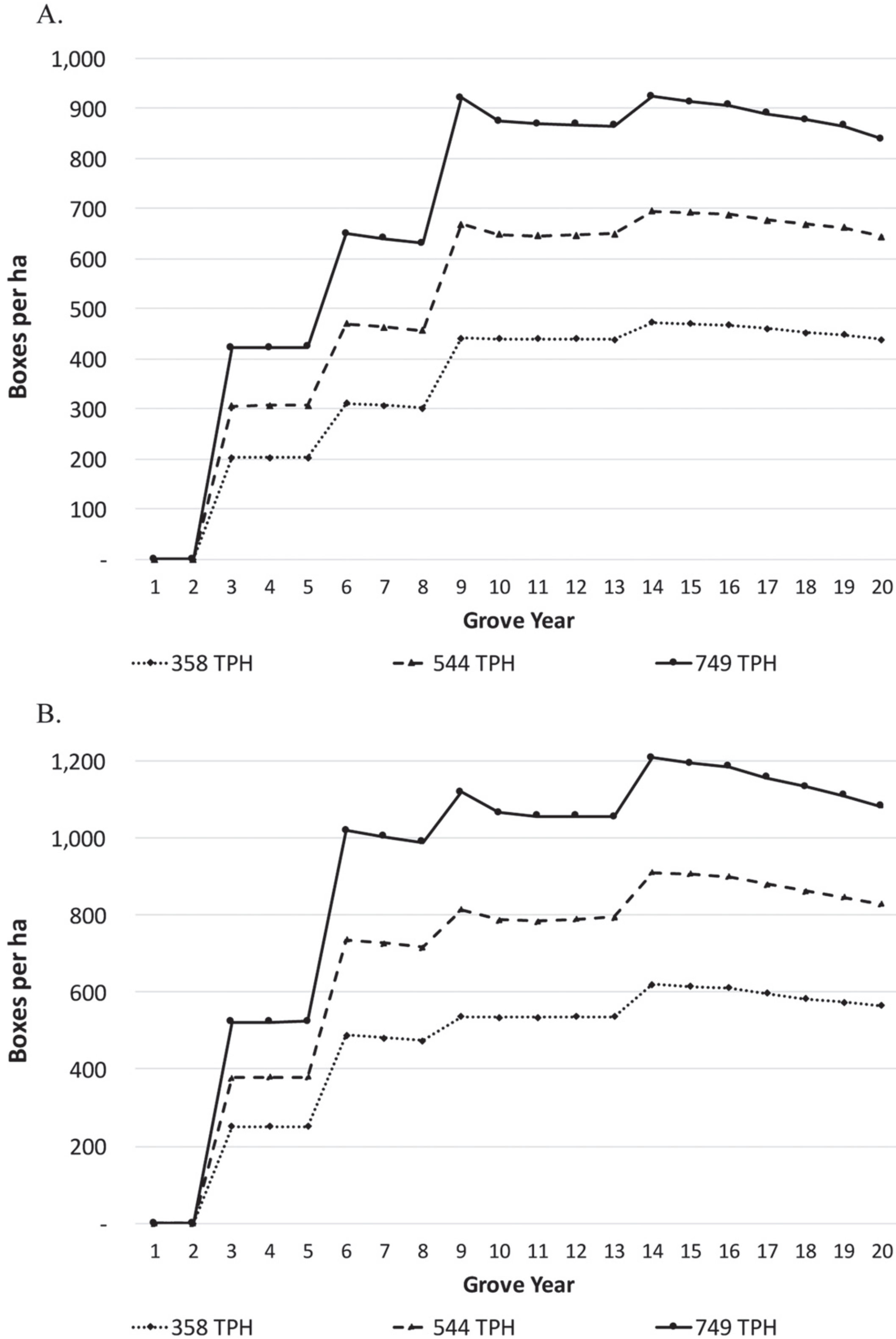


Fig. 8. Yield per hectare by grove year for 358, 544, and 749 trees/ha (TPH). (**A**) Low-yield scenario: Boxes per hectare are based on data from the U.S. Department of Agriculture-Natural Agricultural Statistics Service on boxes per tree for each of the different tree age cohorts in Southwest Florida during seasons 2013–14 through 2015–16. (**B**) High-yield scenario: Boxes per hectare are based on data from growers.

Investment analysis is used to evaluate the profitability of long-term investments such as an orange grove. The net present value (NPV) can be used as a methodology for such evaluation, which consists of summing all the discounted cash flows, as denoted by the equation

$$NPV = \sum_{n=1}^{N} \frac{CF_n}{(1+r)^n},$$

where CF is the cash flow at time n, and r denotes the discount rate. The choice of the discount rate is key and it represents the cost of capital (or its opportunity cost). As a rule of thumb, investments with a positive NPV should be accepted and those with a negative NPV, rejected. The reasoning for accepting investments with positive NPVs is that they yield greater returns than the discount rate (i.e., cost of capital). However, it is impossible to estimate a discount rate that represents the cost of capital for all growers as each individual grower has a different opportunity cost of capital. Therefore, we show the results of the investment analysis using the internal rate of return (IRR) methodology. The IRR is the actual rate of return on the investment. As such, it depends only on the cash flows of the investment (Ross et al., 2005); it is the discount rate that makes the NPV be zero in the previous equation.

Table 2 shows the investment analysis results for the different scenarios and tree densities. Table 2 shows that in a grove with 358 trees/ha, under a scenario with low yield and low prices, the investment is not profitable; with medium prices, the partial-investment scenario yields only a 1% return. These scenarios illustrate the situation currently faced by many growers (denoted in Fig. 2). Table 2 also shows that when prices are high, there is a modest return between 1% and 3%, depending on the

Table 2. Internal rate of return (IRR) from investing in a new citrus grove.

Tree density (trees/ha scenario)	Yield scenario	Price ($)		Capital investment	IRR	Payback period (yr)
358	Low	Low	15.62/box	Full	–7%	Not in 20 yr
			2.50/ps	Partial	–5%	Not in 20 yr
		Medium	17.78/box	Full	–2%	Not in 20 yr
			2.85/ps	Partial	1%	20
		High	19.23/box	Full	1%	20
			3.08/ps	Partial	3%	17
	High	Low	15.62/box	Full	1%	19
			2.50/ps	Partial	4%	16
		Medium	17.78/box	Full	5%	15
			2.85/ps	Partial	8%	13
		High	19.23/box	Full	7%	14
			3.08/ps	Partial	10%	12
544	Low	Low	15.62/box	Full	2%	18
			2.50/ps	Partial	4%	16
		Medium	17.78/box	Full	5%	15
			2.85/ps	Partial	8%	13
		High	19.23/box	Full	7%	13
			3.08/ps	Partial	10%	12
	High	Low	15.62/box	Full	8%	13
			2.50/ps	Partial	11%	11
		Medium	17.78/box	Full	11%	11
			2.85/ps	Partial	15%	9
		High	19.23/box	Full	13%	10
			3.08/ps	Partial	17%	8
749	Low	Low	15.62/box	Full	5%	15
			2.50/ps	Partial	8%	13
		Medium	17.78/box	Full	8%	12
			2.85/ps	Partial	11%	11
		High	19.23/box	Full	10%	11
			3.08/ps	Partial	13%	10
	High	Low	15.62/box	Full	11%	11
			2.50/ps	Partial	14%	9
		Medium	17.78/box	Full	14%	9
			2.85/ps	Partial	18%	8
		High	19.23/box	Full	16%	9
			3.08/ps	Partial	20%	8

ps = pound solids.

Table 3. Breakeven prices for different payback periods

			Payback period (yr)		
Tree density (trees/ha)	Yield scenario	Capital investment	8	10	15
358	Low	Full	6.29[z]	4.85	3.57
		Partial	5.65	4.21	3.25
	High	Full	4.53	3.73	2.84
		Partial	4.05	3.25	2.61
544	Low	Full	4.85	3.73	2.77
		Partial	4.21	3.41	2.53
	High	Full	3.57	2.93	n/a
		Partial	3.09	2.61	n/a
749	Low	Full	4.21	3.25	2.45
		Partial	3.73	3.09	n/a
	High	Full	3.09	2.58	n/a
		Partial	2.77	n/a	n/a

[z]Breakeven (delivered-in) price (measured in dollars per pound solids).
n/a = the payback period under that scenario is attained sooner.

level of investment in machinery and irrigation. Under a high-yield scenario, the return of a grove with 358 trees/ha varies from 1% up to 10%, depending on the combination of prices and investment requirement. The payback period is 12 years in the best-case scenario.

Table 2 also shows that in a grove with 544 trees/ha, despite the greater initial investment relative to the 358-trees/ha density baseline, the returns are positive. Under a low-yield scenario, the rate of return ranges between 2% and 10%, depending on market conditions and the level of investment required. The payback period is at least 12 years. Under a high-yield scenario, depending on the level of prices and investment, the rate of return ranges from 8% to 17%, and the payback period can be as short as 8 years in the best-case scenario.

Last, Table 2 shows the returns for a grove with 749 trees/ha improved those obtained for 544 trees/ha even further (despite the even greater level of initial investment relative to the baseline). Under a low-yield scenario, the rate of return ranges between 5% and 13%, depending on market conditions and the level of investment needed. In a high-yield scenario, depending on prices and the investment required, the return ranges from 11% to 20%, and the payback period can be as short as 8 years in some cases. Table 3 provides a summary of breakeven prices in each scenario for different payback periods—namely, 8, 10, and 15 years.

Conclusions

We analyzed the investment of planting a new grove in Florida under the current endemic HLB environment across the state. We found that establishing a new grove with a tree density similar to that of the state's average is not profitable under current market conditions. Such a density only attains a modest return under potential greater prices. Despite the greater level of investment required for planting 544 and 749 trees/ha, such investments are profitable under the assumptions and scenarios we analyzed.

The main driver for the results discussed here is that, although the costs of greater density groves do not increase proportionally with the number of trees, yield per hectare does. More specifically, although with greater density groves each tree produces somewhat less yield on a per-tree basis relative to a lower density grove, the greater number of trees contributes to obtaining a greater yield per hectare. Therefore, planting greater density groves could help partially offset the impact of HLB by generating a simultaneous increase in yield per hectare and a decrease in the cost of production per box (as a result of costs being allocated to a greater number of boxes), ultimately resulting in an increase in profitability per hectare.

Our results should prove useful not only to citrus growers to help in their decision-making process of determining whether to plant a high-density grove, but also to other industry stakeholders and policymakers in their efforts to support the Florida citrus industry in dealing with HLB. A policy implication that follows from our findings is that public and private incentive programs for replanting should encourage growers' investment in greater density groves, and should take into account the significantly greater expenses related to such an investment.

The limitations of this analysis are the following. First, because HLB was first found in Florida in 2005, it is not yet clear how trees will be affected by the disease in the future. Therefore, in our model, the impact of HLB on yield of trees that are 13 years old and older is a projection based on current data. Second, we did not include any potential impact of weather events such as freezes or hurricanes (and their effect on prices) in this analysis. Third, potential future management strategies or solutions to HLB could involve planting (new) trees with resistant or tolerant traits to the disease, which could potentially make an existing grove with trees that do not have such traits obsolete.

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EXHIBIT BB

Florida Agriculture & Natural Resource Facts UF|IFAS

Produced July 2018

FLORIDA AGRICULTURE & NATURAL RESOURCE FACTS

- **Florida is 1^{st} in the U.S.** in the value of production of cucumbers, grapefruit, squash, sugarcane, fresh market tomatoes, radishes, guavas, mangoes, passion fruit, watermelon and kumquats. Florida is also 1^{st} in the U.S. in the value of production of several non-food products, including indoor foliage plants, cut flowers and cut florist greens, potted flowering plants, aquatic plants, and ornamental fish.
- Agricultural land (cropland and ranchland) and forest land make up nearly **⅔ of the state's land area**. This land is critical to our water supply, air quality, climate, wildlife habitat and outdoor recreation.
- Florida has **47,590 farm operations**; **9.7 million acres of farmland**.
- Total direct output (sales revenues) of crop, livestock, forestry, and fisheries production was **$10.2 billion** as of 2018 and these sectors directly supported **137,790 fulltime and part-time jobs**.
- Florida's agriculture, natural resource, and food industries supported **2.4 million fulltime and part-time jobs** throughout Florida's economy (14.2% of all jobs in the state), contributing **$149.6 billion** to gross state product in 2018.

Forest Products

- Florida has over **17 million acres of forestland** (nearly ½ the state's land area) including **4.63 million acres of planted timberland**.
- About **16 million tons of softwood and hardwood pulpwood and sawtimber**, valued at around **$315 million**, is harvested annually from Florida forests.
- In 2016, Florida had **78 primary wood-using mills** and **363 secondary wood and paper product** manufacturers.
- Florida's forestry and forest product industries supported **124,104 fulltime and part-time jobs** throughout Florida's economy, contributing **$10.96 billion** to gross state product in 2016.

Citrus

- Florida had over **387,000 acres** of commercial citrus groves producing nearly **77 million boxes** of citrus fruit in 2019.
- Total production value was **$1.09 billion** in 2018-19.
- Florida's citrus industry supported **37,431 fulltime and part-time** jobs throughout Florida's economy, contributing **$2.73 billion** to gross state product during the 2018-19 season.

Horticulture, Nursery & Landscaping

- Florida is the **2^{nd} largest producer** of nursery and greenhouse crops in the U.S.
- Florida's environmental horticulture industry supported **247,113 fulltime and part-time jobs,** contributing **$15.05 billion** to gross state product in 2018.

Cattle

- over **5.4 million acres** of improved pasture, rangeland, and woodland are used for beef and dairy cattle production, representing **15.6%** of the state's land area.
- Florida has **1.63 million cattle and calves**, including **886,000 beef cows** and **124,000 dairy cows** as of 2018.
- Florida cattle and allied industry sectors supported **118,191 fulltime and part-time jobs,** contributing **$7.65 billion** to gross state product in 2017.

Other Top Crops

- Tomatoes: **27,000 acres**; **$344 million** in total value in 2018
- Strawberries: **9,426 acres**; **$292 million total value** in 2018
- Sugarcane: **412,300 acres**; **$537 million total value** in 2018

Commercial Fishing

- Key species targeted by commercial fishers in Florida include **shrimp**, **spiny lobster**, **stone and blue crabs**, and **reef fish** (snapper, grouper, amberjack, tilefish, etc.).
- Dockside value of Florida's commercial fishing landings was **$221 million** in 2019.
- The commercial fishing industry supported **6,749 fulltime and part-time jobs** throughout the state, contributing **$365 million** in gross state product in 2018.

Information from the Florida Agriculture Facts publication produced in July 2018 and additional sources published by the UF/IFAS Economic Impact Analysis Program in 2019 and 2020.

<u>EXHIBIT K</u>

Tuck, Brigid, 2019
Economic Contribution of Southern Minnesota Beet Sugar Cooperative University of Minnesota,
Extension Center for Community Vitality

UNIVERSITY OF MINNESOTA | EXTENSION

EXTENSION CENTER FOR COMMUNITY VITALITY

Economic Contribution of Southern Minnesota Beet Sugar Cooperative

A REPORT OF THE ECONOMIC IMPACT ANALYSIS PROGRAM

Authored by Brigid Tuck

PROGRAM SPONSOR: SOUTHERN MINNESOTA BEET SUGAR COOPERATIVE

Economic Contribution of Southern Minnesota Beet Sugar Cooperative

A REPORT OF THE ECONOMIC IMPACT ANALYSIS PROGRAM

March 2019

Authored by Brigid Tuck, Senior Economic Impact Analyst

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University of Minnesota | Extension

Authored by Brigid Tuck, Senior Economic Impact Analyst

EXECUTIVE SUMMARY: ECONOMIC CONTRIBUTION OF SOUTHERN MINNESOTA BEET SUGAR COOPERATIVE

Minnesota is the nation's leading sugarbeet producer. As a result, sugarbeets play an important role in the state's economy. Southern Minnesota Beet Sugar Cooperative (SMBSC), located in Renville, is a major beet sugar extraction cooperative. Five hundred twelve shareholders annually grow approximately 3.6 million tons of sugarbeets, producing up to one billion pounds of pure white sugar.

Given its production and extraction role, Southern Minnesota Beet Sugar Cooperative wanted to understand its contribution to the regional and state economy. SMBSC hired University of Minnesota Extension to conduct an economic contribution analysis. The primary study area for the analysis was the 20-county region in which SMBSC shareholders grow sugarbeets. The counties included were Big Stone, Brown, Chippewa, Cottonwood, Douglas, Kandiyohi, Lac qui Parle, Lyon, McLeod, Meeker, Nicollet, Pope, Redwood, Renville, Sibley, Stearns, Stevens, Swift, Watonwan, and Yellow Medicine.

Beet Production and Sugar Extraction: In 2017, Minnesota produced 12.5 million tons of sugarbeets, making it the nation's largest sugarbeet producing state. Minnesota's 2017 production was the largest recorded harvest. It accounted for 35 percent of national production. Minnesota is served by three major beet sugar extraction cooperatives. Two are in the Red River Valley. The third is Southern Minnesota Beet Sugar Cooperative.

Direct Effect of Sugarbeet Production: Sugarbeet growers (shareholders of SMBSC) spent an estimated $159.8 million to produce their 2017 crop. This includes $28.0 million in labor income. There were an estimated 1,750 workers (including shareholders and hired labor) involved in sugarbeet production. It is important to note that, while labor income estimates include a labor and management charge for the producer, producers may receive profits from their operation above labor income.

Direct Effect of Beet Sugar Extraction: In FY 2017-2018, Southern Minnesota Beet Sugar Cooperative spent $198.5 million to operate (not including the purchase of sugarbeets). This included $61.0 million in payments for labor. The Cooperative employed 830 workers. In addition, its third-party trucking company employed 110 truckers to haul sugarbeets.

Total Economic Contribution of Southern Minnesota Beet Sugar Cooperative: In total, Southern Minnesota Beet Sugar Cooperative contributed an estimated $708.5 million in economic activity to the 20-county region in 2017. The Cooperative supported 4,965 jobs. It contributed $197.5 million of income to regional residents. It also contributed $19.9 million in taxes to local and state governments. The largest share of ripple effect jobs were in the real estate industry followed by the professional and scientific services and wholesale trade industries.

Economic Contribution through Time: Overall, factors influencing the economic contribution of Southern Minnesota Beet Sugar Cooperative are trending up, indicating the economic contribution of SMBSC is increasing in the region.

Economic Contribution in Minnesota: In 2017, SMBSC generated an estimated $817.8 million in economic activity in the state, including $227.9 million in labor income. Southern Minnesota Beet Sugar Cooperative supported 5,240 jobs in the state.

Notes on the Analysis: The data, analysis, and findings described in this report are specific to the geography, period, and project requirements of Southern Minnesota Beet Sugar Cooperative.

INTRODUCTION

Minnesota is the nation's leading sugarbeet producing state. As a result, sugarbeets play an important role in the state's economy. Southern Minnesota Beet Sugar Cooperative (SMBSC), located in Renville, is a major beet sugar extraction cooperative. Five hundred twelve shareholders grow 3.6 million tons of sugarbeets annually, producing up to one billion pounds of pure white sugar for the Cooperative.

Given its production and extraction role, Southern Minnesota Beet Sugar Cooperative wanted to understand its contribution to the regional and state economy. SMBSC hired University of Minnesota Extension to conduct an economic contribution analysis. This report presents the results.

The primary study area for the analysis was the 20-county region in which SMBSC shareholders grow sugarbeets. The counties included were Big Stone, Brown, Chippewa, Cottonwood, Douglas, Kandiyohi, Lac qui Parle, Lyon, McLeod, Meeker, Nicollet, Pope, Redwood, Renville, Sibley, Stearns, Stevens, Swift, Watonwan, and Yellow Medicine.

The Beet Sugar Extraction Process

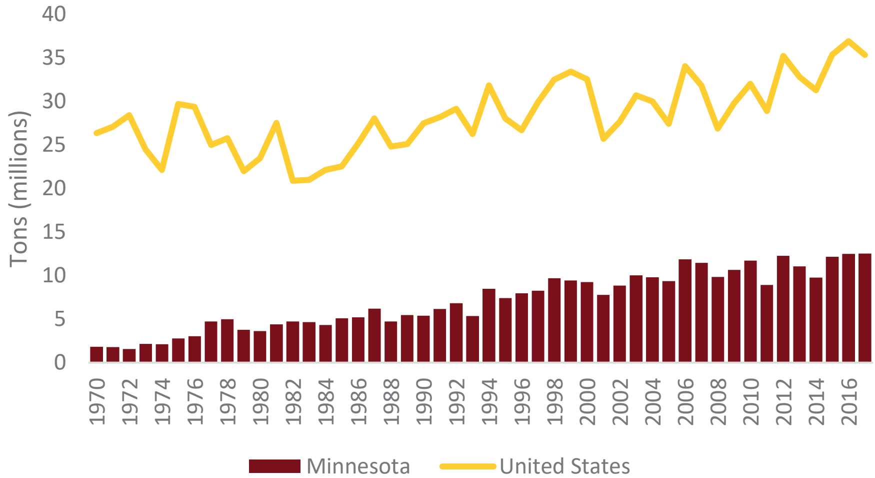
Shareholders grow sugarbeets and Southern Minnesota Beet Sugar Cooperative extracts the beet sugar. Growers harvest beets and deliver them to either the extraction plant or local collection sites. At the extraction plant, the beets are cleaned with water, and any rocks and remaining debris are removed before the beets are sliced. The sliced beets are put in the extraction system where hot water is used to extract a raw beet juice, which contains the sugar removed from the beet. The raw beet juice is treated in a complex purification system to create a clear juice that is stable to heat. Water is then removed from the clear juice through an energy-efficient, multiple-effect evaporation system creating two streams—thick sugar syrup and distilled water.

Sugar is crystallized out of the thick syrup by growing sugar crystals during a boiling process. The syrup undergoes three successive boiling steps where three grades of sugar are crystallized out. The first boiling creates white, fine granulated sugar, which is dried and made available for sale. The second and third boiling create high-color sugar that is dissolved into the thick syrup going to the first boiling to increase its sugar content. About 88 percent of the sugar can be removed through crystallization, leaving beet molasses as the byproduct. Through a process called ion-exclusion, about 65 percent of the sugar left in the molasses can be recovered.

Sugarbeet Production in Minnesota

In 2017, Minnesota produced 12.5 million tons of sugarbeets, making it the nation's largest sugarbeet producing state (followed by Idaho, North Dakota, Michigan, and Nebraska). Sugarbeet production varies by year, but in general, total production has been increasing since the 1970s (Chart 1). Minnesota's 2017 production was the largest recorded harvest. It accounted for 35 percent of national production.

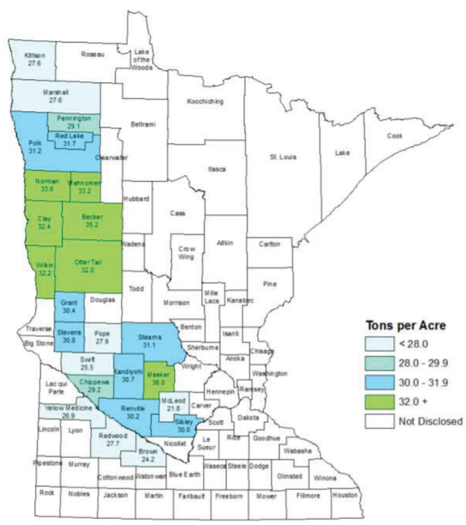
Chart 1: Sugarbeet Production, 1970 to 2017



Source: USDA

Minnesota's sugarbeet production is concentrated along the Red and Minnesota River Valleys, extending from Northwest Minnesota into Southwest/South Central Minnesota (Map 1).

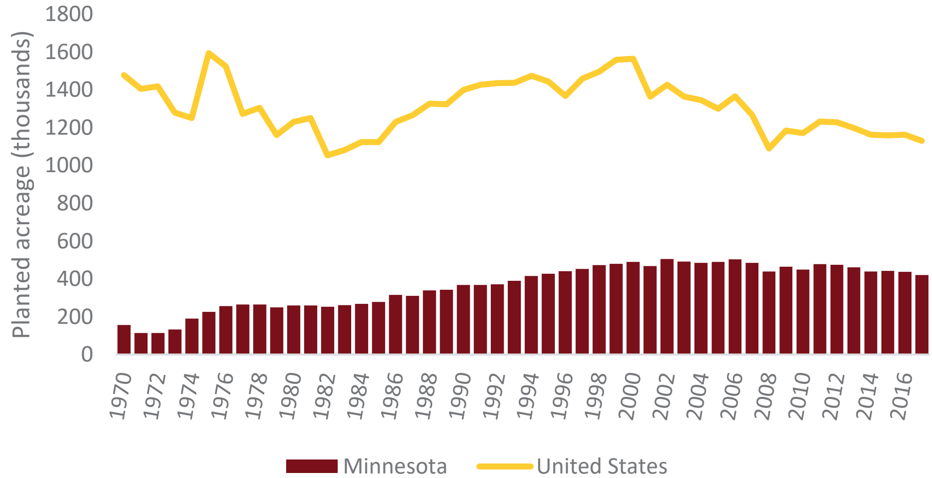
Map 1: Sugarbeet Production by Minnesota County, 2017



Source: USDA

Planted sugarbeet acreage in the United States has declined from its peak in 2000. Minnesota's planted acreage has also been trending down during the past five years (Chart 2). Despite this trend, total production (in tons) continues to increase. This is a result of improved sugarbeet hybrids, which allows higher production per acre.

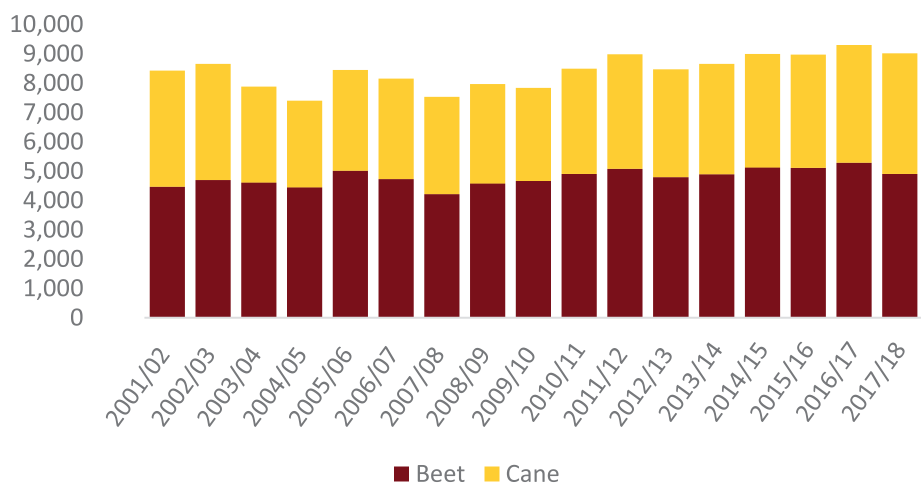
Chart 2: Planted Sugarbeet Acrage, 1970-2018



Source: USDA

Overall, United States sugar production continues to increase. In fiscal year 2017-2018, the United States' sugar production was an estimated 9 million short tons (raw value). This is a 14 percent increase compared to fiscal year 2001-2002 (Chart 3). Sugar extracted from beets accounts for slightly more than 50 percent of sugar production nationally.

Chart 3: United States Sugar Production by Fiscal Year, 2001-2019



Source: USDA

Beet Sugar Extraction in Minnesota

Minnesota is served by three major beet sugar extraction cooperatives. Two are in the Red River Valley. The third is Southern Minnesota Beet Sugar Cooperative. The Cooperative has 512 shareholders that grow approximately 3.6 million tons of sugarbeets annually, roughly one-quarter of Minnesota's total production. The sugarbeets, in turn, produce up to one billion pounds of pure white sugar.

ECONOMIC CONTRIBUTION

Total economic contribution is composed of direct, indirect, and induced effects. Calculating the total economic contribution of a business begins with determining its direct effects. Indirect and induced effects are then calculated using input-output models.

Southern Minnesota Beet Sugar Cooperative contributes to the economy in two ways. First, the Cooperative spends money for its extraction operations, purchasing items such as extraction and packaging equipment and materials, laboratory equipment, repair and maintenance services, and utilities. One of the major inputs into the extraction facility is, of course, sugarbeets. Second, sugarbeet producers also contribute to the economy through growing and harvesting activities. This analysis measures the impact of both the extraction and production of sugarbeets associated with Southern Minnesota Beet Sugar Cooperative. These are the direct effects of the Cooperative.

Input-output models trace the flow of dollars throughout a local economy and capture the indirect and induced, or secondary, effects of an economic activity. To quantify the indirect and induced effects of Southern Minnesota Beet Sugar Cooperative, the direct effects were entered into the input-output model IMPLAN. This analysis uses IMPLAN version 3.0 with SAM multipliers and 2016 data.[1]

Indirect effects are those associated with a change in economic activity due to spending for goods and services directly tied to the business. In this case, these are the changes in the local economy occurring because Southern Minnesota Beet Sugar Cooperative purchases goods (e.g., extraction materials and equipment, utilities, and laboratory equipment) and related services (e.g., advertising services, accounting, and tax preparation). As the Cooperative makes purchases, this creates an increase in purchases across the supply chain. Indirect effects are the summary of these changes across an economy.

