# A Framework for Assessing the Economic Impacts of Agricultural Equipment Emission Reduction Strategies on the Agricultural Economy in the San Joaquin Valley

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## **Executive Summary**

The objective of this study is to collaborate with experts to develop a framework that will enhance the California Air Resources Board's (ARB or Board) existing economic analysis capability to assess the impact of regulatory costs on the agricultural economy in the San Joaquin Valley (SJV) of California. The San Joaquin Valley includes portions of the following counties: San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, Tulare, and Kern. This study is the first phase in a series that develops a framework that can be used to assess the economic impact of additional regulations on San Joaquin Valley agriculture from the farm-level through all ancillary industries. The data-driven modeling framework developed for this study begins with a discussion of the regulatory environment faced by San Joaquin Valley farmers in 2012, the most current year for Census of Agriculture data, a set of case study interviews, and interviews with farm equipment dealers or manufacturer representatives. The baseline data is then built into and a suite of three flexible tools: (i) farm simulation models, (ii) a calibrated regional agricultural production optimization model, and (iii) a regional input-output (or "multiplier") model that can be updated to reflect current cost and return information.

The combined framework allows ARB to evaluate the impact of proposed emission regulations and the economic impact of equipment cost share programs jointly and individually at three scales, (i) individual farms, (ii) direct San Joaquin Valley agricultural production, and (iii) the San Joaquin Valley agricultural economy and ancillary industries. In addition, the combined framework can be used to evaluate the economic impact of proposed strategies to decrease the average age of farm equipment inventory in the San Joaquin Valley.

Through a series of 22 in-depth case study interviews spanning different commodities, farm sizes (defined by acreage of the specific commodity studied and not cumulative farm acreage), and location within the San Joaquin Valley, and interviews with agricultural equipment dealers and manufacturers, a baseline framework for assessing the impact of additional regulation has been created. The interviews are a snapshot of farm-level information on prices, yields, and per acre costs of production, as well as, a comprehensive detail of the regulatory costs faced by the farm in the base year of 2012. The detail of farm level regulatory costs, relative to their ability to generate revenue, is then fed into the three tools developed for ARB. This report augments the suite of spreadsheet-based tools by describing the regulatory environment faced by the farms interviewed and providing an example of the type of analysis and output that can be generated when assessing additional regulation.

General insights about the regulatory environment faced by farms in 2012 in the San Joaquin Valley based upon the case study interviews include:

- 1. Air quality regulations were among the highest average regulatory cost averaging 36% of total regulatory costs across farms, with dust control measures and tree waste comprising the largest components.
- 2. Large variations are apparent in water quality requirements depending on farm location in the San Joaquin Valley and water coalition membership, with anticipation

of higher costs in the future as groundwater nitrogen monitoring is implemented in 2017.

- 3. Pesticide costs of regulation were largely underreported because of the difficult nature of discerning regulatory costs embedded in pest control adviser (PCA) fees and pesticide prices. Pesticide applications were the most commonly contracted work and regulatory costs were hidden within application contracts.
- 4. Farmers surveyed have a variety of opinions regarding the efficacy of the Tier 4 equipment regarding cost of use, fuel efficiency, and reliability. All surveyed farmers who had adopted Tier 4 equipment had used a cost-share program, and would likely have not upgraded their equipment without the incentive program.
- 5. All of the equipment dealers and manufacturers commented that the incentive programs were essential for growers to buy new tractors, and that the methods of acquiring necessary agricultural equipment is changing.
- 6. Larger farms tend to have lower average costs per acre largely based on the lower fixed average cost of employment and training costs.
- 7. The farm owner's self-reported value of time contributed to variation in the total regulatory costs across interviewed farms, particularly in the education and training regulatory category, and also contributed to higher per acre costs for smaller operations. Smaller operations were owned by people with professional off-farm employment, and thus their opportunity cost of time was easier to value at a higher rate.

The findings of the regional analysis using the Statewide Agricultural Production Model (SWAP), an economic model covering 97 percent of irrigated agriculture in California, include:

- 1. The 22 case studies are combined with data from the USDA, CDFA, UC Cooperative Extension, published studies, and other secondary sources to develop the SWAP model for application to regulatory cost impact analysis.
  - a. Small and large farms are modeled separately (and jointly within the single market for each crop) in the SWAP model data, calibration, and optimization.
  - b. The study found that the default crop cost-of-production budgets do not include a full accounting of all regulatory costs.
  - c. The SWAP model is used to evaluate the incremental change, relative to current baseline conditions, in additional regulatory costs while acknowledging drought conditions, income and population shifts, and increasing real production costs.

- 2. There are important differences in production costs between small and large farms for many crops produced in the San Joaquin Valley. Prior to this study, this information was not included in the SWAP model input data. In general, larger farms are able to capitalize on economies of scale, by spreading capital costs over a larger operation.
- 3. Current regulatory compliance costs vary significantly by farm size. Many small operators will use owner-operator time to manage regulatory requirements, whereas many large operators will have full-time staff. Both indirect and direct costs of regulatory compliance are included in the SWAP model input data.
- 4. Small increases in regulatory compliance costs generally have a small effect on the regional agricultural economy. However, when these costs are considered concurrently with drought, market risk, and other production pressures, the regional economic impact increases.
- 5. Streamlining regulations can further reduce the economic impact of complying with new regulations. Growers spend a significant amount of their own time ("indirect compliance costs") complying with and learning about regulations, which in some instances, overlap between agencies.

The findings of the regional economic analysis using the Impact for Analysis and Planning Model (IMPLAN) include:

- 1. The IMPLAN model is linked to the SWAP model and used to simulate the effect of changes in crop production on all ancillary industries.
- 2. Higher regulatory compliance costs cause growers to reduce output (fallow), switch crop mix, and adjust inputs used on a per-acre basis. These changes affect input purchases and output sales to related industries. For example, fewer fertilizer purchases, reduced expenditures by employees in the local economy, and less custom harvest services. These changes are an additional cost to the San Joaquin Valley economy. Balanced against these costs, are potential economic benefits not quantified in this analysis. For example, regulations that require growers to invest in new machinery or equipment will result in increased sales for local machinery and input suppliers, with potentially positive economic impacts to the region.
- 3. The San Joaquin Valley economy is heavily dependent on agriculture-related industries. As such, changes in agriculture in the San Joaquin Valley have a potentially higher proportional impacts relative to changes in another part of the state (such as Southern California) or other parts of the world. It is important to keep this in mind when evaluating the impact of a new regulation.
- 4. The San Joaquin Valley economic multipliers range from 1.3 2, meaning that a dollar increase in primary farm production can cause an additional 30 cents to 1 dollar

in additional losses in related industries. Multipliers vary by crop, region, and industry.

This study has completed a primary survey of 22 growers to establish farm-level regulatory compliance costs relative to their individual costs of production in 2012. A per acre cost of production budget for each case study offers a snapshot into growers' ability to make a profit under increasing regulations and stochastic prices and yields. These data feed into the regional economic model, SWAP. The SWAP model is augmented with cost-of-production data to disaggregate production costs by farm size. In addition, the Census of Agriculture is used to estimate the proportion of small, medium, and large farms, for each model region. The model is able to estimate the regional changes in direct farm production resulting from changes in regulatory costs. Finally, the SWAP model feeds directly into the IMPLAN input-output model, which is used to estimate effects on value-added, output, jobs, and taxes in the local economy. Together, the integrated framework provides a robust set of tools that ARB staff can use to evaluate the economic impact of regulations from the farm to all linked industries.

Prior to this study, a suite of tools to evaluate agricultural regulatory impacts did not exist. This study, through careful data gathering and 22 case studies, has developed a unique framework that is easily updated and augmented to include a more robust set of case study interviews and/or changes in on-farm practices and regulatory costs since the 2012 baseline. To be sure, 22 case studies does not nearly capture the total variation in operating and regulatory costs that span the thousands of farms operating in the San Joaquin Valley but this represents a necessary starting point and baseline that now has the potential to more accurately capture the regulatory environment in which all farms operate. It is difficult to quantify regulatory costs because detailed and proprietary financial data are required to estimate the additional cost imposed by a regulation. For example, without detailed accounting it is difficult, if not impossible, to estimate the cost of management time required to fill out forms, learn about new regulations, and participate in informational meetings. For this reason, the first phase of work has focused on creating a framework and a suite of tools to assess the impact of additional regulation at the farm and regional level with plans for future phases to assess the change in regulatory environment between Census years 2012-2017 and expand the operating set of case studies that feed into the regional models.

The limitations of the study broadly fall into two categories: (i) technical limitations of the modeling, and (ii) and practical resource limitations. In addition, the scope of the analysis included in the Analysis Tool is the San Joaquin Valley. This means that the potential for crops to shift to the Sacramento Valley, or other regions, is not explicitly modeled in the analysis.

First, models are by definition simplifications of a more complex system. The stochastic farm budgets simulate net returns to land and management on a representative farm, and as such, care must be taken when extrapolating results to the entire San Joaquin Valley. The SWAP and IMPLAN models are larger scale, but lack the farm-level detail found in the stochastic farm budgets. In other words, estimates of the impact of additional regulatory policy can easily be taken out of context and care must be taken when utilizing the models.

Other practical limitations are related to the data. For example, there are 22 case studies and these are used to generate cost-of-production budgets for the SWAP model. However, not all of the SWAP crops were represented in the sample. In turn, it was necessary to compile supplemental data from USDA, Census of Agriculture, California Agricultural Statistics, and other published studies to "fill gaps" in the model. While this does not limit the effectiveness of the modeling framework, it is important to be clear that additional data can be gathered to increase the robustness of the models.

