California Specialty Crops Council

Please see our attached letter. Thank you.

CALIFORNIA
SPECIALTY CROPS COUNCIL

Submitted electronically via CDPR's Public Comment Portal

November 9, 2023

Ms. Julie Henderson
Director
California Department of Pesticide Regulation
1001 I Street / P.O. Box 4015
Sacramento, CA 95812-4015

Re: Department of Pesticide Regulation Draft Strategic Plan 2024-28

Dear Ms. Henderson:

I am the Executive Director of the California Specialty Crops Council. The California Specialty Crops Council (CSCC), a 501(c) 5 non-profit organization, is a trusted source of field-based information spanning horticultural crop production, pest management, food safety and stewardship activities in fruit, root, vegetable, and vine crops (fresh, dried, and processed). Combined, over 3,000 CSCC growers generate $5.0 billion annually on approximately 545,786 acres of California farmland. Our members include:
CA Cherry Board, CA Celery Research Board, CA Prune Board, CA Fresh Carrot Advisory Board, CA Garlic and Onion Research Advisory Board, CA Leafy Greens Research Program, CA Melon Research Board, CA Pear Advisory Board, CA Pepper Commission, and the Artichoke Research Association.

The CSCC is committed to transparent scientific and technical exchange, responsible agricultural practices and effective public policy solutions developed through partnerships with the scientific community, policymakers, and other stakeholders in agriculture.

I would like to comment regarding the Department's Draft Strategic Plan 2024-28

We are concerned that the Draft Strategic Plan has a number of goals/subgoals that will require significant financial budgetary support. There appears to be a lack of information in the Plan regarding the financing of the various goals. CDPR should first identify and seek funding before committing to goals/subgoals in the Plan that may or may not be funded.

Thoughts regarding specific goals:

Goal 1.2 - *"Create a streamlined pathway for the registration of efficacious alternatives to high-risk priority pesticides and alternatives that cover gaps in priority pest management."* This is an important aspect of the plan, but since there has already been delayed action in the past for registrations, it is imperative that this goal maintain it prioritization and does not further delay the registration of new products, especially for those that would be alternatives to the priority pesticides. We do support having timelines for reviews and the registration processes to ensure timely reviews of submissions.

Goal 1.3 - *"Begin an annual process of initiating formal mitigation for at least two identified priority pesticides."* And *"begin an annual process of completing formal mitigation for at least two identified priority pesticides."* These goals could be premature and arbitrary. While priority pesticides can be identified, assuming that there will annually be at least two formal mitigations does not necessarily follow the science. What if there is only one identified priority pesticide? Also, a lack of viable alternatives to the priority pesticides could end up creating a roadblock to meeting this goal.

Goal 1.4 Regarding facilitation and support for SPM technical assistance and innovation….
SPM, and IPM, are important components for ensuring implementation of these goals by growers. It would be very beneficial to identify a funding source for these efforts before committing to this goal. We are also concerned about a goal of supporting SPM transition measured by a 5% annual reductions in priority pesticide use. This goal needs to further account for the changing pest pressures and for those situations when the priority pesticide might be the best, or only viable, solution to control certain pest invasions.

Growers have concerns about the use of alternatives, especially for those that have not been thoroughly tested, such as some of the new biologicals that are coming to the market. It would be extremely helpful in this transition for the Department to support the UCCE program with funding to test these new alternatives. When they do the testing, it alleviates growers from having to sacrifice their for-profit production acreage to find and test new products. Also, the UCCE advisors can test many different products on a given commodity and accumulate information for growers as to what works, what doesn't, what are the prices for the products that work, and they can provide a cost/benefit analysis to growers to provide them with the information they need to make decisions on various alternatives when needed to control certain pest invasions. Also, the UCCE perform their research in a third-party capacity. Again, growers need availability of the most effective alternatives. Inefficient alternatives will only work against sustainable practices.

We are also attaching an economic study for lettuce that shows the potential negative effects for growers and for the community when less efficient alternatives are put into place. The bottom line is there is a decline in production, a decline in revenue back to the farm and an increase in prices to consumers. The assumption is that when retail prices increase, especially on those farm products that are considered to be luxury items, consumers will stop purchasing and stop consuming a portion of their diet that is beneficial to their health.

In closing, on behalf of the specialty crops growers that we represent, who farm 7.5% of the production acreage in California, we strongly urge the Department to follow the science and make science-based decisions in the process of moving forward with this draft strategic plan and the sustainable pest management roadmap. As you know, the 8th Circuit Court of Appeals recently took the position of upholding the need for and use of sound science when EPA banned the use of chlorpyrifos, while the Agency disregarded its own scientists' findings by revoking uses that they previously determined were safe. Again, make science-based decisions.

Respectfully submitted,

Gary W. Van Sickle

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Enclosure: *Economic Considerations for Conceptual Pesticide Policies*

ERA Economics
Environment • Resources • Agriculture

ERA Economics
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Technical Memorandum

Subject: Economic Considerations for Conceptual Pesticide Policies

By: ERA Economics LLC

To: California Bountiful Foundation

Date: July 19, 2022

Purpose and Background

California Bountiful is working with a consortium of agricultural industry representatives to evaluate conceptual proposals related to pesticide restrictions that have been discussed by policymakers in California. The industry consortium is guided by an advisory group and larger steering committee of the Coalition for Sensible Pesticide Policy (CSPP). ERA Economics (ERA) is assisting the CSPP project team by analyzing the economic implications of the conceptual pesticide policy.

ERA was asked to analyze the effects of a policy that would restrict (ban) specific pesticide usage in California. It is generally understood that the pesticide policy could potentially include restrictions on Tier 3[1] pesticides, as defined by the Department of Pesticide Regulation (DPR) label-based signal word classification. This policy would be loosely based on the conceptual European Union (EU) Farm-to-Fork framework, which would reduce the use of specific pesticides. It is generally understood that the EU policies are based on the precautionary principle rather than scientific evidence-based findings used in the United States. The purpose of this preliminary economic analysis is to support evidence-based findings by developing a data-driven economic analysis that illustrates likely implications of the proposed policy.

Pesticides are an important part of integrated pest management. Limiting access to specific pesticides increases costs for the grower, which in turn increases farming risk. It would also affect farm input suppliers and labor as well as "downstream" industries such as processing, transportation, and manufacturing. It can ultimately result in impacts to food prices and consumers.

This technical memorandum (TM) describes the conceptual policy and its implications for California growers, other businesses, individuals, and food prices. The TM describes both general economic effects (e.g., how pesticide restrictions affect farming costs and crop prices) and specific potential impacts based on an economic analysis of a representative crop/industry: romaine lettuce as affected by potential

[1] DPR implemented Tier 1, 2, and 3 classification system for its implementation of tiered mill assessments. The tiers are based on signal words in the product's label that DPR related to general toxicity measures.

restrictions on pyrethroid and neonicotinoid insecticides. The economic analysis framework and policy conclusions are summarized in the following subsections.

It is important to emphasize that this TM describes the results of a preliminary economic assessment of the conceptual pesticide policy. It was developed to help the reader understand practical limitations to implementing such a policy, the economic implications of the policy if it were implemented, and specific examples of economic impacts for the representative romaine lettuce crop. The analysis is intended to support better-informed discussion about the conceptual pesticide policy. The economic analysis framework should be refined and applied in the future as additional information about the conceptual policy becomes available, including evaluation of potential benefits attributable to eliminating pyrethroid and neonicotinoid use.

Summary Conclusions

This technical memorandum summarizes the results of a reconnaissance-level (preliminary) economic analysis that was developed to evaluate the economic implications of a conceptual pesticide policy that would ban the use of pyrethroid and neonicotinoid insecticides in California.

A typical economic analysis of a proposed policy starts with a review of how the proposed policy would be implemented. This, in turn, informs the analysis approach to assess how the policy would affect decisions of businesses and individuals, and then quantify different measures of economic costs and benefits attributable to the policy. The conceptual pesticide policy is based on the concepts described in the European Union Farm to Fork Strategy.[2] At this time it is a conceptual policy, there is no specific plan for implementation. Further, it is generally understood that the EU policies are based on the precautionary principle rather than scientific evidence-based findings used in the United States.

Changes in the cost and availability of pesticides affect grower farming costs and risk. As costs increase in response to a pesticide regulation, this reduces the aggregate supply of the affected crop (or crops). As supply decreases, this increases the price of the crop at the farm (with implications for grower net returns and risk), and through the broader supply chain, ultimately increases consumer food prices.

A series of economic analyses were developed to illustrate these industry dynamics and provide the reader with an understanding of how a policy that would ban certain pesticides would affect crop prices and outputs. The economic analysis is developed for an example crop/industry (romaine lettuce) and an example ban on specific insecticides (neonicotinoids and pyrethroids), the results of which are used to illustrate the broader economic implications.

Summary conclusions of the economic analysis are as follows:

1. Pyrethroids and neonicotinoids are an important part of Integrated Pest Management (IPM) for California crops. Both are popular with agricultural operations because they effectively and safely manage a wide range of pests. In addition, the relatively short field re-entry interval after application is valuable for fresh produce that needs to be harvested in specific windows. As part of IPM, access to pyrethroids and neonicotinoids, in addition to other insecticides, provide

[2] The broader EU strategy documents are available at: https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en.

growers with options for managing pests and pest resistance. Pyrethroids are particularly valuable because they effectively manage a wide range of pests. Neonicotinoids are highly valuable for specific pests that can cause substantial crop damage, such as Asian citrus psyllid (ACP) and whitefly in desert lettuce producing regions.

2. Pyrethroids and neonicotinoids currently have few effective alternatives. Research, development, and registration of new products involves an expensive and time-consuming process. Delays at both the state and federal levels have continued to slow the approval process. Industry experts interviewed for this study indicated that this is driven, in part, by the increased volume and complexity of data required to register new products. Limited access to new products and alternatives increases the value (including both economic benefits and the importance for IPM) of existing products, including pyrethroids and neonicotinoids.