Types of Effects

Direct: Spending and employment by Southern Minnesota Beet Sugar Cooperative and its member growers

Indirect: Activity generated by Southern Minnesota Beet Sugar Cooperative and member spending for goods and services (business-to-business spending)

Induced: Activity generated by Southern Minnesota Beet Sugar Cooperative's employees and member spending for household operations (consumer-to-business spending)

Induced effects are those associated with a change in economic activity due to spending by the employees of businesses (labor) and by households. These are economic changes related to spending by people directly employed by Southern Minnesota Beet Sugar Cooperative and its members. They create effects as they make purchases for things like health care, housing, and food. Induced effects also include household spending related to indirect effects.

Economic contribution effects can be measured in terms of output (sales), labor income, and employment. Output is typically the most common result of an economic contribution study. Labor income is also recommended as a measure, because it indicates the economic benefits that accrue for study area residents. Employment includes full-time, part-time, and seasonal employment, not full-time equivalents.

[1] www.implan.com

The following section details the contribution of SMBSC in the region. A later section examines its impact on the state of Minnesota. The study area in this instance matters, since the larger the study area the more options there are to purchase locally. As a result, the contribution tends to be higher in larger study areas.

Direct Effect

In fiscal year (FY) 2017-2018, Southern Minnesota Beet Sugar Cooperative and its growers spent $358.3 million to operate (Table 1).[2]

SMBSC's operational costs include those made to operate the extraction plant (inputs and payroll), to market its products, and to conduct the Cooperative's business (management). In FY 2017-2018, SMBSC spent $198.5 million on operational expenditures. This does not include the cost of raising sugarbeets.

Sugarbeet growers also make expenditures to bring the sugarbeets to the extraction plant. During the 2017 growing season, SMBSC growers spent an estimated $159.8 million to grow their beets.

Table 1: Expenditures Related to Southern Minnesota Beet Sugar Cooperative, FY 2017-2018

Sugarbeet production costs	$159.8 million
Cooperative extraction expenditures (excluding beet payment)	$198.5 million
Total expenditures	$358.3 million

Source: University of Minnesota Estimates (based on FINBIN) and SMBSC

The two expenditure categories included above in Table 1 comprise Southern Minnesota Beet Sugar Cooperative's direct effect. Broadly, the categories can be grouped as production and extraction. The sugarbeet growers' expenditures contribute to the production direct effect. The operational expenditures create the extraction direct effect. Each expenditure category generates different indirect and induced effects. Thus, adequately quantifying the total economic contribution requires separating the two components. The next two sections of this report explain how the direct effects were measured and entered into the input-output model.

Sugarbeet Production

The direct effect of sugarbeet production is essentially the spending and labor by growers to produce sugarbeets for the Cooperative. In total, SMBSC shareholders spent an estimated $159.8

[2] Southern Minnesota Beet Sugar Cooperative's fiscal year runs from September 1 to August 31.

million to plant and harvest their 2017 sugarbeet crop (Table 1). Direct costs, including seed, fertilizer, and land rent were the largest costs.[3]

Included in the total is an estimated $28.0 million for labor (custom, hired, and management). While labor income estimates include a labor and management charge for the producer, producers may receive profits from their operation above labor charges.

To determine estimated expenditures per acre, Extension used the sugarbeet crop budget from University of Minnesota's farm financial database FINBIN (see full budget in Appendix 1). Specifically, Extension used the budget for growers in Southern Minnesota, as growing conditions, prices, and inputs vary between Southern Minnesota and the Red River Valley.

The Cooperative had 512 shareholders. In 2017, SMBSC shareholders planted 126,965.8 acres.

Table 2: Estimated Expenditures by Shareholders (Sugarbeet Producers) for Southern Minnesota Beet Sugar Cooperative, 2017 Growing Season

Expenditure Category	Per Acre	Total (Millions)
Direct expenses		
Seed	$189.11	$24.0
Fertilizer and chemicals	$228.45	$29.0
Land rent	$235.51	$29.9
Hauling and trucking[4]	$27.57	$3.5
All other direct expenses	$234.04	$29.7
Total direct expenses (no labor)	$914.68	$116.1
Total overhead expenses	$123.66	$15.7
Labor expenses (includes hired labor, custom hire, and a labor and management charge)	$220.63	$28.0
Total expenses	$1,258.97	$159.8
Per acre costs derived from FINBIN		

[3] Extension used the FINBIN cash rent report; therefore, land rent is the value for farms paying cash rent. Obviously, not all farms rent land. This approach was taken to allow cash rent to serve as a proxy for the land costs for those owning their land.

[4] Hauling and trucking costs can be split across categories. For example, if a producer custom hires for trucking, then the costs related to the truck itself might be classified as hauling and trucking, but the labor might be classified under custom hire (labeled as labor expenses in Table 2).

The direct effect of SMBSC sugarbeet producers was $159.8 million of output, including $28.0 million of labor income. Extension estimates there were 1,750 workers directly employed by sugarbeet producers. This includes the 512 shareholders, plus their hired labor for planting, harvesting, and trucking.

There is no direct source for the number of workers employed by sugarbeet producers. Estimating employment is complex given the time intensive nature of planting, harvesting, and hauling sugarbeets. Sugarbeet industry experts estimate producers and hired labor work 84 hours per week during the three weeks of planting and four weeks of harvesting. Extension's conversations with industry experts also indicate the average operation has five employees during harvest season (peak employment). Operations tend to have, at a minimum, a lifter, a topper, and three trucks running during harvest. SMBSC has 512 shareholders with 350 operations. Therefore, Extension estimated there were 1,750 workers related to sugarbeet production in 2017.[5]

Table 3: Direct Effect of Shareholders (Sugarbeet Producers), Southern Minnesota Beet Sugar Cooperative, 2017

Metric	Total
Output (millions)	$159.8
Employment	1,750
Labor Income (millions)	$28.0

Estimates by University of Minnesota Extension

Sugarbeet Extraction and Cooperative Functions

In fiscal year (FY) 2017-2018[6], Southern Minnesota Beet Sugar Cooperative spent $198.5 million to extract sugar from the beets, to market its products, and to operate the Cooperative. Major expenditures included production expenses, marketing, general and administrative, and labor. SMBSC provided its budget and employment figures to Extension (Table 4).

[5] Employment could also be estimated based on hours worked. The FINBIN report lists 5.34 hours of labor per acre. Based on 84 hours per week during the three weeks of planting and four weeks of harvesting, sugarbeet production employment would be an estimated 1,150 people.

[6] Southern Minnesota Beet Sugar Cooperative's fiscal year runs from September 1 to August 31.

Table 4: Expenditures by Southern Minnesota Beet Sugar Cooperative for Sugarbeet Extraction and Cooperative Functions, FY 2017-2018

Expenditure Category	Total (Millions)
Production expenses	$68.6
Marketing expenses	$54.4
General and administrative	$14.5
Labor-related	$61.0
Total expenses	$198.5

Source: SMBSC

The Cooperative employed 830 workers during fiscal year 2017-2018. During normal production periods, the Cooperative employed 380 workers. During peak season, the Cooperative hired an additional 450 workers. It also hired a third-party trucking company to haul sugarbeets from the collection points to the extraction plant.[7] That particular trucking company reported hiring 110 truckers in 2017.

Thus, the total direct effect of beet sugar extraction and cooperative functions was $198.5 million in output, including $61.0 million in labor income and 940 jobs (Table 5).

Table 5: Direct Effect of Sugarbeet Extraction and Cooperative Functions, Southern Minnesota Beet Sugar Cooperative, FY 2017-2018

Metric	Total
Output (millions)	$198.5
Employment	940
Labor Income (millions)	$61.0

Estimates by University of Minnesota Extension

[7] Sugarbeet producers truck sugarbeets from their fields to the collection point. SMBSC hauls from the collection point to the extraction plant.

Adding the direct effect of sugarbeet production to the direct effect of beet sugar extraction and cooperative functions yields the total direct effect of Southern Minnesota Beet Sugar Cooperative (Table 6). In FY 2017-2018, SMBSC directly created $358.3 million in output in the region, including $89.0 million of income paid to workers. SMBSC was directly responsible for 2,690 full-time, part-time, and seasonal jobs.

Table 6: Total Direct Effect of Southern Minnesota Beet Sugar Cooperative, FY 2017-2018

Metric	Total	Production	Extraction
Output (millions)	$358.3	$159.8	$198.5
Employment	2,690	1,750	940
Labor Income (millions)	$89.0	$28.0	$61.0

Estimates by University of Minnesota Extension

Indirect and Induced Effects

As detailed, indirect and induced effects are measured by input-output models. Once Extension determined the direct effects, they were entered into the IMPLAN model to measure total economic contribution.

Total Effect

In total, Southern Minnesota Beet Sugar Cooperative contributed $708.5 million in economic activity to the 20 county region in 2017 (Table 7). The Cooperative supported 4,965 jobs. It contributed $197.5 million of income to regional residents.

Table 7: Total Economic Contribution of Southern Minnesota Beet Sugar Cooperative, 20-County Region, 2017

Metric	Direct	Indirect	Induced	Total
Output (millions)	$358.3	$298.2	$52.0	$708.5
Employment	2,690	1,830	445	4,965
Labor Income (millions)	$89.0	$92.3	$16.2	$197.5

Estimates by University of Minnesota Extension

Both sugarbeet production and beet sugar extraction contribute to total economic contribution. Sugarbeet production accounted for 50 percent of the total output impact in 2017 (Table 8).

Table 8: Total Economic Contribution of Southern Minnesota Beet Sugar Cooperative, Production and Extraction, 20-County Region, 2017

Metric	Production	Extraction	Total	Production Percent of Total
Output (millions)	$356.5	$352.0	$708.5	50%
Employment	2,920	2,045	4,965	59%
Labor Income (millions)	$86.5	$111.0	$197.5	44%

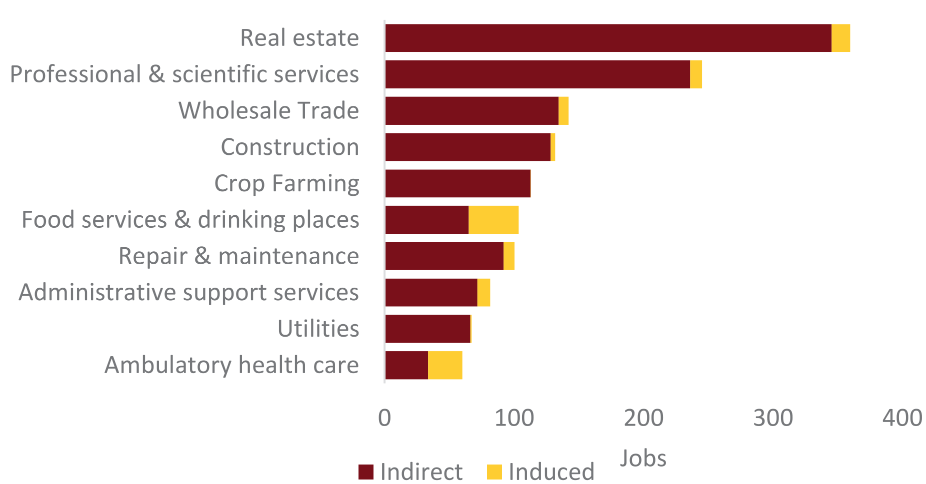
Estimates by University of Minnesota Extension

Top Industries Affected

Southern Minnesota Beet Sugar Cooperative supported 4,965 jobs in the 20-county region in 2017. Of those, 2,690 were directly involved in the production of sugarbeets and extraction of beet sugar. The other 2,275 jobs were in industries across the economy. The largest share of jobs were in the real estate industry, followed by the professional and scientific services and wholesale trade industries (Chart 4).

Southern Minnesota Beet Sugar Cooperative generated relatively high indirect effects, given that beet sugar extraction relies on a product grown in the region. Thus, the indirect effects are a significant portion of the chart. Induced effects are higher in areas related to household spending, including food and drinking places and ambulatory health care.

Chart 4: Top Industries Effected (Indirect and Induced) by Southern Minnesota Beet Sugar Cooperative, 2017, Sorted by Employment



Source: University of Minnesota estimates based on IMPLAN

Tax Contribution

In 2017, Southern Minnesota Beet Sugar Cooperative contributed $19.9 million in taxes to local and state governments (Table 9). The largest contributions were in sales, property, and income taxes.

Table 9: Total State and Local Tax Contribution of Southern Minnesota Beet Sugar Cooperative, 20-County Region, 2017

Metric	State and Local Taxes (millions)
Sales tax	$8.0
Property tax	$5.7
Income tax	$3.4
Corporate tax	$0.8
All other taxes	$2.0
Total	$19.9

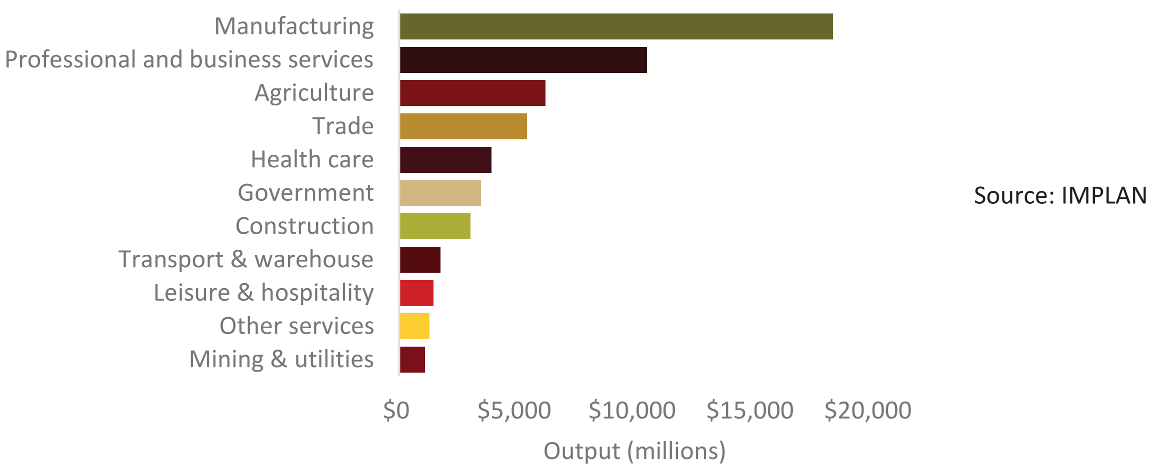
Estimates by University of Minnesota Extension

Economic Contribution in the Context of the Regional Economy

The 20-county region in this analysis includes the heart of Minnesota's agricultural industry. Renville County, home to SMBSC, was Minnesota's number one corn producing county and the number two soybean producing county in 2017. Neighboring Redwood County was the third-largest producing county for both corn and soybeans.

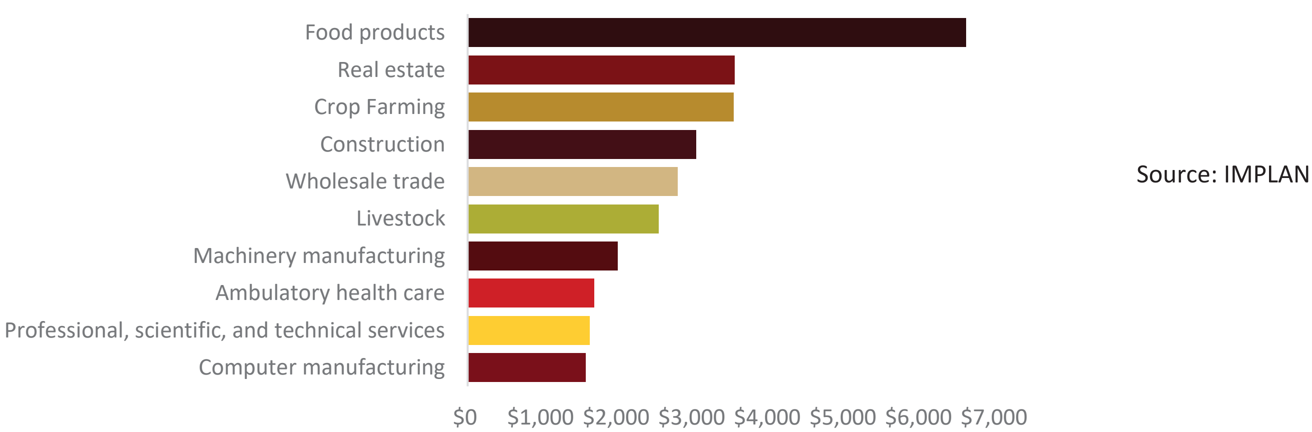
Not surprisingly, then, agriculture is one of the largest generators of output in the region (Chart 5). Manufacturing businesses generated $18.4 billion of output in 2016, followed by professional and business services at $10.5 billion. The third-largest industry ($6.2 billion) was agriculture. In total, businesses and enterprises in the region generated $56.5 billion in output in 2016. SMBSC directly generates jobs in both manufacturing and agriculture, thus contributing to two of the largest industry drivers in the region.

Chart 5: Output by Industry, 20-County Region, 2016



A major component of manufacturing in the region is food product manufacturing. Food product manufacturing includes sugarbeets, along with other major regional items like cheese and poultry. Food products is the largest sector in the region, followed by real estate, crop farming, and construction (Chart 6).

Chart 6: Top Sectors in 20-County Region, Sorted by Output

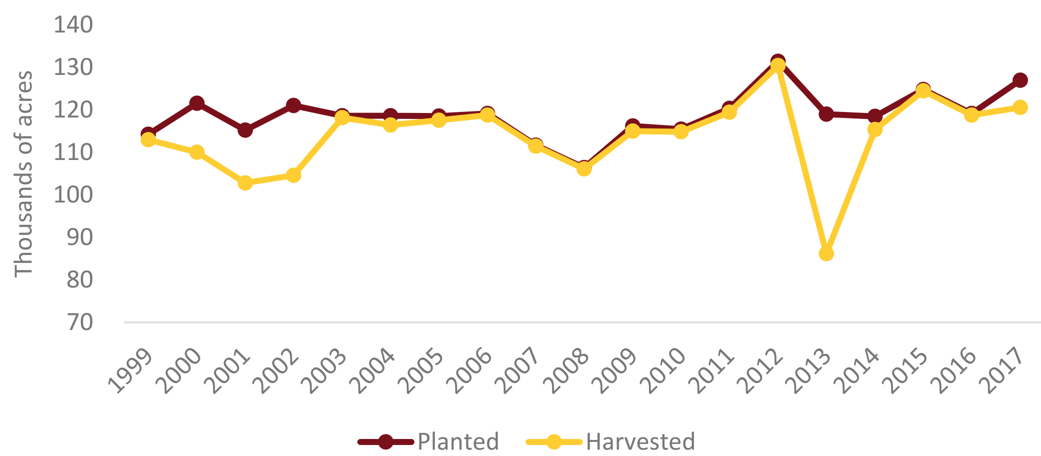


ECONOMIC CONTRIBUTION THROUGH TIME

The economic contribution of Southern Minnesota Beet Sugar Cooperative varies by year. Factors affecting its economic contribution are the number of acres planted with sugarbeets and the growing season. A higher planted acreage increases economic contribution, as farmers invest additional resources into planting. Conversely, a poor growing season can lead to lower economic contribution, as the extraction facility will have lower expenses.

Since 1999, Southern Minnesota Beet Sugar Cooperative's planted acreage has increased by 11 percent. In 1999, growers planted slightly more than 114,000 acres; in 2017, they planted just shy of 127,000 acres (Chart 7). Given this increase in planted acreage, economic contribution related to sugarbeet production is also up compared to 1999. Increases in planted acreage will continue to drive increases in contribution.

Chart 7: Planted and Harvested Acreage, Southern Minnesota Beet Sugar Cooperative, 1999-2017

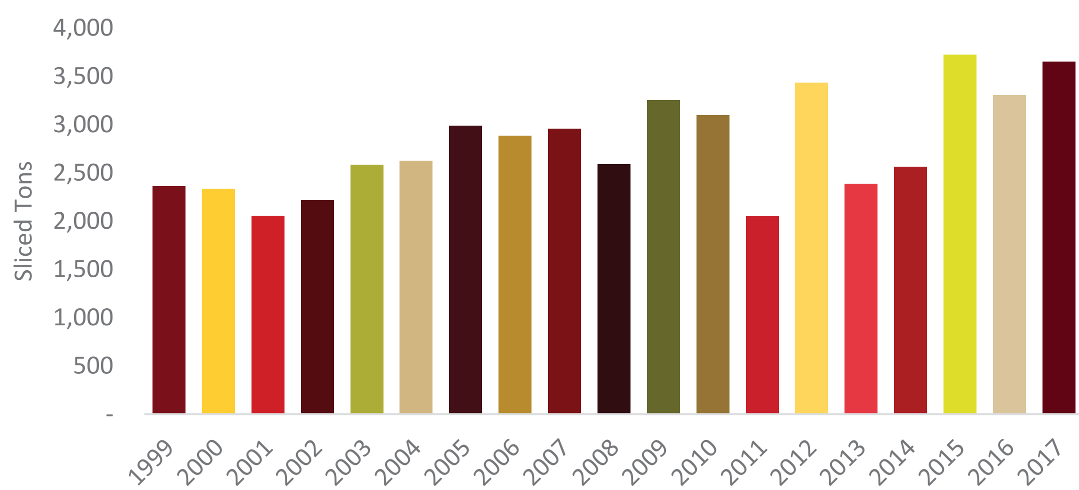


Source: SMBSC

Harvested acreage closely mirrors planted acreage, with the clear exception of 2013. In 2013, poor weather conditions (frost) led to a significant number of unharvested acres.

Beet sugar extraction has also increased with time. Compared to 1999, the total tons of sliced sugarbeets was up 55 percent in 2017. This reflects an overall trend toward increased production of sliced beets (Chart 8). It is also a direct reflection of SMBSC's continued investment in facility upgrades and improvements. These investments have increased the plant's capacity to slice beets and extract beet sugar.

Chart 8: Sliced Tons of Sugarbeets, Southern Minnesota Beet Sugar Cooperative, 1999-2017



Source: SMBSC

Overall, both factors influencing the economic contribution of Southern Minnesota Beet Sugar Cooperative are trending up.

ECONOMIC CONTRIBUTION IN MINNESOTA

Southern Minnesota Beet Sugar Cooperative also contributes to Minnesota's economy. In 2017, the Cooperative generated $817.8 million in economic activity in the state, including $227.9 million in labor income (Table 10). Southern Minnesota Beet Sugar Cooperative supported 5,240 jobs in the state.

Table 10: Total Economic Contribution of Southern Minnesota Beet Sugar Cooperative, Minnesota, 2017

Metric	Direct	Indirect	Induced	Total
Output (millions)	$358.3	$376.6	$82.9	$817.8
Employment	2,690	1,970	580	5,240
Labor Income (millions)	$89.0	$110.5	$28.4	$227.9

Estimates by University of Minnesota Extension

NOTES ON THE ANALYSIS

The data, analysis, and findings described in this report are specific to the geography, period, and project requirements of Southern Minnesota Beet Sugar Cooperative. Findings are not transferable. University of Minnesota Extension neither approves nor endorses the use or application of findings and other contents in this report by other jurisdictions or businesses.

This analysis is an economic contribution study. As such, it looks at the total value of SMBSC. A strong argument could be made that if the land were not in sugarbeet production, it would be used for another agricultural purpose. An economic impact study would examine the net effect—in other words, the value of sugarbeet production as compared to other crop production.

APPENDIX 1: SUGARBEET CROP ENTERPRISE ANALYSIS

This is the sugarbeet crop enterprise budget used by Extension for this economic contribution analysis. It can be retrieved at https://finbin.umn.edu/.

Sugar Beets on Cash Rent

	Avg. Of All Farms	2017
Number of farms	13	13
Acres	267.93	267.93
Yield per acre (ton)	31.58	31.58
Operators share of yield %	100.00	100.00
Value per ton	41.00	41.00
Total product return per acre	1,294.89	1,294.89
Crop insurance per acre	27.03	27.03
Other crop income per acre	34.93	34.93
Gross return per acre	1,356.86	1,356.86
Direct Expenses		
Seed	189.11	189.11
Fertilizer	79.41	79.41
Crop chemicals	149.04	149.04
Crop insurance	45.39	45.39
Fuel & oil	32.84	32.84
Repairs	55.21	55.21
Custom hire	66.29	66.29
Hired labor	10.26	10.26
Land rent	235.51	235.51
Stock/quota lease	36.66	36.66
Machinery leases	8.38	8.38
Hauling and trucking	27.57	27.57
Marketing	1.29	1.29
Operating interest	21.03	21.03
Miscellaneous	33.24	33.24
Total direct expenses per acre	991.22	991.22
Return over direct exp per acre	365.63	365.63
Overhead Expenses		
Hired labor	38.01	38.01
Machinery leases	1.10	1.10
Farm insurance	14.94	14.94
Utilities	8.38	8.38
Dues & professional fees	3.76	3.76
Interest	5.42	5.42
Mach & bldg depreciation	60.18	60.18
Miscellaneous	5.09	5.09
Total overhead expenses per acre	136.87	136.87
Total dir & ovhd expenses per acre	1,128.09	1,128.09
Net return per acre	228.76	228.76
Government payments	2.53	2.53
Net return with govt pmts	231.29	231.29
Labor & management charge	94.86	94.86
Net return over lbr & mgt	136.43	136.43
Cost of Production		
Total direct expense per ton	31.38	31.38
Total dir & ovhd exp per ton	35.72	35.72
Less govt & other income	33.68	33.68
With labor & management	36.68	36.68
Net value per unit	41.00	41.00
Machinery cost per acre	217.42	217.42
Est. labor hours per acre	4.55	4.55

APPENDIX 2: DEFINITIONS AND TERMS

Special models, called input-output models, exist to conduct economic impact analysis. There are several input-output models available. IMPLAN (IMpact Analysis for PLANning, Minnesota IMPLAN Group)[8] is one such model. Many economists use IMPLAN for economic impact analysis because it can measure output and employment impacts, is available on a county-by-county basis, and is flexible for the user. IMPLAN has some limitations and qualifications, but it is one of the best tools available to economists for input-output modeling. Understanding the IMPLAN tool, its capabilities, and its limitations will help ensure the best results from the model.

One of the most critical aspects of understanding economic impact analysis is the distinction between the "local" and "non-local" economy. The local economy is identified as part of the model-building process. Either the group requesting the study or the analyst defines the local area. Typically, the study area (the local economy) is a county or a group of counties that share economic linkages. In this analysis, the primary study area was the 20-county region.

A few definitions are essential in order to properly read the results of an IMPLAN analysis. The terms and their definitions are provided below.

Output

Output is measured in dollars and is equivalent to total sales. The output measure can include significant "double counting." Think of corn, for example. The value of the corn is counted when it is sold to the mill, again when it is sold to the dairy farmer, again as part of the price of fluid milk, and yet again when it is sold as cheese. The value of the corn is built into the price of each of these items and then the sales of each of these items are added up to get total sales (or output).

Employment

Employment includes full- and part-time workers and is measured in annual average jobs, not full-time equivalents (FTEs). IMPLAN includes total wage and salaried employees, as well as the self-employed, in employment estimates. Because employment is measured in jobs and not in dollar values, it tends to be a very stable metric.

Labor Income

Labor income measures the value added to the product by the labor component. Therefore, in the corn example, when the corn is sold to the mill, a certain percentage of the sale goes to the farmer for his/her labor. Then when the mill sells the corn as feed to dairy farmers, it includes some markup for its labor costs in the price. When dairy farmers sell the milk to the cheese manufacturer, they include a value for their labor. These individual value increments for labor can be measured, which amounts to labor income. Labor income does *not* include double counting.

Direct Impact

Direct impact is equivalent to the initial activity in the economy. In this study, it is spending by the sugarbeet producers and the extraction plant.

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[8] IMPLAN Version 3.0 was used in this analysis. The trade flows model with SAM multipliers was implemented.

Indirect Impact

The indirect impact is the summation of changes in the local economy that occur due to **spending for inputs** (goods and services) by the industry or industries directly impacted. For instance, if employment in a manufacturing plant increases by 100 jobs, this implies a corresponding increase in output by the plant. As the plant increases output, it must also purchase more inputs, such as electricity, steel, and equipment. As the plant increases purchases of these items, its suppliers must also increase production and so forth. As these ripples move through the economy, they can be captured and measured. Ripples related to the purchase of goods and services are indirect impacts. In this study, indirect impacts are those associated with spending by the sugarbeet producers and the extraction plant for operating items.

Induced Impact

The induced impact is the summation of changes in the local economy that occur due to **spending by labor**. For instance, if employment in a manufacturing plant increases by 100 jobs, the new employees will have more money to spend to purchase housing, buy groceries, and go out to dinner. As they spend their new income, more activity occurs in the local economy. Induced impacts also include spending by labor generated by indirect impacts. So, if a sugarbeet producer purchases services from a local tax preparer, spending of the tax preparer's wages would also create induced impacts. Primarily, in this study, the induced impacts are those economic changes related to spending by the sugarbeet producers, their employees, and employees of the extraction facility.

Total Impact

The total impact is the summation of the direct, indirect, and induced impacts.