Given the resource constraints of the project and the objective of creating a framework and a suite of tools to evaluate the impact of future regulation, it was necessary to limit the number of case studies to 22. The sample is small and by no means random, however it covers the industry well in terms of variety in commodity, size, location, and, most importantly, impact of various regulations and regulatory bodies,

The lack of a centralized information source for regulatory compliance create significant indirect costs for agricultural producers. The amount of time reported by growers just to learn about new regulation is substantial. In addition, some of the direct regulatory costs, especially those related to labor laws and water and air quality, are much higher than in other states, causing some labor-intensive facilities such as dairies to consider relocation elsewhere. The 2017 World Ag Expo in Tulare, California, had six other states, including Kansas, North Dakota and South Dakota, as exhibitors in the Dairy Pavilion, specifically recruiting California dairies to move to their operations. One of the main selling points in each exhibit was the lower cost of regulation.

### Introduction

The objective of this work is to augment and enhance California Air Resources Board's (ARB) existing economic analysis capability to assess potential strategies that may be developed for reducing emissions from agriculture in the San Joaquin Valley (SJV) of California. In order to create a robust suite of analysis tools, a framework must be created that outlines the existing regulatory environment at both the individual farm level relative to cost of production, and regionally relative to the economy as a whole. This study is the first phase in a series and focuses on developing that framework through a small sample of case study interviews that are distilled down into Excel-based analysis tools. This report accompanies the Excel-based tools and includes an overview of the sample selection and data collection process, a discussion of the regulatory environment faced by SJV farmers in the 2012 base year and beyond, an outline of the economic framework for analysis, and an example of how this framework can be used to regionally assess potential policy.

The suite of tools informed by the assessment of the regulatory environment include: (i) farm simulation models, (ii) a calibrated regional agricultural production optimization model, and (iii) a regional input-output (or "multiplier") model. The combined framework allows for the evaluation of the impact of proposed emission regulations jointly and individually at three scales, (i) individual farms, (ii) direct SJV agricultural production, and (iii) the SJV agricultural economy and ancillary industries. It can be used to evaluate the economic impacts of alternative emission reduction scenarios, as required in an economic impact analysis in support of the rulemaking process. It can also incorporate the existing agriculture equipment inventory and provide insight into the effectiveness of incentive programs utilized to update that inventory.

The economic framework is built upon of a series of 22 case studies conducted as in-person grower interviews. These interviews allow for quantification of farm regulatory costs relative to standard operating costs and lead to the development of farm simulation models of the individual farms' ability to generate net cash income or returns to land and management. The case study data is then integrated into a custom version of the Statewide Agricultural Production Model (SWAP). Furthermore, the SWAP model is updated using compiled secondary data from U.S. Department of Agriculture (USDA), Agricultural Census, UC Cooperative Extension, and published studies. Next, supplemental analyses of farm size and regulatory costs is completed, and an IMPLAN input-output model is developed to assess the regional impacts of changes in farm regulatory costs. These models are all distilled into a suite of Excel-based analysis tools that can be used by ARB to evaluate the impact of imposing various estimated regulatory costs on farms in the San Joaquin Valley.

The farm-level analysis utilizes primary data from in-person grower interviews and supplemental secondary data. This primary data collection from growers is critical for assessing variability in net farm income before taxes by key factors such as farm size, crop type, cultural practices, and location. Regulatory compliance costs are typically not included in average cost of production budgets prepared by University of California or other research organizations. As such, the true production costs, and production risks, under this framework can be understated. While the case

study sample size -22 spanning 7 major crop types - is quite small relative to the number of operating farms in the San Joaquin Valley, it is the largest set of case studies of this type ever completed and provides a foundation for regional modeling in the San Joaquin Valley. The second phase of the project will be focused on expanding that sample size to include other crop types and farm sizes as well as updating the baseline regulatory environment in congruence with the 2017 Census of Agriculture.

The regional agricultural production model analysis builds on the farm-level analyses and supplemental data. The economic analysis of regional agricultural production in the San Joaquin Valley uses a modified version of SWAP. SWAP is an economic optimization model covering 97 percent of irrigated cropland in California, developed and maintained by ERA Economics. It is widely applied by state and federal agencies for economic impact analysis and feasibility studies including the California Department of Food and Agriculture (CDFA), U.S. Bureau of Reclamation, Army Corps of Engineers, California Department of Water Resources (DWR), State Water Resources Control Board (SWRCB), and others. The SWAP model is used to estimate direct agricultural impacts (e.g. gross agricultural revenues and crop acreage) in the San Joaquin Valley resulting from changes in air emission regulations. Importantly, the SWAP model simulates the statewide market for crops produced in the San Joaquin Valley, and as such, is able to explicitly acknowledge other factors affecting the farming industry, such as drought, labor shortages, and policy changes. The SWAP model was significantly modified for this project, including integrating regulatory compliance costs, farm size, linkage to IMPLAN, and updating the baseline data and calibration. Prior to this study, the SWAP model was not able to analyze the incremental impacts of regulatory costs.

The final model in the suite of tools developed for this study is the IMPLAN input-output model (MIG, Inc.). The IMPLAN model estimates the link between farming and related industries. For example, farm workers purchase food and housing, growers purchase machinery and variable inputs from supply stores, and farm production is sold to processors and distributors. All of these industries contribute significant economic activity to the San Joaquin Valley economy. When there is a change in primary farm production, as estimated using the SWAP model, this affects other sectors of the economy. IMPLAN is linked to the SWAP model and used to estimate these effects in terms of jobs, taxes, value-added (economic contribution), and expenditures in the local (San Joaquin Valley) and statewide economy.

The farm budgets, SWAP model, and IMPLAN model are formally linked and distilled into a series of Excel Workbooks that allow ARB staff to evaluate the economic impact of changes in regulatory costs at the farm, region, and across linked industries. The sections of the report are structured as follows: First, an overview of assessing the regulatory environment in agriculture is provided. Second, the case study sampling and interview process is outlined, followed by an overview of the regulatory environment faced by SJV farms in 2012 and beyond. Third, the economic framework for assessing future policy is presented, with an example. Finally, key limitations and extensions are provided. Technical details regarding the models can be found in the accompanying appendices.

## Assessing the Regulatory Environment

Regulations can provide benefits to producers by, for example, signaling to consumers that California produce is safe and reliable, but regulations also impose compliance costs on agricultural businesses. Workers benefit from improved safety, and consumers benefit from improved air quality, water quality, and food safety. It is important to recognize the current regulatory environment when developing a framework for economic analysis of any new regulations.

Regulatory costs can be classified as either direct, involving a cash outlay in response to the regulation, or indirect, involving an opportunity cost to the business or industry as a result of the regulation. Both direct and indirect costs of regulations to agricultural producers in California have been increasing in recent years. For example, in 2012 groundwater regulations were added to the Irrigated Lands Regulatory Program, which was initiated in 2003 to regulate run-off from irrigated acreage. AB 32 the California Global Warming Solutions Act of 2006, which requires reduction of greenhouse gas emissions, does not directly regulate agriculture but has indirect implications through increased energy costs. SB 700 signed in 2003, brought agriculture into compliance with air quality regulations in 2006. The Farm Worker Safety Act of 2012 requires farm managers and contractors to provide shade structures, breaks and cold water for farm employees. More recently, SB 1383 requires California dairies to significantly reduce methane gas emissions from cows. The increasing costs of regulatory compliance over time, as well as the possibilities of even more stringent regulations in the future, are widely cited as a major source of concern in the agricultural industry. There are relatively few studies that estimate regulatory compliance costs to agriculture because assessing both the direct and indirect costs requires individual firms to reveal sensitive financial information.

The total cost of regulatory compliance for specialty crop<sup>1</sup> producers in California is estimated to equal more than \$2 billion (approximately 10% of cash receipts) per year (Hurley and Noel 2006). The increasing complexity of the regulatory environment in California has been cited by several studies as an area of growing concern for California producers and a factor that is likely to have negative impacts on the future competitiveness of the industry (Hurley 2005; Johnston and McCalla 2004; Noel, Paggi, and Yamazaki 2013).

The main areas of regulation in California agriculture can be classified as: (i) labor regulations, such as safety and health, worker compensation and rights, (ii) regulations pertaining to consumer health and safety, (iii) environmental regulations, such as air and water quality, water rights, threatened or endangered plants and animals, and wetlands, and (iv) regulations related to transportation of materials including hazardous waste.

1. **Labor regulations**. Relative to other states, California has higher minimum wages, mandatory workers' compensation insurance, liability insurance, and health care benefits. Workers' compensation rates for agricultural workers vary between 10 and 25 percent of base salary for field and packing shed workers, to as low as 0.5 percent for clerical

<sup>&</sup>lt;sup>1</sup> Specialty crops include fruits, vegetables, nuts, and nurseries.

workers. Because of these regulations, California producers in total spend millions more than farmers in states without workers compensation requirements and generally lower labor expenses (Hurley 2005; Hamilton 2006). For some growers, workers' compensation can comprise up to half of total regulatory costs (Noel and Paggi 2012).

- 2. Consumer health and safety regulations. The main focus of regulations specific to consumer health and safety is preventing the contamination of food products by foodborne illnesses and harmful chemical residues. Regulations on the use of pesticides are developed with consumer safety in mind. The Food Safety Modernization Act (FSMA) is the most recent salient example of consumer health and safety regulations. The total regulatory impact of the rules resulting from FSMA is yet to be determined.
- 3. Environmental regulations. Following the development of the Central Valley Project (CVP) and State Water Project (SWP), California water management has shifted from an era of building dams to one of increased focus on the environment. Environmental concerns have generated many new regulations that affect agricultural producers, and regulatory agencies are still trying to strike the right balance between competing demands for scarce water resources. Environmental regulations can be sub-divided into areas such as water quantity, water quality, air quality, and pesticide regulations. The Irrigated Lands Regulatory Program (ILRP) and the 2009 Biological Opinion are recent examples of major changes in environmental regulations.
- 4. **Transportation regulations**. Transportation regulations affect farm operations, packershippers, and the broader distribution industry. Regulatory compliance costs to specialty crop distributors are difficult to identify because most distribution businesses are diversified across crops and industries. Furthermore, distribution is linked to both primary production and processing, so who bears the cost of a new regulation is determined by the relative supply and demand elasticities for these linked industries.