3. Alternatives to neonicotinoids and pyrethroids are more costly, less effective, and require additional management by growers and pest control advisers (PCAs). A preliminary economic analysis developed for this study of an example crop (romaine lettuce) found that additional direct costs of alternatives are between $230 and $290 per acre. Crop yield and quality losses vary by region and pest pressures but are estimated between 5 and 30 percent.

4. Higher costs and lower crop yields and quality increase farming risk. Lower net returns and higher net return variability pushes growers to shift to different crops or otherwise reduce production. Lettuce growers already face substantial variability in annual net returns due to external market forces, with net returns at or below breakeven in nearly half of all years. Higher costs and lower yields due to pesticide restrictions increase the variability of net returns and increase the likelihood that a grower realizes a loss in any given year.

5. Higher costs and lower crop yields causes a decrease in the supply of the crop (that is, for a given farm gate price, less will be produced). This puts upward pressure on the cost to produce the crop and ultimately prices, which increases costs for produce buyers and results in higher food costs for consumers. As food prices increase, consumers substitute to other crops and products, leading to less overall volume for growers and buyers. Simply stated, growers produce less, and consumers buy less. The preliminary (reconnaissance-level) economic analysis of pyrethroids and neonicotinoids for romaine lettuce estimated that banning their use could result in variable production costs increasing by an average of 12.25 percent, which would result in consumer price increases of approximately 8.22 percent. A preliminary assessment of the associated effect on downside net return risk to romaine lettuce producers would increase by $188 per acre in the coast region and $570 per acre in the desert region. This would increase farming risk, cause growers to produce less, and potentially shift production to other regions (e.g., Mexico and Arizona) without such restrictions on insecticides.

6. Lower-income consumers spend a larger share of their budget on food purchases than high-income consumers. Therefore, increasing food prices due to restrictions on pesticides will tend to disproportionately impact lower-income families. This is particularly important in the rural communities of California that are home to a high proportion of lower-income and economically disadvantaged families. It is also important in the context of current, broader inflationary

pressures that are increasing the costs of goods and services (including food) due to other macroeconomic factors.

7. Reduced production results in less economic activity in lettuce producing regions where a substantial share of seasonal farm jobs depend on the growing and harvesting of lettuce. This could further exacerbate socioeconomic problems on already economically disadvantaged communities and thus increase overall societal costs. Additionally, tax revenue would decrease with lower production and employment, providing less resources to local governments to cover the costs of providing healthcare, public safety, roads, and public works infrastructure.. The preliminary economic analysis estimated that a 12.25 percent increase in operating costs would result in approximately 4 percent decrease in output (volume of lettuce produced). Assessing the impact of a decrease in output independent of any increase in price for romaine lettuce production only, this would result in the loss of more than 420 full time equivalent jobs, \$30.5 million in local economic value added activity, and \$42.9 million total gross output value in the state. These impacts are for romaine lettuce (farming and related industries) only and would increase substantially if other crops and industries are included.

8. In addition to reducing production in different growing regions, policies that increase farming costs in California can push the industry into other states and countries. This is sometimes referred to as "leakage," where a locally grown crop shifts to another state or country. For winter lettuce production, this means shifting production from the Imperial and Coachella Valleys to Yuma, Arizona and Mexico. In addition to the local regional economic impacts this can represent a permanent shift in production, with implications for state agricultural industries and national food security. Other regions have entirely different labor and environmental standards.

9. Lowering registration costs (including costs and timeliness) for new crop protection products and additional investment in pest management research can help reduce the costs of complying with new regulations on older products. Investment in agricultural research provides benefits to society. Recent research[3] shows that the productivity growth attributable to public investment in agricultural research and development have benefit-cost ratios that are well above 1.0. That is, investment in agricultural research and development provides economic benefits that exceed the costs. However, a July 2022 report from the USDA shows that the United States research investment (covering all agricultural research) has dropped by more than one-third over the last two decades, falling behind other countries' investments in agricultural research and development[4].

10. An economic analysis of a policy limiting certain pesticides is typically developed to assess the incremental impact (costs and benefits) of the new policy relative to current (baseline) conditions. It is important to establish baseline conditions that accurately reflect known industry

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[3] Alston, J.M., M.A. Andersen, J.S. James and P.G. Pardey. Persistence Pays: U.S. Agricultural Productivity Growth and the Benefits from Public R&D Spending. New York: Springer, 2010.

[4] Nelson, K. and Fuglie, K. Investment in Public US Agricultural Research and Development. USDA Economic Research Service. Amber Waves. June 6, 2022. https://www.ers.usda.gov/amber-waves/2022/june/investment-in-u-s-public-agricultural-research-and-development-has-fallen-by-a-third-over-past-two-decades-lags-major-trade-competitors/

cost pressures to provide an accurate assessment of how the proposed policy change would affect the agricultural industry. For example, an economic analysis of a new policy/regulation that would be implemented soon should account for current inflationary cost pressure for inputs (e.g., labor, equipment, and materials costs), as well as other laws that are being implemented and will affect specific input costs (e.g., increasing labor costs under AB 1066 and SB 3 that reduce limits for overtime hours and increase the minimum wage per hour worked).

In summary, a ban on specific classes of pesticides would likely impose substantial costs that disrupt the market for crops that rely on those materials, which can ultimately increase the retail cost of food. A policy is typically intended to achieve specific benefits. The benefits of general pesticide restrictions are not clearly defined in the conceptual policy proposal, and therefore it is not possible to evaluate if there might be lower-cost ways to achieve the desired benefits. These should be evaluated under future iterations of this analysis.

The economic analysis illustrates that banning pyrethroid and neonicotinoid use would result in higher costs to growers (higher input costs and lower yields), additional farming risk, and higher food prices for consumers. It is important to recognize the value of sensible pesticide regulations for protecting individuals and the environment. The U.S. and California already has a regulatory system for registration and use that focus on mitigating risk. The focus is on science, data-driven evidence to support this process. There is a potential for real unintended consequences (as highlighted in this analysis) by moving away from the current system to one without thorough analysis, or a clear definition and approach to accomplishing public policy goals.

This preliminary economic analysis suggests that regulation development should attempt to identify cost-effective[5] ways to achieve the objectives of the regulation. This could include streamlining the process for review and approval of newer, softer chemistries, and expanded funding for research and development. Reducing the direct costs of a new regulation lessens impacts to growers, local communities, and food prices.

Economic Analysis Approach

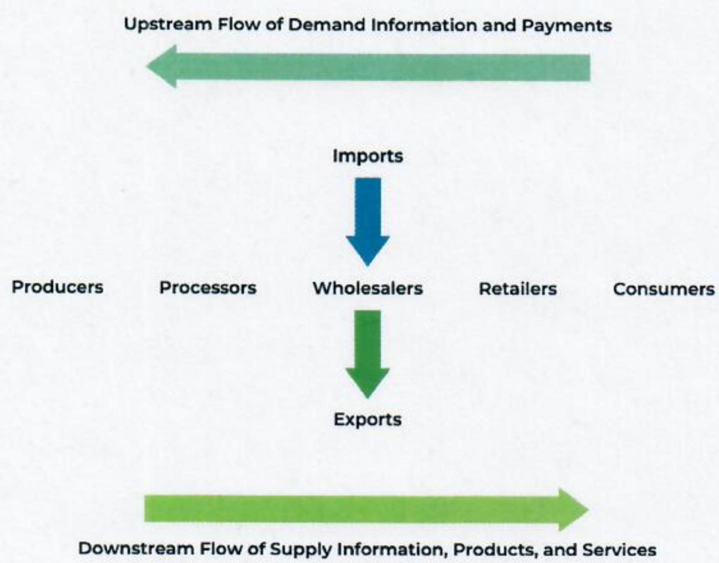
An economic analysis framework was developed to evaluate how a conceptual pesticide policy would affect growers, businesses, and individuals in California. Since the policy has not been specifically defined this analysis should be viewed as a preliminary, reconnaissance-level assessment to support a broader discussion about the merits of the policy. The analysis framework can be refined in the future to analyze more specific policy proposals.

[5] We note that there is a process in place under the Administrative Procedures Act for California state rulemaking agencies to evaluate alternatives, report costs and benefits of each, and identify potentially cost-effective alternatives. This information is disclosed in the STD-399 form with the Initial Statement of Reasons or the DF-141 form and associated Standardized Regulatory Impact Assessment for regulations that meet the Major Regulation threshold. Affected stakeholders should have input during this process and can submit public comments on the content of the proposed regulations and any economic analysis used to support the agency's conclusions.

A new policy or regulation creates direct costs and indirect costs through its effects on the broader agricultural supply chain and consumers. It is helpful to first provide an overview of the key sectors in the supply chain and how they are linked.

Figure 1 summarizes key components of the agricultural supply chain. The supply chain starts with input suppliers and specialized service providers, and ultimately ends with exporters/retailers to consumers in domestic and export markets. A change to the system, for example from a new regulation, policy, or other shock, that affects one sector will affect other sectors across the entire supply chain. For example, the 2020 COVID-19 pandemic shutdown affected food service demand and labor availability across all businesses. Consumers shifted purchases to online stores and delivery take-out food orders. Greater overall demand for online delivery services has led to increasing packaging and transport costs. These in turn have led to increasing costs for input suppliers, growers, and wholesale buyers, which affects the aggregate supply of crops, and ultimately affect retail food prices for consumers.

Figure 1. Illustration of the Agricultural Supply Chain



Our economic analysis framework represents the entire supply chain and is tailored to evaluate specific impacts at specific industry points. Figure 2 illustrates the key components of a typical agricultural economic assessment of a proposed policy or regulation. Farm-level costs typically represent the direct cost of a new policy or regulation. These, in turn, affect the industry supply curve for that crop, which affects the market clearing price of the commodity. As industry supply and prices change this affects businesses and individuals in the regional economy. These changes ultimately affect the retail consumer. Each component of the impact analysis is evaluated using a different set of linked economic models that are tailored to a specific crop or market.

Figure 2. Illustration of Agricultural Impact Analysis Components

Farm-Level Costs	Market Effects	Supply Chain Effects	Regional Impacts	Consumer
•How does the policy affect farm-level costs/finances?	•How does the policy affect the market (crop prices and production)?	•How does the policy affect ancillary businesses?	•How does the policy affect regional jobs, income, taxes, DACs, etc.?	•How does the policy affect consumer demand (food prices) for affected products?