Input-Output, Supply and Demand, and Size of Market

Care must be taken when using regional input-output models to ensure they are being used in the appropriate type of analysis. If the models are used to examine the impact of an industry so large that its expansion or contraction results in major supply and demand shifts causing the price of inputs and labor to change, then input-output can overstate the impacts or impacts. Since this analysis looks at the current contribution of the industry (and does not project the impact of changes), the model should estimate reliably. It is important to remember this information, however, when considering this analysis.

EXHIBIT X

2017 Census of Agriculture – Table 37

Excerpt Issued April 2019

2017 CENSUS OF AGRICULTURE

Florida

State and County Data

Volume 1 • Geographic Area Series • Part 9

AC-17-A-9

Issued April 2019

United States Department of Agriculture
Sonny Perdue, Secretary
National Agricultural Statistics Service
Hubert Hamer, Administrator

Table 37. **Specified Fruits and Nuts by Acres: 2017 and 2012** (continued)

[Totals may not add due to rounding. For meaning of abbreviations and symbols, see introductory text.]

Crop	Total		Bearing age acres		Nonbearing age acres	
	Farms	Acres	Farms	Acres	Farms	Acres
Noncitrus fruit, all (see text) - Con.						
Pears, all ... 2017	199	(D)	122	(D)	101	(D)
2012	255	142	111	41	154	101
Pears, Bartlett ... 2017	52	(D)	37	(D)	21	2
2012	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Pears, other than Bartlett ... 2017	161	(D)	91	42	88	(D)
2012	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Persimmons ... 2017	227	266	151	187	126	79
2012	164	324	99	188	102	135
Pineapples (see text) ... 2017	36	(D)	28	(D)	11	(D)
2012	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Plums and prunes ... 2017	141	94	87	(D)	61	(D)
2012	65	38	31	17	39	21
Plums ... 2017	139	(D)	85	(D)	61	(D)
2012	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Prunes ... 2017	2	(D)	2	(D)	-	-
2012	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Pomegranates ... 2017	131	146	56	48	86	98
2012	58	(D)	7	5	54	(D)
Other noncitrus fruit (see text) ... 2017	1,095	4,409	892	(D)	424	(D)
2012	1,019	5,287	904	4,232	384	1,054
Citrus fruit, all ... 2017	3,044	474,540	2,775	446,044	1,111	28,496
2012	3,639	539,181	3,378	508,511	1,334	30,670
2017 acres:						
0.1 to 0.9 acres	403	130	262	70	198	61
1.0 to 4.9 acres	477	1,092	391	810	206	282
5.0 to 14.9 acres	554	4,844	526	4,194	156	649
15.0 to 24.9 acres	274	5,224	270	4,570	105	654
25.0 to 49.9 acres	364	12,753	361	11,485	121	1,268
50.0 to 99.9 acres	394	26,905	390	24,843	120	2,062
100.0 to 249.9 acres	318	46,763	316	43,437	105	3,327
250.0 to 499.9 acres	103	35,862	103	33,825	39	2,038
500.0 to 749.9 acres	44	25,412	44	24,162	12	1,251
750.0 to 999.9 acres	23	19,902	23	18,321	7	1,581
1,000.0 acres or more	90	295,653	89	280,328	42	15,325
2012 acres:						
0.1 to 0.9 acres	366	130	256	88	155	42
1.0 to 4.9 acres	589	1,416	514	1,100	243	316
5.0 to 14.9 acres	854	7,154	803	6,121	291	1,033
15.0 to 24.9 acres	378	7,188	369	6,282	127	907
25.0 to 49.9 acres	478	16,450	470	14,823	160	1,627
50.0 to 99.9 acres	310	21,165	307	19,060	135	2,106
100.0 to 249.9 acres	351	52,505	348	48,761	108	3,744
250.0 to 499.9 acres	132	46,632	131	43,391	44	3,242
500.0 to 749.9 acres	63	36,517	62	34,185	22	2,332
750.0 to 999.9 acres	23	19,624	23	(D)	10	(D)
1,000.0 acres or more	95	330,400	95	(D)	39	(D)
Grapefruit ... 2017	496	40,248	441	38,207	155	2,042
2012	771	60,732	685	57,058	206	3,674
2017 acres:						
0.1 to 0.9 acres	125	29	84	17	57	12
1.0 to 4.9 acres	95	212	86	192	17	21
5.0 to 14.9 acres	76	572	72	514	20	58
15.0 to 24.9 acres	40	742	40	664	17	78
25.0 to 49.9 acres	41	1,397	41	1,278	11	119
50.0 to 99.9 acres	52	3,584	52	3,105	19	479
100.0 acres or more	67	33,713	66	32,437	14	1,276
100.0 to 249.9 acres	37	5,361	37	(D)	7	(D)
250.0 to 499.9 acres	12	(D)	12	(D)	-	-
500.0 to 749.9 acres	6	(D)	5	3,052	3	(D)
750.0 to 999.9 acres	4	3,593	4	(D)	1	(D)
1,000.0 acres or more	8	16,263	8	16,233	3	30
2012 acres:						
0.1 to 0.9 acres	199	53	145	37	62	16
1.0 to 4.9 acres	153	355	136	276	50	79
5.0 to 14.9 acres	167	1,349	157	1,202	29	148
15.0 to 24.9 acres	46	861	46	761	16	100
25.0 to 49.9 acres	65	2,164	61	1,929	18	235
50.0 to 99.9 acres	51	3,688	51	3,492	11	196
100.0 acres or more	90	52,262	89	49,362	20	2,900
100.0 to 249.9 acres	38	5,698	38	(D)	7	(D)
250.0 to 499.9 acres	22	8,379	21	(D)	5	(D)
500.0 to 749.9 acres	12	(D)	12	(D)	1	(D)
750.0 to 999.9 acres	6	(D)	6	(D)	3	353
1,000.0 acres or more	12	(D)	12	(D)	4	(D)
Kumquats ... 2017	81	59	49	48	35	11
2012	24	35	17	30	9	6
Lemons ... 2017	217	272	124	124	107	148
2012	56	77	45	(D)	24	(D)
Limes ... 2017	104	66	74	59	37	7
2012	40	241	28	229	16	12
Oranges, all ... 2017	2,486	422,421	2,334	397,764	845	24,657
2012	3,123	465,001	2,932	439,181	1,119	25,820

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EXHIBIT I

Nate Hultgren – Hultgren Farms
Objections and Request to Stay Tolerance
Revocations: Chlorpyrifos (EPA-HQ-OPP-2021-0253)

October 2021

Submitted electronically via Federal eRulemaking Portal

RE: Formal Written Objections and Request to Stay Tolerance Revocations: Chlorpyrifos (EPA-HQ-OPP-2021-0523)

My name is Nate Hultgren and my family own and operate Hultgren farms in Minnesota. My family has been farming since 1932. On an annual basis, I cultivate approximately 1,200 acres of sugarbeets, and I have been growing sugarbeets for over 20 years. I also grow the following other crops: Soybeans, Corn, Sweet Corn, Alfalfa, Dry Beans, and Green Peas. We have used the pesticide chlorpyrifos on our sugarbeet crop for many years in full compliance with all EPA regulations. I am aware of EPA's August 30, 2021 rule that would revoke all pesticide tolerances for chlorpyrifos, (EPA-HQ-OPP-2021-0523). Pursuant to the Federal Food, Drug, and Cosmetics Act (FFDCA) section 408(g) (21 U.S.C. § 346a), I am writing to file formal objections regarding this action. Based on these objections, I urge EPA to rescind the final rule revoking tolerances for sugarbeets and consider continued safe uses of chlorpyrifos. This rule will cause significant and irreparable harm to me and my operation, and I also request the Agency stay implementation of the rule until these objections can be formally addressed and responded to by EPA.

EPA's rule will completely remove the ability to apply chlorpyrifos to sugarbeets. If this rule is permitted to become effective as currently scheduled on February 28, 2022, it would have a devastating effect on the productivity of the crops that we raise and significantly diminish my farm's ability to operate. We use chlorpyrifos to combat cutworm, lygus bugs, and aphids. According to U.S. Department of Agriculture's website, the sugarbeet root maggot alone affects almost half of sugarbeet acres in the U.S, and without control tools, can lead to 40% yield losses in certain areas. At my farm, chlorpyrifos is the only tool that has proven to be consistently effective in controlling those pests. In an average year, I apply chlorpyrifos on approximately 500 acres. While pest pressure can vary year to year, I estimate that on average my yield per acre is significantly greater using chlorpyrifos than using any other pesticide. Without the ability to apply chlorpyrifos to my sugarbeet crop, the reduction in yield will lead to a large loss in profits for me and my cooperative, because we would have less throughput of mature and healthy sugarbeets. In addition, the alternative pesticides that I would need to use in the absence of chlorpyrifos I have found to be much less effective. I have found that my farm is forced to apply greater volumes of other pesticides raising costs and potentially other environmental impacts.

EPA's extremely short timeline for rescinding the tolerance does not allow sufficient time to plan for a dramatic change to our operation. In the past, EPA has been able to strike the proper balance between sound science and risks, and I am urging EPA to fulfill its commitment to scientific integrity in this decision. The data just does not support a revocation of chlorpyrifos tolerances for sugarbeets. My understanding is that EPA's own analysis in December 2020 found that chlorpyrifos could continue to be safely used on 11 specific crops, including sugarbeets. Thus, it does not make any sense to revoke a tolerance that EPA has found to be safe for sugarbeets.

Given that EPA has said using chlorpyrifos on sugarbeets is safe, I urge you to find some way to allow the continued use for sugarbeets without revoking the tolerance. Give my farm the chance to continue to thrive, and do not inflict this unnecessary and irreparable harm on our industry.

Sincerely,

Nate Hultgren
nate@hultgrenfarms.com
11804 15th Ave SW//Raymond, MN 56282

EXHIBIT U

Cherry Marketing Institute
Objections and Request to Stay Tolerance Revocations:
Chlorpyrifos (EPA-HQ-OPP-2021-0523)

October 18, 2021

October 18, 2021

Environmental Protection Agency
1200 Pennsylvania Ave, NW
Washington, DC 20460

RE: Formal Objection to Chlorpyrifos Tolerance Revocation (EPA-HQ-OPP-2021-0523)

To Whom It May Concern,

Cherry Marketing Institute (CMI) would like to take this opportunity to formally object to the Environmental Protection Agency's (EPA) revocation of tolerances for Chlorpyrifos. CMI is a national organization that represents the interest of the U.S. tart cherry industry and the Michigan sweet cherry industry. Not only do we believe that EPA is wrong in its final decision to revoke tolerances, but we believe that EPA took an inappropriate approach to doing so. Furthermore, revoking the tolerances of Chlorpyrifos, the only effective chemistry the cherry industry has to protect from trunk borers, would leave our industry open to substantial loss of trees, causing significant and irreparable harm. Due to the injury this rule would inflict, we urge the EPA to stay its implementation until the agency can formally review, consider, and respond to stakeholder objections.

Michigan, the number one state for growing tart cherries, grows roughly 75% of the total U.S. production of tart cherries and 20% of the total sweet cherries. Together, with Wisconsin, another major tart cherry producing state, both would be at great risk of losing vast quantities of cherry trees without the use of Chlorpyrifos to combat trunk borers. Currently, the industry uses this chemistry to control the American plum borer, peachtree borer, and lesser peachtree borer in both tart cherry and sweet cherry trees[1]. It is important to understand that our industry is 90% mechanically harvested with serious potential that the shakers will cause damage to the bark around the tree trunks (Rothwell, personal communication). As well, the climate in both states plays a role as well. In the early spring, temperatures can get above 32 degrees in the day and below 32 degrees at night. The constant contraction and expansion of the tree trunks can cause the trunks to crack. In both situations, damage to the trunks invite the trunk borers to burrow into the trees, ultimately leading to their death. It is worth noting that MSU researcher tested mating disruption of peachtree borers and lesser peachtree borers from 2007-2010. It was found that this method of control was not effective (Rothwell, unpublished data).

[1] Wise, J., A. Schilder, B. Zandstra, E. Hanson, L. Gut, R. Isaacs and G, Sundin. 2021 Michigan Fruit Management Guide. MSU E-154. Annually 2008-2020.

Economist from Michigan State University (MSU) estimate that it would cost growers $180 to replace a tree. Furthermore, we must factor in the loss of production from that newly replanted tree. The average tart cherry tree can produce upwards of 150 pounds of cherries a year. Factoring in the 10-year average price per pound of cherries being $0.28, that equates to $42 per tree, per year in lost income. Moreover, it takes as much as seven years in the ground before a cherry tree is viable for harvest, meaning that every tree that dies from trunk borers cost a grower roughly $294. According to a 2018-2019 survey completed by the United States Department of Agriculture's National Agriculture Statistics Service (USDA NASS), Michigan alone has approximately 3.7 million tart cherry trees and an additional 1 million sweet cherry trees, for a combined total of 4.7 million cherry trees that would be susceptible to trunk borers without the use of Chlorpyrifos. The economic impact of this would also extend far beyond the cherry growers, themselves. Considering the untold harm that would occur to the processing facilities and the communities they are located in, not having a sufficient supply of cherries could lead to massive layoff and the closing of food processing plants. The direct and indirect economic damages due to a loss of cherries trees that cannot be protected without Chlorpyrifos would be massive.

Furthermore, CMI is concerned with the way EPA has gone about revoking the tolerances for Chlorpyrifos. As general procedure is to cancel the label and allow the USDA to provide insight on the subject, giving growers time to use existing stocks of a chemistry prior to eliminating tolerances, we feel that EPA's detour from this normal process in immediately jumping to eliminating the tolerances is inconsistent with past behavior. This avenue taken by EPA did not allow USDA or other stakeholders to provide any comments on the final decision, nor does it allow our growers to use existing stocks or procure any meaningful alternatives to protect future crops.

Lastly, in EPA's Proposed Interim Registration Review Decision (Docket Number EPA-HQ-OPP-2008-0850) pertaining to Chlorpyrifos, it is stated "…the total annual economic benefit of chlorpyrifos to crop production is estimated to be $19-$130 million. These estimates are based on the additional costs of alternative pest control strategies likely to be used in the absence of chlorpyrifos or **reduced revenue for some crops that do not have effective alternatives to chlorpyrifos for some pests. In some cases, effective alternatives could not be found**;…" (p.39). Here, we see that EPA acknowledges that the lack of Chlorpyrifos could be devastating to industries that have no effective alternative, like the cherry industry against trunk borers. We believe that use on cherries is one of these "no effective alternatives" scenarios for the reasons described above, and damages are likely to be much higher than EPA assumes in the PID.

The PID goes on to say in Sec. 5(a)(1), "Table 10 provides a list of the **high-benefit agricultural uses that the agency has determined will not pose potential risk of concerns**…" (p.40). Table 10 includes the Michigan tart cherry industry as a high-benefit area. Based on that assessment, we are further confused and frustrated by EPA's decision to revoke the tolerance for cherries if it is both high-benefit and will not pose a potential risk of concern.

In summary, CMI believes that the revocation of tolerances for Chlorpyrifos on cherry trees will be detrimental to our industry, community, and economy. The absence of this chemistry would leave our industry needlessly defenseless against trunk borers, causing irreparable damage. Furthermore, even by EPA's own admission, the cherry industry receives "high-benefit" from this product that does not "pose potential risk of concern". We believe this action, in conjunction with EPA's highly unusual regulatory approach to this rule, shows significant disregard for the science and the well-being of farmers, their livelihoods, and our rural communities.

Again, we formally oppose the revocation of tolerances for Chlorpyrifos on cherry trees; requesting that EPA modify its rule to continue to permit this safe, high-benefit product for continued use. Furthermore, we urge EPA to stay implementation of this harmful rule until it can consider and respond to stakeholder objections.

If you wish to discuss this issue further, please feel free to contact me at (517) 669-4264.

Respectfully,

Kyle Harris
Director, Grower Relations
Cherry Marketing Institute
12800 Escanaba Dr., Suite A
DeWitt, MI 48820

EXHIBIT P

Agricultural Stakeholders
Objections and Request to Stay Tolerance Revocations:
Chlorpyrifos (EPA-HQ-OPP-2021-0523)

October 19, 2021

October 19, 2021

Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Submitted electronically via Office of the Administrative Law Judges E-Filing System and Federal eRulemaking Portal

RE: Formal Written Objections and Request to Stay Tolerance Revocations: Chlorpyrifos (EPA-HQ-OPP-2021-0523)

To Whom It May Concern:

We represent growers, retailers, co-ops, applicators, refiners, crop consultants, and other agricultural stakeholders. We write concerning EPA's final rule issued on August 30, 2021, to revoke all tolerances for the insecticide chlorpyrifos (EPA-HQ-OPP-2021-0523). Pursuant to the Federal Food, Drug, and Cosmetics Act (FFDCA) section 408(g) (21 U.S.C. 346a) we are writing to file formal objections regarding this action, as we believe it is inconsistent with federal statute, the Agency's own record on chlorpyrifos, and sound, science-based and risk-based regulatory practices. Based on these objections, we urge EPA to rescind the final rule revoking tolerances and consider continued agricultural uses of chlorpyrifos under its ongoing, normal-order registration review of chlorpyrifos. Furthermore, because this rule will cause significant and irreparable harm to food and agricultural stakeholders, we request the Agency stay implementation of the rule until these objections can be formally addressed and responded to by EPA.

Harm to Food & Agricultural Stakeholders, the Environment

As many of our organizations have commented regarding the ongoing registration review for chlorpyrifos (EPA-HQ-OPP-2008-0850), this chemistry holds a unique and significant value for many agricultural producers. Chlorpyrifos has more than 50 registered agricultural uses on numerous crops, many of which are high-benefit uses to protect against economically significant pests. We object to the tolerance revocation of all uses, as EPA's own risk assessments show some uses meet the legal standard under FFDCA. Additionally, this action will leave thousands of growers across the country defenseless to devastating pests, which is why we also request that EPA stay implementation of this rule until the Agency can thoroughly consider and respond to objections. To lose the ability to use chlorpyrifos, as would occur through implementation of the rule, would unnecessarily result in significant and immediate economic and environmental damage.

For example, Michigan cherry producers currently have no other effective control options besides chlorpyrifos for American Plum Borers and Peachtree Borers. These insect pests can bore into trunks of cherry trees ultimately leading to the tree's death.[1] What is worse, since fruit trees take years to reach maturity, growers who lose trees will be harmed for not just one growing season, but many years to come. Michigan State University (MSU) Economists estimated that a grower who loses a tree to borers would spend $180 replacing it, as well as $42 per year in lost income for the average of seven years it takes a tree to begin producing marketable fruit, ultimately costing the producer $474 in lost revenue

[1] *Tart Cherry Pest Management in the Future: Development of a Strategic Plan*. June 2011. 23-24. https://ipmdata.ipmcenters.org/documents/pmsps/MITartCherryPMSP.pdf

and replacement costs for every deceased tree.[2] Given that USDA estimates Michigan has more than 4.7 million cherry trees planted,[3,4] this action would expose Michigan cherry producers to potentially tens to hundreds of millions of dollars in irreparable damage through the loss of chlorpyrifos.

U.S. sugarbeet growers will also face significant damages from this rule. These growers contend with sugarbeet root maggots (SBRM) – flies that lay their eggs at the base of sugarbeets, whose larvae then hatch, burrow into the plant, and feed on the sugarbeet. Chlorpyrifos is the most effective product available for treating emerged SBRM. The few other products registered can only suppress SBRM, not control it, or are only registered for use on adult flies, not larvae.[5] Without chlorpyrifos, sugarbeet growers will be exposed to this damaging pest which can inflict up to 45 percent yield loss and $500 in damages per acre.[6] When considering more than 140,000 acres of sugarbeets are at risk of from SBRM,[7] U.S. sugarbeet growers could be looking at tens of millions of dollars in irreparable damages annually should this rule take effect.

It is important to note that it is not just farmers, but also our environment that will be impacted should this rule take effect. For example, soybean growers use chlorpyrifos to control both two-spotted spider mites (TSM) and soybean aphid populations that have developed resistance to other insecticides, such as pyrethroids. These pests can inflict yield losses as high as 60 percent if left unchecked.[8] For growers who face these pests, there is no one-to-one replacement for chlorpyrifos – it is the only option that will control both pests.[9] Should this rule take effect, soybean growers who face TSM and pyrethroid-resistant aphids will now have to choose between applying twice as much pesticide active ingredient (which will also significantly increase their operational costs) or face serious crop damage. This results in an increase in pesticides used in the environment and additional sprays which unnecessarily increase the use of water and fuel.

These are just a few examples out of many where agricultural producers, supply chains, and our environment will face irreparable harm should this rule take effect. Wheat, asparagus, peach, apple, alfalfa, citrus, peanut, onion, and other producers will experience similar costly adverse impacts. We object to the rule on the basis that it will inflict significant economic damage to the tune of hundreds of millions of dollars to these farmers and many others. To ensure that this irreparable harm does not occur from this rule, which the Agency may yet modify or rescind based on public comment, we request

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[2] Gordon, Julie and Kyle Harris. *Comments submitted by Cherry Marketing Institute to Pesticide Registration Review: Proposed Interim Decision for Chlorpyrifos (EPA-HQ-OPP-2008-0850)*. February 26, 2021.

[3] United States Department of Agriculture. National Agriculture Statistics Service. 2019. *2018-2019 Michigan Fruit Inventory: Tart Cherries*. https://www.nass.usda.gov/Statistics_by_State/Michigan/Publications/Michigan_Rotational_Surveys/mi_fruit18/Tart%20Cherries.pdf

[4] U.S. Department of Agriculture. National Agriculture Statistics Service. 2019. *2018-2019 Michigan Fruit Inventory: Sweet Cherries*. https://www.nass.usda.gov/Statistics_by_State/Michigan/Publications/Michigan_Rotational_Surveys/mi_fruit18/Sweet%20Cherries.pdf

[5] Franzen, David, Mark Boetel, Ashok Chanda, Albert Sims, and Thomas Peters. North Dakota State University. January 2021. "2021 Sugarbeet Production Guide." https://www.ag.ndsu.edu/publications/crops/sugarbeet-production-guide

[6] Boetel, Mark. North Dakota State University. June 10, 2021. "NDSU Helping Control Sugarbeet Root Maggot." *Newsletter.* https://www.ndsu.edu/vpag/newsletter/ndsu_helping_control_sugarbeet_root_maggot/

[7] Ibid.

[8] Hodgson, Erin. Iowa State University Extension and Outreach. July 6, 2016. "Spider Mite Injury Confirmed in Soybean." *Integrated Crop Management*. https://crops.extension.iastate.edu/cropnews/2016/07/spider-mite-injury-confirmed-soybean

[9] Koch, Robert, Theresa Cira, Raj Mann, Bruce Potter, Anthony Hanson. University of Minnesota Extension. August 19, 2021. "Environmental Protection Agency's Cancellation of Chlorpyrifos Tolerances: Alternatives for Management of Key Crop Pests." *Minnesota Crop News.* https://blog- crop- news.extension.umn.edu/2021/08/environmental-protection-agencys.html

that EPA stay implementation of this rule until it considers and formally responds to additional objections raised below and by other stakeholders.

Harm to Holders of Safe, Otherwise-Legal Foods

We also object to this rule on the grounds that its implementation will likely force the disposal of significant volumes of safe, legal food and feed products. EPA has indicated that detectable food and feed residues of chlorpyrifos after the February 28, 2022 implementation date will be subject to section 408(l)(5) of FFDCA and FDA's channels of trade guidance. Under these provisions, FDA requires that:

> *"In order to avoid possible regulatory action against a food containing a residue of a pesticide chemical that is subject to the channels of trade provision, the party responsible for the food must, under section 408(l)(5) of the FFDCA, demonstrate that the residue is present as a result of a lawful application or use of the pesticide chemical and that the residue does not exceed a level that was authorized at the time of that application or use."*[10]

While this will not be an immediate issue, this provision is likely to become a significant concern once the rule takes full effect in February 2022. Since many finished food and feed products have extended shelf lives, there are almost certainly already foods in commerce with detectable residues from applications made prior to EPA's revocation rule and before applicators knew special channels of trade application records would be retroactively required. Without these special records, products could be unnecessarily found adulterated and subsequently destroyed despite applications being made legally and residues not exceeding legal levels at time of application. This will potentially result in millions of dollars of additional food waste losses and further irreparable harm to agricultural supply chains. These significant food and feed losses do not seem to have been considered by the Agency in its issuance of the rule. We also object to the rule on this basis and, due to these additional economic harms that would occur should the rule take effect, request that EPA stay the rule's implementation until it can fully consider and respond to these objections.

Lack of Clarity on Continued Use, Existing Stocks

We are also greatly concerned with and object to EPA's approach to existing stocks of chlorpyrifos under the rule and in additional clarification guidance.[11] The Agency has effectively not taken a position on the matter or how it expects to responsibly wind-down use of the product. As very few growers are using chlorpyrifos this late into the 2021 growing season, millions of gallons remain in storage across the country and are unlikely to be used ahead of the rule's February 2022 implementation date. Most users will be effectively prohibited from using the product even if the registration has not been formally cancelled at that point, placing the financial and logistical burden on users and retailers to determine how to responsibly dispose of product. Without additional clarification from EPA on what to do with these existing stocks, it could inadvertently lead to inappropriate or mass disposal of product which would have significant environmental consequences.

Significant Regulatory Action Subject to OIRA Review

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[10] United States Food & Drug Administration. *Guidance for Industry: Channels of Trade Policy for Commodities With Residues of Pesticide Chemicals, for Which Tolerances Have Been Revoked, Suspended, or Modified by the Environmental Protection Agency Pursuant to Dietary Risk Considerations*. Jeffrey Shuren. Federal Register 70, No. 95. (May 18, 2005): 28544. https://www.federalregister.gov/documents/2005/05/18/05-9811/guidance-for-industry-on-channels-of-trade-policy-for-commodities-with-residues-of-pesticide

[11] United States Environmental Protection Agency. Last Updated September 20, 2021. *Frequent Questions about the Chlorpyrifos 2021 Final Rule*. Accessed October 8, 2021. https://www.epa.gov/ingredients-used-pesticide-products/frequent-questions-about-chlorpyrifos-2021-final-rule

We also take objection with EPA's determination that this rule is not an economically significant regulatory action as defined by section 3(f)(1) of Executive Order (E.O.) 12866, subject to review by the Office of Information and Regulatory Analysis (OIRA). By EPA's own analysis, the December 2020 proposed interim decision (PID) suggests this rule is likely to trigger the impacts threshold of an economically significant action. In the benefits section of the PID, EPA attests that the annual economic benefit of chlorpyrifos could be as high as $130 million.[12] Many of our organizations provided comment to the PID in a letter dated March 6, 2021 demonstrating how we believe this assessment drastically undervalues chlorpyrifos' annual economic benefit, and that the actual value is likely to be much higher. The grower harm scenarios provided above for cherries and sugarbeets alone offer scenarios where harm might occur to individual crop groups in excess of the $100 million threshold of an economically significant regulatory action, to say nothing of the dozens of other crop producer groups who also will be economically impacted by the loss of chlorpyrifos resulting from this action.

And this is only the impact on growers. As previously discussed, the economic damage from this action is likely to ripple across the agricultural supply chain as food holders may be required to discard millions of dollars in food and feed due to special retroactive channels of trade document challenges. It also does not factor in the costly paperwork burdens for stakeholders who may be capable of meeting the arduous channels of trade requirement, nor does it account for millions of gallons of existing stocks that may need to be discarded after the rule takes effect, and so on. When these factors are all considered, this rule will vastly exceed the $100 million economically significant threshold.

If there continues to be any doubt that this rule is economically significant, the $100 million threshold is only one factor of several that can trigger this status under section (3)(f)(1). If a rule is also likely to "adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities,"[13] it is also considered economically significant. We have provided numerous examples how this rule is likely to adversely affect the entire agricultural economy, jobs, productivity, and our environment. At this point, there should be no doubt to the Agency that this action is in fact economically significant.

As an economically significant action, EPA should have provided OIRA with a copy of this draft regulatory action, required cost and benefit assessments, and other documents enumerated in sections (a)(3)(B) and (C) of E.O. 12866. However, the Agency conducted none of these requirements for this action. While we appreciate the Ninth Circuit Court of Appeals gave EPA a swift deadline for considering its order, E.O. 12866 also provides a mechanism for managing just such a scenario. Section (a)(3)(D) stipulates "for those regulatory actions that are governed by a statutory or court-imposed deadline, the agency shall, to the extent practicable, schedule rulemaking proceedings so as to permit sufficient time for OIRA to conduct its review…." We object to this action on the grounds that EPA had an obligation to conduct an OIRA review of this rule – a review which may have resulted in a significantly different regulatory outcome. However, EPA neglected to carry out this essential review function directed by E.O. 12866 and as a result our organizations will be subject to significant harm from this rule. EPA should rescind the rule and, should it seek to advance it or another economically significant rule again, do so through appropriate regulatory review processes.

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[12] United States Environmental Protection Agency. December 3, 2020. *Chlorpyrifos Proposed Interim Registration Review Decision Case Number 0100*. (EPA-HQ-OPP-2008-0850-0971). 39. https://www.regulations.gov/document/EPA-HQ-OPP-2008-0850-0971

[13] *Executive Order 12866 of September 30, 1993: Regulatory Planning and Review*. Clinton, William J. Federal Register 50, No. 98. (October 4, 1993). https://www.reginfo.gov/public/jsp/Utilities/EO_12866.pdf, https://www.epa.gov/laws-regulations/summary-executive-order-12866-regulatory-planning-and-review.