The regulatory environment in California is constantly changing in response to new laws policies, and legislative mandates. The complexity of the regulatory environment is a major factor driving increases in the costs of compliance (Hurley et al. 2006). Indirect compliance costs are perceived to have a higher negative impact on the production process than direct cash costs. This is largely due to the uncertainty created by the regulatory environment. Producers want to comply with regulations, but find it difficult to obtain timely information (Hurley et al. 2006). Local farm bureaus and industry groups offer meetings and information sessions, which requires growers to commit management time to attend these meetings, which can be costly.

A second source of concern for growers is that there are multiple agencies overseeing regulations. California producers face multiple agencies and regulations derived from at least 28 separate state and federal laws governed by various separate state and federal agencies. New regulations must be considered in the context of existing laws, and ideally, should be consistent with existing rules. The framework developed under this study explicitly acknowledges existing regulation compliance costs at the farm, including direct and indirect costs of compliance.

#### Factors Affecting Regulatory Costs

Regulatory compliance costs are difficult to quantify because costs can be direct or indirect, result from various laws, result from rules that are often overlapping, and can be managed differently across farms. In other words, regulatory compliance costs must be estimated at the farm-level using sensitive financial information. This study completes an analysis of 22 farms in the San Joaquin Valley to quantify regulatory costs. In consultation with ARB staff and representatives of the agricultural community, the following factors were considered in the process of determining which farm types and commodities would be included in the 22 studies:

- 1. Crop type
- 2. Acreage and value
- 3. Location
- 4. Farm size
- 5. Farm machinery costs
- 6. Contributions to criteria pollutant emissions
- 7. Yield variation

The first task is to narrow the focus of potential commodity types to the sub-set of commodities that are most common in the San Joaquin Valley. Within these commodities, agricultural statistics are used to determine the major crops by value and acreage across the entire San Joaquin Valley and within each county. Next, farm machinery costs by crop from University of California Cooperative Extension crop budgets, in consultation with representatives of the agricultural community, are used to identify crops most likely to be affected by new air quality regulations. Finally, agricultural statistics were used to quantify variation in farm size, production practices, and yield across the San Joaquin Valley as a proxy for variability in farm profitability.

The outcome of the preliminary data analysis was that the seven key factors can be aggregated into three essential factors affecting regulatory costs at the farm: (i) commodity type, (ii) farm size, and (iii) farm location. Detailed regulatory compliance costs vary with these three factors. Namely, mechanization costs, contributions to criteria pollutant emissions, and yield variation are correlated with commodity, size, and location. These are the major factors considered in the analysis used to identify a sample of 22 farms for a case-study analysis.

## **Case Study Sampling and Selection**

An important driving factor for this project is that there are limited data on the direct and indirect costs of regulatory compliance across different farm sizes in California. In addition, there is no comprehensive framework that facilitates analysis of the costs of regulation on farms taking into account the current regulatory environment and market conditions. As such, the first step in this analysis was to identify a representative sample of growers who were willing to share confidential farm financial data that could then be used to estimate regulatory compliance costs. This comprehensive data gathering process involved close consultation with ARB staff and representatives of the agricultural community. The sampling approach is described in this section.

Two competing factors guided the data sampling approach: (i) project resources, and (ii) developing a representative sample of commodities produced in the San Joaquin Valley. ARB staff and the project team determined that the project resources were sufficient to cover 22 individual farm case studies, in addition to a concurrent data gathering effort undertaken by ERA Economics to construct the SWAP and IMPLAN models, with an understanding that future work could be undertaken to expand the sample. As discussed in the previous section, three essential factors affecting regulatory costs at the farm were considered: (i) commodity type, (ii) farm size, and (iii) farm location.

According to the 2012 Census of Agriculture conducted by the USDA, the San Joaquin Valley produces over 150 unique agricultural commodities (crops & livestock) ranging from cattle and dairy to various types of citrus. Many of these commodities share similar production practices and access to markets, and as such, can be grouped together for analysis. DWR and CDFA typically consider 20 crop groups for aggregate analyses of California agriculture. These same groups are used in the SWAP model, which are summarized below in Table 1. The "crop group" column lists the aggregate crop category, the "proxy crop" column lists the representative crop typically used in regional analyses, and "example other crops" lists examples (not a comprehensive list) of other crops in the category. A representative sample from these crop groups is developed for the regulatory case studies. What constitutes a representative sample is a multidimensional question encompassing commodity type, geographical location, and farm size (which could be measured by acres, total value, and/or machinery usage). We discuss the sampling approach in light of these limitations below.

Crop Group	Proxy Crop	Example Other Crops
Almonds and Pistachios	Almonds	Pistachios
Alfalfa	Alfalfa Hay	
Corn	Grain Corn	Corn Silage
Cotton	Pima Cotton	Upland Cotton
Cucurbits	Summer Squash	Melons, Cucumbers, Pumpkins
Dry Beans	Dry Beans	Lima Beans
Fresh Tomatoes	Fresh Tomatoes	
Grain	Wheat	Oats, Sorghum, Barley
Onions and Garlic	Dry Onions	Fresh Onions, Garlic
Other Deciduous	Walnuts	Peaches, Plums, Apples
Other Field	Sudan Grass Hay	Other Silage
Other Truck	Broccoli	Carrots, Peppers, Lettuce, Other Vegetables
Pasture	Irrigated Pasture	
Potatoes	White Potatoes	
Processing Tomatoes	Processing Tomatoes	
Rice	Rice	
Safflower	Safflower	
Sugar Beet	Sugar Beets	
Subtropical	Oranges	Lemons, Misc. Citrus, Olives

#### **Table 1. California Crop Groups**

Crop Group	Proxy Crop	Example Other Crops
Almonds and Pistachios	Almonds	Pistachios
Alfalfa	Alfalfa Hay	
Corn	Grain Corn	Corn Silage
Vine	Wine Grapes	Table Grapes, Raisins

The first step in the sampling approach was to review top commodities by total production value for each county. It is immediately clear that the 150 crop types reported by USDA are dominated by 17 key crops in the San Joaquin Valley. Each commodity was then grouped into seven broader groups: citrus, stone fruit, tree nut, grapes, cotton, silage, and vegetables. Grains, grasses, legumes, and tubers are not represented in this list due to their relatively lower contribution to total agricultural acreage and value. With the analysis framework in place, the case study sample can easily be expanded to include additional commodities in a future study. Each of the 7 commodity types were grouped by location in the San Joaquin Valley to isolate differences in both production and regulatory costs across sub-regions. For example, the eastside Friant-Kern Canal area is well known for citrus and stone fruit production, and areas to the west include more field and fodder crops. To simplify the sampling process San Joaquin Valley counties were divided into regions (East/West and North/South) to acknowledge these important geographic differences between regions. The project team, ARB staff, and representatives of the agricultural community reviewed the proposed regions in the San Joaquin Valley, and all parties agreed that the north-south and east-west characterization generally describes access to water and different production conditions in the San Joaquin Valley.

Having identified representative crop types by value and production location, the next task was to identify a breakdown by farm size and machinery usage. Table 2 summarizes the percentage breakdown of the number of farms by acreage and asset value of machinery across SJV counties according to the 2007 Census of Agriculture. It is clear that there are differences between counties for the breakdown of farm size in terms of acreage. Furthermore, it is important to note that some commodities lend themselves to certain farm sizes within the San Joaquin Valley, e.g. there are very few small cotton growers, and very few large stone fruit growers. At least two farm sizes are evaluated for each commodity, to identify if there are differences in regulatory costs.

% of Farms by						San		
Acreage	Fresno	Kern	Kings	Madera	Merced	Joaquin	Stanislaus	Tulare
1 to 50 acres	59.2	31.3	43.6	40.8	51.5	60.7	63.4	62.9
50 to 259 acres	23.1	27.5	25.2	37.0	28.3	24.3	24.1	23.6
260 acres or more % of Farms by	17.7	41.2	31.2	22.2	20.1	15.0 San	12.5	13.5
Value of Machinery	Fresno	Kern	Kings	Madera	Merced	Joaquin	Stanislaus	Tulare
Less than \$50,000	57.6	48.5	47.7	49.2	52.0	58.1	60.8	62.2
\$50,000 or more	42.4	51.5	52.3	50.8	48.0	41.9	39.2	37.8

#### Table 2. Farm size and machinery breakdown

Information on production value, farm size, machinery, and contributions to criteria pollutant emissions were combined and reviewed generating the breakdown of specific commodities and farm sizes to sample. To preserve the anonymity of study participants, case studies will be referred to throughout this report by their respective commodity groupings and/or general location within the San Joaquin Valley. Table 3 summarizes the final selection of the 22 case studies by aggregate region (South of CA 198, North of CA 180/CA 168, and Central) and farm size by the acreage of commodity in question grown.

Commodity Group	Citrus	Stone Fruits	Tree Nuts	Grapes	Cotton	Corn for Silage	Tomatoes
Survey Locations	2	2	3	2	2	3	1
	South, Central	South, Central	South, Central, North	South, North	South, Central	South, Central, North	Central
Farm Size Selection							
Under 50 acres	1	1	2	1	0	1	0
51-250 acres	1	1	1	2	1	2	1
251 acres or more	1	0	1	1	1	2	1
Total Sample Farms	3	2	4	4	2	5	2

#### Table 3. Case study selection

#### Case Study Interview Process

Representatives of the agricultural community identified growers to participate in the 22 case studies. ERA Economics provided templates for cost of production based on UC Cooperative Extension Budgets for each of the commodities included in the study, and case study interviews were conducted on-site. The interviews commenced in late 2014 and continued into early 2016. Because the agricultural commodities studied varied substantially by crop and location, harvest extended throughout the year, making it difficult to schedule interviews. In total, accessibility, the 22 case studies were conducted over the 15-month period from December 2014 to February 2016.

Pre-interview questionnaires were distributed prior to the in-person meetings. The questionnaires included qualifying questions regarding farm size. It also included various questions regarding regulatory costs to help the participants begin to think about all the different types of these costs they face. Finally, the questionnaire included questions regarding farms' financial abilities when acquiring mobile equipment. A summary of specific questions is included in the following section.