The conceptual pesticide policy is evaluated as a ban on the use of pyrethroids and neonicotinoids, and a single example crop of romaine lettuce is considered. Romaine lettuce was selected because it is a major cash crop in the state, is produced in different regions throughout the state, and its production across different regions is dependent on both pyrethroid and neonicotinoid use to manage various pest pressures. Therefore, it offers a nice representation of a typical agricultural supply chain and was applied for this analysis. The results of the industry-specific assessment are used to illustrate broader economic logic and considerations for this policy.

Data to support the analysis were developed from industry sources, published literature, and a series of industry interviews with growers, PCAs, and other industry professionals. Since this policy would represent a substantial change to the industry, most of the economic impact measures are costs (i.e., losses). Industry benefits are not quantified but described where appropriate. The general analysis framework can be extended in the future to evaluate more specific formulation of the proposed policy once it is developed.

As illustrated in Figure 2, the economic analysis was tailored to different questions based on the pesticide policy target. The economic analysis focuses on the effect on farm-level costs and the broader market. These include:

- **Farm-level Costs**. The direct effect of increasing restricting (ban) pyrethroids and neonicotinoids is a change in costs to a grower. Alternative chemicals to these have substantially higher material costs, and often require more applications, and resulting increase in pesticide product, labor, application, and equipment costs[6]. This affects the input costs to growers. In addition, with alternative chemicals, romaine lettuce growers expect to face lower and more variable yields. This affects the gross revenue and risk to growers. These direct costs were estimated based on a series of interviews with industry experts, analysis farm budgets, and review of peer-reviewed studies and industry publications. Measures of farm-level costs are expressed as annual costs and the effect on farm net income, as well as the change in farm income risk.

[6] Potential implications for greenhouse gas emissions were not assessed for this study, but could be an additional consideration in future analysis.

- ***Net Income***. Net income is a standard measure of the financial returns to a grower defined as gross revenue minus appropriate input costs. It provides a simple measure of the effect of a proposed policy on growers' profit and loss statements. Financial impact measures can also be expanded to consider growers' cash positions, and net earnings after depreciation and taxes.

  This analysis developed a farm budget for romaine lettuce in two primary growing regions with different production seasons – the coast and the desert. These include an accounting of input costs and a time series of yields and prices. To simulate impacts on net farm income a stochastic farm budget model was developed. In contrast to a static accounting measure of net income, a stochastic farm budget models how net income changes as specific cost and return parameters vary, namely crop prices and yield.

- ***Downside Risk***. The economic analysis also explicitly measures net income risk, which is typically overlooked in assessments of direct costs attributable to a proposed policy or regulation. Pesticide restrictions will lead to lower yields and higher yield variability. The historical yield distribution for romaine lettuce in the coast and desert region were developed and the cost of downside risk was then calculated.[7] This illustrates the impact of the pesticide policy on farm net income risk.

- **Market Effects**. Changes in the cost and risk to produce a crop, or a policy that mandates a specific change in pesticide application, affects the aggregate industry supply. As supply shifts, this affects the price of the crop. A standard economic equilibrium displacement model (EDM) was developed to illustrate the effect of increasing costs due to pesticide restrictions. Discussion of potential interaction with export markets is also provided.

A quantitative analysis for the romaine lettuce industry was developed. The analysis illustrates how the policy affects the agricultural sector and specific economic effects on the entire food supply chain.

Pesticide Policy

ERA was asked to analyze the effects of a conceptual policy that would restrict (ban) the use of pyrethroids and neonicotinoids in California. This was assumed to include all currently registered active ingredients (ai) in each of these insecticide classes.

The policy concept to reduce the use of certain types of pesticides is broadly based on the European Union (EU) Farm to Fork and Biodiversity Strategies.[8] The general objective of the EU policy for pesticides is to reduce use. The EU already has a very strict system for authorizing and controlling pesticides. Their sustainable use of pesticides directive (SUD) would take that one step further. A report[9] on the implementation of SUD by member states is accompanying the Farm to Fork Strategy.

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[7] Sortino, F., & Van der Meer, R. (1991). Downside Risk. The Journal of Portfolio Management, 17, 27-31.

[8] The broader EU strategy documents are available at: https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en

[9] Sustainable Use of Pesticides Directive. https://food.ec.europa.eu/system/files/2020-05/pesticides_sud_report-act_2020_en.pdf

The report states "the Commission will take actions to reduce by 50% the use and risk of chemical pesticides by 2030 and reduce by 50% the use of the more hazardous pesticides by 2030." However, this report does not include an economic analysis or inventory of costs that the policy would have on EU farmers and the broader supply chain.

Researchers at the United States Department of Agriculture (USDA) Economic Research Service (ERS)[10] and Wageningen University[11] separately analyzed the potential macroeconomic implications of the broader EU policy strategy. The conclusion of both independent studies was that the EU policy would result in negative economic impacts (i.e., costs) across the agricultural industry. Primary costs include lower agricultural output from the EU, associated regional economic impacts from those losses in the EU, and higher food prices in the EU and around the world. The USDA ERS study estimated global welfare impacts (losses) of the proposed EU strategies between $96 billion and $1.1 trillion.

This analysis illustrates potential impacts in California under a conceptual pesticide restriction modeled after the EU policy. Specifically, the pesticide policy under consideration would ban the use of pyrethroid and neonicotinoid insecticide classes. This policy could contribute to an eventual 50% reduction in "hazardous" pesticide use and/or risk as is broadly defined in the EU policy. This analysis does not attempt to identify or quantify potential environmental or health benefits of the policy.

Pyrethroids and Neonicotinoids Baseline

Insecticides are an important tool for integrated pest management (IPM). These products help the agricultural industry avoid damage from acute pest pressures during the growing season, provide long-term protection, and provide spill-over benefits to nearby fields by keeping pest pressure low on treated fields.

Pyrethroids are common in home and garden pest control products as well as in commercial agriculture. They are popular for agricultural operations because they treat a variety of different pests. They are also popular because they are generally safe for humans, which allows for a short re-entry interval after application. This is particularly valuable for fresh fruits and vegetables with specific harvest windows that require workers to be in the fields. Because pyrethroids can be used for many different pests, and due to concerns about insects developing resistance to common chemicals, pyrethroids are often used with other insecticides. Common lettuce pests managed with pyrethroids in California include various types of worms, caterpillars (and other lepidoptera), thrips, and beetles.

Pyrethroids are synthetic pesticides that were derived from pyrethrins. Pyrethrins are naturally occurring pest control chemicals produced by the Chrysanthemum plant. Pyrethroids offer an affordable control of multiple insects which in turn help reduce food cost-of-production. Further, pyrethroids are found to effectively degrade to less harmful compounds via abiotic (e.g., hydrolysis, photolysis) and biotic (e.g.,

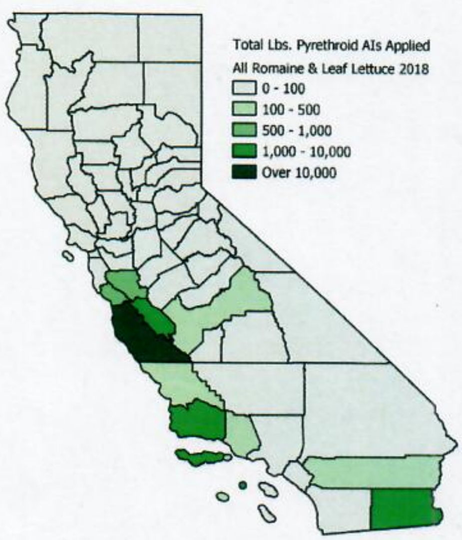
[10] Beckman, J., M. Ivanic, J. L. Jelliffe, F. G. Baquedano, S. G. Scott. Economic and Food Security Impacts of Agricultural Input Reduction under the European Union Green Deal's Farm to Fork and Biodiversity Strategies. USDA ERS. Economic Brief Number 30. November 2020.

[11] Bremmer, J., A. Gonzalez-Martines, R. Jongeneel, H. Huiting, R. Stokkers, M. Ruijs. Impact Assessment of the EC 2030 Green Deal Targets for Sustainable Crop Production. Wageningen University. Report 2021-150.

microbial degradation) methods in the environment and are considered relatively safe for use by humans for agricultural food production.

Figure 3 illustrates example 2018 application total across all pyrethroids for lettuce production, by county. The figure illustrates total active ingredient applied, as reported in raw DPR data. Total applications are greatest in the Monterey County area, followed by Imperial County. The data illustrate a snapshot of 2018. Use varies over time based on varying pest pressure.

Figure 3. 2018 Pyrethroid Application Summary



Neonicotinoids are labeled for a wide variety of crops and pests and are popular due to their short re-entry period. They are also used in home and garden settings, but this may change if AB 2146 is passed. For commercial agriculture, there are specific crops and pests in California for which neonicotinoids (e.g., imidacloprid) are essential. For example, Asian citrus psyllid (ACP) in citrus. Without imidacloprid to control ACP, diseases could spread at a rate that might put the entire citrus industry in jeopardy.[12] Another example is whitefly pest pressure in the desert lettuce growing regions. Prior to the introduction of imidacloprid, whitefly infestations were routinely damaging more than 50% of lettuce fields in the desert region during the winter growing season.[13]

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[12] Goodhue, et al. 2019. Economic and pest management evaluation of nitroguanidine-substituted neonicotinoid insecticides: nine major California commodities. Prepared for the Department of Pesticide Regulation by the California Department of Food and Agriculture's Office of Pesticide Consultation and Analysis, the University of California, and the University of California Cooperative Extension

[13] Gianessi, Leonard. 2009. The Benefits of Insecticide Use: Lettuce. Report by the CropLife Foundation Crop Protection Research Institute.

Figure 4 illustrates 2018 application total across all neonicotinoids for lettuce production, by county. The figure illustrates total active ingredient applied. Total applications are greatest in the Monterey County area. The data illustrate a snapshot of 2018. Use varies over time based on varying pest pressure.