Revocation of Tolerances for High-Benefit Uses, Even with FQPA 10X Safety Factor

We also object to EPA's revocation of uses that the Agency describes as high-benefit and which EPA's record for chlorpyrifos, as established by EPA's career scientists, indicates would be safe for continued use. In its April 29, 2021 decision which precipitated this rule, the Ninth Circuit ordered EPA to "issue a final regulation within 60 days following issuance of the mandate that either (a) revokes all chlorpyrifos tolerances or (b) modifies chlorpyrifos tolerances and simultaneously certifies that, with the tolerances so modified, the EPA 'has determined that there is a reasonable certainty that no harm will result from aggregate exposure to the pesticide chemical residue, including all anticipated dietary exposures and all other exposures for which there is reliable information' including for 'infants and children.'"[14]

Importantly, the Agency has ample evidence instructing this matter from its ongoing registration review of chlorpyrifos. In the December 2020 chlorpyrifos PID, EPA identified 11 high-benefit agricultural uses that "the agency has determined will not pose potential risks of concern with a Food Quality Protection Act (FQPA) safety factor of 10X and may be considered for retention."[15] These uses include or are similar to the ones described above where growers or the environment would be significantly harmed if access to chlorpyrifos were lost. The PID is clear that these 11 agricultural uses meet the FFDCA safety standard when EPA evaluated the aggregate exposure for both food residues and drinking water concentrations. While we do not believe this 10X FQPA safety factor is necessary for the Agency to adopt and EPA's water estimates significantly overstate potential drinking water exposures, which we further discuss in our below objections, these uses clearly satisfy FFDCA standards and the criteria the Court gave to EPA.

Despite that EPA was given the option by the Court to modify chlorpyrifos tolerances, the Agency instead opted to arbitrarily revoke all tolerances in this rule, even those that EPA's own record supported as meeting FFDCA safety standards to protect human health. EPA supposes in the rule that it must consider "all currently registered uses" when determining aggregate exposure risks and whether tolerances can be maintained, but this is simply not true. The Court permitted EPA to modify tolerances in response to the ruling and the law permits EPA to modify or revoke individual tolerances (21 U.S.C. 346(b)). We object to this rule in that it unnecessarily revokes tolerances for these 11 high-benefit agricultural uses that EPA's own assessments establish are safe, will protect human health from aggregate exposures, satisfies the orders given to EPA by the Court, and would otherwise help to minimize the rule's environmental and economic impact on stakeholders.

Import Tolerance Concerns

It is also concerning, and we take objection that the rule makes no accommodation for retaining import tolerances. Food residues are the only potential domestic exposure source from imports with chlorpyrifos residues, and the Agency has clearly stated those are not of concern. Since the Agency clarifies in the rule that "exposures from food and non-occupational exposures individually or together do not exceed EPA's levels of concern," and since there are no domestic drinking water or environmental risks that could arise from foreign chlorpyrifos applications, there is no science-based reason for EPA to revoke these tolerances.
U.S. producers regularly face prejudice in export markets that impose restrictions on pesticide residues that are not aligned with CODEX standards or are otherwise scientifically unsupported. U.S. trade representatives constantly struggle convincing foreign governments to align their import tolerances with

[14] *League of United Latin American Citizens, et al. v. Michael S. Regan*, 996 F.3d 673. 67. (9th Cir. 2021).
[15] United States Environmental Protection Agency. *Chlorpyrifos Proposed Interim Decision*. 40.

these international standards. However, when EPA takes steps mirroring the unscientific actions of foreign governments, it erodes the ability of U.S. trade negotiators and producers to seek appropriate regulatory treatment abroad. This is yet another reason why the Agency should have sought OIRA review of this rule, to ensure EPA's action would not undermine the mission of other federal agencies.

Finally, our trade partners have expressed concern at previous EPA proposals to revoke chlorpyrifos tolerances, suggesting that "the EPA's revocation on all tolerances for this product may unfairly impact Canadian products exported to the U.S. market."[16] Given that EPA does not seem to have consulted with the U.S. Trade Representative on this action, we are concerned the Agency has not sufficiently ensured it is compliant with U.S. trade obligations which has great potential to disrupt international trade. We object to the rule on the basis that it does not permit import tolerances that are important to the U.S. agricultural trade strategy, as these residues pose no domestic dietary or environmental risks.

Uses on Non-Food Crops, Foods Not Resulting in Residues

Similar to our concerns with import tolerances, there are numerous domestic uses that are not intended for food purposes or will not result in food or feed residues, and thus pose little to no risk. Regardless, EPA has indicated it plans to revoke tolerances and will soon move to cancel these uses. We object to this aspect of the rule as well. For example, applications to fruit tree trunks where product is not directly applied to fruit will not result in residues and should not be cancelled. Sugarbeets are not sold as a raw commodity, but are highly refined, resulting in no residues in finished product. This use also should not be cancelled. Although EPA may have concerns with drinking water exposures resulting from these uses based on very conservative water modeling estimates, we would point the Agency to additional comments below on new drinking water data that should be considered which EPA did not use in developing this rule. The Agency should carefully review these uses and not unnecessarily revoke tolerances or cancel uses that truly do not pose a dietary exposure risk and will only result in burdening producers.

Epidemiological, Drinking Water Data Concerns

Finally, as suggested above, we have numerous concerns with the underlying data and methodologies EPA has used to establish a 10X FQPA safety factor and ultimately reach the revocation decision in this rule. We continue to believe EPA's record on chlorpyrifos strongly supports use of a 1X FQPA safety factor. The primary driver of the Agency's decision to use the 10X safety factor is three epidemiological cohorts that supposedly identified links between chlorpyrifos or organophosphates generally and alleged neurodevelopmental effects from a potentially unknown mode of action (MOA) beyond the known acetylcholinesterase (AChE)-inhibition.

We object to EPA's use of this data for establishing the use of a 10X FQPA safety factor for numerous reasons. First, these cohorts – and most notably the Columbia Center for Children's Environmental Health (CCCEH) epidemiologic studies, which was specific to chlorpyrifos – have not to date provided raw study data to EPA, despite numerous requests from the Agency. Without this underlying data, it is impossible for the Agency to determine alleged exposure sources, exposure levels, and actual causes of neurodevelopmental effects. For these limitations and others, EPA's expert FIFRA Scientific Advisory

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[16] Panday, Chris. *Comments submitted by Agriculture and Agri-Food Canada to Tolerance Revocation: Chlorpyrifos (EPA-HQ-OPP-2015-0653)*. December 22, 2015.

Panel (SAP) on several occasions in recent years has cautioned the Agency against using these three cohorts as the basis for regulatory decisions.[17]

The weight the Agency should place on these studies is further diminished by other factors. In the years since these cohorts were released, several other epidemiological studies (which EPA has as part of its record) have been released finding no link between organophosphates and alleged neurodevelopmental effects beyond known AChE-inhibition, to say nothing of decades of animal and other tests that also do not support the findings of these three cohorts. The results of these three studies have not been reproducible to date. Moreover, an additional, unknown MOA beyond the commonly-accepted AChE-inhibition that could have potentially caused neurodevelopmental effects to date has never been identified, for chlorpyrifos or any other organophosphate. Finally, even if an unknown MOA does exist, EPA's own career scientists at the Office of Research and Development (ORD) have developed data that indicates the mitigations the Agency has put in place to protect against AChE-inhibition would also be protective against the effects alleged in the epidemiological cohorts regardless of any unknown MOA.

In the rule itself EPA acknowledges that food residues and non-occupational exposures are not a concern, only ultimately raising concern with modeled estimates of drinking water exposure risks. We believe these concerns can also be addressed, as in the rule EPA states of its 2020 drinking water assessment (DWA) that it "applied the new methods for considering the entire distribution of community water systems PCA [percent cropped area] adjustment factors, integrated state level PCT [percent crop treated] data, incorporated refined usage and application data, and included quantitative use of surface water monitoring data in addition to considering state level usage rate and data information" relative to its previous 2016 DWA. Using this improved DWA in its 2020 human health risk assessments for the registration review of chlorpyrifos, EPA sought to determine drinking water risks on the subset of 11 critical, high-benefit crop uses (the uses that the PID recommended retaining under the FQPA 10X scenario). The Agency found under the improved 2020 DWA none of the assessed uses exceeded drinking water levels of concern. It should also be noted that the 2016 DWA EPA reported there were no detections of chlorpyrifos-oxon degradates in any finished drinking water samples that people actually consume[18] – another sign of how inappropriately conservative the Agency's drinking water assessments are in this rule.

Confoundingly, the Agency contends it cannot use the 2020 DWA because it is not comprehensive across all currently registered uses. This is an inappropriate determination. In this rule, EPA has instead opted to revert to its cruder 2016 DWA for all uses, concluding it should throw out every use even when it has better data it could utilize. EPA has the opportunity and obligation to use the best available science where it can and can explore the appropriateness of modeling or extrapolation where there may be gaps. We strongly encourage EPA to reconsider its decision in this rule using the improved, best-available science in the 2020 DWA.

Conclusion

To summarize our concerns, FIFRA is a risk-benefit statute which directs the Agency to identify hazards of a pesticide use, determine the risks caused by that hazard, weigh those risks against the benefits of uses, and assuming they can be mitigated, reasonably mitigate those risks so the benefits of use

[17] United States Environmental Protection Agency. FIFRA Scientific Advisory Panel. "Meeting on Chlorpyrifos: Biomonitoring Data." (Meeting transcript: Arlington, VA; April 19-21, 2016). 644-646. https://www.epa.gov/sites/default/files/2016-05/documents/fifra_sap_04_19_16_to_04_21_16_final_transcript.pdf

[18] United States Environmental Protection Agency. Office of Chemical Safety and Pollution Prevention. *Chlorpyrifos Refined Drinking Water Assessment for Registration Review.* April 14, 2016. 104.

outweigh the risks. This process is done in concert with FFDCA, incorporating a stringent safety standard to protect the safety of the food supply. However, in this instance EPA has not even identified a hazard. The Agency has three limited, inconclusive studies which suggest a *potential* hazard, to say nothing of possible risks, the findings for which have never been confirmed or reproduced. There is also an abundance of additional human epidemiological and other evidence refuting the existence of this potential hazard. Even if a hazard exists and it presents a risk, EPA's own experts believe that risk can be mitigated using existing controls.

Despite all this, to mitigate the potential risks that may be posed by the alleged hazard, through this rule EPA is opting to eliminate hundreds of millions of dollars in agricultural benefits and inflict tens to hundreds of millions of dollars in additional costs to supply chains and the environment. We are very concerned about the precautionary precedent this rule poses to EPA's pesticide program and object on the grounds that it is fundamentally averse to the processes by which Congress directed the Agency to regulate pesticides, as well as commonly-accepted principles of modern science and risk-based regulation. We urge EPA to rescind this rule based on the above objections and to stay the rule's implementation to avoid these irreparable harms from taking effect until the Agency can thoroughly review and respond to these concerns.

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<u>EXHIBIT H</u>

Brent Baldwin Objections and Request to Stay Tolerance Revocations: Chlorpyrifos (EPA-HQ-OPP-2021-0523)

October 26, 2021

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10/26/21

RE: Formal Written Objections and Request to Stay Tolerance Revocations: Chlorpyrifos (EPA-HQ-OPP-2021-0523)

My name is Brent Baldwin, I farm with my parents, wife, daughter, and sons in rural North Dakota, near the town of Saint Thomas. I am an 4th generation farmer, and I am hoping for my kids and grandkids will one day be the 5th and 6th generations to take over my farm. I am a member of American Crystal Sugar Company, a farmer-owned beet sugar cooperative in the Red River Valley of Minnesota and North Dakota. I raise approximately 3000 acres of sugarbeets annually, in addition to sugarbeets I also grow soybeans, wheat, and edible beans.

This letter is in response to EPA's August 30, 2021 rule that would revoke all pesticide tolerances for chlorpyrifos, (EPA-HQ-OPP-2021-0523). Pursuant to the Federal Food, Drug, and Cosmetics Act (FFDCA) section 408(g) (21 U.S.C. § 346a), I am writing to file formal objections regarding this action.

I have safely applied chlorpyrifos on my sugarbeet crop for many years to combat sugarbeet root maggot and as necessary to control other pests that may threaten our crop to avoid economic loss. It is the most effective management tool we have for controlling sugarbeet root maggot flies. There are very few options to treat sugarbeet root maggot and none are as effective as chlorpyrifos. The loss of this treatment would reduce crop yields and significantly impact the profitability of our sugarbeet operation and may affect the long-term viability of the entire farm. The combined impacts on many sugarbeet farmers will also have an affect the future success of American Crystal, which will further reduce financial returns to all members of the cooperative, whether affected by root maggots or not.

In an average year, I apply chlorpyrifos to 2000 acres. We carefully time applications to make sure they only occur at the right time and in the right place, if at all. This is done by scouting to determine when the population of flies is present and in high enough numbers that justify an application. Chlorpyrifos is typically applied by licensed certified applicators through ground sprayers in the field. It is important to note that no one, other than the operator, is in the field during or immediately after these applications.

Without the ability to apply chlorpyrifos I estimate I would have a reduction in yield on my sugarbeet crop. That loss would equate to an approximate $114.97/acre loss or an annual loss of about $229,940 for my farm. This is a material financial impact on our farm, especially given the continued reduction in the overall economics of farming.

Through EPA's analysis in December of 2020, it was found that chlorpyrifos could be safely applied on 11 crops, one of which was sugarbeets. Given this analysis and based on these objections, I urge EPA to rescind the final rule revoking tolerances for sugarbeets and permit farmers to continue the safe use of chlorpyrifos on sugarbeets. The loss of chlorpyrifos will cause significant and irreparable harm to my farming operation. I also request the Agency stay implementation of the rule until my objections and those of others in the industry can be formally addressed by EPA.

Sincerely,

Brent Baldwin

Sugarbeet Grower

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<u>EXHIBIT O</u>

American Farm Bureau Federation
Objections and Request to Stay Tolerance Revocations:
Chlorpyrifos (EPA-HQ-OPP-2021-0523)

October 27, 2021

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1200 Pennsylvania Avenue, NW
Washington, DC 20460

RE: Formal Written Objections and Request to Stay Tolerance Revocations: Chlorpyrifos (EPA HQ-OPP-2021-0523)

To Whom It May Concern:

AFBF is the nation's largest general farm organization. We represent farmers and ranchers in all 50 states and Puerto Rico, and they are engaged in every conceivable facet of agricultural production, including farmers who utilize chlorpyrifos to mitigate insect pressures on their crops. Considering this, AFBF is concerned with EPA's final rule issued on August 30, 2021, to revoke all tolerances for the insecticide chlorpyrifos. Pursuant to the Federal Food, Drug, and Cosmetic Act (FD&C Act) section 408(g) (21 USC 346a), AFBF writes to file formal objections regarding this action. AFBF urges EPA to rescind the final rule revoking tolerances and consider continued uses of chlorpyrifos following the Agency's registration review process. AFBF has also joined over 80 other agricultural stakeholders in a joint objection filed on October 19, 2021, and would like to reiterate our organization's support for the arguments made in the coalition objection. AFBF also supports the requests in the group objection to rescind the final rule revoking tolerances and to delay the implementation of the rule until EPA can respond to the objections.

EPA's decision to revoke tolerances for chlorpyrifos takes away critically needed crop protection for which there is no equal replacement. Chlorpyrifos has more than 50 registered agricultural uses on numerous crops, many of which are high-benefit uses to protect against economically significant pests. EPA's action leaves thousands of growers across the country defenseless against devastating pests. The loss of chlorpyrifos also negatively impacts the environment. Without access to pesticide products like chlorpyrifos that provide targeted treatment, farmers will have to use greater quantities of less-effective products, contributing to resistance issues among insects. Considering the significant economic and environmental impact of this decision, AFBF urges EPA to reexamine this decision and allow farmers to maintain access to this chemistry.

EPA's decision does not account for applications of chlorpyrifos when an actual food crop is not present, such as to tree trunks before the fruit has developed, on dormant fields, or to crops subject to further processing in which residues would not be detected. AFBF objects to the discontinuation of these uses.

AFBF also takes issue with the manner in which EPA came to this decision, as chlorpyrifos was currently under registration review. Many stakeholders, including AFBF, provided comments throughout the registration process and noted that the Agency described many high-benefit, safe uses of chlorpyrifos in EPA's own documentation. This revocation decision also discourages further study and scrutiny of data used to establish the 10X FQPA safety factor, which contributed to the revocation decision.

As EPA plans to implement this disappointing decision, there is confusion throughout the food supply chain regarding how food products with previously legal residues of chlorpyrifos will be handled. Chlorpyrifos applications between now and February 28, 2022 are now subject to special record-keeping requirements. However, chlorpyrifos applications prior to EPA's final rule announcement were not subject to these record-keeping requirements, and many of these food products have long shelf lives. AFBF is concerned that these products will be considered adulterated should chlorpyrifos levels be detected due to the lack of record-keeping to demonstrate that the presence of chlorpyrifos is from a legal application. Should EPA not be responsive to the objections raised by agricultural stakeholders, AFBF is concerned about the lack of information in EPA's plan to manage existing stocks of chlorpyrifos. Without further intervention, farmers and retailers will bear the financial and logistical burden of determining how to dispose of leftover products.

In conclusion, the decision to revoke tolerances of chlorpyrifos will negatively impact farmers, the environment and food production in a multitude of ways, and for these reasons AFBF objects to the final rule ordering the revocation of tolerances for chlorpyrifos. AFBF joins many other agricultural stakeholders in requesting the agency rescind this rule and return to making pesticide decisions based on the best available science through the regular registration review process.

Sincerely,

Sam Kieffer

Vice President, Public Affairs

<u>EXHIBIT N</u>

Minn-Dak Farmers Cooperative
Objections and Request to Stay Tolerance Revocations:
Chlorpyrifos (EPA-HQ-OPP-2021-0523)

October 28, 2021

October 28, 2021

RE: Formal Written Objections and Request to Stay Tolerance Revocations: Chlorpyrifos (EPA-HQ-OPP-2021-0523)

Minn-Dak Farmers Cooperative is a grower-owned sugarbeet processing facility located at the southern end of the Red River Valley in Wahpeton, North Dakota. We have proudly been in business since 1974 and continue to be one of the industry's most advanced and proficient sugar production facilities today. My primary area of responsibility is focused upon the research and production aspects of the agricultural arena. I am responsible for the research of both current production techniques and future technologies encompassing the growing, harvesting and delivering of sugarbeets for processing from 500 shareholders raising sugarbeets on 105,000+ acres.

Year in and out, pest control has been and continues to be one of the most predominant production challenges of raising sugarbeets in the Red River Valley of Minnesota and North Dakota. Unlike corn and soybean (which have a combined acreage of 175 million across the United States), sugarbeets are a very small market by comparison, raising only 1.1 million acres annually. As such, the pesticide portfolio that is currently available to our growers has not only dwindled over the past decade, but the major chemical manufacturers are no longer producing sugarbeet-specific products. Instead, our industry is at the mercy of the 'table scraps' developed for the corn and/or soybean market and actually consider ourselves lucky that they still continue to screen these chemistries on sugarbeets during part of their developmental process. This simple fact makes the continued use of existing chemistries within our current pesticide portfolio vital to our small industry.

Chlorpyrifos is by far the most effective post-emerge insecticide product that is utilized by our growers for the control of various insects, the most notable being the Sugarbeet Root Maggot (SBRM - an insect pest in which larvae feed on and damage sugarbeet roots). Our Cooperative is very aware of the U.S. Environmental Protection Agency's (EPA) August 30th ruling that would revoke all pesticide tolerances for this unique chemistry (EPA-HQ-OPP-2021-0523). Pursuant to the Federal Food, Drug, and Cosmetics Act (FFDCA) section 408(g) (21 U.S.C. § 346a), please consider this letter a formal objection regarding this recent action. Chlorpyrifos has been registered for use in sugarbeets by both the North Dakota Department of Agriculture (NDDA) and the Minnesota Department of Agriculture (MDA) for decades and when applied according to the label, is a safe an effective crop protection product. I implore the EPA to rescind the final rule revoking tolerances for sugarbeets and consider continued safe uses of this active ingredient. Simply put, this ruling will cause significant and irreparable harm to our Cooperative. As a reference, where Chlorpyrifos is needed but is not used, we can see losses of up to 2,042 lbs. (> 30%) of Recoverable Sugar/Acre and $400/acre in lost revenue. (Dr. Boetel, NDSU - Combined Analysis 2016-2019 Research).

A common misconception surrounding the use of Chlorpyrifos in sugarbeets is that it is annually applied as a 'blanket' application – nothing could be farther from the truth. Chlorpyrifos applications within our Cooperative are structured in a very targeted and precise manner. Carefully monitoring the SBRM population through the use of insect traps and an advance population forecasting system, our Agricultural Staff works on a one-on-one basis with each of our growers (who are licensed pesticide applicators) to make the decision whether or not a field needs to be treated based upon a proven economic threshold developed by the entomology departments of both North Dakota State University and the University of Minnesota.

The EPA's extremely short timeline for rescinding the tolerance does not allow our Ag Staff or our growers sufficient time to plan for such a significant change to our production practices. As I recall, the

EPA has always been able to strike the proper balance between sound science and risks and I am urging the EPA to fulfill its commitment to scientific integrity in this specific decision. The EPA's own December 2020 analysis found that this active ingredient could continue to be safely used on eleven different crops, including sugarbeets. The data just does not support a revocation of Chlorpyrifos tolerances for sugarbeets and it clearly does not make any sense to revoke a tolerance that the EPA has found to be safe for sugarbeets.

It is vitally important to our Cooperative to continue to have Chlorpyrifos available as insecticide in our arsenal to control SBRM and other insect pests. Given that the EPA has indicated using Chlorpyrifos on sugarbeets is safe, I strongly urge you to find a way to allow the continued use of this for sugarbeets without revoking the tolerance. Minn-Dak Farmers Cooperative requests the Agency stay implementation of the rule until our objections and those of others in the industry can be formally addressed by EPA. Sugarbeets are a relatively small acreage crop compared to others and keeping crop protection products labeled that are proven to work in a safe and effective manner is crucial as there are very few tools and options available. Sugarbeets have a major impact on the viability of farms and production agriculture in our region, it is important that you allow us to continue to be good stewards of this product.

Thank you for your consideration.

Sincerely,

Mike Metzger, Ph.D.
Vice President – Agriculture & Research
Minn-Dak Farmers Cooperative

EXHIBIT F

American Sugarbeet Growers Association/U.S. Beet Sugar Association Objections to Decision Revoking All Chlorpyrifos Tolerances With Request for Evidentiary Hearing Under 21 U.S.C. § 34a(g)(2)(B)

October 29, 2021

October 29, 2021

Via EPA E-Filing System and Federal eRulemaking Portal

U.S. Environmental Protection Agency
Office of Administrative Law Judges
Mail Code 1900R
1200 Pennsylvania Ave., NW
Washington, DC 20460

RE: Objections to Decision Revoking All Chlorpyrifos Tolerances (EPA-HQ-OPP-2021-0523)

To Whom It May Concern:

Under Section 408(g) of the Federal Food, Drug, and Cosmetic Act (FFDCA), 21 U.S.C. § 346a(g), the American Sugarbeet Growers Association (ASGA) and the U.S. Beet Sugar Association (USBSA) (collectively, the "Associations") hereby submit their objections to the U.S. Environmental Protection Agency's (EPA or the "Agency") August 30, 2021 decision to revoke all tolerances for the insecticide chlorpyrifos (the "Final Rule").[1] The Final Rule is inconsistent with the Agency's own scientific record on chlorpyrifos with respect to the safety of certain uses. It is also inconsistent with the requirements of applicable statutes and regulations, as well as a court order. This arbitrary decision causes unnecessary and irreparable harm to the Associations' members, the growers and manufacturers of beet sugar. Based on our objections, we request that the Final Rule be immediately reversed, or, at the very least, amended to reflect modification of the tolerances for sugarbeets consistent with the Agency's safety findings. We also request a stay of the effective date of the Final Rule to allow EPA time to respond to these objections, including consideration of maintaining the tolerances for sugarbeets,[2] without unduly and irreparably harming our members.[3]

I. INTRODUCTION

A. The American Sugarbeet Growers Association and the U.S. Beet Sugar Association

[1] Chlorpyrifos; Tolerance Revocations, 86 Fed. Reg. 48,315 (Aug. 30, 2021).
[2] There are four beet sugar tolerances; we request EPA retain each of them: (1) Beet, sugar, dried pulp, 5.0 parts per million (ppm); (2) Beet, sugar, molasses, 15 ppm; (3) Beet, sugar, roots, 1.0 ppm; and (4) Beet, sugar, tops, 8.0. 40 C.F.R. § 180.342(a)(1).
[3] *See* American Sugarbeet Growers Association and U.S. Beet Sugar Association, *Request for a Stay of Decision Revoking All Chlorpyrifos Tolerances* (EPA-HQ-OPP-2021-0523) (filed concurrently with these objections, requesting, at a minimum, a stay as to the 11 safe uses identified in the EPA's December 2020 Proposed Interim Decision for Chlorpyrifos, EPA-HQ-OPP-2008-0850-0971).

The American Sugarbeet Growers Association and the U.S. Beet Sugar Association represent farmer-owners and manufacturers that both grow and process over 56 percent of all sugar produced in the United States. ASGA's members associations represent 10,000 family farmers. And USBSA's nine manufacturing firms operate 21 factories that process refined white sugar, molasses, and dried beet pulp from sugarbeets. Together, we account for 1.2 million acres grown in 11 states: California, Colorado, Idaho, Michigan, Minnesota, Montana, Nebraska, North Dakota, Oregon, Washington, and Wyoming. Our farmers and farmer-owned processing facilities account for over 100,000 rural jobs, and contribute over $10.6 billion annually to the U.S. economy. The U.S. beet sugar industry has become a global leader in environmental sustainability as we have invested in significant programs that preserve our natural resources, family farms, unionized workforces, and rural communities for future generations. As a result, our industry now produces 29 percent more sugar on 8 percent less land than 20 years ago, and sugarbeets now require significantly less land, water, fuel and fewer pesticide inputs to grow.

Our industry depends significantly on chlorpyrifos as a critical, and in certain circumstances the only, crop protection tool available to fight pests and to meet the sugar demands of the U.S. food economy. In 2020, EPA recognized the high total benefits of chlorpyrifos use, estimating high-end benefits to be up to $32.2 million per year for sugarbeets.[4] This estimate is likely an underestimate.[5] According to EPA's own estimates, the per acre benefits of chlorpyrifos could be as high as $500 in parts of Minnesota and North Dakota, leading to Agency-estimated high-end benefits over $30 million overall.[6] And EPA acknowledges the lack of alternatives leading to potential yield loss in sugarbeet crops in Minnesota and North Dakota.[7] Losing chlorpyrifos as a critical tool would be devastating to our growers. As another example, Oregon seed production growers estimate that without chlorpyrifos they would suffer between $251,000 and $753,000 in revenue losses just from loss of seed production due to symphylan (garden centipede) damage.[8]
One of the primary pest targets for chlorpyrifos use in sugarbeets is the sugarbeet root maggot (SBRM). Chlorpyrifos is the most effective post-emergence liquid insecticide available for the control of SBRM flies. Registered alternatives to chlorpyrifos can only suppress SBRM, not

[4] U.S. EPA, Memorandum, Revised Benefits of Agricultural Uses of Chlorpyrifos (PC# 059101), EPA-HQ-OPP-2008-0850-0969, at 49 (Nov. 18, 2020) [hereinafter, "Benefits Analysis"], https://www.regulations.gov/document/EPA-HQ-OPP-2008-0850-0969. For all agricultural uses of chlorpyrifos, EPA estimated the "total annual economic benefit of chlorpyrifos to crop production is estimated to be $19 - $130 million." U.S. EPA, Proposed Interim Decision for Chlorpyrifos, EPA-HQ-OPP-2008-0850-0971, at 39 (Dec. 3, 2020) [hereinafter, "PID"], https://www.regulations.gov/document/EPA-HQ-OPP-2008-0850-0971.
[5] We believe EPA has underestimated the percent crops treated with chlorpyrifos in their underlying benefits analysis, thus leading to an underestimate of benefits of chlorpyrifos in the PID. The Benefits Analysis notes that in states other than MN and ND, the percent crop treated (PCT) is 9%. Benefits Analysis at 10. Kynetec data for 2014–2018, however, show that for Idaho the PCT is 40–80%. U.S. EPA, Memorandum, Chlorpyrifos (059101) National and State Use and Usage Summary, EPA-HQ-OPP-2008-0850-0968, at 10 (Apr. 1, 2020), https://www.regulations.gov/document/EPA-HQ-OPP-2008-0850-0968. It is not clear that EPA appropriately accounted for this when averaging Idaho with other states. We also note the importance of an accurate tally of all states in which sugarbeets are grown. *Compare* PID at 41 (listing IL, LA, and WI as states that grow sugarbeets, and omitting WY), *with* Use Summary at 5, 10 (not listing IL, IA, and WI, but including WY).
[6] PID at 42.
[7] Benefits Analysis at 5.
[8] Chlorpyrifos is the only fully registered rescue option available in early spring to control symphylans and is typically applied on 25% to 33% of total sugarbeet seed production acres.

control it, or are only registered for use on adult flies, not larvae.[9] It is important to note, however, that not all sugarbeet acres are treated with chlorpyrifos each crop year. Chlorpyrifos applications for SBRM fly control are made only after determining there is a need,[10] and are targeted to specific areas of need based on monitoring of the sugarbeet growing geography.