In addition to the questionnaire, a sample cost of production worksheet and sample regulatory cost worksheet was distributed. The in-person interviews consisted mainly of a discussion of the individual's cash cost of producing an acre of the commodity in question during the 2012 growing season, Table 4 lists some of these reported operating costs. UC Cooperative Extension

budgets for the commodity being studied, scaled to 2012 dollars, were used as a baseline for determining the individual costs. It should be noted that the case study production costs expectedly varied from costs reported in the UC Cooperative Extension budgets. UC Cooperative Extension budgets are created from a panel of growers and can be essentially thought of as representative costs of production for a specific crop in a specific region, whereas the case studies are individual farm specific. While the individual costs vary from those created by UC Cooperative Extension, they are within the reported ranges and not so different as to draw question to their validity.

<b>OPERATING CASH COSTS:</b>	CASH OVERHEAD COSTS:
Insecticide/Fungicide	Office Expense
Herbicide	Insurance
Fertilizer	Property Taxes/Rent
Soil Amendments	Misc. all other cash overhead expenses
Irrigation	TOTAL CASH OVERHEAD COSTS/ACRE
Water - Surface/pump	
Repair/Maintenance	
Custom/Contract:	
Labor (machine)	
Labor (non-machine)	
Fuel - Diesel	
Machinery repair	
Misc. supplies	
Replant costs	
Interest on operating capital 3%	
TOTAL OPERATING COSTS/ACRE	

## Table 4. Sample Operating Costs

After the operating costs were recorded, the interview focused on identifying all the regulatory costs incurred in the same year. Nine general categories were used to group all regulatory costs; Education and Training, Air Quality Requirements, Water Quality Requirements, Pesticide Use Requirements, Employee Safety Requirements, Capital Investment, Risk Management, Food Safety Requirements, and Other Regulatory Costs. Table 5 lists a number of potential regulatory costs that individual farms face under the nine different categories.

As illustrated in Table 5, there are some regulatory costs that are assessed at the farm level and some that can be attributed to growing the specific commodity in question. When a regulatory cost is assessed at the farm level, the acreage percentage of the commodity in question relative to the whole farm is multiplied by the per acre regulatory cost in order to calculate the dollar per acre that can be attributed to that commodity. Take, for example, a 100-acre farm that grows 25 acres of citrus. If they spend \$1,000 on employee safety training annually, the dollar per acre assessment of safety training that can be attributed to citrus would be \$10/acre (25%\*\$1,000/25 acres).

#### **Table 5. Sample Regulatory Costs**

Education/Training for Regulatory Compliance	Employee Safety Requirements
Employment Issues - Time/Cost of program - employees	Hazardous materials safety gear & signage
Employment Issues - Time/Cost of program - owner	Canopies for shade
Pesticide Issues Time - Spent/Cost of program - employees	Drinking water - Infraction not cold & clean
Pesticide Issues Time - Spent/Cost of program - owner	Portapotty cleaning
Water/Fertilizer Quality Issues - Time Spent/Cost of program	Wash stations + drinking water
Keeping up with new regulations	Capital Investment
CPR Trainer's Fee	Increased expense to offset regulatory cost
Air Quality Requirements	Loss use of equipment
CMP Fee	Risk Management
Time Spent in filling out forms, drawing maps, etc	Increased liability insurance cost
Dust Control	Food Safety Requirements
Equipment Cost	Field auditor
Labor	Medium residue level testing
Materials - water	Full time staff for retail audits
Materials - oil/sand	Other Regulatory Costs
Burn permit	Full time environmental compliance manager
Stump chipping - machine	Environmental Impact Report
Stump chipping - labor	Notification to dig
Replacing fuel tanks	Truck Scale Weighmaster Registration - CDFA
Water Quality Requirements	Waste oil recycling
Cost to join water waiver coalition	Plastic containers of chemicals for disposal
Permits/paperwork to comply with ground water quality	Loss of land use
Well-water testing	
Pesticide Use Requirements	
Filing paperwork/record keeping	

Buffer zone yield losses

Posting buffer zone signs

During the conversations, a set of narratives was developed that not only detailed the costs incurred in 2012 but also those incurred after 2012, as well as growers' opinions on any future costs. These narratives are presented in Appendix A along with a percentage breakdown of the farms' cash costs including regulatory costs by the aggregate categories. It should be noted, that any regulatory costs incurred post 2012 are not included in the stochastic farm models nor the regional models. The models have been constructed to allow for the flexible input of any future costs, so if the same farms are revisited in the future an efficient estimation of increased regulatory costs may be calculated.

In total, each interview took approximately 2-3 months to complete, including follow-up after the in-person meetings. Each in-person interview lasted on average approximately 3 hours. In all cases, participants shared the necessary information for the models to be developed and provided an honest estimate of the regulatory costs they face on an annual basis.

The only way to gather data on regulatory cost is through the grower interview process, because the vast majority of publicly available data is not comprehensive of all types of regulatory costs and is generally limited. In addition, the linkage of primary farm survey data on regulatory costs and farm size to the regional economic model, SWAP, allows for the consideration of the effects on the regional economy and ancillary industries (through IMPLAN). This is the first time such a comprehensive framework and suite of tools have been developed and they provide a baseline for estimating changes in the regulatory environment faced by farms in the San Joaquin Valley.

## The 2012 Regulatory Environment and Beyond

This section summarizes the regulatory compliance costs at the farm level in 2012. In addition, through a series of interviews with mobile agricultural equipment dealers, insights are drawn into the current regulatory environment and the growers' ability to acquire equipment. We note again that the scope of the analysis is not to evaluate a specific regulation, but to develop a framework that can be used to evaluate the impact of changes in the regulatory environment given an estimated regulatory cost per acre. As such, the information presented in this section is a snapshot of the regulatory environment faced by a small sample of farms. Averages across commodity groups are taken from an even smaller set of farms, 2-5 interviews per group, so values cannot be thought of as general results. While this sample is small relative to the number of farms in the San Joaquin Valley, the general picture illustrated gives insight to the variability of the regulatory environment faced by all farms in the region.

The cost of regulatory compliance depends on the size of the farm, crop mix, and location. In order to give context to the regulatory costs presented, Table 6 lists the average production costs for the different commodities. Operating cash costs are the sum of cultural, harvest/contracting, and interest, and details of specific costs (chemical, labor, etc.) are omitted to preserve the anonymity of participants.

	Citrus	Cotton	Grape	Tree Nut	Silage	Stone Fruit	Tomato
				\$/acre			
Cultural Cost	\$2,252	\$638	\$2,447	\$1,931	\$611	\$4,232	\$1,665
Harvest/Contracting Cost	\$3,080	\$153	\$2,998	\$335	\$174	\$4,309	\$503
Interest on Operating Cost	\$53	\$34	\$186	\$54	\$11	\$117	\$24
Total Overhead Cost	\$477	\$266	\$803	\$426	\$145	\$378	\$366
Total Cash Cost	\$5,862	\$1,090	\$6,434	\$2,746	\$941	\$9,036	\$2,558

#### Table 6. Average production costs per acre by commodity

This section details how average regulatory costs per acre vary across these factors for the 22 case studies. The case study narratives present individual perspectives.

Table 7 summarizes what are broadly defined as environmental regulations. Note that air quality regulations impose the highest estimated annual cost per acre. Complying with air quality requirements typically requires expensive dust control measures involving hundreds of hours of labor, equipment and materials costs as well as chipping biomass. As a share of cash operating costs, costs of compliance with environmental regulations per acre range from under 1 percent up to 4.34 percent.

	Average Total Cash Costs	Air Quality Requirements	Water Quality Requirements \$/acre	Pesticide Use Requirements	Total Environmental	Share of Total Cash Costs (%)
Citrus	\$5,862	\$41.97	\$9.16	\$15.67	\$66.80	1.14%
Cotton	\$1,090	\$0.47	\$45.65	\$1.14	\$47.26	4.34%
Grape	\$6,434	\$21.60	\$8.02	\$4.89	\$34.51	0.54%
Silage	\$957	\$14.58	\$10.93	\$0.76	\$26.27	2.74%
Stone Fruit	\$6,651	\$52.89	\$3.44	\$0.60	\$56.92	0.86%
Tomato	\$2,558	\$36.43	\$4.67	\$56.34	\$97.44	3.81%
Tree Nut	\$2,723	\$57.99	\$6.45	\$10.81	\$75.25	2.76%

Table 7. Average annua	l environmental	regulatory	costs by	crop
i abic 7. mittinge annua		i i cguiatoi y	costs by	crop

Table 8 summarizes the average annual costs per acre of compliance with labor and other regulations. These labor costs do not include the cost of workers' compensation insurance because it is a cost-of-business in California and not a separate regulatory cost. Education and training have the highest average compliance costs per acre. All farm labor has to undergo annual safety training. For example, if chemicals were applied to the crop, then the workers handling those chemicals had to go through special training to obtain a private applicators license. This labor time is a direct regulatory cost to the farm. The cost of labor compliance as a proportion of average annual operating costs ranges from less than 1 percent up to 1.64 percent.

	Average Total Cash Costs	Education/Training for Regulatory Compliance	Employee Safety Requirements	Total Labor	Share of Total Cash Costs
		\$/acre	(%)		
Citrus	\$5,862	\$28.62	\$3.94	\$32.55	0.56%
Cotton	\$1,090	\$6.08	\$7.67	\$13.75	1.26%
Grape	\$6,434	\$15.53	\$10.03	\$25.57	0.40%
Silage	\$957	\$5.41	\$2.35	\$7.76	0.81%
Stone Fruit	\$6,651	\$25.19	\$1.49	\$26.68	0.40%
Tomato	\$2,558	\$11.23	\$2.99	\$14.22	0.56%
<b>Tree Nut</b>	\$2,723	\$39.40	\$5.21	\$44.61	1.64%

Table	<b>8.</b> A	Annual	labor	regulato	ry (	costs	by	crop
					•/		•/	

Overall, average total regulatory costs share an important portion of farms' total operating costs, as shown in Table 9. There is a great deal of variation depending on crop type and size, discussed in detail below and for each case study.