Figure 4. 2018 Neonicotinoid Application Summary

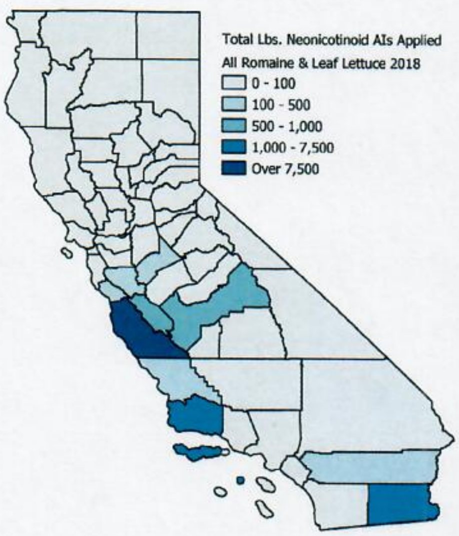

Table 1 summarizes the data illustrated in figures 3 and 4 for lettuce as well as for other select fruit, nut, and vegetable crops in California. It shows total pounds (AI) of pyrethroids and neonicotinoids applied in 2018.[14] This is based on raw DPR data.

Table 1. Total Pyrethroid and Neonicotinoid Active Ingredient Applied by Crop in 2018

Crop	Total Acres [a]	Total Lbs. Pyreth. Applied [b]	Total Lbs. Neonic. Applied [b]
Almonds [c]	1,390,000	192,308	4,521
Broccoli	103,000	6,432	13,609
Carrots	64,300	533	3,670
Citrus	265,300	29,244	88,385
Grapes (Table) [c]	132,000	7,881	39,106
Grapes (Wine) [c]	637,000	824	97,789
Lettuce [d]	210,400	39,113	30,454
Spinach	44,200	9,220	2,372
Strawberries	35,300	10,361	9,878

[14] This was the most recent year of data available at the time of the analysis.

Tomatoes [e]	260,600	17,313	70,974

[a] Source: California Department of Food and Agriculture (CDFA). 2021. California Agricultural Statistics Review 2020-2021.
[b] Source: California Department of Pesticide Regulation (CDPR). 2021. California Pesticide Information Portal (CALPIP) Application.
[c] Includes bearing and non-bearing acreages
[d] Includes head, leaf, and romaine lettuce
[e] Includes fresh market and processing tomatoes

There is increasing interest in restricting or prohibiting the use of pyrethroids without understanding the benefits of a potential ban, or the costs that such a ban would impose on growers and consumers.[15] The Environmental Protection Agency (EPA) has a process for reviewing and approving pesticides. For example, it has specific risk mitigation measures for pyrethroids.[16] State agencies can take additional action.[17] Some pyrethroids (e.g, cypermethrin), have already been banned in the EU due to concerns over toxicity to bees and aquatic organisms.[18]

Neonicotinoids have received similar attention for their potential to affect honeybees. The EU severely restricts the use of clothianidin, imidacloprid, and thiamethoxam, which are currently under legal challenge.[19] The California DPR has proposed a similar regulation, targeting the use of neonicotinoids on crops during specific windows to mitigate potential impacts to pollinators. DPR estimated that its tiered system for restricting neonicotinoid use would reduce overall usage of products in this class by 45 percent in the state.[20] No monetization of economic benefits was developed to support this policy, and the estimated reduction in usage was based on assumptions regarding current use rates.

Based on the increasing pressure put on both pyrethroid and neonicotinoid insecticide classes, this preliminary economic analysis considers a potential policy scenario where both are prohibited for the example crop, romaine lettuce.

Economic Analysis of Conceptual Pesticide Policy: Romaine Lettuce Example Crop

Growers rely on pyrethroids and neonicotinoids as part of integrated pest management in all major growing lettuce regions in the state. Production regions include the Central and Southern California Coast, low desert (Imperial Valley), and San Joaquin Valley (primarily in the Fresno County area).

[15] Donley, Nathan. 2019. The USA lags behind other agricultural nations in banning harmful pesticides. Environmental Health (2019) 18:44.

[16] U.S. Environmental Protection Agency (EPA). 2019. Pyrethroids and Pyrethrins: Ecological Risk Mitigation Proposal for 23 Chemicals. Docket Number EPA-HQ-OPP-2008-0331. September 2019.

[17] Joseph, S., Martin, T., Steinmann, K., and Kosina, P. 2017. Outlook of Pyrethroid Insecticides for Pest Management in the Salinas Valley of California. Journal of Integrated Pest Management (2017) 8 (1): 6; 1-11. doi: 10.1093/jipm/pmx001

[18] Dermine, Martin. 2022. First EU anti-pesticides legal challenges: PAN Europe takes advantage of the recently revised Aarhus regulation. Pesticide Action Network (PAN) Europe.

[19] European Commission. Food Safety - Neonicotinoids. 2022.

[20] California Department of Pesticide Regulation (CDPR). 2022. DPR Proposes Regulatory Restrictions on the Use of Neonicotinoids to Protect Bees.

The lettuce supply chain consists of growers, packer-shippers, and buyers. Growing companies and packer-shippers are generally centered around the key growing region in the Salinas Valley in Monterey County. During the winter, the lettuce industry moves to the low desert, namely Yuma, Arizona and the Imperial Valley in California. In desert regions, the introduction of imidacloprid effectively saved the industry from widespread whitefly crop damage. Lettuce production in the San Joaquin Valley is limited to western Fresno County for harvests during a few weeks in spring and again in the fall.

California accounts for approximately 74 percent of all lettuce production in the U.S. Over 50 percent of production is from Monterey County, with Imperial County accounting for an additional 20 percent. These two California counties account for over half of all U.S. lettuce production.[21] Historically, iceberg lettuce was the primary variety grown, representing more than 80 percent of lettuce produced in the state in 1992.[22] By 2021, iceberg had decreased to 45 percent of the total lettuce and romaine represented around 36 percent. This shift was driven by consumer tastes and preferences for romaine instead of iceberg lettuce.

Direct Costs

The direct cost of a conceptual policy to prohibit pyrethroids and neonicotinoids include the cost of alternative materials, growers management time to adjust practices, and any direct crop quality and yield losses. These direct costs vary by region due to differences in insect pest pressures. The analysis was developed for the central coast and desert regions separately.

Baseline production cost data were developed from a University of California Cooperative Extension (UCCE) cost and return study for romaine lettuce. The baseline budget was adjusted to reflect current conditions and based on interviews with growers and other industry experts. The coast region includes Monterey County and other lettuce growing regions on the central and southern California coast. The desert region consists primarily of the Imperial Valley with some winter lettuce produced in the Coachella Valley. All costs were converted to current dollars[23].

Table 2 summarizes the differences in pest pressures by production region.

Table 2. Romaine Lettuce Pest Pressure Summary

	Coast	Desert	San Joaquin Valley
Pyrethroids	Beet Armyworm, Corn Earworm, Loopers, other worms & larval stages	Beet Armyworm, Loopers, Tobacco Budworm, other worms & larval stages	Beet Armyworm, Corn Earworm, Loopers, other worms & larval stages

[21] USDA National Agricultural Statistics Service (NASS). 2021. Data and Statistics.

[22] Geisseler, D., and Horwath, W.R. 2016. Lettuce Production in California. University of California, Davis, in collaboration with the CDFA and Fertilizer Research and Education Program (FREP).

[23] Costs and other dollar values in this analysis are reported in 2020 dollars, converted using a Gross Domestic Product Implicit Price Deflator (GDP-IPD). A baseline of January 2020 is used based on consistency with other data, and to avoid results biased by the COVID-19 pandemic, ensuing supply chain problems, and recent inflation.

Neonicotinoids	Foxglove Aphids, Lettuce Aphids, Green Peach Aphids, Potato Aphids	Whiteflies, some aphids	Limited

Feasible alternatives to pyrethroids and neonicotinoids were developed based on outreach conducted for the project and a review of peer-reviewed literature. Alternatives were classified according to major pest categories (worms, aphids, whiteflies). Table 3 summarizes the pest and alternative active ingredients.

Table 3. Alternatives to Pyrethroids and Neonicotinoids for Romaine Lettuce

Pest Pressure	Primary	Alternatives (AI)
Worms / Larval Stages	Permethrin, other pyrethroids	Methomyl & Spinetoram (increased use if already using for thrips)
Aphids	Imidacloprid (neonicotinoid)	Spirotetramat, Flupyradifurone, Sulfoxaflor
Whiteflies	Imidacloprid (neonicotinoid)	Spirotetramat, Flupyradifurone, Sulfoxaflor

For management of worms, methomyl and spinetoram are the two main alternatives. Material costs are nearly eight times more expensive and would also require one or two additional sprays during the growing season to accommodate the additional chemicals used. Pest pressure is most substantial in the coastal production regions during the late summer and fall growing season, while impacting the full desert growing season. It is also important to note that these alternatives for worms are also the primary chemicals used for thrips, which is a vector for the destructive Impatiens necrotic spot virus (INSV). Therefore, there is some additional risk of pest resistance from overdependence on these active ingredients, although this was not quantified for the analysis.

For management of aphids in lettuce, neonicotinoids, specifically imidacloprid, are used in the coast region. The desert region relies on imidacloprid for managing whitefly infestations affecting lettuce crops. In both regions, the two main alternatives to imidacloprid are spirotetramat and flupyradifurone. Material costs of these alternatives are two to three times greater and they require five to six additional sprays during the growing season. Additional sprays are needed because imidacloprid is typically applied either as a seed treatment once at planting or as a foliar treatment twice early in the season, while the alternatives are foliar treatments that need to be applied more frequently. Based on the potential severity of whitefly in the desert region in the absence of imidacloprid, cost increases are projected to be greater in the desert than in the coast region.

Table 4 summarizes the per acre additional cost of alternatives for three scenarios: banned use of pyrethroids, neonicotinoids, and both. The additional cost per acre is $230 in the coastal regions and $290 in the desert regions. This reflects the direct cost of the alternative plus additional applications. It does not include additional management time or risk. It also does not include potential costs for increased resistance, or cost increases that may occur as the price of alternatives increases due to increased demand. Therefore, these should be interpreted as conservative direct cash costs.