B. Statutory Authority

i. FFDCA Tolerance Revocations

The FFDCA requires EPA to set food safety "tolerances," the maximum levels of pesticide residue allowed in or on food.[11] EPA "may establish or leave in effect a tolerance for a pesticide chemical residue in or on a food only if the Administrator determines that the tolerance is safe" and "shall modify or revoke a tolerance if the Administrator determines it is not safe."[12] When establishing, modifying, or revoking a tolerance, EPA must consider, among other things, "the validity, completeness, and reliability of the available data from studies of the pesticide chemical and pesticide chemical residue."[13]

The Food Quality Protection Act (FQPA) amended the FFDCA to establish, among other things, a safety standard for pesticide tolerances pertaining to pesticide residues in or on raw agricultural commodities, such as sugarbeets. Such a tolerance is deemed "safe" if "there is a reasonable certainty that no harm will result from aggregate exposure to the pesticide chemical residue, including all anticipated dietary exposures and all other exposures for which there is reliable information."[14] This provision contemplates exposures from food, drinking water, and in residential settings, but *not* occupational exposure. When assessing "reasonable certainty of no harm," EPA applies an additional tenfold ("10x") margin of safety "to take into account potential pre- and post-natal toxicity and completeness of the data with respect to exposure and toxicity to infants and children."[15] The Agency may, however, apply a different margin of safety—for instance, a 1x safety factor—if there is "reliable data" to support doing so.[16]

ii. Tolerance Revocation and FIFRA

When revoking a tolerance "for a pesticide chemical residue in or on food, the Administrator shall coordinate such action with any related necessary action under [FIFRA]."[17] That related action may be canceling that pesticide's registration and entering an "existing stocks" order under which

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[9] David Franzen, et al., North Dakota State University, 2021 Sugarbeet Production Guide (Jan. 2021), https://www.ag.ndsu.edu/publications/crops/sugarbeet-production-guide.
[10] *See Comment submitted by Joe Hastings, General Agronomist, American Crystal Sugar Company*, EPA-HQ-OPP-2008-0850-0978), https://www.regulations.gov/comment/EPA-HQ-OPP-2008-0850-0978 (comment submitted on EPA's Notice of Proposed Interim Decision for Chlorpyrifos, EPA-HQ-OPP-2008-0850-0964).
[11] 21 U.S.C. § 346a.
[12] *Id.* § 346a(b)(2)(A)(i).
[13] *Id.* § 346a(b)(2)(D)(i).
[14] *Id.* § 346a(b)(2)(A)(ii).
[15] *Id.* § 346a(b)(2)(C)(ii)(II).
[16] *Id.*
[17] *Id.* § 346a(l)(1).

EPA may "permit the continued sale and use of existing stocks of a pesticide whose registration is suspended or cancelled."[18]

C. The Agency's Decision to Revoke All Chlorpyrifos Tolerances

On August 30, 2021, EPA issued a Final Rule revoking *all* tolerances for chlorpyrifos.[19] EPA stated that "given the currently registered uses of chlorpyrifos, EPA cannot determine that there is a reasonable certainty that no harm will result from aggregate exposure to residues, including all dietary (food and drinking water) exposures and all other exposures for which there is reliable information," notwithstanding the FQPA 10x safety factor to address "uncertainties" in relevant epidemiology studies.[20] At the same time, however, EPA re-acknowledged or confirmed findings from its December 2020 Proposed Interim Decision (PID). For instance, regarding aggregate exposure, EPA confirmed that "exposures from food and non-occupational exposures individually or together do not exceed EPA's levels of concern,"[21] and only the combination of drinking water exposures with food and non-occupational exposures would raise the risk of concern.[22] Consistent with the PID, the Agency acknowledged that drinking water exposures associated with use on only 11 enumerated crops in specific regions do not exceed levels of concern.[23] EPA even admitted that "there may be limited combinations of uses that could be safe."[24]

As described in the Final Rule, EPA's action was against the backdrop of many years of administrative process and litigation surrounding chlorpyrifos. In 2007, several nongovernmental organizations (NGOs) petitioned EPA to revoke all chlorpyrifos tolerances. After years of delay, EPA issued an order denying that petition (2017) and subsequently denied the NGOs' objections made to that order (2019).[25] After additional litigation, on April 29, 2021, the U.S. Court of Appeals for the Ninth Circuit vacated both denials. On remand, the Court ordered the Agency to:

> [I]ssue a final regulation within 60 days following issuance of the mandate that either (a) revokes all chlorpyrifos tolerances or (b) modifies chlorpyrifos tolerances and simultaneously certifies that, with the tolerances so modified, the EPA "has determined that there is a reasonable certainty that no harm will result from aggregate exposure to the pesticide chemical residue, including all anticipated dietary exposures and all other exposures for which there is reliable information," including for "infants and children"; and . . . modify or cancel related FIFRA registrations for food use in a timely fashion consistent with the requirements of 21 U.S.C. § 346a(a)(1).[26]

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[18] 7 U.S.C. § 136d(a), (b).
[19] 86 Fed. Reg. at 48,315.
[20] *Id.* at 48,317.
[21] *Id.* at 48,333.
[22] *Id.*
[23] *Id.* The 11 uses that EPA determined to be high-benefit, critical crop uses are alfalfa, apple, asparagus, cherry, citrus, cotton, peach, soybean, **sugarbeet**, strawberry, and wheat. PID at 15–17.
[24] 86 Fed. Reg. at 48,333.
[25] *See League of United Latin Am. Citizens v. Regan*, 996 F.3d 673, 680–90 (9th Cir. 2021) ("*LULAC*") (detailing procedural history beginning with 2007 petition).
[26] *Id.* at 703–04.

The Court's order made clear that EPA could "choose to modify chlorpyrifos tolerances, rather than to revoke them," if the decision included the required safety determination.[27] In issuing its decision, the Court was aware of EPA's PID for chlorpyrifos, which had identified 11 uses of chlorpyrifos, including for sugarbeets, that could continue even if the Agency applied the 10x FQPA safety factor. The Court explained:

> [D]uring the pendency of this proceeding, in December 2020, the EPA issued a Proposed Interim Registration Review Decision proposing to modify certain chlorpyrifos tolerances. The EPA also convened another [Scientific Advisory Panel] in 2020. If, based upon the EPA's further research the EPA can now conclude to a reasonable certainty that modified tolerances or registrations would be safe, then it may modify chlorpyrifos registrations rather than cancelling them.[28]

Four months later, EPA published its Final Rule in response to the Court's order. Yet, rather than modify tolerances consistent with its own preliminary findings that 11 crop uses in select regions were safe,[29] the Agency chose to revoke *all* chlorpyrifos tolerances. EPA set tolerances to expire on February 28, 2022, a mere six months from publication of the Final Rule.

II. OBJECTIONS

The Associations object to EPA's flawed decision on multiple grounds. The Agency turned a blind eye to scientific data and safety findings in its own PID, improperly canceling tolerance uses that the Administrator can and should leave in effect under the requirements of the FFDCA. The Agency also failed to comply with the FFDCA and the Ninth Circuit's order by failing to harmonize its revocation decision with FIFRA. In addition, EPA abused its discretion by taking an overly cautious risk assessment approach based on hedging for uncertainty. The Agency also failed to consider other relevant scientific information and comments entirely, thus depriving stakeholders of due process. In addition to these flaws, EPA did not address the implications of its decision on existing stocks of chlorpyrifos products. Further, the Agency failed to undertake proper interagency review of the Final Rule before it was issued.

For these reasons, and because of the unnecessary, significant, imminent, and irreparable harm the Associations' members will suffer because of EPA's decision to revoke *all* tolerances,[30] the Final Rule should immediately be reversed, or, at the very least, amended to leave in effect the tolerances for sugarbeets consistent with the Agency's safety findings.

A. EPA's Failure to Rely on Its Own Prior Safety Findings for Eleven High-Benefit Crop Uses and to Harmonize those Findings with the FIFRA Registrations is Arbitrary and Capricious.

EPA's stated rationale for the revocation of *all* tolerances was that it could not make a safety finding for all current chlorpyrifos registered uses. As discussed further below, the Associations

[27] *Id.* at 702.
[28] *Id.* at 703.
[29] *See* PID at 40.
[30] As set out in detail in the Associations' accompanying stay request. *See* note 3*, supra*.

object generally on the grounds that EPA failed to base its decision on best available science for all uses and tolerances, for example by relying on the 2016 Drinking Water Assessment instead of the refined 2020 Drinking Water Assessment. But the Agency's decision to revoke *all* tolerances—including 11 high-benefit crop uses in specific regions that it previously identified in its PID as safe, such as sugarbeets—is arbitrary and capricious and otherwise not in accordance with the FFDCA. The PID carefully considered 11 crop uses in specific regions and determined that those uses "will not pose potential risks of concern with an FQPA safety factor 10x."[31] But even after reaffirming the PID's safety findings in the Final Rule, EPA simply refused to apply those findings when it determined to revoke the tolerances for the safe high-benefit crop uses. EPA clearly has the necessary data, the ability, and the authority to preserve the tolerances for these 11 uses. Not leaving the tolerances in effect for these 11 uses when the record supports doing so is arbitrary and capricious.[32]

EPA justified its decision by assuming that all currently registered uses are the baseline against which it must make its FFDCA safety evaluation. The Final Rule states that "the Agency's analysis indicates that aggregate exposures (i.e., exposures from food, drinking water, and residential exposures), ***which stem from currently registered uses***, exceed safe levels, when relying on the well-established 10% red blood cell acetylcholinesterase (RBC AChE) inhibition as an endpoint for risk assessment . . . ."[33] But nothing in the FFDCA or the Ninth Circuit's order directs that approach; in fact they encourage the opposite. Section 408(b)(2) of the FFDCA directs that EPA may "leave in effect a tolerance . . . if the Administrator determines that the tolerance is safe."[34] And "[t]he Administrator shall modify or revoke a tolerance if the Administrator determines it is not safe."[35] In making this finding, EPA must consider the "result from aggregate exposure to the pesticide chemical residue, including all anticipated dietary exposures and all other exposures for which there is reliable information."[36]

The Final Rule's conclusion that EPA cannot make the required safety finding is premised on a faulty baseline of *all* chlorpyrifos tolerances and *all* chlorpyrifos registrations remaining in place. EPA is fully capable of cancelling the tolerances where it cannot make the FFDCA safety finding and leaving in place the tolerances for the 11 safe uses, including sugarbeets. To fail to leave in effect the 11 tolerances for which the PID's science-based conclusions have already supported a safety finding runs afoul of the express direction in Section 408(b)(2). And nowhere in the Final Rule does EPA claim that this approach is unavailable to it. Accordingly, if EPA has the authority and necessary scientific support to lawfully leave in effect the tolerances for the 11 uses, yet it chooses to revoke these tolerances on the false premise that it cannot tailor its decision appropriately under FFDCA and FIFRA, it has significantly misapprehended its legal authority.

[31] PID at 40. We also object to EPA's specific application of the 10x FQPA safety factor "to account for uncertainties" in relevant epidemiological studies. EPA improperly inserted data from studies that, by its own admission, were incomplete and unreliable, to support application of the 10x safety factor. EPA is authorized to make decisions based on valid, complete, and reliable data in its safety analysis. *See* 21 U.S.C. § 346a(b)(2)(D)(i). The Agency's misapplication of that authority is an abuse of discretion.
[32] The Associations request an evidentiary hearing under 21 U.S.C. § 346a(g)(2)(B) to demonstrate that the best available science, including EPA's 2020 PID, supports a finding that the tolerances for sugarbeets can remain in effect.
[33] 86 Fed. Reg. at 48,333 (emphasis added).
[34] 21 U.S.C. § 346a(b)(2)(A)(i).
[35] *Id.*
[36] 86 Fed. Reg. at 48,333 (quoting 21 U.S.C. § 346a(b)(2)).

This conclusion also sets a very negative precedent that the Agency could broadly revoke all tolerances, regardless of whether registrants, users, or EPA's own career scientists, have demonstrated the safety of the continued food use of a pesticide under the proper set of conditions on specific crops. EPA's all or nothing approach could be very damaging to pesticide programs in the future if it is allowed to stand.

Beyond EPA's clear ability to leave in effect a subset of chlorpyrifos tolerances for the 11 safe uses, EPA's faulty baseline also ignores its legal obligations under FFDCA to harmonize a tolerance revocation with FIFRA—that is, where the Agency revokes a tolerance, it must take corresponding action under FIFRA regarding the relevant registration. The FFDCA states in relevant part:

> (1)Coordination with FIFRA
>
> To the extent practicable and consistent with the review deadlines in subsection (q), in issuing a final rule under this subsection that suspends or revokes a tolerance or exemption for a pesticide chemical residue in or on food, ***the Administrator shall coordinate such action with any related necessary action under the Federal Insecticide, Fungicide, and Rodenticide Act*** [7 U.S.C. 136 et seq.].[37]

This is a statutory duty. The statutory scheme for food uses of pesticides obviously contemplates tolerances and registrations to work in concert. The Final Rule offers no explanation why it is not "practicable" to cancel the FIFRA registrations and the tolerances for the food uses where EPA cannot make a safety finding,[38] while maintaining the registrations and tolerances that the 2020 PID found to be safe.[39] By not proposing this alternative or offering any discussion of this more tailored approach EPA disregarded its statutory duty to coordinate its tolerance revocation decisions with FIFRA. Moreover, nothing prevented EPA from using a baseline in its revocation decision that assumes the continued registration for only the 11 uses. The failure to even analyze an alternative baseline in the Final Rule, which is safe yet less burdensome to the agriculture sector, demonstrates that EPA has not considered all aspects of the problem, and is therefore arbitrary and capricious.

What is more, the Ninth Circuit expressly ordered the Agency on remand to "correspondingly modify or cancel related FIFRA registrations for food use in a timely fashion" when issuing a final decision to revoke or modify the chlorpyrifos tolerances.[40] The Court recognized that the PID

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[37] 21 U.S.C. § 346a(l)(1) (emphasis added).

[38] *See* Gharda Chem. Int'l, Inc., Objections to the Final Rule Revoking All Tolerances for Chlorpyrifos, EPA-HQ-OPP-2021-0523, at 30 (noting that registrant voluntarily agreed with EPA to cancel unsafe registrations). *See generally* Part III.I, *infra* (incorporating by reference Gharda's comments, among others).

[39] The Final Rule provides for no corresponding action regarding chlorpyrifos registrations. Nor do the answers on EPA's Final Rule FAQ webpage, launched after the Final Rule was issued, provide any guidance. There, at most, the Agency paid mere lip service to its duty to take action on registrations by stating, without any elaboration on process or timing, that it "intends to cancel registered food uses of chlorpyrifos associated with the revoked tolerances under FIFRA, as appropriate." U.S. EPA, Frequent Questions About the Chlorpyrifos 2021 Final Rule, Question 9, https://www.epa.gov/ingredients-used-pesticide-products/frequent-questions-about-chlorpyrifos-2021-final-rule#question-9.

[40] *LULAC*, 996 F.3d at 678, 703–04.

contemplated modifying certain tolerances and that it was possible for EPA to do so if it made the safety determination based on the PID's findings.[41] Thus, EPA's failure to harmonize its decision with FIFRA is not only a failure to uphold a statutory duty but also is inconsistent with a Court order.

EPA's communications with the Associations after issuing the Final Rule demonstrate that EPA has no concern that the sugarbeet tolerances can be safely retained. EPA invited stakeholders to submit questions regarding its revocation decision, and the Associations submitted questions, including asking about sugarbeet residue data. In answering, the Agency reminded the Associations that "chlorpyrifos risks from food, including sugar from sugar beets and all other foods, is very low *and not of concern*; sugar beets are not expected to contribute significant risk to the total dietary exposure. The primary contribution to overall chlorpyrifos risks is from residues in drinking water."[42] Consistent with this communication, the Agency could easily make a safety finding for sugarbeets based on the PID and thereby leave in effect the existing tolerances for sugarbeets (as well as the 10 other safe uses). Yet, EPA has decided to subject the Associations to additional administrative processes by leaving them no recourse but to seek new use tolerances for sugarbeets. The burden on the Associations to establish new use tolerances for sugarbeets would be incredibly heavy both procedurally and because of the preventable crop losses that will occur in the interim while EPA considers setting a new tolerance.[43] It makes no sense to subject the Associations to that protracted, costly endeavor where, based on all the information it has available to it, EPA could easily leave in place the tolerances (and registrations) for a food use—sugarbeets—that it has deemed safe.

The Associations object to the unnecessary manner in which EPA erects all of the existing registered chlorpyrifos uses as an impediment that allegedly forces EPA to cancel the tolerances for the 11 uses found safe in the PID along with all other uses of chlorpyrifos. This approach is pretextual, not supported by sound science, and fails to adhere to the FFDCA and the Court's order.[44] EPA should at a minimum preserve the tolerances for the 11 uses and harmonize any modifications needed (if any) on the registrations for those uses, and it should stay the effective date of the Final Rule to allow for this work if necessary. Sugarbeet growers will suffer severe economic harm when the revocation takes effect if EPA fails to address these issues.

B. In Issuing an Unnecessary and Overbroad Revocation of the Tolerances EPA Failed to Adequately Consider the Beet Sugar Industry's Reliance Interests.

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[41] *Id.* at 703.

[42] Letter from Mr. Ed Messina, EPA, to Ms. Cassie Bladow and Mr. Luther Markwart, 5 (Oct. 12, 2021) [hereinafter, "Messina Letter"] (emphasis added) (attached hereto as "Attachment A").

[43] *See* U.S. EPA, PRIA Fee Category Table - Registration Division - New Uses, https://www.epa.gov/pria-fees/pria-fee-category-table-registration-division-new-uses (last visited Oct. 28, 2021) (for action code R150, new food use, listing the decision time as 21 months and an application fee of $349,608; and, for action code R170, additional food use, listing the decision time as 15 months and an application of $87,483).

[44] *See LULAC*, 996 F.3d at 678, 703–04 (instructing that EPA "may modify chlorpyrifos registrations rather than cancelling them," "[i]f, based upon the EPA's further research," namely the 2020 PID as well as a 2020 Scientific Advisory Panel, "EPA can now conclude to a reasonable certainty that modified tolerances or registrations would be safe"; and expressly ordering EPA to "correspondingly modify or cancel related FIFRA registrations for food use in a timely fashion" when issuing a final decision to revoke or modify the chlorpyrifos tolerances).

"When an agency changes course, . . . it must 'be cognizant that longstanding policies may have engendered serious reliance interests that must be taken into account.'"[45] The agency is "required to assess whether there were reliance interests, determine whether they were significant, and weigh any such interests against competing policy concerns."[46]

EPA's overbroad revocation upends decades of Agency-approved chlorpyrifos use, where EPA otherwise could lawfully and based on sound science leave in effect the tolerances for the 11 high-benefit crops—including sugarbeets. The Final Rule fails to consider the sugarbeet growers' and processors' reliance interests in applying safe and effective pesticides. Had EPA properly weighed those significant interests, it would have left the tolerances in effect for which it could have made a safety finding under the FFDCA, while revoking the tolerances where it could not. By this failure, EPA improperly minimized the interests of a multi-billion dollar industry that is responsible for over 100,000 jobs, and that has relied on chlorpyrifos for decades to grow and process over half of all sugar produced in the United States. "It w[as] arbitrary and capricious to ignore such matters."[47]

C. EPA's Decision is Highly Conservative and Overly Protective.

The Associations also object because the scientific record is highly conservative and unnecessarily protective. We focus on two main areas in EPA's general risk evaluation approach, which includes compounded conservative assumptions.

i. EPA Misapplies the 10x FQPA Factor.

The weight of the evidence does not support the use of epidemiology data to apply a Food Quality Protection Act (FQPA) 10x safety factor for chlorpyrifos. In the Final Rule, EPA applies the 10x safety factor to address the "uncertainties surrounding the potential for adverse neurodevelopmental outcomes."[48] This is a highly conservative approach. EPA has been unable to establish any plausible biological explanation for the reported neurodevelopmental associations. For 10 years EPA has sought to address neurodevelopmental effects of chlorpyrifos and as stated in the Final Rule "these efforts ultimately concluded with the lack of a suitable regulatory endpoint based on these potential effects."[49] EPA determined that the most appropriate toxicological endpoint for assessing chlorpyrifos risks is to continue to use cholinesterase inhibition.[50] The 10x FQPA safety factor is admittedly applied by EPA as a "presumption" and is not based on reliable or sufficiently valid evidence. The concerns with the epidemiology data have been repeatedly presented to EPA, including most recently by the OP Coalition.[51] In fact, EPA has never been able to verify the conclusions of the epidemiology studies, and due to EPA's inability to receive the underlying data from the researchers, EPA likely will never be able to verify the conclusions of these studies. Yet these unsupported and unreliable data are inappropriately used by EPA to

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[45] *Dep't of Homeland Sec. v. Regents of the Univ. of California*, 140 S. Ct. 1891, 1913 (2020) (quoting *Encino Motorcars, LLC v. Navarro*, 136 S. Ct. 2117, 2126 (2016)).
[46] *Id.* at 1915.
[47] *Id.* at 1913 (quoting *Encino*, 136 S. Ct. at 2126).
[48] 86 Fed. Reg. at 48,325.
[49] *Id.* at 48,322.
[50] *Id.* at 48,325.
[51] *See generally* Part III.I, *infra* (incorporating by reference OP Coalition's comments, among others).

support application of the 10x safety factor. While the FQPA provides that a different safety factor may be used if based on "reliable data," EPA takes a highly conservative approach by choosing to keep the 10x safety factor based on these unreliable data. If these unreliable epidemiological studies were removed from consideration, there would be no justification for maintaining the 10x safety factor as the rest of the scientific record clearly supports a safety factor of 1x.

ii. EPA's Use of the 2016 Drinking Water Assessment is Highly Conservative and Inaccurate.

The Final Rule acknowledges that the 2016 Drinking Water Assessment was refined to better account for variability and to better estimate regional and watershed drinking water concentrations.[52] These refinements underwent peer review, as described in the Final Rule and resulted in the release of a September 2020 refined drinking water assessment.[53] The refinements included incorporating new surface water modeling scenarios, the quantitative use of surface water monitoring data, new methods for considering the entire distribution of community water systems percent cropped area and integration of state level crop treated data using percent crop treated factors. However, in deciding to revoke all chlorpyrifos tolerances, EPA simply ignored the 2020 highly-refined assessment and used the less-refined 2016 Drinking Water Assessment.

On March 23, 2021, EPA Administrator Regan reaffirmed scientific integrity as a core value at EPA and noted that EPA's "ability to pursue its mission to protect human health and the environment depends upon the integrity of the science on which it relies."[54] By relying on an admittedly outdated water assessment in a final regulatory action, when a more robust assessment exists and is available, EPA is failing to meet its own standards of scientific integrity and excellence. The 2020 refined drinking water assessment represents the best available science, yet EPA arbitrarily and capriciously opted to rely on the earlier 2016 assessment. EPA explained:

> While the 2020 DWA produced estimated drinking water concentrations that were below the DWLOC of 4.0 ppb, those EDWCs were contingent upon a limited subset of chlorpyrifos use. When assessing different combinations of only those 11 uses in specific geographic regions, the modeling assumed that chlorpyrifos would not be labeled for use on any other crops and would not otherwise be used in those geographic regions. At this time, however, the currently registered chlorpyrifos uses go well beyond the 11 uses in the specific regions assessed in the 2020 DWA. Because the Agency is required to assess aggregate exposure from all anticipated dietary, including food and drinking water, as well as residential exposures, the Agency cannot rely on the 2020 DWA to support currently labeled uses.[55]

EPA's explanation does not address the primary issue. The 2020 DWA, a robust, refined study, clearly supported a safety finding for the 11 enumerated uses in specific geographic regions. But

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[52] *Id.* at 48,332.
[53] *See generally* U.S. EPA, Memorandum, Updated Chlorpyrifos Refined Drinking Water Assessment for Registration Review, EPA-HQ-OPP-2008-0850-0941 (Sept. 15, 2020), https://www.regulations.gov/document/EPA-HQ-OPP-2008-0850-0941.
[54] *See* Michael S. Regan, Message from the Administrator (Mar. 23, 2021), https://www.epa.gov/sites/default/files/2021-03/documents/regan-messageonscientificintegrity-march232021.pdf.
[55] 86 Fed. Reg. at 48,333.

EPA maintained that it could not use the regionally focused 2020 DWA to support all currently labeled uses. But the Ninth Circuit ordered EPA to *modify* tolerances if the data and information supported a safety finding, *and* to accordingly modify or cancel registrations. EPA had the ability and all the information it needed to modify registrations for these 11 uses. There is no adequate explanation in the Final Rule for rejecting this more tailored approach.

iii. EPA Failed to Adequately Consider Relevant Scientific Data and Information.

Because of EPA's excessive delays in this matter, the Ninth Circuit specifically chose not to remand to the Agency for further fact finding, but rather directly ordered the Agency to revoke or modify the chlorpyrifos tolerances based on the abundant data and information the Agency had on hand.[56] The Court believed that EPA could make its final decision based on that information. Yet, the Agency managed to ignore substantial pieces of information and data, including in comments and studies challenging EPA's 2016 DWA, among other things. The Agency's refusal to properly consider them resulted in a decision based on incomplete analysis, which affects all stakeholders, including the Associations and the growers and processors they represent.

D. EPA Has Failed to Respond to Comments Throughout this Process, thus Depriving the Stakeholders of Due Process.

EPA has failed to respond to comments throughout the history of this matter, namely, the over 90,000 comments the Agency received on its 2015 proposed rule to revoke tolerances. The Agency's failure to consider pertinent information and respond to comments deprives all stakeholders of their due process rights and renders the Final Rule arbitrary and capricious.

E. EPA Failed to Adequately Address the Revocation's Implications for Existing Stocks of Chlorpyrifos Products.

Related to its failure to perform its statutory and court-ordered duty to take action on chlorpyrifos registrations, EPA also failed to adequately address its broad revocation's implications for existing stocks of chlorpyrifos products. Again, on this issue, the Final Rule says nothing. And the FAQ webpage offers no workable guidance. There, the Agency has reasoned that because it "has not cancelled any chlorpyrifos products as a result of the final tolerance rule," "there are no existing stocks at this time."[57] That statement simply ignores that end-users like sugarbeet growers may have large inventories of chlorpyrifos products, the proper handling of which will be unclear once the tolerance revocation takes effect.

FIFRA authorizes EPA not only to cancel or suspend pesticide registrations[58] but also to issue existing stock orders, which allows for "the continued sale and use of existing stocks of a pesticide

[56] *LULAC*, 996 F.3d at 702–03.
[57] U.S. EPA, Frequent Questions About the Chlorpyrifos 2021 Final Rule, Question 9, https://www.epa.gov/ingredients-used-pesticide-products/frequent-questions-about-chlorpyrifos-2021-final-rule#question-9.
[58] 7.U.S.C. § 136d(a), (b).

whose registration is suspended or cancelled."[59] These orders are imperative to ensuring the safe handling of pesticide products that can no longer be used. Here, EPA has revoked all chlorpyrifos tolerances and has stated that once that revocation takes effect, "sale and distribution of chlorpyrifos products labeled for use on food crops would be considered misbranded; therefore, it would be a violation of FIFRA to sell and distribute those products."[60] But EPA fails to fulfill its duty under FIFRA to facilitate proper handling of existing stocks. As a result, sugarbeet growers have no clear path for handling existing stocks, which would cause nothing but undue confusion, increased risk of legal liability, and excess costs incurred as they attempt to navigate these waters without agency guidance.

F. EPA's Final Rule Failed to Comply with the Interagency Review Process, Thereby Denying Stakeholders an Opportunity to Participate in the Process.