Share of Total Cash Costs	Average Total Regulatory Costs	Average Total Cash Costs	
(%)	\$/acte		
%L9°I	86\$	<b>798</b> ' <b>\$</b> \$	SurtiD
%09 <sup>°</sup> S	19\$	060'I\$	Cotton
%86`0	٤9\$	<b>*</b> \$\$	Grape
%67 <sup>°</sup> E	EE\$	L\$6\$	Silage
%S2.I	E8\$	159'9\$	Stone Fruit
%£7`7	8113	855'28	Tomato
%24.4	\$155	\$7 <sup>2</sup> 73	Tree Nut

Table 9. Average total regulatory costs as a share of average operating costs

Figure 1 illustrates the variability in different regulatory costs. Plotted are the minimum, average, and maximum assessed total regulatory costs for each category. Not all farms incurred all categories of costs; food safety regulation is not a concern for cotton farmers, however, all farms incurred costs associated with education and training, air quality regulations, and a vast majority had water quality requirements, pesticide use requirements, and labor requirements.



Figure 1. Range of regulatory costs per acre by regulatory category

As is shown, there was a large amount of variability in the cost of regulations to farms in the San Joaquin Valley. Air quality requirements on average had the highest cost but also an extensive amount of variability. The primary reason for this high average cost of regulation can be attributed to two activities, dust control measures taken on dirt roads and chipping of biomass. A majority of farms utilized water trucks and continuously watered the dirt roads during peak use season. There were a few cases where farms had implemented more sustainable methods of dust control such as reclaimed road asphalt, and a silicone binding spray. For those farms that grew perennial crops; grapes, nuts, citrus, and stone fruit, there was an added air quality requirement when removing pruning and/or when replacing old growth. Most farms used to burn the woody biomass and now are required to chip it at an increased cost.





Education and training for regulatory compliance was on average the second highest regulatory cost category. All farm labor, be it seasonal, permanent, or management, must undergo annual safety training. If chemicals were applied to the crop, then the workers had to go through special training and many farm managers had their private applicators licenses. All the time spent training employees has an opportunity cost born by the farm. Interestingly, the farms varied in how they implemented trainings. Some utilized daily/weekly tailgate meetings to remind employees of the hazardous working conditions, while others held large one-day meetings on an annual/biannual basis.

Water quality regulations were primarily paid through the farm's local water coalition fees, with the remaining costs being primarily associated with time spent filling out forms, permits, and documentation. Under the Irrigated Lands Program of 2003, in the San Joaquin Valley, all commercial irrigated lands must have regulatory coverage. Farms can acquire coverage by joining their local water coalition group or obtaining individual permits. The vast majority of farms sampled were members of at least one coalition group, sometimes multiple depending on the location of the farm, in order to comply with the regulatory program. There was a general consensus that the shortage of water in California did not just mean higher water prices but high associated regulatory costs, as most farms have seen the coalition fees increase since 2012. Some farms have begun to monitor nitrogen displacement and most anticipate nitrogen management regulations coming soon.

The remaining costs that were generally born by most farmers consisted of employee safety requirements, such as mandatory shade, toilets, and water, as well as pesticide use requirements, such as filling reports and posting of signs. Some farms were able to minimize some of these costs by hiring independent contractors. For instance, in several cases the farm employed a third party for all chemical applications. Since these firms specialized in chemical application and were far more efficient at completing and filing pesticide use reports, their per-acre cost of regulation due to lost time was negligible.

In all cases, the actual costs of pesticide regulation are likely under-reported. Previous work (Hamilton, 2006) has shown that California's cost of pesticide regulation is higher than other states, both in the cost of pesticides as well as the required use of pesticide control advisors who either charge a per-acre fee or whose costs are included in the price of the recommended pesticides. Because of the embedded nature of these costs, it was impossible to separate the true cost of pesticide regulation.

Overall, there was a wide variation in average total regulatory costs per acre across commodity type (Figure 3) and size (Figure 4). As discussed above perennial crops tended to have higher regulatory costs due to the necessity of chipping waste biomass. In the past, the chipped biomass was delivered to cogeneration plants offsetting some of the costs, however, it appears that the availability of these waste stream outlets has diminished and farmers are having to either incorporate the materials into their land or ship it to landfills.



Figure 3. Average total regulatory costs per acre by commodity type



Figure 4. Average total regulatory costs per acre by farm size

On average, the total cost of regulation per acre diminishes as farm size increases. This primarily is due to economies of scale in labor. Labor use and farm size are not linearly related so the per acre labor costs diminish with increased farm size as do regulatory costs associated with education and training of that labor. In addition, the majority of small farms sampled are owned/operated by people with professional off-farm employment. For this reason, their opportunity cost of time was easier to value at a higher rate. Figure 5 presents the percentage breakdown of regulatory costs by category across farm size. One of the driving reasons for the different mix of costs can be attributed to the commodities sampled for each size group, see Table 3.





Finally, Table 10 below illustrates the breakdown of all regulatory categories across the seven commodity groupings. As discussed above there are substantial differences between the types and sizes of regulatory costs across commodities. The individual narratives discussed in Appendix A describe in detail these costs and relate the individual decision-making process under the complex regulatory environment in the San Joaquin Valley.

					Stone		Tree
<b>Regulatory Categories</b>	Citrus	Cotton	Grape	Silage	Fruit	Tomato	Nut
Air Quality Requirements	38.6%	0.8%	26.4%	42.1%	62.6%	32.0%	45.4%
Capital Investment	2.9%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%
Education/Training for Regulatory Compliance	26.3%	10.0%	19.0%	15.6%	29.8%	9.9%	30.9%
Food safety	5.7%	0.0%	21.0%	0.0%	0.8%	0.3%	0.0%
Employee Safety Requirements	3.6%	12.6%	12.3%	6.8%	1.8%	2.6%	4.1%
Pesticide Use Requirements	14.4%	1.9%	6.0%	2.2%	0.7%	49.4%	8.5%
Risk Management	0.0%	0.0%	0.0%	0.0%	0.2%	0.6%	3.1%
Water Quality Requirements	8.4%	74.8%	9.8%	31.5%	4.1%	4.1%	5.1%
Other Regulatory Costs	0.0%	0.0%	5.6%	1.8%	0.0%	1.1%	0.0%
Total	100%	100%	100%	100%	100%	100%	100%

Table 10. Percent of average regulatory costs by category across commodity groupings.

Given the magnitude of differences in production costs among the crops studied (e.g. \$957 average production cost per acre for silage vs. an average of \$6,651 for stone fruit), the regulatory environment presented suggest that farms producing lower cost, but also lower value crops such as cotton, silage and processing tomatoes, bear a greater impact of regulatory costs as a share of production costs than the fruit and tree nut producers. While the cost per acre for regulatory compliance is higher for the fruit and tree nut producers (see Figure 3), those costs comprise approximately 1-4% of operating costs for fruit growers as opposed to approximately 4-6% of operating costs for field crops (see Table 9). In addition, higher valued crops that show the highest percentages of air quality requirements also tended to have some of the lowest regulatory costs as a percent of operating costs.

The fixed nature of some regulatory costs also means that smaller farms bear a larger regulatory burden, e.g. the cost per acre of a flat fee burn permit decrease with the number of acres of the commodity grown. Across crop categories, small farms had higher average costs of regulation from both a cost per acre and as a percentage of production costs. Each farm requires a certain amount of training for employees, as well as environmental compliance measures. Only the very smallest farms in the study (less than 100 acres) were exempt from air quality controls or Conservation Management Practices (CMP) plans; and as the smaller farms had less acreage to average out the regulatory costs, their costs per acre were higher than larger farms.

In order to stay ahead of the regulatory curve on mobile equipment, many of the growers interviewed had purchased Tier 4 equipment using a state or federal incentive program. Of the 22 growers, 14 had purchased at least one tractor using a mobile equipment replacement incentive, and one of the large farms in the study had purchased 14 tractors under the incentive program. Each grower noted that without the grant programs, they would not have replaced the equipment; they moved ahead with the purchases to trade out old equipment that, while still functional; would soon fall out of compliance with air emissions. Regarding their ability to purchase, all 22 growers noted that they would either purchase equipment outright with bank financing, cash, or; depending on their tax situation, they might lease equipment rather than purchase it. Overall, growers had positive comments about the program, with the exception of the paperwork and time lag from the start of the process until the equipment was purchased.

There were a variety of reasons for the growers who had not participated in the incentive program; at least one large grower believed they were not eligible because of their ownership structure. In their case, they had actually been fined for non-complaint diesel engines, but this fit right into their strategy – they chose not to upgrade equipment until the costs of non-compliance became too high. At the opposite end of the spectrum, one of the smallest growers in the study was waiting for the final ruling on equipment emissions; he did not want to upgrade his tractor if it would only be in compliance for a few years. In another case, the farm served as a machinery testing center for an equipment manufacturer, so they did not need to purchase equipment for their operation.

#### The Regulatory Environment Beyond 2012

Four farm equipment dealers or manufacturer representatives who do business in the San Joaquin Valley were also interviewed to complete the picture of the impact of the regulatory environment on farms<sup>2</sup>. The equipment dealers are members of the Far West Equipment Dealers Association, and represented a range of companies, including John Deere, Case IH and Case New Holland. Dealers from Kern County to Sacramento County were interviewed to capture any regional differences. Several themes emerged from those conversations regarding the regulatory environment, the equipment replacement programs, and the economics of the farm equipment under high regulatory costs and low commodity prices.