Table 4. Increased Romaine Lettuce Costs Per Acre without Pyrethroids and Neonicotinoids

Region	Increased Costs w/o Pyrethroids	Increased Costs w/o Neonicotinoids	Increased Costs w/o Both
Coast	$96.71	$135.24	$231.95
Desert	$124.41	$163.29	$287.70

In addition to increased material costs, alternatives are less effective at managing these target pests. The alternatives would result in both crop yield and quality losses. Potential yield losses under the alternative insecticide regimes were estimated based on outreach conducted for this project and a reconnaissance-level review of published studies. Yield losses include crop losses and crop quality impacts. In most cases, the specific yield estimates of switching from pyrethroids and neonicotinoids to the least cost alternative were not available. In these instances, a range of values was determined based on the literature and verified through outreach, with values on the lower end selected to be conservative. For example, lettuce yields in the desert regions are estimated to be about 22% lower without neonicotinoids. Published studies suggest in the long run that losses could be as high as 75% and potentially decimate the industry in this region.

Table 5 summarizes estimated yield losses under the alternatives for three scenarios: banned use of pyrethroids, neonicotinoids, and both. The yield decrement reflects both quality and crop losses. It is reported as an average over the range of values form published studies and industry interviews conducted for this study.

Table 5. Romaine Lettuce Yield Loss without Pyrethroids and Neonicotinoids

Region	Yield Loss w/o Pyrethroids	Yield Loss w/o Neonicotinoids	Yield Loss w/o Both
Coast	4.5%	5.6%	10.1%
Desert	9.0%	21.9%	30.9%

Other indirect costs of alternatives were not quantified for this preliminary assessment, but are important considerations for this or any new pesticide policy. Pest resistance can be a bigger concern with alternatives because alternatives are less effective and require more applications. In addition, banning pyrethroids and neonicotinoids would reduce the number of products available to growers, which would also increase resistance to other materials. These alternatives to pyrethroids and neonicotinoids represent the least-cost alternative, under current prices. Eliminating pyrethroids and neonicotinoids would increase the demand for these alternatives, which would increase prices. This would result in additional costs.

There are additional industry costs for research, development, and registering alternatives. An expedited registration process can become problematic if not completed, such as with the fumigant methyl iodide in 2010.[24] Costs (including the time to move a new product through the system) for developing and registering new active ingredients have been increasing. Surveys of agrochemical companies in the U.S. and EU conducted from 2010 to 2014 found that the total costs to develop a new chemical product had nearly doubled since 1995. Of all cost categories, registration costs had increased the most. Based on the same survey, the estimated time from first discovery of an active ingredient to the first sale of a product containing it was over 11 years, up from a reported 8 years in 1995. The increased time is due to the volume and complexity of data required by regulators.[25]

Lettuce industry representatives interviewed for this study also noted a perceived lack of interest by agrochemical companies in developing new products for specialty crops like lettuce versus larger commodity crops such as corn and soybeans. The reality is that U.S. agrochemical companies Tend to be driven, like the majority of corporations in the U.S. by return on investment. Lower research and development effort on new products increases reliance on and value of currently available registered materials in California, including pyrethroids and neonicotinoids.

Other potential market challenges specific to pesticide regulations include international trade changes due to the maximum residue limits (MRLs) for pesticides. These are set by the country that is importing the crop from the U.S. Pyrethroids, neonicotinoids, and their alternatives have different MRLs in the different export markets. For example, permethrin has an MRL in North America of 20 ppm, but in Europe it is only 0.05 ppm. This effectively limits the ability to apply permethrin to crops that would be exported to Europe (this is sometimes called a non-tariff trade barrier). In contrast, imidacloprid, the most common neonicotinoid, shows comparable MRLs in these markets (3.5 ppm in North America and 2 ppm in Europe). Identified alternatives, including spinetoram, methomyl, and flupyradifurone, mostly face substantially lower MRLs outside of North America.[26] As discussed below, there are additional costs, label restrictions, registration for California crops, and resistance that increase costs and risk to the grower.

Market Effects

As shown above, the direct cost of pyrethroids and neonicotinoids restrictions is a combination of higher pest management costs and lower crop yields/quality. These changes affect the industry supply curve, which describes the incremental unit cost, or marginal cost, of producing a crop as total industry production increases or decreases. In particular, the changes described above increase the marginal cost to produce a crop (in this case, the example crop of romaine lettuce), shifting the supply curve upward. As supply shifts this affects the resulting equilibrium market price and quantity produced, which results in impacts to other businesses in the supply chain, and ultimately to consumers by way of higher food prices.

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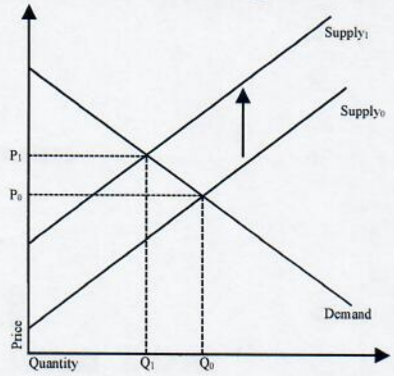
[24] Froines, J., Kegley, S., Malloy, T., and Kobylewski, S. 2013. Risk and Decision: Evaluating Pesticide Approval in California, Review of the Methyl Iodide Registration Process. Report by the UCLA Sustainable Technology & Policy Program.

[25] McDougall, Phillips. 2016. The Cost of New Agrochemical Product Discovery, Development and Registration in 1995, 2000, 2005-8 and 2010-2014. A Consultancy Study for CropLife International, CropLife America and the European Crop Protection Association. March 2016.

[26] USDA Foreign Agricultural Service (FAS). 2022. Maximum Residue Limits (MRL) Database.

This preliminary analysis develops an Equilibrium Displacement Model (EDM) of the supply and demand for romaine lettuce based on McFadden et al. (2021).[27] The model was applied to illustrate the effect of increasing production costs (i.e., decreasing the supply of romaine lettuce by shifting the supply curve up and to the left). The model assumes no changes in demand will result from the pesticide policy. Figure 5 illustrates the market changes considered in this analysis. Supply shifts up with an increase in production costs. The figure shows this supply shift with a downward sloping demand curve for lettuce. The resulting equilibrium quantity decreases and equilibrium price increases with this supply shift. That is, the outcome of increasing production costs for growers will be a higher price and less overall production.

Figure 5. Illustrating Effect of Supply Shift on Price of Romaine Lettuce



The direct costs summarized in the previous section were used as input into the EDM to estimate the shifts in market price and quantity. The EDM analysis was developed for the coast region only. It can be extended to other regions under future iterations of this analysis. Accordingly, the estimated cost increase associated with using alternatives ($231.95 per acre) and the estimated average annual yield losses (10.1%) would result in an increase in production costs[28] per ton of 12.25%.

An example simulation was developed to illustrate the impact of this supply shift. Retail price would increase by approximately 8.22%. Total tons of lettuce produced decrease by 4.03%. Table 6 summarizes the impact of the conceptual pesticide policy. Baseline values are from the 2021 CDFA annual report[29]. The impact measure shows the loss in production and higher crop prices.

Table 6. Impact of Conceptual Pesticide Policy

	Baseline	Policy Impact
Production (1,000 tons)	1,135,700	-4.03%
Price ($/ton)	$612.00	+8.22% (retail)

[27] McFadden, Brandon R., Bovay, John, and Mullally, Conner. 2021. What are the overall implications of rising demand for organic fruits and vegetables? Evidence from theory and simulations. Q Open 1.1 (2021): qoab008.

[28] Production costs in this context include growing and harvest costs.

[29] California Department of Food and Agriculture. Annual Crop Statistics. 2021.

Multiplier Effects

Changes in production would have additional regional economic effects. These are sometimes called "multiplier" effects. These capture how changes in crop production ripples through ancillary businesses and impacts jobs, income, and regional tax base.

Reduced production results in less economic activity in lettuce producing regions where a substantial share of seasonal farm jobs depend on the industry. These economic activities include not only direct costs and market effects, but also interactions within the economy, and the leakage of activity to the surrounding areas[30]. Value added, or the difference between an industry's output and the cost of intermediate inputs, includes labor income and taxes on production. The resulting total gross regional output include indirect spending (i.e., business-to-business spending), and induced spending (i.e., household spending). This analysis uses multiplier data from the input-output model IMPLAN to estimate the full potential impacts. Multipliers are coefficients developed based on observed market transactions among industries that can be used to estimate the greater effect of a direct change in a regional economy.

The effects of banning use of the pyrethroid and neonicotinoid insecticide classes include a 12.25% increase in costs and 4% decrease in total industry output. In the aggregate these are likely to contribute to losses in gross industry revenue.

An example to illustrate the multiplier impacts of a 4 percent decrease in lettuce production—corresponding to an approximate direct value loss of $28 million—was developed[31]. A 4 percent decrease in production, independent of a change in price, reduces local economic activity (i.e., value added) by $30.54 million and reduces gross regional output by $42.86 million. Additionally, it results in the loss of 420 full-time equivalent farm jobs. Given the seasonal nature of farm labor, each full-time equivalent farm job may correspond to 3 or 4 seasonal jobs, meaning this loss could affect more than 1,600 workers. Table 7 summarizes the results of the multiplier analysis showing the total economic impact (including direct, indirect, and induced effects) for a 4 percent decrease in lettuce production. This does not consider the offsetting effect of higher lettuce prices at the farm.

Table 7. Example Total Economic Impact of Decrease in Lettuce Production

	Jobs	Value Added	Output Value
Total Impact	(420)	$ (30.54)	$ (42.86)

Grower Net Returns and Downside Risk

An industry can only remain viable if its producers can consistently make positive net returns without unreasonable risk of losses. This section examines how the dynamics of net returns and downside risk change with the introduction of the policy. Two approaches are used. First, net returns were analyzed

[30] This would potentially include California prohibition on pesticides inducing production shifts to Yuma or Mexico. This may be partially accounted for in the relative elasticity estimates, and can be further assessed in future iterations of this analysis.