In effect since 1993, Executive Order 12866, sought "to restore the integrity and legitimacy of regulatory review and oversight; and to make the process more accessible and open to the public."[61] These important goals have been respected by all Presidents and administrations since 1993. Executive Order 12866 requires that significant regulatory actions go to the Office of Management and Budget (OMB) for coordinated interagency review. Significant regulatory actions are defined to include regulatory actions that "[h]ave an annual effect on the economy of $100 million or more or adversely effect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities."[62] Further, in 1993 guidance, OMB clarified that while some actions regarding tolerances were exempt from OMB review, an OMB review was still required for actions "that make an existing tolerance more stringent."[63]

EPA's Final Rule clearly meets the significant regulatory action criteria in Executive Order 12866 and as a rulemaking which makes a tolerance more stringent (by effectively revoking it to make the tolerance equivalent to zero), this rulemaking clearly should have undergone interagency review as directed by the Executive Order. In responding to questions about the bypassed review process, EPA has stated that "[t]he court-ordered deadline that the Agency was subject to comply with for this action resulted in the rapid timeline for this final rule."[64] EPA did not deny that the Final Rule should have gone to OMB for review. However, there are no exceptions in Executive Order 12866 for rapid timelines, and OMB has a history of accommodating reviews that are shorter than the typical 90 day review. While the OMB review process is limited to 90 days in the Executive Order, there is no minimum period for review. As such, EPA should have submitted this rule to OMB. Such a review not only would have afforded EPA the benefit of valuable feedback from other agencies, including the United States Department of Agriculture (USDA), but also it would have allowed our greatly impacted industry to voice our concerns with EPA and other agencies, including White House officials. As EPA noted in the PID and Benefits Analysis, our

[59] *Id.* § 136d(a)(1).
[60] *Id.*
[61] Exec. Order No. 12866, Regulatory Planning and Review, 58 Fed. Reg. 51,735 (Oct. 4, 1993).
[62] *Id.* § 3(f)(1).
[63] OMB, Memorandum for Heads of Executive Departments and Agencies and Independent Regulatory Agencies on Guidance for Implementing E.O. 12866, M-94-3, app. C at 15 (Oct. 12, 1993), https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/assets/inforeg/eo12866_implementation_guidance.pdf.
[64] Messina Letter at 10.

industry is highly impacted by EPA's revocation of the tolerances for sugarbeets and had we been afforded the opportunity, we believe our compelling facts would have altered the outcome of the Final Rule which ignored EPA's own science and arbitrarily and capriciously revoked the chlorpyrifos tolerances for all food uses.

G. Publicly Available Data Show No Residues of Chlorpyrifos on Sugarbeets and Sugarbeet Products.

While tolerances exist for sugarbeet roots, sugarbeet tops, dried beet pulp, and sugarbeet molasses, the record shows that no residues have ever been detected. As such, analyses conducted by EPA using the tolerance level as an exposure level are highly conservative. The data do not support the need for tolerances for sugarbeets and sugarbeet products. FDA's own Total Diet Study[65] shows no chlorpyrifos in processed sugar. In addition, residue data tests conducted by American Crystal Sugar Company, which has been testing products since 2016, have found no residues on sugarbeet products, including on crystallized sugar, molasses, and dried pulp.[66] EPA's own Pesticide Monitoring Program Fiscal Year 2016 Pesticide Report does not mention any findings of residues of chlorpyrifos on sugarbeets, sugarbeet tops, or any sugarbeet products (beet sugar, dried pulp, or molasses).[67] The Associations object to the extent that EPA assumed in the Final Rule that sugarbeets are a source of chlorpyrifos in the food supply.

H. EPA Appears to Have Considered Factors that it Could Not Lawfully Consider Under the FFDCA.

The safety standard for pesticide tolerances under the FQPA is whether "there is a reasonable certainty that no harm will result from aggregate exposure to the pesticide chemical residue, including all anticipated dietary exposures and all other exposures for which there is reliable information."[68] This standard contemplates exposures from food, drinking water, and in residential settings. It does not contemplate occupational exposure.

On August 18, 2021, EPA issued a press release leading up to publication of the Final Rule.[69] There, EPA suggested that there are harmful and unnecessary exposures to farmworkers due to chlorpyrifos use.[70] Not only is that simply inconsistent with the scientific record in this administrative matter but also it speaks to occupational exposure, which EPA does not have authority to consider under the FFDCA safety standard.

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[65] *See* U.S. Food & Drug Admin., Analytical Results of the Total Diet Study, https://www.fda.gov/food/total-diet-study/analytical-results-total-diet-study (last updated Aug. 25, 2021).
[66] Tests were conducted using the CFDA multiresidue method (2016) and more recently using the PQAOE Pesticide Quenchers test method. Results are available upon request.
[67] *See* U.S. Food & Drug Admin, Pesticide Residue Monitoring Program Fiscal Year 2016 Pesticide Report, https://www.fda.gov/food/pesticides/pesticide-residue-monitoring-2016-report-and-data.
[68] 21 U.S.C. § 346a(b)(2)(A)(ii).
[69] U.S. EPA, Press Release, EPA Takes Action to Address Risk from Chlorpyrifos and Protect Children's Health (Aug. 18, 2021), https://www.epa.gov/newsreleases/epa-takes-action-address-risk-chlorpyrifos-and-protect-childrens-health.
[70] *See id.*

The health and safety of the growers we represent, as well as the farmworkers who support our industry, are paramount. We importantly note that chlorpyrifos is applied by licensed certified applicators who are trained to safely handle pesticides. In addition, our growers take significant steps to ensure that chlorpyrifos is used only when needed and in the amounts that are needed. FIFRA is the statute that addresses concerns regarding pesticide application and occupational safety, whereas the FFDCA and FQPA address dietary and residential safety.

I. Other Objections

The Associations hereby incorporate by reference and set forth the objections to the Final Rule filed by Gharda Chemical International, Inc., CropLife America (CLA) and Responsible Industry for a Sound Environment (RISE); Agricultural Retailers Association, et al.; the Coalition of Organophosphate (OP) Registrants; the American Crystal Sugar Company; and other individual members of ASGA and USBSA.

III. CONCLUSION

For these reasons, and because of the significant, imminent, and irreparable harm the Associations will suffer because of EPA's decision to revoke all tolerances, the Final Rule should immediately be reversed, or, at the very least, amended to reflect modification of the tolerances for sugarbeets consistent with the Agency's safety findings. We also request a stay of the effective date of the Final Rule to allow EPA time to revisit its decision, including consideration of maintaining the tolerances for sugarbeets, without unduly and irreparably harming our members.

Respectfully submitted,

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ATTACHMENT A

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

October 12, 2021

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

Ms. Cassie Bladow
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Mr. Luther Markwart
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Dear Ms. Bladow and Mr. Markwart:

Thank you for your letter of September 7, 2021, to the U.S. Environmental Protection Agency (EPA) regarding chlorpyrifos. Below are the questions that you posed to the Agency and the Agency's responses to those questions. At the end of this response, we have also provided the questions sent on September 9, via email, from Scott Herndon, the Vice President and General Counsel of the American Sugarbeet Growers Association, and the Agency's responses to those questions.

Historical Categorization/Technical Correction:

1) Could you help us understand the process and timing surrounding the upcoming chlorpyrifos cancellation order, guidance and Q&A?

Agency Response: Q&A were available on EPA's website at: https://www.epa.gov/ingredients-used-pesticide-products/frequent-questions-about-chlorpyrifos-2021-final-rule beginning on September 20, 2021.

Under FFDCA section 408(g), 21 U.S.C. 346a(g), any person may file an objection to any aspect of the final rule and may also request a hearing on those objections. All objections and requests for a hearing must be in writing and must be received by the Hearing Clerk on or before October 29, 2021. Please see Section I.C of the final rule for instructions on providing feedback. EPA will review any objections and hearing requests in accordance with 40 CFR 178.30, and will publish its determination with respect to each in the Federal Register.

Any registrant, including those who hold registrations of chlorpyrifos, can cancel the registration of a pesticide product or use at any time by voluntarily submitting a request to the Agency. If no requests are submitted, the Agency can issue a Notice of Intent to Cancel (NOIC) under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) to cancel registered food uses of chlorpyrifos associated with the revoked tolerances. When EPA issues an NOIC, it will be published in the Federal Register. For more information on the NOIC process, visit EPA's website: https://www.epa.gov/pesticide-tolerances/pesticide-cancellation-under-epas-own-initiative.

(continuation of question #1): The final rule that was published in the Federal Register on 8/30/21 states, "In this final rule, EPA is revoking all tolerances for chlorpyrifos contained in 40 CFR 180.341." However, in EPA's 8/18/21 stakeholder briefing and in press reports, EPA indicated some uses will remain (namely for cotton, cow tags and golf courses). How will these and other commodities be able to retain uses?

Specifically:

a. Will any tolerances contained in 40 CFR 180.342, other than cotton, be preserved outside of the 8/18 announced final rule, and then potentially undergo reregistration in the final Interim Decision for Chlorpyrifos, which is statutorily required in 2022? Will EPA consider data that may allow other commodities to be considered in this process to retain uses?

b. If not, will cotton and other uses set to be preserved, be revoked, and then potentially reregistered through either: 1) a new registration process; or 2) an alternative means of registration RUP and/or Sec. 18 Emergency Exemption under FIFRA?

<u>Agency Response:</u> *During the stakeholder meeting, we did state that the final rule does not impact non-food uses of chlorpyrifos. The Agency referenced cattle ear tags, public health uses for mosquito control, and USDA quarantine use for fire ant control. However, ear tags should not have been included in this list. Use on cattle ear tags is considered a food use because residues have been detected in cattle milk and fat, which are considered human food and/or animal feed. In addition, use on commodities such as cotton is considered a food use because products derived from it are considered human food and animal feed; therefore, tolerances are required. Application after the tolerances expire would render these products to be adulterated, and distribution in interstate commerce would be a violation of the FFDCA. Products in the channels of trade that contain chlorpyrifos residues and were treated prior to the expiration of the tolerances would be governed by section 408(l)(5) of the FFDCA, which describes conditions that must be met in order for such food to be distributed. EPA has been working closely with FDA on guidance for treated commodities in the channels of trade that is expected to be published by the date the tolerances expire on February 28, 2022.*

Per the Revised Human Health Risk Assessment for Registration Review, residential post-application exposures can occur for adults and children golfing on chlorpyrifos-treated golf course turf and from contacting treated turf following a mosquitocide application. There are no residential post-application risk estimates of concern for adults or children from chlorpyrifos use on golf course turf or as a mosquitocide on the day of application. EPA will continue to evaluate the non-agricultural, non-food uses as part of the ongoing registration review for chlorpyrifos, which is expected to be completed by October 2022.

2) Should sugar beets have originally been considered "non-food uses," given our data demonstrates zero residues on our end food and feed products and FDA studies from 2002-2017 (most recent) demonstrate no chlorpyrifos residues on sugar?

a. Could you provide us with an initial understanding of why EPA has set the tolerances for sugar beets as "food-uses" in 40 CFR § 180.342 and in the updated 2020 Proposed Interim Registration Review (PID)?

b. Should sugar beets originally have been considered "non-food uses" under 40 CFR § 180.2003 (Subpart E – Pesticide Chemicals Not Requiring a Tolerance or an Exemption From a Tolerance) which is defined as:

"(b) Non-food uses are those uses that are not likely to yield residues in food or feed crops, meat, milk, poultry or egg." Our data confirms there are no residues in our end products (see below information on lack of residues on sugar beets)."

Furthermore, the most recently published FDA Total Diet Studies from 2014-2017 tested sugar for traces of chlorpyrifos and found none.

c. The Pesticide Residue Monitoring Program Fiscal Year 2016 Pesticide Report examined residues in food and feeds and did not mention any findings of residues of chlorpyrifos in food or animal foods. Can EPA explain why they believe that residues for chlorpyrifos exist on sugarbeet products?

<u>Agency Response:</u> *The sugar beet use of chlorpyrifos is and should be considered a food use. In addition to the residues in sugar beet roots (1 ppm tolerance), residues concentrate in the processed commodities of molasses (15 ppm tolerance) and dried pulp (5 ppm tolerance), both of which are livestock feedstuffs and may contribute to residues in meat and milk. Also, Codex established an MRL for sugar beets at 0.05 ppm for chlorpyrifos. Since we established tolerances previously with the available data, any reconsideration of status as a food use would have to come in through the PRIA process.*

d. Is EPA aware our data demonstrates no residues on our end products such as crystallized sugar, molasses, dried pulp? As you may know, sugar beet co-ops do significant testing on our products for quality control. Our data indicates zero chlorpyrifos residues remain on our end products sold into commerce—which are crystallized sugar, dried pulp, and molasses. This contradicts the definition of "food-uses," which are defined as:
"(a) food uses are the uses of a pesticide chemical that are likely to yield residues in food or feed crops, meat, milk, poultry or egg."
What is the best way to provide you our data to update your analysis?

<u>Agency Response:</u> *The study numbers (MRIDs) would need to be provided to confirm whether the Agency has these data or not; however, these data will likely not change our conclusions since they appear to be monitoring data rather than field trial data which are used to set tolerances. Tolerances are established based on residues "at the farm gate". Monitoring data could be collected at any point in the chain of commerce and would likely not be acceptable for establishing tolerances or determining food-use status. Since the Agency established tolerances previously with the available data, any reconsideration of status as a food use would have to come in through the PRIA process.*

3) Could you provide us with an understanding of how EPA has set the tolerances for sugar beets in 40 CFR § 180.342 and in the updated 2020 Proposed Interim Registration Review (PID)? Both are mentioned in your final rule.

<u>Agency Response:</u> *Field trial data are used to set tolerances. Tolerances are established based on residues "at the farm gate". For more information about how we set tolerances, please see the following link: https://www.epa.gov/pesticide-tolerances/setting-tolerances-pesticide-residues-foods#food-safety. Tolerances are set on the processed commodities of sugar beets based on processing studies. For more information describing all of the processed commodities from sugar beets which we consider (e.g., molasses), please see the following link: https://www.regulations.gov/document/EPA-HQ-OPPT-2009-0155-0002.*

a. When considering dietary risk, does the data factor in that sugar beets are not consumed raw nor are they sold into interstate commerce to be consumed raw? In fact, the user agreement that growers must sign to utilize the seed technology, states that the grower agrees that sugarbeet seeds, and the resulting crop, are solely for the processed sugar, energy production, or animal feed.

Agency Response: *Use on commodities such as sugar beet is considered a food use because products derived from it are considered human food and animal feed; therefore, tolerances are required. For sugar beets (consumed as the processed blended commodities sugar and molasses), a processing factor of 0.02 was applied to the sugar beet (Raw Agricultural Commodity (RAC)) tolerance of 1 ppm and corrected for 20% crop treated to come up with a residue of 0.004 ppm. For more information about how we set tolerances, please see the following link: https://www.epa.gov/pesticide-tolerances/setting-tolerances-pesticide-residues-foods#food-safety. For more information describing all of the processed commodities from sugar beets which we consider (e.g., molasses), please see the following link: https://www.regulations.gov/document/EPA-HQ-OPPT-2009-0155-0002.*

b. Chlorpyrifos is a contact insecticide that is not absorbed by or translocated within a plant which would explain the lack of residue in sugar beet and its related products.

c. Similar to EPA's PDP, a US Market Basket Analysis found 90% of all products tested were absent of chlorpyrifos and the remaining 10% well below legal tolerances.

d. Although Eaton et al. recognize consumptive exposure as the greatest non-occupational exposure they concluded: "Based on the weight of the scientific evidence, it is highly unlikely that current levels of chlorpyrifos exposure in the United States would have any adverse neurodevelopmental effects in infants exposed in utero to chlorpyrifos through the diet." These authors applied extensive scientific rigor in comparing studies from Columbia, Mount Sanai, and Berkley. Although two showed correlative effects between chlorpyrifos levels there was zero consistency between cohorts when analyzed by meta-analysis suggesting no causal relationship between chlorpyrifos levels and neurological issues. The authors concluded up to 10 ppb per day of exposure resulted in no adverse effects.

e. Given the aspects in points why would there need to be a tolerance for tops, and leaves for food or feed? Page 50 of the final rule states: "EPA has determined that the metabolite chlorpyrifos oxon is not a residue of concern in food or feed, based on available field trial data and metabolism studies that indicate that the oxon is not present in the edible portions of the crops. In addition, the chlorpyrifos oxon is not found on samples in the USDA PDP monitoring data. Furthermore, the oxon metabolite was not found in milk or livestock tissues"

Agency Response: *There are chlorpyrifos residues found in sugar beet tops as indicated by the established tolerances. The fact that residues of the metabolite, chlorpyrifos-oxon, are not present does not change the conclusion that tolerances for these commodities are required.*

4) Where did EPA's existing residue data for sugar beet originate? As noted in your rule, "Both the acute and steady state dietary exposure analyses are highly refined. The large majority of food residues used were based upon PDP monitoring data except in a few instances where no appropriate PDP data were available. In those cases, field trial data or tolerance level residues were assumed." The PDP data base does not list sugar or sugar beets as a commodity.

a. Given this omission, and given that our data shows no residues, is the field data being used to determine residue, despite the fact that no raw sugar beet enter commerce for human consumption?

b. If EPA retains such field data, can we work with the agency to retroactively correct it so that the agency's science is more accurate?

<u>Agency Response:</u> For sugar beets (consumed as the processed blended commodities sugar and molasses), a processing factor of 0.02 was applied to the sugar beet (Raw Agricultural Commodity (RAC)) tolerance of 1 ppm and corrected for 20% crop treated to come up with a residue of 0.004 ppm.

As a reminder, chlorpyrifos risks from food, including sugar from sugar beets and all other foods, is very low and not of concern; sugar beets are not expected to contribute significant risk to the total dietary exposure. The primary contribution to overall chlorpyrifos risks is from residues in drinking water. In setting tolerances, EPA must consider aggregate exposure, which consists of food, drinking water, and any residential exposure. Regardless, use on sugar beets remains a food use requiring tolerances. Since the Agency established tolerances previously with the available field trial data, any reconsideration of status as a food use would have to come in through the PRIA process. Additionally, field trial data are used to establish tolerance levels reflective of residues likely to be found "at the farm gate". Field trial data generally represent unwashed, whole commodities rather than the washed, edible portion of a commodity represented by monitoring data such as that generated by the Pesticide Data Program (PDP) which is used for dietary risk assessment.

5) As stated in your rule, "Without a tolerance or exemption, pesticide residues in or on food is considered unsafe, 21 U.S.C. 346a(a)(1), and such food, which is then rendered "adulterated" under FFDCA section 402(a), 21 U.S.C. 342(a), may not be distributed in interstate commerce, 21 U.S.C. 331(a)." Assuming that no residues exist in or on food, does it need a tolerance or exemption to enter interstate commerce?

a. In sum, while sugar beets may be treated with chlorpyrifos, none of the products (crystallized sugar, dried pulp, molasses) sold into commerce have residues, so may they be distributed via interstate commerce?

b. Is EPA aware of any other commodities that also fall in this distinct category?

<u>Agency Response:</u> The FFDCA prohibits the introduction of adulterated food into interstate commerce. Adulterated food includes any food that contains pesticide residues not covered by a tolerance. If there are no pesticide residues, then the food would not be adulterated. The Agency's available data indicate that sugar beets treated with chlorpyrifos will have pesticide residues "at the farm gate" and thus need a tolerance.

6) In the event sugar beets continue to be considered by EPA as "food-uses," uncertainty still rests in that classification.

a. Has EPA considered that sugar beets are unique in that they are not consumable as "foods" in raw form, and zero commerce takes place between harvest and processing? This is unique from other "food uses" subject to the final rule.

b. Objectively, should an input that is never intended to be consumed or enter commerce really be classified as a food?

<u>Agency Response:</u> Use on sugar beets is considered a food use because products derived from it are considered human food and animal feed; therefore, tolerances are required. For more information, please see above response to question #2.

<u>Current Crop:</u>

7) While our products do not contain residues, given that EPA has historically assigned tolerances we have an interest to ensure any forthcoming guidance with EPA and FDA provides clear understanding of what may or may not be considered adulterated. EPA's rule states that "any residues of these pesticides

in or on such food shall not render the food adulterated so long as it is shown to the satisfaction of the Food and Drug Administration that:

1. The residue is present as the result of an application or use of the pesticide at a time and in a manner that was lawful under FIFRA, and

2. The residue does not exceed the level that was authorized at the time of the application or use to be present on the food under a tolerance or exemption from tolerance that was in effect at the time of the application. Evidence to show that food was lawfully treated may include records that verify the dates when the pesticide was applied to such food."

a. For example, sugar beets grown in 2021 and that are set to be processed from this growing season, and from past growing season, will have been treated lawfully with chlorpyrifos will be processed well into 2022. Assuming there is no allowable future use of chlorpyrifos, will FDA provide guidance that these products do not need to be segregated while awaiting processing? Given the millions of tons of sugarbeets affected, segregation would be virtually impossible. Will EPA and FDA work to clarify this language to ensure it provides certainty for both food and feed uses and so that sugarbeet products have the presumption of satisfying the requirements of FDA outline above? For example, could EPA and FDA provide guidance that such foods may be processed in the ordinary course by producers and/or third-party processors and any resulting food or feed products shall likewise not be considered adulterated? Could EPA and FDA provide blanket guidance that commodities harvested under a lawful manner under FIFRA be processed and not be considered adulterated without the need for new record keeping requirements?

Agency Response: *It is the timing of application that determines whether food treated with chlorpyrifos is adulterated. Until the date the tolerances expire, chlorpyrifos may be used on food commodities in accordance with label directions and the existing tolerances. Residues of chlorpyrifos in or on the food after the tolerances expire would not render the food adulterated as long as those conditions are met. After the tolerances are revoked, application of chlorpyrifos will render any food so treated adulterated and unable to be distributed in interstate commerce. Food in the channels of trade that was treated prior to the expiration of the tolerances would be governed by section 408(l)(5) of the FFDCA, which describes conditions that must be met in order for such food to be distributed. EPA has been working closely with FDA on a guidance for treated commodities in the channels of trade.*

b. How is EPA coordinating with your sister agencies at the Association of American of Pesticide Control Officials to ensure that enforcement will be consistent with federal intent and will not create new record keeping requirements?

Agency Response: *EPA met with representatives from AAPCO on Wednesday, August 18, 2021, the day of pre-publication of the final tolerance rule, to discuss the rule and answer questions. EPA representatives also presented at the SFIREG Joint Meeting of the Environmental Quality Issues (EQI) and Pesticide Operations and Management (POM) Committees on Monday, September 20, 2021, to discuss the final tolerance rule and answer questions.*

Existing Stocks:

8) After the tolerance revocation takes effect in 6 months, would EPA consider continued use of chlorpyrifos via an "Order Governing Existing Stocks to be used in conjunction with the tolerance revocation?"— either for sugar beets until the aforementioned arguments are resolved or for growers more broadly?

Agency Response: Existing stocks is a term under FIFRA generally used in connection with the pesticide products that have been released for shipment as of the date a product registration is cancelled. EPA has not cancelled any chlorpyrifos products as a result of the final tolerance rule; therefore, there are no existing stocks at this time.

The tolerance rule issued on August 30, 2021, does not prohibit sale and distribution of registered pesticide products. However, once the tolerances expire and are revoked in six months, sale and distribution of chlorpyrifos products labeled for use on food crops would be considered misbranded; therefore, it would be a violation of FIFRA to sell and distribute those products. Once the tolerances are revoked, there is no provision for continued use of product.

EPA intends to cancel registered food uses of chlorpyrifos associated with the revoked tolerances under FIFRA, as appropriate. That cancellation action would only address the registered food uses of chlorpyrifos; it would not impact nonfood uses of chlorpyrifos, including public health uses for mosquito control and USDA quarantine use for fire ant control. EPA will continue to evaluate the non-agricultural, non-food uses as part of the ongoing registration review for chlorpyrifos. Following the cancellation of food uses, there may be some products that have label instructions for both food and non-food uses. Those labels would need to be amended to remove any food-uses that were cancelled.

Additionally, a registrant, including those of chlorpyrifos, can cancel the registration of a pesticide product or use at any time by voluntarily submitting a request to the Agency.

Drinking Water Analysis:
9) EPA's assessment discusses impacts on drinking water for determining risk (i.e., drinking water exceeds 4 ppb (DWLOC) which is the exposure level determined safe for children)

一 a. EPA does not explain how you reached that 4 ppb as a safe standard. Could you elaborate on how you reached that number?

Agency Response: Please see Section 7.0 Aggregate Exposure/Risk Characterization of the 2020 Human Health Risk Assessment, which starts on page 44, which covers the specifics of deriving the drinking water level of comparison (DWLOCs) (calculations are in the footnotes of the tables). The 2020 Human Health Risk Assessment can be found at the following link:https://www.regulations.gov/document/EPA-HQ-OPP-2008-0850-0944.

一 b. This document cites "Chlorpyrifos Refined Drinking Water Assessment for Registration Review" (Ref 28) to justify revocation of tolerance as it demonstrates the DWLOC exceeds 4 ppb. In this document EPA states:

一 i. The EPA acknowledges in the body of Ref 28 that the models used overestimate water contamination (e.g., assume highest label rates and lowest application intervals) and further explain the actual exposure is more sporadic as well as spatially and temporally variable.

一 ii. Although the document concludes chlorpyrifos concentrations "could be greater than 100 ppb (100 ug/L)" those assumptions are "based off of peak values from models derived from the highest label rate crops (tart cherries)." Looking at the model averages for more representative crops (bulb onions) the concentration drops to 0.8 ppb (0.8 ug/L) far below the DWLOC.

一 iii. The document (Ref 28) shows extensive data collected measuring actual presence of chlorpyrifos in surface water. The highest number collected was 2.1 ppb (half of the DWLOC), but most were under 0.3 ppb. These numbers dropped significantly following filtration (standard practice in water treatment) since chlorpyrifos can adsorb to particulate.

一 iv. The document (Ref 28) also states "…there were no detections of chlorpyrifos-oxon in paired finished water samples from the PDP monitoring program. Tierney et al., 200394 also did not detect chlorpyrifos in finished water at community water systems."

c. If EPA uses PDP monitoring to justify the lack of threat from food residue, why does it ignore the PDP data to justify a lack of risk from drinking water?

Agency Response: *EPA has considered available PDP monitoring data for chlorpyrifos in drinking water. Evaluation of PDP data is described in the 2016 DWA, which can be found at the following link: https://www.regulations.gov/document/EPA-HQ-OPP-2015-0653-0437. In summary, samples from raw intake water (source water) as well as finished drinking water are analyzed as part of the PDP, typically on a bimonthly basis. Samples have been collected from 82 locations in 28 states and the District of Columbia; however, only a subset of these sampling locations are sampled each year. Furthermore, although sampling sites fall within pesticide use areas, sample collection was not designed to specifically coincide with pesticide applications.*

EPA acknowledges that the highly censored nature, i.e., many non-detects, of the monitoring data available for chlorpyrifos and chlorpyrifos-oxon make it difficult to interpret the data. Non-detects could be the result of an inadequate sampling frequency, lack of use in the watershed, local meteorological conditions not conducive to runoff prior to sample collection, or sampling did not coincide with the chlorpyrifos application window. The limited number of site-years and limited sample frequency limits the utility of the PDP data for estimating concentrations of chlorpyrifos and chlorpyrifos-oxon in drinking water. Consistent with the 2019 FIFRA SAP on the Approaches for Quantitative Use of Surface Water Monitoring Data in Pesticide Drinking Water Assessments, EPA addressed sampling frequency with sampling bias factors and SEAWAVE-QEX in the 2020 DWA, *which can be found at the following link: https://www.regulations.gov/document/EPA-HQ-OPP-2008-0850-0941.*

d. Is EPA aware biological monitoring reported in the peer-reviewed literature shows infants and small children only routinely being exposed to 0.5 ppb chlorpyrifos through nonoccupational exposure and concluded "exposure has been overstated by more than 1000-fold"?

Agency Response: *The Agency completed an extensive review of the literature for chlorpyrifos. All pertinent data that would affect our risk assessment were incorporated into our assessment. Without knowing what specific data is being referred to here, the Agency cannot comment further.*

Future Uses:

10) Does EPA plan to start a new registration process that may provide new restrictions on chlorpyrifos use?

a. Will this use the current decision documents including the 2020 PID, or will EPA be altering course in light of the 9th Circuit's decision?

Agency Response: *EPA does not initiate registration actions in general and does not plan to start a new registration process for the food uses of chlorpyrifos.*

b. Will EPA be reproposing for comment the Chlorpyrifos Proposed Interim Registration Review Decision from December 2020, especially in light of all the changes in the August 18, 2021, pre-published final rule on Chlorpyrifos; Tolerance Revocations?

Agency Response: EPA will continue to evaluate the non-agricultural, non-food uses as part of the ongoing registration review for chlorpyrifos, with the Interim Decision expected to be completed by October 2022. EPA does not intend to release a revised PID for comment.

11) Further, is EPA considering registering the pesticide as Restricted Use Products with increased restrictions?

Agency Response: EPA will continue to evaluate the non-agricultural, non-food uses as part of the ongoing registration review for chlorpyrifos, which is expected to be completed by October 2022. If the Agency determines that the pesticide, when applied in accordance with the label's directions for use, warning and cautions, or in accordance with a widespread and commonly recognized practice, may generally cause, without additional regulatory restrictions, unreasonable adverse effects, the Agency will classify the pesticide as an RUP. FIFRA 3(D)(1)(c). The Agency did not make that determination at the time of the PID, but if comments are received relevant to consideration of changes to the proposed mitigation, they will be addressed in the interim decision.

12) If chlorpyrifos is no longer an option for insect control, we are limited to just two labeled post-emergence liquid insecticide options that are both pyrethroids for sugarbeet root maggot control. These pyrethroids are not as effective and do not perform well in warmer temperatures above 80 degrees F. Only using and having available the one mode of action can lead to insect resistance to the pyrethroid chemistry as well.

Has EPA considered whether there are viable alternatives for chlorpyrifos in different crops and, if so, does the agency plan to provide the public with that analysis?

a. Has EPA considered that losing more and more pesticides with different mode of actions will complicate Integrated Pest Management, complicate proper rotation of different modes of action, and with that increase the likeliness of insecticide resistance?

b. Has EPA considered the effects on sustainability, carbon footprint and farm economics? Soft chemistries (pyrethroids) would require more frequent applications, with that an increase in fuel consumption, soil compaction, and a potential decline of beneficial insects (based on more frequent applications)?