The equipment dealers had mostly positive comments regarding the mobile equipment replacement programs. They all noted that the programs had helped their business; all of the dealers commented that the grant program was essential for growers to buy new tractors. All interview subjects noted the significant increase in cost associated with Tier 4 equipment. One manufacturer's representative noted that in the previous years, under Tier 1 and Tier 2 requirements, year-over-year price increases were relatively steady at 1 - 3 %, with occasional years with no price increases. The advent of Tier 3 and Tier 4 Interim and Tier 4 Final tractors result in 8 - 12 % annual price increases to recoup the investment of millions of dollars of R&D to meet the higher emissions standards. The incentive program allowed farm operators to plan their equipment purchases, as one feature of the program is the months-long approval and processing timeline. The equipment dealers noted that the grants allowed farmers to replace equipment before the point of failure, and that without the grants, farmers would wait much longer to replace non-compliant equipment. The dealers noted that some air districts have much higher incentive levels available; up to 80% in Southern California. The San Joaquin Valley dealers (and growers participating in the case studies) reported 40 - 50% cost-shares.

<sup>&</sup>lt;sup>2</sup> Note that this information is to help inform the reader of how the agricultural equipment dealer and manufacturing industry has been affected by the farm regulatory environment and is not included in the modeling framework.

Equipment purchases are currently hampered by increased costs associated with the drought. One dealer reported a recently canceled tractor order because the grower had to drill a deeper well at a cost of \$140,000 and purchase a higher-powered pump for \$40,000. The well drilling was a necessity; the new tractor was not.

The drought, low commodity prices and increased equipment costs were described by one dealer as "a perfect storm." All dealers also noted that uncertainty with respect to emission regulations was a factor in the changing farm equipment business. The current farm economy affects the way growers acquire equipment. Nationwide, farm income has declined 17.2%, the lowest in seven years (USDA). Banks lending to growers report higher collateral requirements because of lower commodity prices as well as softer land values (Newman). All dealers interviewed reported a decrease in the willingness or ability for growers to make outright purchases of equipment, both because of economic uncertainty as well as regulatory uncertainty. Both lease agreements and short-term rentals are becoming more popular with growers – but this is causing problems for equipment dealers and is changing their business model.

Tax implications are also a factor in the lease vs. own decision for the grower. When the farm economy is robust, farmers need depreciation as a way to offset higher farm incomes. With low farm incomes, depreciation is not necessary for tax reduction; another reason that might tip the scales in favor of leasing.

Leasing used to be a secondary business model for farm equipment dealers, and leases were typically for a five-year period. Tractor leasing is similar to automotive leasing in which the lessee takes possession of the equipment for a period of time, with constraints on its use (in the case of tractors, its hours instead of miles). Then the tractor is returned to the dealer, and the dealer must find a secondary market in which to sell the used equipment.

Dealers reported several issues with increased demand for leases. The terms of the lease are shorter with higher charges per hour. Typical leases in current economic conditions are 36 months with a 3,000-hour limit, and the cost per hour may be as high as \$18, as opposed to \$12 of a few years ago. When the lease expires, the equipment dealer now owns a piece of used equipment that may have gone out of compliance during the lease term. All dealers reported that there is currently a glut of used equipment, and many manufacturers are reluctant to enter into new lease agreements because of unexpected backlog of low-value, used equipment.

Short and medium-term rentals are gaining popularity, with all dealers reporting a surge in the six-to-eight-month equipment rentals. Dealers noted that tractor rental business is higher in California than any other market in the U.S. One dealer called the trend "buying power by the hour," as farms rent horsepower rather than purchase equipment. The expensive hourly rates are more than offset by the reduced upfront capital requirements as compared to either a purchase or a lease, as well as the elimination of regulatory risk.

The divide between small and large growers (1,000 acres was the line of demarcation noted by one dealer) was raised in every dealer interview. Large growers are still able to maintain their fleets and purchasing programs, even though they may pare back a bit and space out their

purchases. They can spread out the fixed cost of equipment purchases over more acres, reducing the per-acre cost of ownership. However, even with a cost-share of 40 - 50%, smaller growers are unable to come up with the additional \$50,000 - \$60,000 for their portion of the cost of a tractor. All dealers interviewed reported sales declines of around 20% in 2016.

Increasing regulatory costs – not only for emission reduction, but all regulations – are a growing concern for the dealers interviewed. Several dealers noted that their customers have purchased land in other states, most notably Texas, in anticipation of lower costs of regulation and overall production. As another example of the increased regulatory costs in California, SB 1 will cause state diesel taxes to increase by \$.20 per gallon and state gasoline taxes to increase by \$.12 per gallon on November 1, 2017. Dealers were confident in their company's ability to continue to develop the technology required by increasing emission standards, but expressed growing doubt that their customer base could withstand the higher equipment and other regulatory costs.

## **Economic Analysis Framework**

The following section generally describes the economic analysis framework developed under the project and gives an example of how a policy may be assessed at the regional level. A detailed discussion of the suite of tools and their use can be found in the technical appendices. The analysis framework includes using the farm survey data to develop twenty-two farm simulation models, the SWAP model, and the IMPLAN model.

The farm models developed for this study are simulation models. Simulation models are used extensively in farm level analyzes<sup>3</sup>. Simulation models are numerical or mathematical representations of a real-world process. One use of a simulation model is to evaluate potential economic impacts of changes in market conditions or policy changes on farm profitability before those changes occur.

The farm simulation models in this study are representations of farm income statements (farm budget sheets). The income statement has two basic components: 1) farm revenue and 2) the cash costs of production. The simulation variable of interest is returns to land and management or total farm revenue less total cash costs of production<sup>4</sup>. The returns to land and management variable is simulated many times to statistically represent all possible combinations of returns to land and management. While the case study simulation models are useful in assisting understanding of the economic consequences of a regulatory policy change and can facilitate better decision-making, they should not be used to predict point estimates and make decisions.

<sup>&</sup>lt;sup>3</sup> The Agricultural and Food Policy Center (AFPC) at Texas A&M University provides a robust set of publications that document the use of simulation modeling for analyzing the impacts of policy, market, and technological changes on farm profitability. https://www.afpc.tamu.edu/pubs/.

<sup>&</sup>lt;sup>4</sup> Returns to land and management is like the financial measure of earnings before interest on fixed assets, taxes, depreciation, and amortization (EBITA). It is a proxy for a firm operating profitability as well as a proxy for cash flow.

There were twenty-two farm simulation models developed from the farm case study interviews. The data obtained in those case study interviews included crop prices, yields, in some interviews total revenue, costs of production, and regulatory costs. The question addressed by these farm simulation models is what changes in returns to land and management would occur given changes in total farm income and regulatory costs. Changes in total farm income are driven by changes in crop prices and yields. Crop prices and yields can vary significantly over time. That variability needs to be taken into consideration as regulatory costs change over time.

The second model developed for this study, is the SWAP economic model. The SWAP model incorporates 2012 data, the most recent information on regional crop prices, costs of production, and elasticity of supply response, covering over 97 percent of irrigated agriculture in California. The model calibrates a nonlinear production relationship for each crop and region and simulates the statewide market for those crops using peer-reviewed methodology known as Positive Mathematical Programming (Howitt et al. 2012). The SWAP model maximizes the sum of producer and consumer surplus by adjusting both crops grown in the region and the intensity with which the variable inputs are used. The SWAP model is an evolution of the Central Valley Production Model (CVPM) and has been applied by federal, state, and local agencies to evaluate impacts to agriculture in California. The SWAP model adapted for this analysis is based on the version 6.1 code and data, which is very different from the academic version of the model, as explained in detail in the technical appendices. The model is developed and maintained by ERA Economics. For this study, three key modifications are made: (i) the data and calibration are updated, (ii) crop budgets are updated to reflect the information provided by the case studies discussed above, and (iii) the model is completely updated to represent crop production by farm size.

In addition to the case study data gathered, several sources of secondary data are utilized to calibrate the SWAP model for this project. The 22 case studies completed provide a partial sample for the 20 crop groups in the SWAP model, refer to Table 1. In addition, each of these crop groups is further divided into small, medium, and large farms, each with (potentially) different cultural practices, production costs, and profitability. Crop budget information from UC Cooperative Extension, USDA, and peer-reviewed studies were compiled to construct a series of crop budgets which reflect small, medium, and large farming operations in California for each of the 20 crop groups in the SWAP model. In addition, Agricultural Census data was utilized to disaggregate the proportion of small and large farms, by crop, and by region for the entire San Joaquin Valley. Additional details and citations regarding the SWAP model can be found in the technical appendices.

The third model applied to this analysis framework is the Impact for Planning and Analysis (IMPLAN) regional input-output model. IMPLAN is a commercially available software through MIG, Inc. Whereas the SWAP model simulates the regional production decisions of growers, the IMPLAN model links to the rest of the economy. For example, farm workers purchase goods and services in the county, agricultural products are processed and sold locally and internationally, and all of these related industries pay taxes. IMPLAN calculates the changes in the regional economy and reports the so-called direct, indirect, and induced impacts that result from a change

in primary farm production. It is an important tool for any economic analysis, particularly a regulatory analysis. Additional details regarding the IMPLAN model can be found in the technical appendices.

These three models are used in conjunction to create a comprehensive economic framework to analyze the cost of regulatory compliance. The scope of the project is not to analyze any particular regulation, rather it is to create a framework that can be used to analyze the impact of potential future regulations, given an estimate of regulatory cost per acre. To facilitate this, ERA Economics developed an analysis tool that distills the output from SWAP and IMPLAN into an Excel-based Workbook. The user of the analysis tool is able to quickly query the cost of regulatory compliance on the regional, state, and linked economy. Output is expressed in terms of acreage, value, net farm income, water use, water cost, jobs, taxes, sales, and value added. The change in any one of these components is expressed as the change from a baseline (where the new regulation is not introduced) and the regulatory alternative. The model also includes a series of switches which allow the analysts to evaluate impacts under drought conditions, regulations specific to farm sizes (small or large), and at varying points in time. The tool is documented so that the user can access the inputs and outputs, graphical maps, and tabular displays of the output information. The remainder of the section describes the output of the regional model when assessing a hypothetical policy scenario.