[31] An IMPLAN model database for Coachella and Imperial Counties was applied. Therefore, multipliers are specific to lettuce production in these regions.

using a stochastic farm budget (i.e., one in which key costs and returns vary due to market and production uncertainty). Second, downside risk was analyzed using a financial statistical analysis. The following subsections summarize the results.

Net Returns

Pyrethroids and neonicotinoids reduce the risk of yield loss or crop damage from pests. This is important for lettuce farmers who already face large yield variability. Additionally, regional prices (particularly spot prices not established under contract) can vary widely, resulting in some years with large net returns and some with small or negative net returns. That is, even with access to pyrethroids and neonicotinoids, lettuce farming is a risky business.

Table 8 summarizes average lettuce yields and prices in the coast and desert region for the period 2008 to 2018. Yield data come from the USDA National Agricultural Statistics Service (NASS).[32] Price data come from the USDA Agricultural Marketing Service (AMS),[33] which reports high and low values by week. Average regional yields are based on annual average county estimates, weighted by harvested acres per county. Yields are expressed in cartons, which include twelve (12) bags of three (3) heads of romaine each. Yields are reported in tons by NASS and converted assuming a gross weight of 40 pounds per carton, based on units used by AMS. Average annual prices are estimated using the midpoint values of reported highs and lows by week for each region, with a weighted average taken based on shipped weight per week[34].

Table 8. Romaine Lettuce Yields and Prices by Region, 2008 – 2018

Year	Coast		Desert	
	Yield (cartons)	Price per carton	Yield (cartons)	Price per carton
2008	657	$17.15	740	$14.34
2009	882	$17.65	660	$14.25
2010	879	$14.63	746	$18.01
2011	865	$14.47	533	$29.21
2012	953	$14.47	662	$12.88
2013	958	$13.64	724	$29.80
2014	954	$19.04	535	$10.88
2015	766	$19.07	642	$24.48
2016	920	$16.06	538	$18.14
2017	904	$17.80	387	$18.35
2018	968	$13.63	663	$15.75

[32] USDA National Agricultural Statistics Service (NASS). 2008 – 2018. Data and Statistics.

[33] USDA Agricultural Marketing Service (AMS). 2008 – 2018. Shipping Point and Movement Reports.

[34] It is important to note that AMS (or USDA) reported prices will vary from current contract prices. Lettuce is primarily grown under contract, with prices established in advance (with some contract provisions for adjustments). USDA and AMS reported data can reflect fluctuations on the spot market.

Prices are adjusted using the GDP-IPD, reported in constant 2020 dollars.

As discussed above in the Direct Costs section, banning use of pyrethroids and neonicotinoids would result in lower average yields under alternative pesticides. A stochastic romaine lettuce farm model was constructed based on cost data described in the previous section. These models serve as case studies that can be useful for identifying the possible impacts that California growers can expect to face if they no longer are able to use pyrethroids or neonicotinoids.

The price and yield data summarized in Table 8 were fitted to empirical probability functions (mathematical descriptions of the probability of particular values occurring given the observed data). A Monte Carlo simulation was developed to generate and then compare the distributions of net returns under baseline versus pesticide policy conditions. This was developed for two regions (coast and desert) under four different pesticide scenarios: baseline (no restrictions), ban on pyrethroids only, ban on neonicotinoids only, and ban on both.

Figure 6 summarizes the results of the analysis for the coast region. The bar charts in figure 6 represent the probabilities of making large net returns ($1,500 net returns per acre or more), losses ($250 per acre or less), or small/moderate net returns (between $250 and $1,500 per acre). The low-end threshold of $250 per acre was selected assuming that some return on capital is required for the production enterprise to remain viable, with $250 likely representing a conservative estimate. The high-end estimate of $1,500 was selected assuming that, based on the risk of net losses in many years, growers seek substantial profits during good years.[35]

Figure 6 shows that even under current conditions there is a large risk to growers, with a higher chance of expected losses (49%) than of large net returns (38%). As restrictions (bans) on pyrethroids, neonicotinoids, or on both are added, the chance of losses increases, and chance of large returns decrease. Under the scenario where both are banned, the probability of losses is 58%, while the probability of large net returns is 26%. Under all scenarios, the smallest probability is the middle condition (in yellow) where a grower would make small or moderate net returns, with a probability in the range of 13-16% in each of the different scenarios. This is consistent with industry feedback that lettuce growers routinely suffer through one or more years with negative net returns before recouping losses and profiting in years with large net returns.

[35] A sensitivity analysis of the results reported in figure 6 shows that small to moderate changes to these thresholds do not substantially affect the reported probabilities.

Figure 6. Net Return Probabilities under Different Pesticide Scenarios, Coast Region

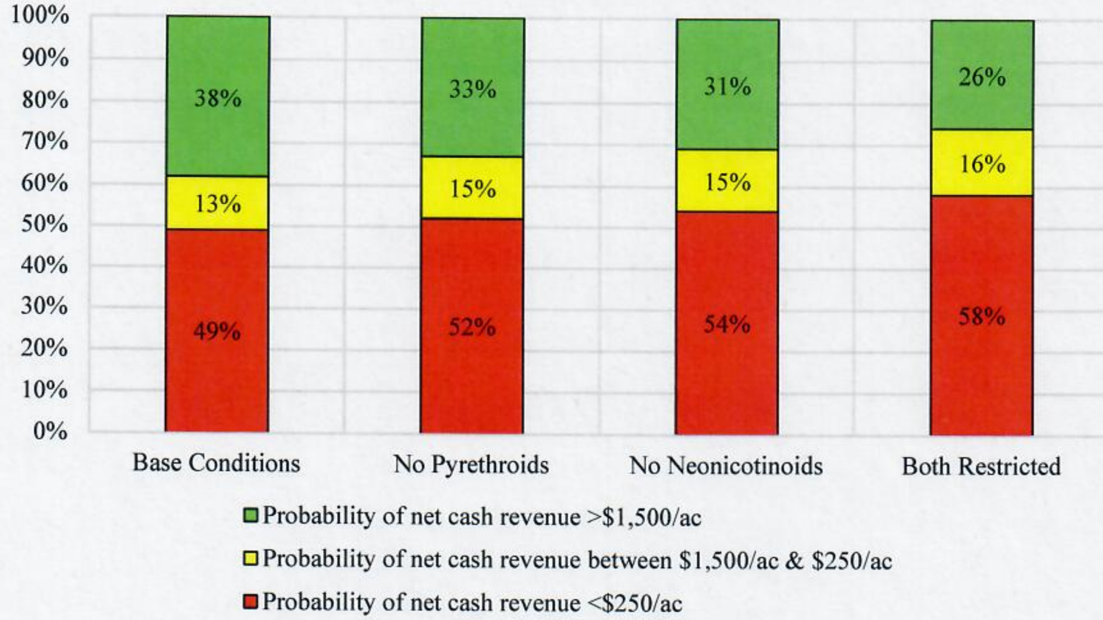
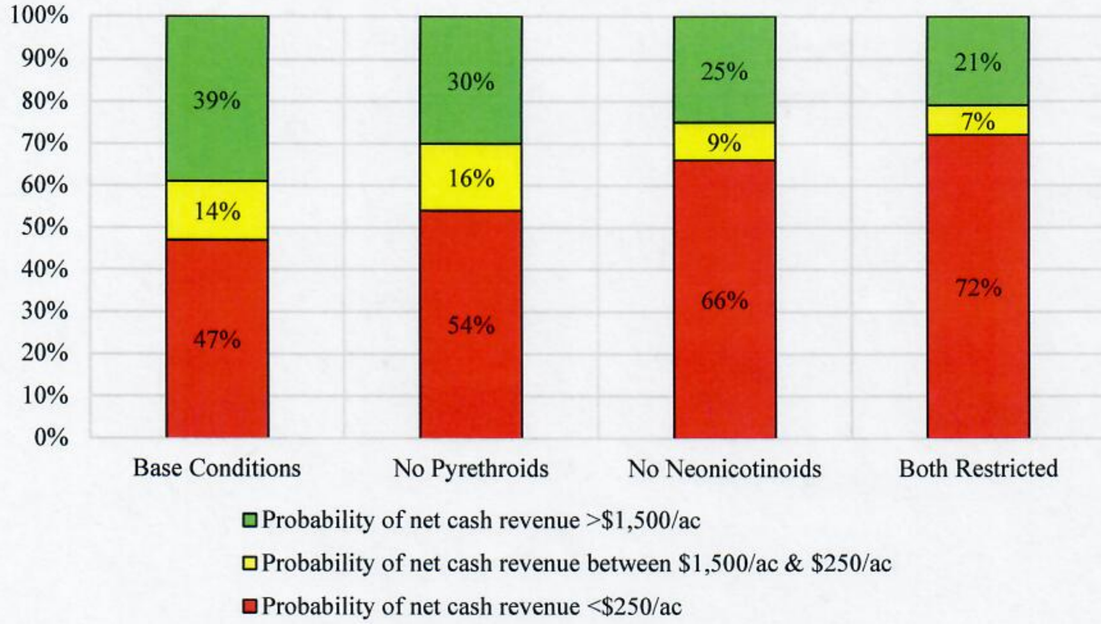


Figure 7 summarizes the results of the analysis for the desert region. Current conditions in the desert region are very similar to the coast region, with 47% probability of expected losses and 39% probability of large net returns. Under the scenario of a ban on only neonicotinoids (but not pyrethroids), the probability of losses increases to 66%, with the probability of large net returns decreasing to 26%. Under a ban on both insecticide classes, these become 72% and 21%, respectively. Similar to the coast, in the desert region the smallest probability is for the middle condition, where a grower receives small or moderate net returns. In the desert region under the condition of bans on both classes, the probability of small or moderate net returns is only 7%.

Figure 7. Net Return Probabilities under Different Pesticide Scenarios, Desert Region



Downside Risk

Given the probability of uncontrollable pest outbreaks, the downside risk of production without access to pyrethroids and neonicotinoids is likely to be greater than under current conditions. This section analyzes the downside yield risk to romaine lettuce in each growing region.