Agency Response: Under the revisions mandated by the FQPA, EPA cannot consider benefits in FFDCA decisions. However, as part of the registration review process under FIFRA, the Agency did evaluate the benefits of chlorpyrifos to growers by crop. The economic benefits to growers are equivalent to the losses they face without chlorpyrifos. This analysis is available in a supporting memorandum in the chlorpyrifos regulatory docket, which is available at the following link: https://www.regulations.gov/document/EPA-HQ-OPP-2008-0850-0969. Sugarbeets was one of several crops discussed in some detail in this document, and EPA acknowledges that it concluded that until suitable alternatives can be adapted to replace chlorpyrifos, sugarbeet yields in production areas of the upper Midwest Red River Valley region could be reduced due to increased problems with the sugarbeet root maggot. EPA is aware that IPM and resistance management are critical pest management benefits of many pesticides, and where benefits considerations are permitted by law, the Agency takes these aspects into serious consideration.

13) Would EPA consider honoring future Section 18 Emergency Exemption Requests for chlorpyrifos—either for sugar beets or for growers more broadly?

Agency Response: Section 18 of FIFRA allows EPA, when emergency conditions exist, to exempt states and federal agencies from the provisions of FIFRA, including the requirement that pesticides must be registered to be sold or distributed. Since at this time, registrations of chlorpyrifos have not been cancelled, no section 18 exemption would be necessary to allow sale and distribution. An emergency exemption cannot reinstate the tolerances under the FFDCA; emergency exemptions only address the sale, distribution, and use of a pesticide under FIFRA. Should EPA receive a request for a section 18 emergency exemption after the food uses for chlorpyrifos are cancelled under FIFRA, EPA would need to establish a time-limited tolerance under FFDCA 408(l)(6). EPA can only establish such a tolerance to cover residues of the pesticide applied under a section 18 emergency exemption if it can determine that the tolerance is safe, as defined by the FFDCA. If EPA cannot determine the tolerances would be safe, EPA cannot establish the tolerances and thus, EPA would not be able to grant a section 18 emergency exemption request.

OMB Process Issues:

14) The final rule states, "The Office of Management and Budget (OMB) has exempted tolerance regulations from review under Executive Order 12866, entitled Regulatory Planning and Review (58 FR 51735, October 4, 1993). Because this action has been exempted from review under Executive Order 12866 (EO 12866), this final rule is not subject to Executive Order 13563 (76 FR 3821, January 21, 2011). B. Paperwork Reduction Act (PRA)."

EPA's posted final rule renders food tolerances more stringent than the status quo and according to previous USDA estimates, and EPA's December 2020 PID, chlorpyrifos has an economic impact over $100 million. Revoking chlorpyrifos tolerances seems to fit the requirements of EO 12866.

a. Why wasn't this rule considered a "significant regulatory action," that should have been subject to interagency review?
b. When will EPA put this rule back out for public comment to comply with the EO?
c. When will EPA be sending the final rule back to OMB for interagency review?

Agency Response: The Agency published a benefits memo from late 2020 that estimated the benefits of chlorpyrifos in agriculture, which is how the Agency would estimate the cost of revoking the tolerances. These estimates reflect significant uncertainty. The court-ordered deadline that the Agency was subject to comply with for this action resulted in the rapid timeline for this final rule. At this time, the Agency intends to proceed in accordance with the process laid out in FFDCA section 408(g).

Follow up questions:

1. Where should we send information on our non-residue data to EPA?

Agency Response: The non-residue data to support reconsideration of status would be subject to review under PRIA. Please find more information on how to submit as a PRIA action at the following link: https://www.epa.gov/pria-fees/fy-2020-2021-fee-schedule-registration-applications and/or please contact the Registration Division.

2. We are also reaching out to USDA for their data too. Please confirm that the below is the appropriate contact at USDA.
   a. **Julie A. Chao, M.A., MSPH**
      Regulatory Risk Assessor
      julie.chao@usda.gov

Agency Response: Julie Chao is the correct contact at USDA.

3. Can you provide a timeline for responding to the questions addressed in the letter sent on Tuesday evening (attached again for convenience)?

   Agency Response: *This document provides the responses to the questions in the letter.*

4. Can you provide us with the list of contacts you are in discussions with at FDA so we can also engage with them?

   Agency Response:
   Center for Food Safety and Applied Nutrition at the US FDA (CFSANTradepress@fda.hhs.gov)
   Alice Chen (alice.chen@fda.hhs.gov)
   Charlotte Liang (Charlotte.Liang@fda.hhs.gov)
   Lauren Robin (Lauren.Robin@fda.hhs.gov)
   Carie Jasperse (carie.jasperse@fda.hhs.gov) (Counsel)

5. Can you point us to where the 4ppb tolerance in the water model came from? As mentioned on the call yesterday, a couple of our scientists wanted to understand that issue better and couldn't find it in the document referenced on the call.

   Agency Response: Please see Section 7.0 Aggregate Exposure/Risk Characterization of the 2020 Human Health Risk Assessment, which starts on page 44, which covers the specifics of deriving the drinking water level of comparison (DWLOCs) (calculations are in the footnotes of the tables). The 2020 Human Health Risk Assessment can be found at the following link:https://www.regulations.gov/document/EPA-HQ-OPP-2008-0850-0944. Please refer to table 7.2.2 in revised draft human health assessment. In the footnote, the formula provided for the calculation is:
   DWLOC: DWLOC ppb= PoDwater (ppb; from Table 4.2.2.1.2) /MOEwater

If you have further questions regarding this matter, please contact Alexandra (Alex) Feitel at feitel.alexandra@epa.gov or 703-347-8631, or Melissa Grable at grable.melissa@epa.gov or 703-308-3953.

Sincerely,

Edward Messina, Esq.
Director

Cc: Loni Cortez Russell, Office of Public Engagement and Environmental Education

EXHIBIT G

American Sugarbeet Growers Association/U.S. Beet Sugar Association Request for a Stay of Decision Revoking All Chlorpyrifos Tolerances

October 29, 2021

American Sugarbeet Growers Association

U.S. BEET SUGAR ASSOCIATION

October 29, 2021

Via EPA E-Filing System and Federal eRulemaking Portal

U.S. Environmental Protection Agency
Office of Administrative Law Judges
Mail Code 1900R
1200 Pennsylvania Ave., NW
Washington, DC 20460

RE: Request for a Stay of Decision Revoking All Chlorpyrifos Tolerances (EPA-HQ-OPP-2021-0523)

I. INTRODUCTION

On August 30, 2021, the U.S. Environmental Protection Agency ("EPA" or the "Agency") issued a final rule revoking all tolerances for the pesticide chlorpyrifos. Final Rule for Chlorpyrifos Tolerance Revocations, 86 Fed. Reg. 48,315 (Aug. 30, 2021) (the "Final Rule"). EPA took this action in response to an April 29, 2021, order of the U.S. Court of Appeals for the Ninth Circuit in the lawsuit League of United Latin American Citizens v. Regan, 996 F.3d 673, 678 (9th Cir. 2021) ("LULAC"), instructing EPA to "either to modify chlorpyrifos tolerances and concomitantly publish a finding that the modified tolerances are safe," "or to revoke all chlorpyrifos tolerances." Rather than modify tolerances consistent with the finding of its expert scientists that 11 key crop uses in select regions are currently safe—as set forth in the Agency's December 2020 Proposed Interim Decision for Chlorpyrifos, EPA-HQ-OPP-2008-0850-0971 ("PID")—EPA revoked all tolerances for chlorpyrifos. EPA did so because it claimed that it is required under Section 408 of the Federal Food, Drug, and Cosmetic Act ("FFDCA"), 21 U.S.C. § 346a, to assess aggregate exposure risks taking into account all "currently registered uses" and that, when taking into account drinking water exposures, it could not conclude that "the products as currently registered" are safe. The Final Rule states that tolerances will expire six months from the date of publication, on February 28, 2022. 86 Fed. Reg. at 48,336.

We represent farmer-owners that both grow and process over 56 percent of all sugar produced in the United States. They account for 1.2 million acres grown in 11 states: California, Colorado, Idaho, Michigan, Minnesota, Montana, Nebraska, North Dakota, Oregon, Washington, and Wyoming. Our 10,000 family farmers and 21 farmer-owned processing facilities account for over 100,000 rural jobs, and contribute over $10.6 billion annually to the U.S. economy. The U.S. beet sugar industry has become a global leader in environmental sustainability as we have invested in significant programs that preserve our natural resources, family farms, unionized workforces, and rural communities for future generations. As a result, our industry now produces 29 percent more sugar on 8 percent less land than 20 years ago, and sugarbeets now require significantly less land, water, and pesticide inputs to grow.

We are challenging the legal and factual sufficiency of the Final Rule by exercising our right to file objections simultaneously with this stay request.[1] Specifically, EPA has abused its discretion,

[1] *See* American Sugarbeet Growers Association & U.S. Beet Sugar Association, *Objections to Decision Revoking All Chlorpyrifos Tolerances* (EPA-HQ-OPP-2021-0523) (Oct. 29, 2021) (letter of objections filed simultaneously with this stay request).

acted arbitrarily and capriciously, and violated the due process rights of the Associations and others. It did so by ignoring scientific data and safety findings in its own Proposed Interim Registration Review Decision ("PID"), and by improperly analyzing the data and information that it did analyze. EPA also failed to consider other relevant scientific information and comments entirely, thus depriving stakeholders of due process. EPA failed to comply with applicable federal law and a court order by failing to harmonize its revocation decision with the Federal Insecticide, Fungicide, and Rodenticide Act ("FIFRA") or address the implications of its decision on existing stocks of chlorpyrifos products and failed to undertake proper interagency review of the Final Rule.

For these reasons and those outlined more fully below, the Final Rule and expiration of chlorpyrifos tolerances for the 11 key crops found safe in the PID should be stayed pending administrative review by EPA and any potential judicial review of our objections. At a minimum, we request that the revocation of the tolerances for sugarbeets be stayed.

II. REQUEST FOR STAY

We request that the stay of the effective date of the Final Rule and the corresponding expiration of tolerances for the 11 key crops found safe in the PID, or at a minimum the expiration of the tolerances for sugarbeets, remain in effect until a final Agency resolution of all of the critical issues raised in our objections. If these issues are not resolved in our favor by the Agency's final order addressing these issues, we further request that the Agency stay the effective date of any revocation action and tolerance expiration until such time as judicial review in the courts is exhausted.

III. THE CRITERIA FOR A STAY ARE MET

For the reasons presented herein, and discussed in detail in our objections and supporting documentation, which are incorporated into this petition by reference, we have met the criteria for a stay of administrative decision set forth by the Food and Drug Administration ("FDA") at 21 C.F.R. § 10.35.[2] Under this criteria, a stay will be granted if: (1) the petitioner will otherwise suffer irreparable injury; (2) the petitioner's case is not frivolous and is being pursued in good faith; (3) the petitioner has demonstrated sound public policy grounds supporting the stay; and (4) the delay resulting from the stay is not outweighed by public health or other public interests. Id. § 10.35(e)(1)–(4) (as amended by 81 Fed. Reg. 78,500 (Nov. 8, 2016)).

A. We Will Suffer Irreparable Injury Absent a Stay.

In order to demonstrate irreparable harm, a party must show both "(1) that the harm is 'certain and great, actual and not theoretical, and so imminent that there is a clear and present need for equitable relief to prevent irreparable harm' and (2) that the harm is 'beyond remediation.'" *Catholic Legal Immigration Network, Inc. v. Executive Office for Immigration Review*, 513 F. Supp. 3d 154, 175 (D.D.C. 2021) (citation omitted); *see also Olu-Cole v. E.L. Haynes Pub. Charter Sch.*, 930 F.3d 519, 529 (D.C. Cir. 2019) (to show irreparable harm, "injury must be both certain and great; it must be actual and not theoretical and of such imminence that there is clear and present need for equitable relief") (internal quotation marks and citations omitted). Irreparable injury can be based on substantial and unrecoverable economic losses, such as lost sales and loss of market share, as well as other losses like damaged consumer goodwill or reputational harm. Indeed, courts have found the irreparable

[2] "In determining whether to grant a stay, EPA will consider the criteria set out in the Food and Drug Administration's regulations regarding stays of administrative proceedings at 21 CFR 10.35." 74 Fed. Reg. 23,046, 23,088 (May 15, 2009).

harm requirement met where many forms of irreparable injury are alleged, including "reputational harm, loss of goodwill, loss of longstanding clients, loss of ability to compete for and attract new clients and partners, incalculable lost profits, and consequential damages for which [petitioner] has no recourse at law." *Beacon Assocs., Inc. v. Apprio, Inc.*, 308 F. Supp. 3d 277, 287–88 (D.D.C. 2018). Losses for which an aggrieved party has no recourse, such as those caused by a governmental entity immune from suit for monetary relief, are "irreparable *per se*." *Feinerman v. Bernardi*, 558 F. Supp. 2d 36, 51 (D.D.C. 2008); *see also Nalco Co. v. EPA*, 786 F. Supp. 2d 177, 188 (D.D.C. 2011) (seller of anti-microbial agent would suffer irreparable harm from EPA stop sale order because it had no right of recourse against the federal government).

Chlorpyrifos is important to the sugarbeet industry because it is the most effective post-emergence liquid insecticide available for the control of sugarbeet root maggots (SBRM) and flies, a particularly problematic pest for sugarbeets.[3] Post-emergence application is application that occurs after the planted crop has emerged from the soil. Post-emergence application of chlorpyrifos is an integral part of the SBRM control plan, which also includes insecticide application at the time the crop is planted. These "At-Plant" insecticides are not adequate to control SBRM on their own and require a post-emergence application of chlorpyrifos to help ensure adequate control. Having adequate chemical control measures for SBRM is imperative because, as hybrid plants, sugarbeets do not have natural resistance to them.

Registered alternatives to chlorpyrifos can only suppress SBRM, not control it, or are only registered for use on adult flies, not larvae.[4] Specifically, grower experiences show that neonicotinoids—treatments coated on sugarbeet seeds—are insufficient by comparison when there is severe pressure from SBRM and for late infestations. Only about five percent of the applied neonicotinoid is actively absorbed and translocated throughout the plant and plant protection lasts only an estimated six weeks. As chlorpyrifos can be applied in furrow at the time of planting, there can be better pest control, especially under high pressure conditions, because the effects of chlorpyrifos last longer than neonicotinoids. Further, neonicotinoids also cost $16 per acre more than chlorpyrifos, a significant cost when treating over 140,000 at-risk acres.[5] Chlorpyrifos applied post-emergence controls the adult, egg-laying fly population, thereby reducing the number of potential larvae that would feed upon the sugarbeet. This allows "At-Plant" insecticide to effectively control the reduced population of SBRM larvae. Although there are alternatives for post-emergence chlorpyrifos, they also are not as effective as chlorpyrifos and do not perform well in warmer temperatures above 80 degrees Fahrenheit. Further, acquired resistance to these alternatives has been documented—having only these alternatives available could increase the risk of SBRM resistance.

Chlorpyrifos is also an important tool against symphylan damage. Symphylans are a subterranean insect pest that negatively affects yield and sugarbeet seed production. Chlorpyrifos is the only fully registered recue option available in early spring to control symphylans. Other than chlorpyrifos, there are no other options for symphylan control in sugarbeet seed production after the crop has been transplanted.

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[3] Rodd & Jamie Beyer, Formal Written Objections and Request to Stay Tolerance Revocations: Chlorpyrifos at 1 (Oct. 20, 2021), https://www.regulations.gov/comment/EPA-HQ-OPP-2021-0523-0008.
[4] *Id.*
[5] U.S. EPA, Memorandum, Revised Benefits of Agricultural Uses of Chlorpyrifos (PC# 059101), EPA-HQ-OPP-2008-0850-0969, at 49 (Nov. 18, 2020) [hereinafter, "Benefits Analysis"], https://www.regulations.gov/document/EPA-HQ-OPP-2008-0850-0969.

The sugarbeet industry would suffer significant economic harm in the absence of a stay. The industry simply cannot afford to support the domestic food economy without chlorpyrifos as a critical crop protection tool. EPA's own estimates bear this out. In 2020, EPA estimated the overall benefits of chlorpyrifos to growers by crop, and in turn, the losses experienced without chlorpyrifos. According to this estimate, the total loss without chlorpyrifos could be more than $100 million.[6] EPA noted though that these benefits, and in turn the losses without chlorpyrifos, are "concentrated in specific crops and regions that rely on chlorpyrifos without available effective alternatives to control pests."[7] With respect to sugarbeets, EPA estimated that chlorpyrifos provides benefits of up to $32.2 million per year.[8] And that is likely an underestimate.[9] EPA acknowledged that it had concluded in its Benefits Analysis that "until suitable alternatives can be adapted to replace chlorpyrifos, sugarbeet yields in production areas of the upper Midwest Red River Valley region could be reduced due to increased problems with the sugarbeet root maggot."[10] According to EPA's own estimates, in North Dakota and Minnesota, a lack of alternatives means that without chlorpyrifos, SBRM alone can inflict up to 45 percent yield loss.[11] Those loses would erode the per acre benefits of chlorpyrifos for sugarbeets in those states, which EPA has estimated could be as high as $500.[12] As a result, the total annual cost of revoking the tolerances in those states alone would be between $774,000 and $29,639,000.[13] When considering that more than 140,000 acres of sugarbeets are at risk of from SBRM, the sugarbeet industry would face tens of millions of dollars in irreparable damages annually should this rule take effect. As another example, Oregon seed production growers estimate that without chlorpyrifos they would suffer between $251,000 and $753,000 in revenue losses just from loss of seed production due to symphylan (garden centipede) damage.

In addition to the financial harm, the sugarbeet industry is likely to suffer reputational harm as well. In its August 18, 2021 press release, EPA said its decision was an "overdue step to protect public health" and "following the science."[14] These statements are inconsistent with EPA's scientific record with respect to the 11 crops identified as safe in the PID. EPA's Final Rule notes that there are no concerns for food safety overall,[15] and the PID shows that chlorpyrifos can be safely used on

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[6] Benefits Analysis at 7; U.S. EPA; *see also* U.S. EPA, Proposed Interim Decision for Chlorpyrifos, EPA-HQ-OPP-2008-0850-0971, at 39 (Dec. 3, 2020) [hereinafter, "PID"], https://www.regulations.gov/document/EPA-HQ-OPP-2008-0850-0971.

[7] PID at 39.

[8] Benefits Analysis at 49.

[9] We believe EPA has underestimated the percent crops treated with chlorpyrifos in their underlying benefits analysis, thus leading to an underestimate of benefits of chlorpyrifos in the PID. The Benefits Analysis notes that in states other than MN and ND, the percent crop treated (PCT) is 9%. Benefits Analysis at 10. Kynetec data for 2014–2018, however, show that for Idaho the PCT is 40–80%. U.S. EPA, Memorandum, Chlorpyrifos (059101) National and State Use and Usage Summary, EPA-HQ-OPP-2008-0850-0968, at 10 (Apr. 1, 2020) [hereinafter, "Use Summary"], https://www.regulations.gov/document/EPA-HQ-OPP-2008-0850-0968. It is not clear that EPA appropriately accounted for this when averaging Idaho with other states. We also note the importance of an accurate tally of all states in which sugarbeets are grown. *Compare* PID at 41 (listing IL, LA, and WI as states that grow sugarbeets, and omitting WY), *with* Use Summary at 5, 10 (not listing IL, IA, and WI, but including WY).

[10] Letter from Mr. Ed Messina, EPA, to Ms. Cassie Bladow and Mr. Luther Markwart, 9 (Oct. 12, 2021) [hereinafter, "Messina Letter"] (attached as Attachment A to the Associations' *Objections to Decision Revoking All Chlorpyrifos Tolerances* (EPA-HQ-OPP-2021-0523)).

[11] Benefits Analysis at 5, 48.

[12] PID at 42.

[13] Benefits Analysis at 7.

[14] U.S. EPA, Press Release, EPA Takes Action to Address Risk from Chlorpyrifos and Protect Children's Health (Aug. 18, 2021), https://www.epa.gov/newsreleases/epa-takes-action-address-risk-chlorpyrifos-and-protect-childrens-health.

[15] 86 Fed. Reg. at 48,332 ("Considering food exposures alone, the Agency did not identify risks of concern for either acute or steady state exposures.").

specific crops identified as critical uses for chlorpyrifos, including sugarbeets.[16] EPA's statements are likely to cause ill-will against the industry from customers and the public that will affect the industry's ability to sell its products. Such reputational damage is irreparable. *See Jones v. District of Columbia,* 177 F. Supp. 3d 542, 547 (D.D.C. 2016) (citations omitted) (reputational injury can be used to establish irreparable harm); *Xiaomi Corp. v. Dep't of Def.,* Civ. A. No. 21-280, 2021 WL 950144, at *1, *10 (D.D.C. Mar. 12, 2021) (reputational damage, in conjunction with serious unrecoverable financial harm, weighs in favor of granting preliminary relief).

B. The Case Is Not Frivolous and Is Undertaken In Good Faith

A stay of administrative decision set forth by the FDA requires a showing that the case is not frivolous, is being pursued in good faith. 21 C.F.R. § 10.35. As set forth below, we have met this standard. We have submitted objections to the Final Order setting forth in detail the numerous substantive and procedural flaws in the Final Order. The objections and supporting materials demonstrate, among other things, that EPA: (1) improperly ignored its own prior safety findings for 11 high-benefit crop uses and failed to harmonize its tolerance revocation with FIFRA, (2) issued a highly conservative and overly protective decision, (3) failed to adequately consider relevant scientific data and information and respond to comments throughout the process, (4) failed to adequately assess the revocation's implications for existing stocks of chlorpyrifos products, (5) failed to comply with the interagency review process, (6) failed to adequately consider the sugarbeet industry's reliance interests, (7) ignored the fact that available data show no residues of chlorpyrifos on sugarbeets and sugarbeet products, and (8) appears to have considered factors that it could not lawfully consider under the FFDCA. We incorporate by reference the arguments made in those objections as well as summarize them below.

First, EPA ignored its own prior safety findings for 11 high-benefit crop uses and harmonize its tolerance revocation with FIFRA. EPA's stated rationale for the revocation of *all* tolerances was that it could not make a safety finding for all current chlorpyrifos registered uses. But the Agency's decision to revoke *all* tolerances—including 11 high-benefit crop uses in specific regions that it previously identified in its PID as safe, such as sugarbeets—is arbitrary and capricious and otherwise not in accordance with the FFDCA. The PID carefully considered 11 crop uses and determined that those uses "will not pose potential risks of concern with an FQPA safety factor 10x."[17] But even after reaffirming the PID's safety findings in the Final Rule, EPA simply refused to apply those findings when it determined to revoke the tolerances for the safe high-benefit crop uses. EPA clearly has the necessary data, the ability, and the authority to preserve the tolerances for the 11 uses. Not leaving the tolerances in effect for these 11 uses when the record would support doing so is arbitrary and capricious.

The record does not support EPA's decision under the FFDCA. Section 408(b)(2) of the FFDCA directs that EPA may "leave in effect a tolerance . . . if the Administrator determines that the tolerance is safe." 21 U.S.C. 346a(b)(2)(A)(i). The Final Rule's conclusion that EPA cannot make the required safety finding is premised on a faulty baseline of all chlorpyrifos tolerances and all

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[16] *Id.* at 48,331–33.

[17] PID at 40. We also object to EPA's specific application of the 10x FQPA safety factor "to account for uncertainties" in relevant epidemiological studies. EPA improperly inserted data from studies that, by its own admission, were incomplete and unreliable, to support application of the 10x safety factor. EPA is authorized to make decisions based on valid, complete, and reliable data in its safety analysis. *See* 21 U.S.C. § 346a(b)(2)(D)(i). The Agency's misapplication of that authority is an abuse of discretion.

chlorpyrifos registrations remaining in place. EPA is fully capable of cancelling the tolerances where it cannot make the FFDCA safety finding and leaving in place the tolerances for the 11 safe uses, including sugarbeets. EPA's faulty baseline also ignores its legal obligations under FFDCA to harmonize a tolerance revocation with FIFRA—that is, where the Agency revokes a tolerance, it must take corresponding action under FIFRA regarding the relevant registration.[18]

The Ninth Circuit expressly ordered the Agency on remand to "correspondingly modify or cancel related FIFRA registrations for food use in a timely fashion" when issuing a final decision to revoke or modify the chlorpyrifos tolerances.[19] The Court recognized that the PID contemplated modifying certain tolerances and that it was possible for EPA to do so if it made the safety determination based on the PID's findings.[20]

Second, EPA's decision is highly conservative and overly protective. EPA misapplied the 10x Food Quality Protection Act (FQPA) 10x safety factor. In the Final Rule, EPA applies the 10x safety factor to address the "uncertainties surrounding the potential for adverse neurodevelopmental outcomes."[21] This is a highly conservative approach. EPA has been unable to establish any plausible biological explanation for the reported neurodevelopmental associations. For 10 years EPA has sought to address neurodevelopmental effects of chlorpyrifos, and, as stated in the Final Rule, "these efforts ultimately concluded with the lack of a suitable regulatory endpoint based on these potential effects."[22] EPA determined that the most appropriate toxicological endpoint for assessing chlorpyrifos risks is to continue to use cholinesterase inhibition. The 10x FQPA safety factor is admittedly applied by EPA as a "presumption" and is not based on reliable or sufficiently valid evidence.

EPA's use of the 2016 Drinking Water Assessment is also highly conservative and inaccurate. The Final Rule acknowledges that the 2016 Drinking Water Assessment was refined to better account for variability and to better estimate regional and watershed drinking water concentrations.[23] These refinements underwent peer review, as described in the Final Rule and resulted in the release of a September 2020 refined drinking water assessment.[24] The refinements included incorporating new surface water modeling scenarios, the quantitative use of surface water monitoring data, new methods for considering the entire distribution of community water systems percent cropped area and integration of state level crop treated data using percent crop treated factors. However, in deciding to revoke all chlorpyrifos tolerances, EPA simply ignored the 2020 highly-refined assessment and used the less-refined 2016 Drinking Water Assessment.

Third, EPA failed to adequately consider relevant scientific data and information and respond to comments throughout the process. Because of EPA's excessive delays in this matter, the Ninth

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[18] *See* 21 U.S.C. §346a(l)(1) ("To the extent practicable and consistent with the review deadlines in subsection (q), in issuing a final rule under this subsection that suspends or revokes a tolerance or exemption for a pesticide chemical residue in or on food, *the Administrator shall coordinate such action with any related necessary action under the Federal Insecticide, Fungicide, and Rodenticide Act* [7 U.S.C. 136 et seq.]." (emphasis added)).
[19] *LULAC*, 996 F.3d at 678, 703–04.
[20] *LULAC*, 996 F.3d at 703.
[21] 86 Fed. Reg. at 48,325.
[22] *Id.* at 48,322.
[23] *Id.* at 48,332.
[24] *See generally* U.S. EPA, Memorandum, Updated Chlorpyrifos Refined Drinking Water Assessment for Registration Review, EPA-HQ-OPP-2008-0850-0941 (Sept. 15, 2020), https://www.regulations.gov/document/EPA-HQ-OPP-2008-0850-0941.

Circuit specifically chose not to remand to the Agency for further fact finding, but rather directly ordered the Agency to revoke or modify the chlorpyrifos tolerances with the abundant data and information the Agency had on hand. The Court believed that EPA could make its final decision based on that information. However, the Agency managed to ignore substantial pieces of information and data, including in comments and studies challenging EPA's 2016 drinking water assessment, among other things. EPA also failed to respond to comments throughout the history of this matter, namely, the over 90,000 comments the Agency received on its 2015 proposed rule to revoke tolerances. The Agency's failure to consider pertinent information and respond to comments deprives all stakeholders of their due process rights and renders the Final Rule arbitrary and capricious.

Fourth, EPA failed to adequately assess the revocation's implications for existing stocks of chlorpyrifos products. Related to its failure to perform its statutory and court-ordered duty to take action on chlorpyrifos registrations, EPA also failed to adequately address its broad revocation's implications for existing stocks of chlorpyrifos products. Again, on this issue, the Final Rule says nothing. And the FAQ webpage offers no workable guidance. There, the Agency has reasoned that because it "has not cancelled any chlorpyrifos products as a result of the final tolerance rule," "there are no existing stocks at this time."[25] That statement simply ignores that end-users like sugarbeet growers may have large inventories of chlorpyrifos products, the proper handling of which will be unclear clear once the tolerance revocation takes effect.

Fifth, EPA failed to comply with the interagency review process. Executive Order 12866 requires significant regulatory actions to go to the Office of Management and Budget (OMB) for coordinated interagency review.[26] Significant regulatory actions are defined to include regulatory actions that "have an annual effect on the economy of $100 million or more or adversely effect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities."[27] EPA's Final Rule clearly meets the significant regulatory action criteria in Executive Order 12866 and as a rulemaking "that make[s] an existing tolerance more stringent" (by effectively revoking it to make the tolerance equivalent to zero), this rulemaking should clearly have undergone interagency review as directed by the Executive Order.[28]

Sixth, EPA failed to adequately consider the sugarbeet industry's reliance interests. "When an agency changes course, . . . it must 'be cognizant that longstanding policies may have engendered serious reliance interests that must be taken into account.'"[29] EPA's overbroad revocation failed to take into account the decades of Agency-approved chlorpyrifos use on which the sugarbeet industry relied. What is more it did so even though EPA could have lawfully and based on sound science left in effect the tolerances for the 11 high-benefit crops—including sugarbeets.