#### Regional Hypothetical Policy Example

Regulatory compliance costs affect farm-level planting decisions, input use, and profitability. The regulatory costs described above are incorporated into stochastic farm models (discussed in detail in the technical appendices accompanying the Excel tools) to create a framework for assessing the effect of additional regulatory costs on the annual probability of losing money, breaking even, or making positive returns to land and management on a representative farm. The regional analysis considers the effect of regulatory costs at the farm-level aggregated over an entire region. Regions in the San Joaquin Valley are based on DWR Detailed Analysis Units, which are defined to represent homogenous water and production conditions. Figure 6 illustrates regions 10 - 21c included in the San Joaquin Valley, and an overview of the key water districts in each region.



## Figure 6. SWAP Model Regions in the San Joaquin Valley

## Policy Example - SWAP

As discussed previously, the scope of this project is to develop a suite of tools that can be used to evaluate the economic impact of regulations from the farm to all businesses that are linked to the production of crops in a region. As such, this section presents an illustrative scenario in which an additional \$15 per acre regulatory cost is incurred across all farms. In this example, we specify that the regulation affects all farms, the time horizon is 2016 (current conditions), and water year conditions are "average." Average water supply is defined by the Sacramento River Index "above normal" or "below normal", which generally correlates with South of Delta agricultural water deliveries through the State Water Project and Central Valley Project. In practice, the user can specify all of these parameters within the Analysis Tool, as detained in the technical appendices.

Regional agricultural impacts are typically reported in terms of changes in crop acreage (including fallowing), input use, and farm-gate revenues. The SWAP model includes substantially more detail on the intensive and extensive margins of adjustment in response to regulatory costs (and other policies). Intensive margin is the adjustment in input use per acre and extensive margin is the adjustment in total input use. For example, deficit irrigation is an intensive margin response to water shortage and fallowing land is an extensive margin response. The economic impact of a regulation is defined as the incremental change from a "without regulation" condition and the "with regulation" condition. All other factors except the change in

regulation must be specified and held constant in the same manner for with and without conditions. This is necessary in order to isolate the effect of the regulation, and importantly, control for all other confounding factors. For example, we can specify "dry" water supply conditions, and this will apply to both with and without project alternatives. This is a standard requirement for any economic impact analysis that is frequently misunderstood.

In response to a \$15 per acre regulatory cost, the modeling finds that agricultural farm-gate (gross) revenues decrease by an estimated \$7.75 million annually across all San Joaquin Valley regions. Note that these are gross revenues, and as such, do not represent the direct cost of the regulation on the net farm income of the grower. The impacts of the \$15 additional regulatory cost are distributed, albeit not equally, across regions within the San Joaquin Valley. Areas where the crop mix includes crops with less flexibility to substitute production practices to avoid the additional costs, and regions with crops that have a higher proportion of regulatory costs bear the largest portion of the impacts. Simultaneously, as production decreases in these regions, all else equal, this places upward pressure on the price of the crops that come out of production. Some regions able to manage regulatory costs are able to benefit from these higher prices, and farm-gate revenues increase. We note that these price effects are very moderate, less than one percent, and consistent with the historical trends and market responsiveness. Figure 7 illustrates the change in farm-gate revenues by each model region.



Figure 7. Example Change in Farm-gate Revenues, by region

The SWAP model additionally differentiates the impacts between small and large farms, a capability that was previously not available prior to this study. Impacts can now be viewed by region or the entire San Joaquin Valley, by small and large farm, and for each crop. In general, the decrease in farm-gate revenues is higher for large farms because these farms comprise a larger share of San Joaquin Valley production.

Underlying the changes in farm revenues is a shift in the underlying crop mix and, in some cases, fallowing. In response to increased regulatory costs, growers are likely to shift away from crops that have the most significant increase in regulatory costs towards more profitable alternatives. Of course, some of this supply response is limited by the soil, micro-climate, and market

conditions within each region (or a specific farm), and those factors are accounted for in this type of economic modeling framework. Figure 8 illustrates the estimated change in irrigated acres resulting from a \$15 per acre increase in regulatory cost, by region. Total fallowing under the hypothetical scenario shown here is just over 5,000 acres across all regions and crops. This can also be viewed across changes in crop mix by crop and farm size. In this example, field crops, grains, and pasture are most significantly affected by the \$15 per acre regulatory cost increase.



Figure 8. Example Change in Crop Acres, by region

Changes in the crop mix, fallowing, and intensive margin adjustments result in a change to total water use. The resulting change in water use is an outcome of the regulatory policy, not a result of drought conditions or environmental restrictions on water supply. Figure 9 illustrates this change in on-farm applied water by region. In this hypothetical example, most of the adjustments in crop mix are small. Changes in applied water are primarily driven by land fallowing, as can be seen by the large reduction in region 10. In addition, some regions shift crop mix in response to changes in market conditions (price effects), and applied water increases. The SWAP model is also able to estimate the effects of additional regulatory costs under drought conditions. The resulting crop mix, revenue impacts, and fallowing change substantially in response to changes in other factors such as drought.





In summary, the SWAP model is used to estimate the regional impacts of changes in regulatory costs across different crops, farm sizes, and geographic areas. Economic impacts are summarized in terms of the standard metrics including acreage, revenue, and water use. The model includes a rich economic specification that allows impacts to be analyzed for specific regions, crops, and farm size. In addition, the SWAP model developed for this study includes a full production technology for each crop, meaning that changes in input use per acre, and the corresponding effect on yields, for any given policy may be evaluated. Finally, the SWAP model explicitly accounts for other factors, such as drought, increases in production costs, and other changes in market conditions. In future studies, the model can be adapted and applied to a range of other regulatory impacts.

The output of the economic modeling framework is interpreted as the incremental effect of an increase in regulatory cost to San Joaquin Valley growers. This is the standard way to report, and interpret, economic impacts. In addition, the Analysis Tool reports the total economic output for each category allowing the user to analyze the total impact and the incremental impact of regulations. Results are summarized by region, crop, and year, and should be used by the analyst to quantify the economic impact of additional regulatory costs.

#### **Policy Example - IMPLAN**

An important component of a regulatory impact assessment is the effect that the new regulations will have on linked industries. This is particularly important for agriculture because the economy of the San Joaquin Valley depends critically on agricultural production. Growers purchase machinery and inputs, production is processed locally and sent to international export markets, and all of these businesses employ local residents. In short, a robust economy in the San Joaquin Valley depends on strong California agriculture.

The IMPLAN input-output model is used to evaluate the effect of changes in crop production, resulting from increased regulatory costs, on related industries of the economy. The SWAP model output (change in crop production) is a direct input to the IMPLAN model. The model uses national accounting data (trade flows) to quantify the linkages between one sector of the economy and another, measured by the dollars (and workers) that flow between industries. In this way, for example, the model can estimate the total number of jobs lost in almond production, processing, distribution, and local retail stores in response to the initial change in almond production.

The output values typically generated through IMPLAN input-output analysis include the direct, indirect, and induced economic impacts<sup>5</sup>. These are most commonly expressed in terms of output value, but may also be expressed in terms of employment, labor income, or one of the four components of value added (employee compensation, proprietor income, other property type

<sup>&</sup>lt;sup>5</sup> Direct impacts results from changes in the primary industry (agriculture in this study). Indirect impacts result from changes in input purchases by the primary industry (industries that purchase from agriculture). Induced impacts result from changes in employee expenditures in the local economy by all direct and indirect industries.

income, or tax on production and imports). By definition, the direct impacts are associated with the initial dollars spent within the study area (San Joaquin Valley). Amounts paid to entities located outside of the study area are excluded from the analysis and considered economic "leakage" because these dollars do not circulate within the local economy and thus cannot be counted among the local economic impacts. The indirect impacts are estimated as industries that receive direct spending for the purchase of materials and services necessary for production by the primary industry. Induced impacts result from household consumption made possible by wages paid to workers and by income generated to proprietors and institutions. When combined, this cycle of spending represents an economic multiplier effect, by which a direct change in production, an input to IMPLAN from the SWAP model, results in a total economic impact in the San Joaquin Valley that is greater than the initial direct impact of the change in crop production.

Figure 10 illustrates the direct, indirect, and induced change in gross output value (farm-gate gross revenues) resulting from the hypothetical \$15 per acre increase in regulatory costs as specified in the previous section. Recall that the direct gross farm-gate revenue loss estimated in the SWAP model equals \$7.75 million. This is shown as the direct effects (first bar) in the figure. The indirect effect represents changes in the output value of industries that purchase from or sell to the primary production sector. The induced effects represent changes in spending by employees in the local economy. The total effects are the sum of the direct, indirect, and induced effect. In this example, the direct loss in gross farm-gate revenue of \$7.75 million corresponds to a total output-value change in the San Joaquin Valley of just under \$14 million.



Figure 10. Change in Output Value, San Joaquin Valley

These economic impacts can also be evaluated for specific crops and farm sizes. A more useful measure of the true economic impact is a measure known as value-added. Value added is analogous to the often-cited measure of gross domestic product or GDP. It is a measure that calculates the value of a good after netting out all intermediate input purchases. As such, it represents the true value that is created in the local economy. Figure 11 illustrates the direct, indirect, and induced change in value-added for the same hypothetical regulatory impact scenario. As expected, value-added impacts are less than the total output value impacts because

input purchases that are double-counted in the output value calculation are controlled for. The total impact to the San Joaquin Valley economy is \$6 million per year.



Figure 11. Change in Value Added, San Joaquin Valley

Another useful measure of the economic impact of a new regulatory cost is the change in employment. Like other measures, change in employment is reported in terms of direct, indirect, and induced impacts. Figure 12 shows the job losses resulting from the hypothetical regulatory cost scenario. Note that jobs are reported in (approximately) full-time-equivalent (FTE) terms, meaning that a single job represents 2080 hours of work annually. Agriculture includes much more seasonal labor, and as such, the total number of individuals is greater than the total number of FTE jobs. As shown, the total estimated impact of a \$15 per acre increase in regulatory costs is 93 FTE jobs.