Downside risk is a measure of the additional cost of increased likelihood of adverse (downside) events. In the context of pesticide restrictions, downside events are lower yields and crop quality and higher production costs. A financial analysis of downside risk was developed to quantify this additional cost to the grower. This is in addition to the direct cost/impact of the policy.

In this preliminary analysis we hold the expected price constant at its average value to isolate the downside effect on yields. This downside yield impact results in a similar downside shift in net returns. Estimated yield distribution parameters are used to calculate a set of yields under four different pesticide regimes (baseline, no pyrethroids, no neonicotinoids, bans on both) for each region (coast and desert). Data are from 2008-2018, as described above.

The price of romaine lettuce is set constant at its mean of $16.14 per carton in the coast region and $18.74 per carton in the desert region. It is important to note that a constant price creates a clear comparison between net revenues from the base production compared with net revenues under the pesticide restriction example. This is a conservative scenario because substantial cuts in romaine production would elicit a price increase for romaine, as discussed above in the Market Effects section. Modelling the simultaneous interactions between romaine supply and demand price is beyond the scope of this preliminary study but can be considered as part of future work.

Figure 8 illustrates the yield distribution/probabilities for the coast region. At high yield levels, the probabilities drop off sharply on the right-hand side of the figure. At low yield levels on the left-hand side of figure 8, there is a long downward tail associated with outbreaks of pests, disease, adverse weather, or similar events. The base yield distribution with no pesticide restrictions is, as expected, the furthest to the right indicating a higher average yield and a narrower downside tail (lowest variability). Comparison between the three pesticide restriction (ban) scenarios' probability plots shows that banning either neonicotinoid or pyrethroids has a similar effect on the yield distribution in the coast area. Namely, resulting in an equivalent shift to the left that results in a lower mean yield and a fatter probability tail for low yields. The yield probability curve when both pest control substances are banned shows a larger shift to the left with a lower average and longer low yield tail.

Figure 8. Romaine Lettuce Yield Probabilities in the Coastal Region

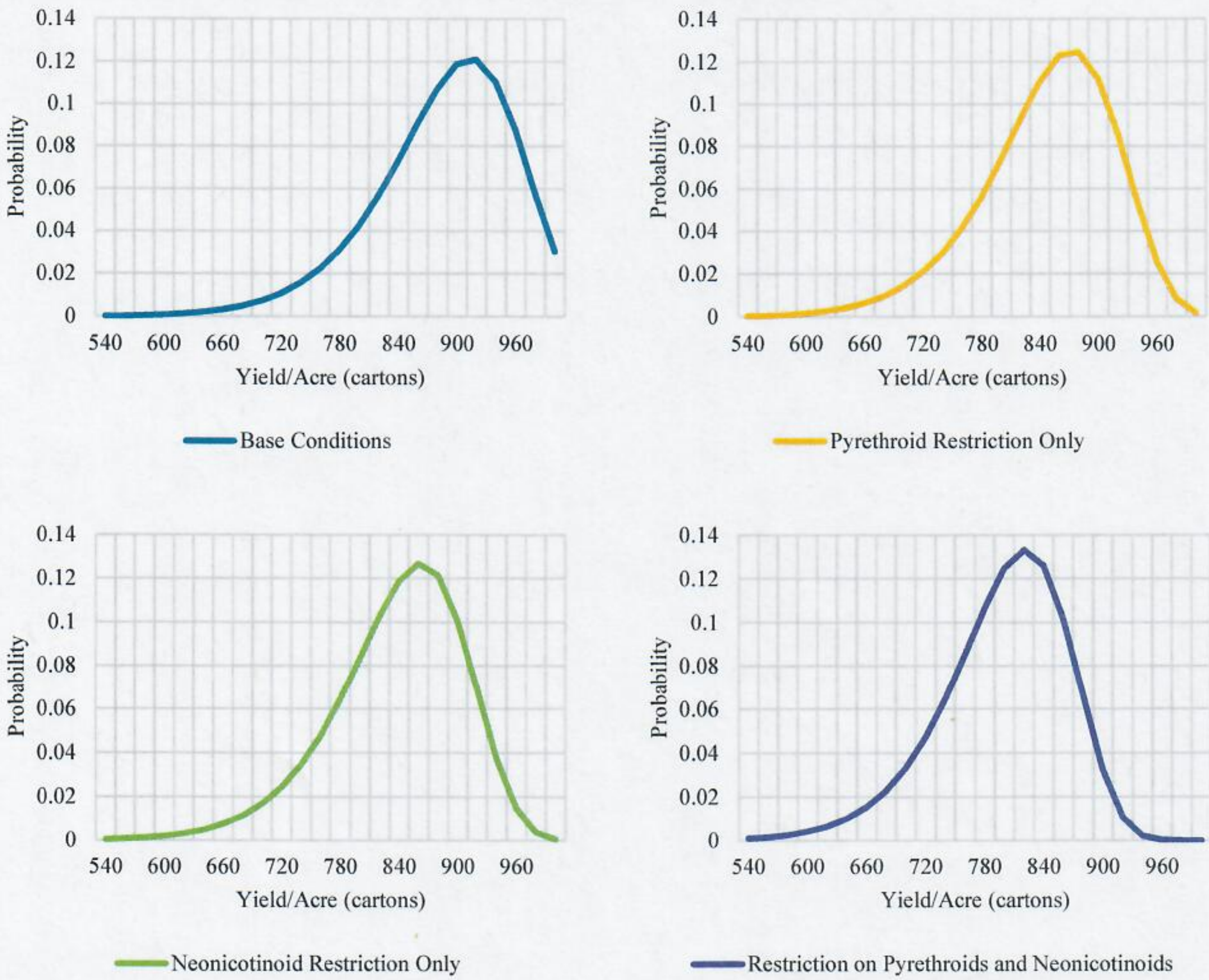
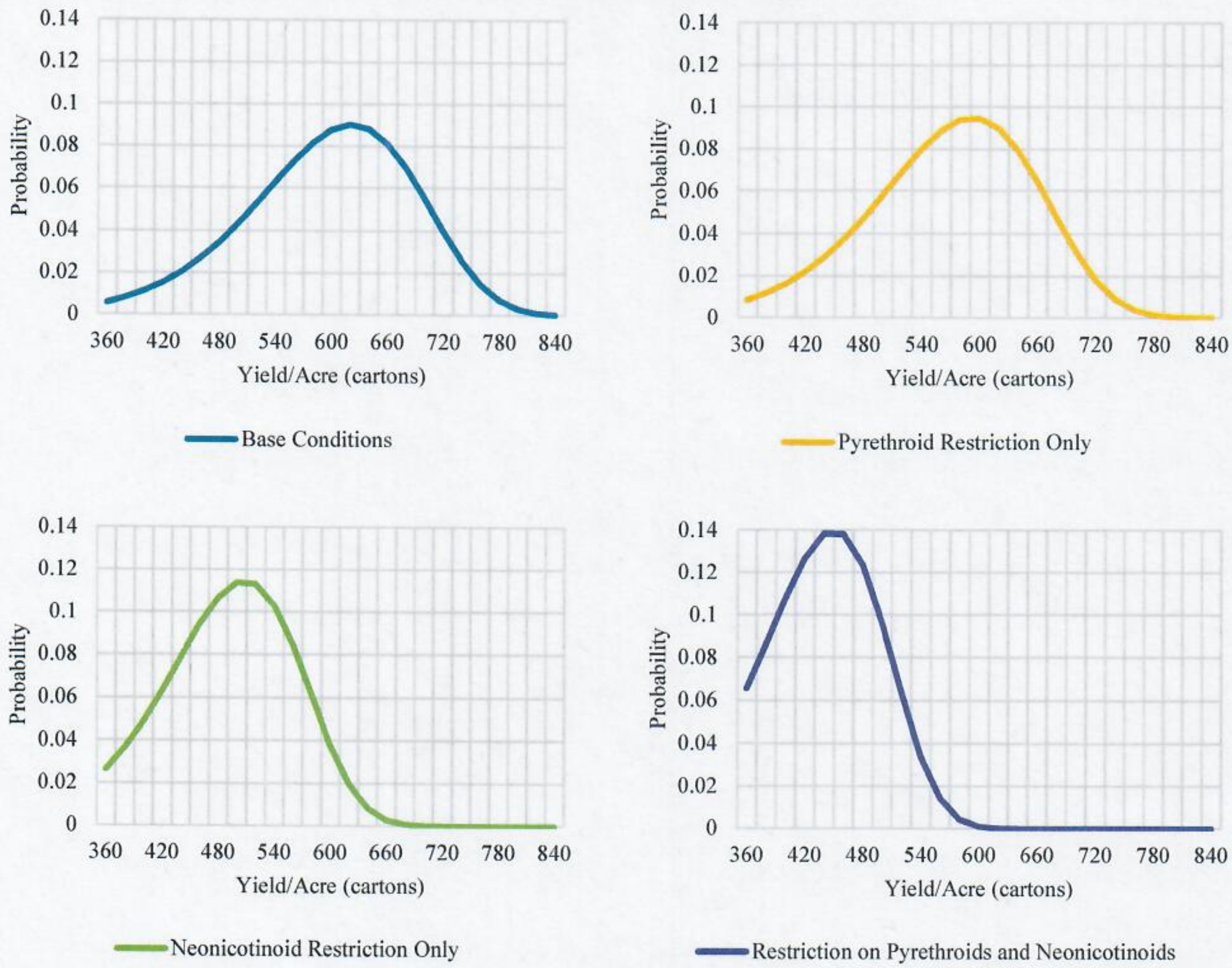


Figure 9 shows yield probability distributions estimated for the desert area. A ban on pyrethroids results in a moderate leftward shift of the yield probability distribution. In contrast, the shift in the probability distribution caused by a ban of neonicotinoids is vastly different than the coast region. In the desert area banning neonicotinoid use results in a substantial leftward shift of the yield probability curve, with higher probabilities of low yields. The difference in neonicotinoid impact compared with the coast region is due to the anticipated damage that could be caused by whitefly in the absence of effective pesticide control method.