Seventh, EPA ignored the fact that available data show no residues of chlorpyrifos on sugarbeets and sugarbeet products. While tolerances exist for sugarbeet roots, sugarbeet tops, dried

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[25] U.S. EPA, Frequent Questions About the Chlorpyrifos 2021 Final Rule, Question 9, https://www.epa.gov/ingredients-used-pesticide-products/frequent-questions-about-chlorpyrifos-2021-final-rule#question-9.
[26] Exec. Order No. 12866, Regulatory Planning and Review, 58 Fed. Reg. 51,735 (Oct. 4, 1993).
[27] *Id.*
[28] OMB, Memorandum for Heads of Executive Departments and Agencies and Independent Regulatory Agencies on Guidance for Implementing E.O. 12866, M-94-3, app. C at 15 (Oct. 12, 1993), https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/assets/inforeg/eo12866_implementation_guidance.pdf.
[29] *Dep't of Homeland Sec. v. Regents of the Univ. of California*, 140 S. Ct. 1891, 1913 (2020) (quoting *Encino Motorcars, LLC v. Navarro*, 136 S. Ct. 2117, 2126 (2016)).

beet pulp, and sugarbeet molasses, the record shows that no residues have ever been detected. As such, analyses conducted by EPA using the tolerance level as an exposure level are highly conservative. The data do not support the need for tolerances for sugarbeets and sugarbeet products. FDA's own Total Diet Study[30] shows no chlorpyrifos in processed sugar. In addition, residue data tests conducted by American Crystal Sugar Company, which has been testing products since 2016, have found no residues on sugarbeet products, including on crystallized sugar, molasses, and dried pulp.[31] EPA's own Pesticide Monitoring Program Fiscal Year 2016 Pesticide Report does not mention any findings of residues of chlorpyrifos on sugarbeets, sugarbeet tops, or any sugarbeet products (beet sugar, dried pulp, or molasses).[32]

Finally, EPA appears to have considered factors that it could not lawfully consider under the FFDCA. On August 18, 2021, EPA issued a press release leading up to publication of the Final Rule.[33] There, EPA suggested that there are harmful and unnecessary exposures to farmworkers due to chlorpyrifos use.[34] Not only is that simply inconsistent with the scientific record in this administrative matter but also it speaks to occupational exposure, which EPA does not have authority to consider under the FFDCA safety standard. The safety standard for pesticide tolerances under the FQPA is whether "there is a reasonable certainty that no harm will result from aggregate exposure to the pesticide chemical residue, including all anticipated dietary exposures and all other exposures for which there is reliable information." This standard contemplates exposures from food, drinking water, and in residential settings. It does not contemplate occupational exposure.

In sum, the claims presented are plainly not frivolous and are being pursued in good faith.

C. <u>The Public Interest Favors a Stay And the Delay of a Stay Is Not Outweighed By the Public Health or Public Interest.</u>

The stay will provide critical relief to the sugarbeet industry, which needs chlorpyrifos to control SBRM, a particularly problematic pest for sugarbeets. Alternatives to chlorpyrifos can only suppress SBRM, not control it or are not as effective and significantly more expensive. As EPA found, sugarbeet growers would be significantly harmed from the loss of chlorpyrifos, which serves as a critical tool in controlling SBRM. As demonstrated, a stay is necessary to prevent substantial, irreparable economic harm. And public health and public interest considerations do not outweigh the need for a stay.

There are no public health or other public interests that would be adversely affected by a stay of the revocation of the tolerances as to the 11 crops in select regions found safe in the PID. As the Final Rule notes, that there are no concerns for food safety with respect to those crops. EPA's most recent scientific evaluation shows that chlorpyrifos can be safely used on those crops, including sugarbeets.

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[30] *See* U.S. Food & Drug Admin., Analytical Results of the Total Diet Study, https://www.fda.gov/food/total-diet-study/analytical-results-total-diet-study (last updated Aug. 25, 2021).

[31] Tests were conducted using the CFDA multiresidue method (2016) and more recently using the PQAOE Pesticide Quenchers test method. Results are available upon request.

[32] *See* U.S. Food & Drug Admin, Pesticide Residue Monitoring Program Fiscal Year 2016 Pesticide Report, https://www.fda.gov/food/pesticides/pesticide-residue-monitoring-2016-report-and-data.

[33] U.S. EPA, Press Release, EPA Takes Action to Address Risk from Chlorpyrifos and Protect Children's Health (Aug. 18, 2021), https://www.epa.gov/newsreleases/epa-takes-action-address-risk-chlorpyrifos-and-protect-childrens-health.

[34] *Id.*

Further, chlorpyrifos is used only when and only as much as necessary. Each beet sugar cooperative has a team of highly trained agricultural staff that create pesticide application programs at the beginning of the growing season and modify them as conditions change. Each cooperative knows exactly what is used and when it is applied and prides itself on the efficient use of the limited available crop protection tools for sugarbeets. As was noted in comments sent to EPA on the 2020 Preliminary Interim Decision, chlorpyrifos applications for SBRM fly control are made only after determining there is a need and are targeted to specific areas of need. This information is collected by scouting to determine that the SBRM population is present and in high enough numbers that justify an application. Highly accurate Degree Day Models have been developed through university research. These are used to calculate when fly activity will be at its height. In conjunction with this, there is extensive fly stake monitoring covering the growing geography to determine SBRM presence and populations that may or may not trigger a chlorpyrifos application for control. Sticky stakes are used to capture flies and to monitor presence and population levels. Economic threshold levels have been developed by university research using these stakes. If the sticky stakes show population levels that are at economic threshold, only then will a treatment of chlorpyrifos will be made. Maps are produced and updated each year to track areas of SBRM that are moderate and severe levels of concern.

As explained in detail in our objections, EPA's decision to revoke the tolerances for the 11 crops found safe in the PID resulted from EPA's failure to thoroughly consider the relevant scientific information and comments. That failure in itself is another reason that the public interest supports, rather than counsels against, a stay. EPA failed to respond to over 90,000 comments on its 2015 proposed rule to revoke tolerances. The agency's failure to respond to these comments deprived stakeholders of their due process rights and renders the agency's decision arbitration and capricious. EPA also failed to address the implications its decision on existing stocks of chlorpyrifos products and to undertake interagency review.

The weighing of the public interest supports a stay based on the substantial, irreparable economic harm that will occur to growers absent a stay and the corresponding lack of public health or public interest counseling against a stay.

IV. CONCLUSION

For all the above reasons, granting a stay with respect to the 11 crops found safe in the PID is in the public interest and in the interest of justice. Therefore, we request that the Agency grant this petition for a stay of the effective date of the Final Rule and the expiration date for chlorpyrifos tolerances for those 11 crops, or at a minimum for sugarbeets, until a final resolution, including potential judicial review, is reached on all of the issues raised in the our objections.

Respectfully submitted,

Cassie Bladow
President
U.S. Beet Sugar Associations
50 F Street SW, Suite 675
Washington, DC 20001

Luther Markwart
Executive Vice President
American Sugarbeet Growers Association
1155 15th Street NW, Suite 1100
Washington, DC 20005

U.S. BEET SUGAR ASSOCIATION

Via EPA E-Filing System and Federal eRulemaking Portal

U.S. Environmental Protection Agency
Office of Administrative Law Judges
Mail Code 1900R
1200 Pennsylvania Ave., NW
Washington, DC 20460

RE: Transmittal of Objections to Decision Revoking All Chlorpyrifos Tolerances (EPA-HQ-OPP-2021-0523)

To Whom It May Concern:

The U.S. Beet Sugar Association represents manufacturers of beet sugar in the United States. Currently, there are nine such firms, operating 21 factories that process refined white sugar, molasses, and dried beet pulp from sugarbeets grown in eleven states. The U.S. beet sugar processing industry is 100% farmer-owned cooperative in structure, and every factory operates with organized union workforce. As a matter of administrative convenience, USBSA has enclosed with this transmittal letter five independent comment letters objecting under Section 408(g) of the Federal Food, Drug, and Cosmetic Act, 21 U.S.C. § 346a(g), to the U.S. Environmental Protection Agency's August 30, 2021 decision to revoke all chlorpyrifos tolerances, 86 Fed. Reg. 48,315 (Aug. 30, 2021). Each of these individual letters complies with the requirements of 40 C.F.R. § 178.25(a) and each contains the email of the commenter. The objections expressed in each letter are those of the respective signatories and are not the objections of USBSA.[1]

Sincerely,

Cassie Bladow

Cassie Bladow
President
U.S. Beet Sugar Associations

[1] USBSA has separately filed its own substantive comments on the regulatory docket (EPA-HQ-OPP-2021-0523).

Southern Minnesota Beet Sugar Cooperative

83550 County Road 21, Renville, Minnesota 56284

October 29, 2021

U.S. Environmental Protection Agency
Office of Administrative Law Judges
Mail Code 1900R
1200 Pennsylvania Ave. NW
Washington, D.C. 20460

RE: Formal Written Objections and Request to Stay Tolerance Revocations: Chlorpyrifos (EPA-HQ-OPP-2021-0523)

To Whom It May Concern:

We, the Southern Minnesota Beet Sugar Cooperative, (SMBSC) located in Renville, Minnesota are writing in objection to the EPA's August 30, 2021 rule that would revoke all pesticide tolerances for chlorpyrifos, (EPA-HQ-OPP-2021-0523). Pursuant to the Federal Food, Drug, and Cosmetics Act (FFDCA) section 408(g) (21 U.S.C. § 346a), we are writing to file formal objections regarding this action. Based on these objections, we urge the EPA to rescind the final rule revoking tolerances for sugarbeets and consider continued safe uses of chlorpyrifos. This rule will cause significant and irreparable harm to the growers of SMBSC and our operation, we also request the Agency stay implementation of the rule until these objections can be formally addressed and responded to by the EPA.

The EPA's rule will completely remove the ability to apply chlorpyrifos to sugarbeets. If this rule is permitted to become effective as currently scheduled on February 28, 2022, it would have a devastating effect on the productivity of the crops that our growers raise and significantly diminish our cooperative's ability to operate. We use chlorpyrifos to combat the sugarbeet root maggot flies, lygus bugs, and other pests. Our growers annually raise about 120,000 acres of sugarbeets and chlorpyrifos is used on nearly half of those acres to combat lygus bugs alone. We have seen a continued increase in lygus bugs in our growing area and we anticipate this problem to only get worse. For SMBSC growers, chlorpyrifos is the only tool that has proven to be consistently effective in controlling these pests. Pest pressure can vary year to year. It is estimated that on average our grower's yield per acre is significantly greater using chlorpyrifos than using any other pesticide. Without the ability of our growers to apply chlorpyrifos, the reduction in yield will lead to a large loss in profits for the growers and the cooperative due to a decrease in throughput of mature and healthy sugarbeets. In addition, the alternative pesticides that our growers would need to use in the absence of chlorpyrifos has been found to be much less effective.

The EPA's extremely short timeline for rescinding the tolerance does not allow sufficient time to plan for a dramatic change to our growers' operations. In the past, the EPA has been able to strike the proper balance between sound science and risks. SMBSC urges the EPA to fulfill its commitment to scientific integrity in this decision. The data does not support a revocation of chlorpyrifos tolerances for sugarbeets. Our understanding is that the EPA's own analysis in December 2020 found that chlorpyrifos could continue to be safely used on 11

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Southern Minnesota Beet Sugar Cooperative

83550 County Road 21, Renville, Minnesota 56284

specific crops, which includes sugarbeets. Thus, it does not make any sense to revoke a tolerance that the EPA has found to be safe for sugarbeets.

Given that the EPA has said using chlorpyrifos on sugarbeets is safe, we urge you to find an approach to allow the continued use on sugarbeets without revoking the tolerance. Give our growers the chance to continue to thrive, and do not inflict this unnecessary and irreparable harm on our industry.

Sincerely,

Todd Geselius
Vice President of Agriculture
Southern Minnesota Beet Sugar Cooperative

October 29, 2021

Via EPA E-Filing System and Federal eRulemaking Portal

U.S. Environmental Protection Agency
Office of Administrative Law Judges
Mail Code 1900R
1200 Pennsylvania Ave., NW
Washington, DC 20460

RE: Formal Written Objections and Request to Stay Tolerance Revocations: Chlorpyrifos (EPA-HQ-OPP-2021-0523)

American Crystal Sugar Company
101 North Third Street
Moorhead, MN 56560

To Whom It May Concern,

American Crystal Sugar Company is a grower-owned cooperative of 2,600 shareholders producing sugarbeets on approximately 400,000 acres in the Red River Valley in northwest Minnesota and northeast North Dakota. The 2,600 shareholders represent 643 farms on which the sugarbeets are grown. Sugar is extracted in our factories from the sugarbeets and then sold as refined sugar. The United States raises roughly 1.1 million acres of sugarbeets domestically. This is a relatively small acreage crop compared to other crops and keeping crop protection products labeled that work for sugarbeets is vital as there are very few tools and options available.

The revocation of chlorpyrifos tolerances will directly reduce the ability to adequately control sugarbeet root maggot (SBRM). In 2021, SBRM affected 348 of the 643 sugarbeet farms (54%) in the American Crystal Sugar Company growing area representing 150,000 acres affected (38% of acres). Dr. Mark Boetel (North Dakota State Entomologist) has stated that revenue losses of up to $500/acre can occur if SBRM is not adequately controlled[1]. Loss is caused from the injury of the SBRM larvae feeding on the sugarbeet root.

When chlorpyrifos is used, it used post emergence to control the adult, egg laying, fly population, there-by reducing the number of eventual larvae that would feed upon the sugarbeet. This application is an integral part of the SBRM control plan, which also includes at-plant insecticides being used. However, the at-plant insecticides are not adequate to control SBRM on their own and require a post emergence application of chlorpyrifos to help ensure adequate control.

It should be noted that chlorpyrifos is only used in a targeted and precise manner and only when required to prevent loss. This is accomplished through the use of degree day models developed by university research to accurately predict when SBRM fly will appear. Fly sticky stakes are placed in

[1] See https://www.ndsu.edu/vpag/newsletter/ndsu_helping_control_sugarbeet_root_maggot/

sugarbeet fields and monitored for the presence and population levels of the SBRM flies. Only when fly populations reach economic threshold levels is an application of chlorpyrifos applied[2].

Dr. Boetel has also evaluated alternatives to chlorpyrifos post emergence, and they are not nearly as effective or adequate for control. In high root maggot pressure areas, the next best alternative to chlorpyrifos shows $116/acre loss and a 764-pound reduction in sugar/acre[3]. The loss of adequate SBRM control greatly hurts the individual farm and the cooperative with a possible total loss of $11,000,000 to growers directly. This corresponds to 82,000,000 pounds of lost sugar production across severe and moderate levels of SBRM acres at American Crystal Sugar Company.

The loss of adequate control doesn't only hurt the current year's production, but the surviving, overwintering SBRM population will continue to increase and spread to additional acres increasing the size of the SBRM territory. This increase in population and area will then compound losses further.

SBRM is the major concern in sugarbeet production fields but chlorpyrifos is also used to control cutworms, lygus bugs, and grasshoppers. Chlorpyrifos is also used in sugarbeet seed production that occurs in Oregon for control of symphylans. Chlorpyrifos is the only registered option for symphylan control and if not available 25 – 33% of the sugarbeet seed production acreage will be affected with up to a 50% loss of seed production. Without adequate control, symphylan populations will increase and spread to additional acres compounding the amount of production lost.

In EPA's Proposed Interim Decision (PID) from December 2020, the EPA found chlorpyrifos to be highly beneficial and safe for sugarbeet production. The EPA recognized the fact of how important it was to maintain chlorpyrifos use for sugarbeet production. Based on EPA's analysis in the PID, American Crystal Sugar Company is urging the EPA to rescind the final rule revoking tolerances for sugarbeets and permit farmers to continue the safe use of chlorpyrifos on sugarbeets. Additionally, American Crystal Sugar Company also requests the Agency stay implementation of the rule until our objections and those of others in the industry can be formally addressed by EPA.

Sincerely,

Joe Hastings
General Agronomist
American Crystal Sugar Company
jhasting@crystalsugar.com

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[2] EPA-HQ-OPP-2008-0850-0987 Comment https://www.regulations.gov/comment/EPA-HQ-OPP-2008-0850-0978

[3] Boetel (2019) A 3-Year Assessment of Postemergence Liquid Insecticide Rates, Timing, and Product Rotations For Sugarbeet Root Maggot Control.

RE: Formal Written Objections and Request to Stay Tolerance Revocations: Chlorpyrifos (EPA-HQ-OPP-2021-0523)

My name is Brodie Griffin and I represent Amalgamated Sugar Company as the Director of Agriculture. I am writing this letter on behalf of the over 500 Grower Members of Amalgamated Sugar.

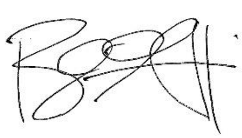
On an annual basis, we cultivate approximately 180,000 acres of sugarbeets in Idaho, Oregon, and Washington. We have used the pesticide chlorpyrifos on our sugarbeet crop for many years in full compliance with all EPA regulations. We are aware of EPA's August 30, 2021 rule that would revoke pesticide tolerances for chlorpyrifos, (EPA-HQ-OPP-2021-0523). Pursuant to the Federal Food, Drug, and Cosmetics Act (FFDCA) section 408(g) (21 U.S.C. § 346a), I am writing to file formal objections regarding this action. Based on these objections and on behalf of our Growers, I urge EPA to rescind the final rule revoking tolerances for sugarbeets and consider continued safe uses of chlorpyrifos. This rule will cause significant and irreparable harm to our Growers, and I also request the Agency stay implementation of the rule until these objections can be formally addressed and responded to by EPA.

EPA's rule will completely remove the ability to apply chlorpyrifos to sugarbeets. If this rule is permitted to become effective as currently scheduled on February 28, 2022, it would have a devastating effect on the productivity of the crops our Growers raise and could significantly diminish our Grower's ability to operate. Our Growers use chlorpyrifos to combat sugarbeet root maggot flies, lygus bugs, leaf miners, and aphids. According to U.S. Department of Agriculture's website, the sugarbeet root maggot alone affects almost half of sugarbeet acres in the U.S, and without control tools, can lead to 40% yield losses in certain areas. For our Growers, chlorpyrifos is the primary tool that has proven to be consistently effective in controlling those pests. While pest pressure can vary year to year, I estimate that, on average, our yield per acre is significantly greater using chlorpyrifos than using any other pesticide. Without the ability to apply chlorpyrifos to the sugarbeet crop, the reduction in yield will lead to a large loss in profits for the cooperative, because we would have less throughput of mature and healthy sugarbeets. In addition, the alternative pesticides available to use in the absence of chlorpyrifos are much less effective and much more expensive.

EPA rule's extremely short timeline for rescinding the tolerance does not allow sufficient time to plan for a dramatic change to our Growers' operations. In the past, EPA has been able to strike the proper balance between sound science and risks, and I am urging the EPA to fulfill its commitment to scientific integrity in this decision. The data just does not support revocation of chlorpyrifos tolerances for sugarbeets. My understanding is that EPA's analysis in December 2020 found that chlorpyrifos could continue to be safely used on 11 specific crops, including sugarbeets. Thus it does not make any sense to revoke a tolerance that EPA has found to be safe for sugarbeets.

Given that EPA has said using chlorpyrifos on sugarbeets is safe, I urge you to find some way to allow the continued use for this crop without revoking the tolerance. Give our Growers the chance to continue to thrive, and do not inflict this unnecessary and irreparable harm on our industry and cooperative.

Sincerely,



Brodie Griffin, on behalf of the Members of Amalgamated Sugar Company
Director of Agriculture
bgriffin@amalsugar.com

October 29, 2021

U.S. Environmental Protection Agency
Office of Administrative Law Judges
Mail Code 1900R
1200 Pennsylvania Ave., NW
Washington, DC 20460

RE: Formal Written Objections and Request to Stay Tolerance Revocations: Chlorpyrifos (EPA-HQ-OPP-2021-0523)

American Crystal Sugar Company
101 North Third Street
Moorhead, MN 56560

To Whom it May Concern,

Sugarbeet seed production in the Willamette Valley of Oregon involves an estimated 2,000 acres, however, this small acreage supplies sugarbeet seed for over 1,000,000 acres of sugarbeet root production, which is a highly important specialty crop in the United States, both to consumers and producers for the refinement of sucrose. U.S. sugarbeet seed is mainly grown in Oregon and Washington. The majority of sugarbeet seed is grown in the Willamette Valley of Oregon, which leads in overall sugarbeet seed crop yield, quality, and climatic security. The Pacific coastal winds and temperate conditions are ideal and greatly limit frost exposure and damage to the sugarbeet seed crop, along with providing ideal temperatures with adequate precipitation for maximum pollination and overall seed production.

Chlorpyrifos use in sugarbeet seed production is vital to the industry. Without chlorpyrifos, sugarbeet seed production will require more production acreage to offset production losses, therefore becoming increasingly expensive and less viable to raise enough seed to meet the demands of the industry.

Sugarbeet seed production fields require physical distance buffers measured in miles from other known pollen sources to maintain genetic purity of sugarbeet seed. Having more acreage in this already active growing region further complicates the ability to maintain genetic purity in these sugarbeet varieties. If these genetic purity standards are not met, that seed may not be allowed for sale and would need to be destroyed. There is a very limited number of sugarbeet seed growers in Oregon. With over 200 other crop options in this region, any further production hurdles for growers in producing sugarbeet seed or reduced income from sugarbeet seed production, will drive them into other crop production options, leaving the sugarbeet seed industry with fewer farms to produce the sugarbeet industries' seed supply.

In Oregon, the primary insect threat results from symphylan damage, especially following perennial grass seed production where the soil is left unworked for multiple years. As a result, symphylan populations can increase in the soil prior to sugarbeet seed production. Symphylans are a subterranean insect pest, whose presence negatively affects proper primary root and secondary root development, which in turn negatively affects yield and sugarbeet seed production. Chlorpyrifos is the only fully registered rescue option available in early spring to control symphylans. It is typically applied on 25% - 33% of total sugarbeet seed production acres. Other than chlorpyrifos, there are no other options for symphylan control in sugarbeet seed production after the crop has been transplanted. Sugarbeet seed production fields vary in soil type, pest content, and productivity. The production fields are small in acreage and assigned to one varietal production per field. Without proper management control of a pest such as symphylans, these small fields could be devastated by symphylan damage thus eliminating an entire sugarbeet variety. This in turn could cause a ripple effect by limiting access to that specific sugarbeet variety and then forcing farms to accept a lesser variety and a negative economic impact for that farm or the region needing that specific variety of sugarbeet seed.

In Oregon, chlorpyrifos is also utilized to offset the damaging impact of more than one species of aphid along with spittlebug, winter cutworms, and other minor insects. Currently there are two other insecticide alternatives available for aphids; however, these are both taken into the plant systemically, and therefore slowly, unlike chlorpyrifos which provides the quick knockdown that is needed once these pests are identified. This knockdown is vital before these insect populations rapidly populate causing escalating crop damage.

In 2021, 27 percent of sugarbeet seed production acres in the Willamette Valley region were treated with chlorpyrifos for symphylan control. Putting this into perspective, potential further losses on the low end of the production spectrum, assuming 25 percent of crop production had symphylan infestations along with 50 percent seed loss, equates to a low-end loss of seed production yield of 12.5 percent or $125,000 in lost revenue. As symphylan populations increase, Oregon growers estimate that they could realistically see a 25 percent loss of seed production yield resulting in $251,000 in revenue losses and a worse-case scenario of 75 percent loss of seed production yield resulting in up to $753,000 in revenue losses.

More importantly, a loss of this magnitude, combined with pressure on available acreage for seed production resulting from reduced yields, could seriously affect the limited supply of sugarbeet seed available to growers around the country and have broad implications for the viability of the entire sugarbeet industry.

Based on these objections, American Crystal Sugar Company is urging the EPA to rescind the final rule revoking tolerances for sugarbeets and permit farmers to continue the safe use of chlorpyrifos on sugarbeets. Additionally, American Crystal Sugar Company also requests the Agency stay implementation of the rule until our objections and those of others in the industry can be formally addressed by EPA.

Sincerely,

Tyler Grove
General Manager Beet Seed Division
American Crystal Sugar Company
tgrove@crystalsugar.com

October 28, 2021

RE: Formal Written Objections and Request to Stay Tolerance Revocations: Chlorpyrifos (EPA-HQ-OPP-2021-0523)

Minn-Dak Farmers Cooperative is a grower-owned sugarbeet processing facility located at the southern end of the Red River Valley in Wahpeton, North Dakota. We have proudly been in business since 1974 and continue to be one of the industry's most advanced and proficient sugar production facilities today. My primary area of responsibility is focused upon the research and production aspects of the agricultural arena. I am responsible for the research of both current production techniques and future technologies encompassing the growing, harvesting and delivering of sugarbeets for processing from 500 shareholders raising sugarbeets on 105,000+ acres.

Year in and out, pest control has been and continues to be one of the most predominant production challenges of raising sugarbeets in the Red River Valley of Minnesota and North Dakota. Unlike corn and soybean (which have a combined acreage of 175 million across the United States), sugarbeets are a very small market by comparison, raising only 1.1 million acres annually. As such, the pesticide portfolio that is currently available to our growers has not only dwindled over the past decade, but the major chemical manufacturers are no longer producing sugarbeet-specific products. Instead, our industry is at the mercy of the 'table scraps' developed for the corn and/or soybean market and actually consider ourselves lucky that they still continue to screen these chemistries on sugarbeets during part of their developmental process. This simple fact makes the continued use of existing chemistries within our current pesticide portfolio vital to our small industry.

Chlorpyrifos is by far the most effective post-emerge insecticide product that is utilized by our growers for the control of various insects, the most notable being the Sugarbeet Root Maggot (SBRM - an insect pest in which larvae feed on and damage sugarbeet roots). Our Cooperative is very aware of the U.S. Environmental Protection Agency's (EPA) August 30th ruling that would revoke all pesticide tolerances for this unique chemistry (EPA-HQ-OPP-2021-0523). Pursuant to the Federal Food, Drug, and Cosmetics Act (FFDCA) section 408(g) (21 U.S.C. § 346a), please consider this letter a formal objection regarding this recent action. Chlorpyrifos has been registered for use in sugarbeets by both the North Dakota Department of Agriculture (NDDA) and the Minnesota Department of Agriculture (MDA) for decades and when applied according to the label, is a safe an effective crop protection product. I implore the EPA to rescind the final rule revoking tolerances for sugarbeets and consider continued safe uses of this active ingredient. Simply put, this ruling will cause significant and irreparable harm to our Cooperative. As a reference, where Chlorpyrifos is needed but is not used, we can see losses of up to 2,042 lbs. (> 30%) of Recoverable Sugar/Acre and $400/acre in lost revenue. (Dr. Boetel, NDSU - Combined Analysis 2016-2019 Research).

A common misconception surrounding the use of Chlorpyrifos in sugarbeets is that it is annually applied as a 'blanket' application – nothing could be farther from the truth. Chlorpyrifos applications within our Cooperative are structured in a very targeted and precise manner. Carefully monitoring the SBRM population through the use of insect traps and an advance population forecasting system, our Agricultural Staff works on a one-on-one basis with each of our growers (who are licensed pesticide applicators) to make the decision whether or not a field needs to be treated based upon a proven economic threshold developed by the entomology departments of both North Dakota State University and the University of Minnesota.

The EPA's extremely short timeline for rescinding the tolerance does not allow our Ag Staff or our growers sufficient time to plan for such a significant change to our production practices. As I recall, the

EPA has always been able to strike the proper balance between sound science and risks and I am urging the EPA to fulfill its commitment to scientific integrity in this specific decision. The EPA's own December 2020 analysis found that this active ingredient could continue to be safely used on eleven different crops, including sugarbeets. The data just does not support a revocation of Chlorpyrifos tolerances for sugarbeets and it clearly does not make any sense to revoke a tolerance that the EPA has found to be safe for sugarbeets.

It is vitally important to our Cooperative to continue to have Chlorpyrifos available as insecticide in our arsenal to control SBRM and other insect pests. Given that the EPA has indicated using Chlorpyrifos on sugarbeets is safe, I strongly urge you to find a way to allow the continued use of this for sugarbeets without revoking the tolerance. Minn-Dak Farmers Cooperative requests the Agency stay implementation of the rule until our objections and those of others in the industry can be formally addressed by EPA. Sugarbeets are a relatively small acreage crop compared to others and keeping crop protection products labeled that are proven to work in a safe and effective manner is crucial as there are very few tools and options available. Sugarbeets have a major impact on the viability of farms and production agriculture in our region, it is important that you allow us to continue to be good stewards of this product.

Thank you for your consideration.

Sincerely,

Mike Metzger, Ph.D.
Vice President – Agriculture & Research
Minn-Dak Farmers Cooperative