Figure 9. Romaine Lettuce Yield Probabilities in the Desert Region



The net returns under different yields were estimated using the operating cost data adjusted to reflect changes in costs due to using alternative pesticides and harvest costs that change with yield.

The cost of downside risk was calculated using a conservative 5 percent rate of return as the target rate for growers. The expected net returns are higher in the desert region under the base scenario due to higher prices for romaine lettuce in that area. Under the pyrethroid ban, the net returns are more than cut in half for the coast region. The neonicotinoid ban has a similar, but slightly higher impact, however for the desert region the neonicotinoid ban reduces the expected net returns from $862 per acre to $81 per acre. Under the scenario in which neither pesticide is allowed, both the coast and desert regions show expected losses. In the absence of major price shifts this would mean that farmers would most likely find it unprofitable to grow romaine lettuce.

Table 9 summarizes the results of the downside risk analysis. For both the coast and desert regions, the downside cost of the pyrethroid ban scenario is 9% and 5% of the expected net revenue for the coast and desert regions, respectively. The neonicotinoid ban scenario has a higher downside cost of 18% of net revenue for the coast region and an extremely high downside cost of 230% of net revenue in the desert region. For the scenario where both pyrethroids and neonicotinoids are banned the downside costs are very large, especially in the desert region, and the expected net revenues are negative.

Table 9. Expected Net Returns and Downside Costs of Pesticide Regimes by Region

Region	Description	Base	No Pyre.	No Neonic.	Neither
Coast	Expected Net Revenue	$812.00	$446.41	$344.05	-$36.29
	Downside Cost	$0.00	-$41.13	-$61.63	-$188.18
	Percent of Net Revenue	0%	9%	18%	N/A
Desert	Expected Net Revenue	$1,242.00	$861.96	$81.37	-$514.95
	Downside Cost	$0.00	-$38.68	-$187.34	-$569.97
	Percent of Net Revenue	0%	5%	230%	N/A

As discussed earlier, the analysis of downside risk does not include price increases which are expected to result from the supply shift under the pesticide policy. Price increases would show higher expected net revenue in table 9 under the pesticide ban scenarios. Modelling the simultaneous interactions between romaine supply and demand price is beyond the scope of this preliminary study but can be considered as part of future work. Nonetheless, the results in table 9 do show how drastic of a change the conceptual pesticide policy would be to downside risk in the industry, all else being equal.

Pesticide Policy Economic Considerations

Restricting (or banning) access to specific pesticides should consider the economic impacts of the proposed policy. A policy that would impose this type of change would affect the production of crops that rely on those pesticides. Namely, it would increase costs and reduce yields, which would reduce production and increase price. This would affect farming risks and increase food prices. Importantly, changes in food prices would be disproportionately felt by lower-income consumers.

The economic analysis of the romaine lettuce industry was developed to illustrate the changes in grower costs, supply and demand for lettuce, and the effects on equilibrium price and quantity. These changes affect growers' net returns and risk, and ultimately affect consumer food prices.

Summary conclusions of the economic analysis are as follows:

1. Pyrethroids and neonicotinoids are an important part of Integrated Pest Management (IPM) for California crops. Both are popular with agricultural operations because they effectively and safely manage a wide range of pests. In addition, the relatively short field re-entry interval after application is valuable for fresh produce that needs to be harvested in specific windows. As part of IPM, access to pyrethroids and neonicotinoids, in addition to other insecticides, provide growers with options for managing pests and pest resistance. Pyrethroids are particularly valuable because they effectively manage a wide range of pests. Neonicotinoids are highly

valuable for specific pests that can cause substantial crop damage, such as Asian citrus psyllid (ACP) and whitefly in desert lettuce producing regions.

2. Pyrethroids and neonicotinoids currently have few effective alternatives. Research, development, and registration of new products involves an expensive and time-consuming process. Delays at both the state and federal levels have continued to slow the approval process. Industry experts interviewed for this study indicated that this is driven, in part, by the increased volume and complexity of data required to register new products. Limited access to new products and alternatives increases the value (including both economic benefits and the importance for IPM) of existing products, including pyrethroids and neonicotinoids.

3. Alternatives to neonicotinoids and pyrethroids are more costly, less effective, and require additional management by growers and pest control advisers (PCAs). A reconnaissance-level economic analysis developed for this study of an example crop (romaine lettuce) found that additional direct costs of alternatives are between $230 and $290 per acre. Crop yield and quality losses vary by region and pest pressures but are estimated between 5 and 30 percent.

4. Higher costs and lower crop yields and quality increase farming risk. Lower net returns and higher net return variability pushes growers to shift to different crops or otherwise reduce production. Lettuce growers already face substantial variability in annual net returns due to external market forces, with net returns at or below breakeven in nearly half of all years. Higher costs and lower yields due to pesticide restrictions increase the variability of net returns and increase the likelihood that a grower realizes a loss in any given year.

5. Higher costs and lower crop yields causes a decrease in the supply of the crop (that is, for a given farm gate price, less will be produced). This puts upward pressure on the cost to produce the crop and ultimately prices, which increases costs for produce buyers and results in higher food costs for consumers. As food prices increase, consumers substitute to other crops and products, leading to less overall volume for growers and buyers. Simply stated, growers produce less, and consumers buy less. The preliminary (reconnaissance-level) economic analysis of pyrethroids and neonicotinoids for romaine lettuce estimated that banning their use could result in variable production costs increasing by an average of 12.25 percent, which would result in consumer price increases of approximately 8.22 percent. A preliminary assessment of the associated effect on downside net return risk to romaine lettuce producers would increase by $188 per acre in the coast region and $570 per acre in the desert region. This would increase farming risk, cause growers to produce less, and potentially shift production to other regions (e.g., Mexico and Arizona) without such restrictions on insecticides.

6. Lower-income consumers spend a larger share of their budget on food purchases than high-income consumers. Therefore, increasing food prices due to restrictions on pesticides will tend to disproportionately impact lower-income families. This is particularly important in the rural communities of California that are home to a high proportion of lower-income and economically disadvantaged families. It is also important in the context of current, broader inflationary pressures that are increasing the costs of goods and services (including food) due to other macroeconomic factors.

7. Reduced production results in less economic activity in lettuce producing regions where a substantial share of seasonal farm jobs depend on the growing and harvesting of lettuce. This could further exacerbate socioeconomic problems on already economically disadvantaged communities and thus increase overall societal costs. Additionally, tax revenue would decrease with lower production and employment, providing less resources to local governments to cover the costs of providing healthcare, public safety, roads, and public works infrastructure.. The preliminary economic analysis estimated that a 12.25 percent increase in operating costs would result in approximately 4 percent decrease in output (volume of lettuce produced). Assessing the impact of a decrease in output independent of any increase in price for romaine lettuce production only, this would result in the loss of more than 420 full time equivalent jobs, $30.5 million in local economic value added activity, and $42.9 million total gross output value in the state. These impacts are for romaine lettuce (farming and related industries) only and would increase substantially if other crops and industries are included.

8. In addition to reducing production in different growing regions, policies that increase farming costs in California can push the industry into other states and countries. This is sometimes referred to as "leakage," where a locally grown crop shifts to another state or country. For winter lettuce production, this means shifting production from the Imperial and Coachella Valleys to Yuma, Arizona and Mexico. In addition to the local regional economic impacts this can represent a permanent shift in production, with implications for state agricultural industries and national food security. Other regions have entirely different labor and environmental standards.

9. Lowering registration costs (including costs and timeliness) for new crop protection products and additional investment in pest management research can help reduce the costs of complying with new regulations on older products. Investment in agricultural research provides benefits to society. Recent research[36] shows that the productivity growth attributable to public investment in agricultural research and development have benefit-cost ratios that are well above 1.0. That is, investment in agricultural research and development provides economic benefits that exceed the costs. However, a July 2022 report from the USDA shows that the United States research investment (covering all agricultural research) has dropped by more than one-third over the last two decades, falling behind other countries' investments in agricultural research and development[37].

10. An economic analysis of a policy limiting certain pesticides is typically developed to assess the incremental impact (costs and benefits) of the new policy relative to current (baseline) conditions. It is important to establish baseline conditions that accurately reflect known industry cost pressures to provide an accurate assessment of how the proposed policy change would affect the agricultural industry. For example, an economic analysis of a new policy/regulation that

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[36] Alston, J.M., M.A. Andersen, J.S. James and P.G. Pardey. Persistence Pays: U.S. Agricultural Productivity Growth and the Benefits from Public R&D Spending. New York: Springer, 2010.

[37] Nelson, K. and Fuglie, K. Investment in Public US Agricultural Research and Development. USDA Economic Research Service. Amber Waves. June 6, 2022. https://www.ers.usda.gov/amber-waves/2022/june/investment-in-u-s-public-agricultural-research-and-development-has-fallen-by-a-third-over-past-two-decades-lags-major-trade-competitors/

would be implemented soon should account for current inflationary cost pressure for inputs (e.g., labor, equipment, and materials costs), as well as other laws that are being implemented and will affect specific input costs (e.g., increasing labor costs under AB 1066 and SB 3 that reduce limits for overtime hours and increase the minimum wage per hour worked).

The economic analysis illustrates that restricting (banning) pyrethroid and neonicotinoid use would result in higher costs to growers (higher input costs and lower yields), additional farming risk, and higher food prices for consumers. Several areas for future extensions of this analysis were identified. These include expanding to other classes of pesticides, other crops, additional regions, and expanding the scope of the analysis to consider statewide in addition to local impacts. This also includes refining some of the assumptions underlying the preliminary analysis. Other analysis could include additional research on the share of US research and development spent on pesticides and how that is changing (declining) over time. Economic costs could be expanded to consider equipment and materials (to growers) as well as the time/effort of new product approval (to companies). Finally, regional economic impacts can be refined to illustrate local changes (jobs, income, economic activity) in specific crop growing regions in addition to statewide changes. As described through this document, this was a preliminary, reconnaissance-level assessment that should be refined in the future with some of these additional changes.