## Limitations

The limitations of the study broadly fall into two categories: (i) technical limitations of the modeling, and (ii) and practical resource limitations. In addition, the scope of the analysis included in the Analysis Tool is the San Joaquin Valley. This means that the potential for crops to shift to the Sacramento Valley, or other regions, is not explicitly modeled in the analysis. As such, the economic impact results are conservative. Both were key factors in how the project was developed, implemented, and the final conclusions.

First, models are by definition simplifications of a more complex system. The stochastic farm budgets simulate net returns to land and management on a representative farm, and as such, care must be taken when extrapolating results to the entire San Joaquin Valley. The SWAP and IMPLAN models are larger scale, but lack the farm-level detail found in the stochastic farm budgets. In other words, estimates of the impact of additional regulatory policy can easily be taken out of context and care must be taken when utilizing the models. This might sound obvious, but it is an important limitation to keep in mind.

Other practical limitations are related to the data. For example, there are 22 case studies and these are used to generate cost-of-production budgets for the SWAP model. However, not all of the SWAP crops were represented in the sample. In turn, it was necessary to compile supplemental data from USDA, Agricultural Census, California Agricultural Statistics, and other published studies to "fill gaps" in the model. While this does not limit the effectiveness of the modeling framework, it is important to be clear that additional data can be gathered in future studies. In addition, in some cases, farm level price and yield data was not readily available from growers. In those cases, if it was accessible, publicly available California Agricultural Statistics (CAS) data was utilized to estimate the probability functions used to generate the stochastic prices and yields in the stochastic case study farm models. In cases where the grower did not provide price and yield data and the complement was not publically available, price and yield are fixed at the 2012 level.

Given the resource constraints of the project and the objective of creating a tool to evaluate the impact of future regulation, it was necessary to limit the number of case studies to 22. This required an extensive discussion with ARB staff and representatives of the agricultural community, in addition to an analysis of farm production data, in order to decide on what commodities, locations, and sizes best represented the San Joaquin Valley. The sample is by no means random, however it covers the industry well in terms of variety in commodity, size, location, and, most importantly, impact of various regulations and regulatory bodies, and is to-date the largest of its size. However, we are confident in the representation of the general impact of regulation on agriculture; in particular, the regional and linked analyses using SWAP and IMPLAN.

Finally, this analysis focuses on the farm impacts, but does not explicitly consider the regulatory impact on upstream and downstream industries. That is, a change in on-farm regulatory costs affects suppliers and purchasers in different ways. A formal economic study of these linkages is beyond the scope of the current study. We note that, in general, there is very limited research on

regulatory compliance costs to processors and distributors. This is, in part, the result of some of these costs being passed-through to the producers. Processors and distributors are typically diversified operations and it is difficult to identify the cost of one specific regulation.

### Summary

As described above and discussed in detail in Appendix A, the costs of regulatory compliance are a significant burden to agricultural producers in the San Joaquin Valley of California, but many of these regulations also provide an economic benefit. This study has completed an initial survey of 22 growers to establish a baseline for farm-level regulatory compliance costs. A farm simulation model for each case study offers a snapshot into growers' ability to make a profit under increasing regulations and stochastic prices, yields, and costs. These data feed into the regional economic SWAP model. The SWAP model is augmented with supplemental cost-ofproduction data to disaggregate production costs by farm size. In addition, the agricultural census is used to estimate the proportion of small, medium, and large farms, for each model region. The model is able to estimate the regional changes in direct farm production resulting from changes in regulatory costs. Finally, the SWAP model feeds directly into the IMPLAN input-output model, which is used to estimate effects on value-added, output, jobs, and taxes in the local economy. Together, the integrated framework provides a robust set of tools that ARB staff can use to evaluate the economic impact of regulations from the farm to all linked industries. The framework can also be used to analyze the economic impact of equipment cost share programs as strategies to improve agricultural air emissions in the San Joaquin Valley.

Prior to this study, a suite of tools to evaluate agricultural regulatory impacts did not exist. This study, through careful data gathering and case studies, is the first step in developing a unique framework. To be sure, a broader set of case studies and updated regulatory costs need to be incorporated to better reflect the regulatory environment that exists today, but these modifications can easily be made. The primary focus of this study was to develop the framework and suite of tools. It is difficult to quantify regulatory costs because detailed and proprietary financial data are required to estimate the additional cost imposed by a regulation. For example, without detailed accounting it is difficult, if not impossible, to estimate the cost of management time required to fill out forms, learn about new regulations, and participate in informational meetings. For this reason, this study to date comprises the most extensive attempt to create a framework and a suite of tools to assess the impact of additional regulation at the farm and regional level.

The duplication of efforts by the controlling agencies and the lack of a centralized information source for regulatory compliance create significant indirect costs for agricultural producers. The amount of time reported by growers spent just to learn about new regulation is substantial (see Appendix A for a detail of these hours for each grower interviewed). In addition, some of the direct regulatory costs, especially those related to labor laws and water and air quality, are much higher than in other states, causing some labor-intensive facilities such as dairies to consider relocation elsewhere. Streamlining overlap between regulatory agencies can lower farm regulatory costs and improve the effectiveness of regulations.

There are limitations to the current study, described previously, and next-steps that should be considered to refine the regulatory analysis framework. We present some of these findings here:

- 1. There is a limited economic literature, and primary studies, that analyze the impact of a change in regulation through the processing and distribution industries. The farm-level analysis stops at the farm. In practice, the production industry is squeezed between processing and distribution, and these industries typically have more market power than an individual grower.
- 2. The case-study analysis can be extended to consider the cost of regulatory uncertainty. That is, this study quantified the direct and indirect costs of current regulations. However, all growers indicated uncertainty about future regulations. This may prevent growers from investing in new technology, or otherwise adjusting operations as they wait for regulators to make decisions. For example, the Irrigated Lands Regulatory Program and CV Salts have uncertain implications for valley growers. This uncertainty has an economic cost that can be quantified.
- 3. The SWAP model can be updated with additional case studies and secondary data. Concurrently, the model can be modified so that it can be quickly applied for a regulatory impact analysis. A SWAP – Excel linkage tool can be developed to facilitate this transfer of data, and the model code can be periodically updated to reflect changes in the broader agricultural industry. For example, as other regulations are implemented, drought conditions change, or other environmental restrictions are in place, the cost of regulatory compliance changes.
- 4. Completing additional case studies would expand the sample size and improve the modeling accuracy. One finding in this study is the wide variability in regulatory costs across farms that produce the same crop. Growers manage regulation in different ways. Additional studies can describe these changes both qualitatively and quantitatively.
- 5. The IMPLAN model includes very coarse agricultural sectors. This introduces aggregation bias by lumping groups of commodities together. In addition, a recent study completed by ERA Economics found that the baseline data in the IMPLAN model, which are derived from national accounts, does not accurately reflect the expenditure patterns, value-added, and employment of agricultural industries. The sectors in the IMPLAN model can be modified to better represent conditions in California through a primary survey approach. This survey is not as in depth as the case studies, and can be completed by mail or on the phone.

Finally, this study can be linked to other agencies who oversee regulations related to agriculture. It can be used to inform the overlapping nature of regulations and develop a more streamlined approach.

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## **Appendix A Case Study Narratives**

The purpose of case study interviews is to work with growers to identify direct and indirect regulatory compliance costs. This requires a detailed conversation so that standard operating costs can be separated from regulatory costs, and importantly, any opportunity costs can be quantified. This extensive process, which, in some cases, takes several hours and involves follow-up phone calls, produces a wealth of qualitative information. This section summarizes some of the important qualitative findings, while preserving grower confidentiality.

#### Cotton

Two pima cotton growers representing a medium and large farming operation were interviewed.

#### Large Cotton Grower – Southern SJV

The cooperating grower is located in Southern San Joaquin Valley. The diversified operation grew a variety of field and tree crops including: wheat, pomegranates, milo, pistachios, and cotton in 2012.

Education and training is a large part of regulatory compliance, primarily for safety issues. The grower contracts with a human resources management company to handle all labor and safety training issues and pays the provider \$12,000 per year. The time that 10 workers are paid to attend safety trainings amounts to 12 hours per year at a rate of \$10/hour, amounting to \$1,200 per year in labor training costs. With respect to pesticides, the farm owner also maintains his private applicator's license. These expenses involve traveling to and from an exam site, a <sup>1</sup>/<sub>2</sub>-day training for a total of \$100/year. Education and training is 53% of total per acre cost of regulation.

Air quality regulatory costs appear in variety across the San Joaquin Valley. Specifically, the San Joaquin Valley Air Pollution Control District implements CMPs to limit the fugitive dust and PM10 emissions. Additional regulations were passed in 2010 to limit NOx and volatile organic compound (VOC) emissions from stationary and portable engines. The application for the grower is \$117 biannually for each of the six subsections of his farm; the annual cost is \$351. The Carl Moyer Program provides funds to offset the purchase cost of new machinery to comply with air quality requirements and the Natural Resources Conservation Service provides grants to help farmers comply with a variety of air and water issues. The owner spends about five hours per year filling out grant applications; this time is valued at \$500 but since it is a volunteer program, the cost is excluded from the overall cost of regulation. As part of the air quality requirements, unpaved roads must be treated for dust mitigation. Licensing and running the watering truck costs about \$250 per year and the labor to operate the truck is about 20 hours per year during harvest at an hourly rate of \$10 per hour. The initial cost of the truck was \$8,500, annual ownership costs are estimated at \$850 over a 10-year life span. The initial filing fee for the farm's air quality permit was \$1,000 and the value of the owner's time to fill out the paperwork was \$400. Total cost of air quality compliance is 9% of total regulatory costs.

Water quality regulations vary greatly across California. However, the lower San Joaquin Valley has the distinction of being in one of the more heavily regulated Regional Water Quality Control Boards. Region 5 requires an individual permit be issued if discharges will affect groundwater or surface water, or that agricultural operators join a Coalition Group. The cost in 2012 to join the local coalition was \$2,800 annually. It should be noted that in 2014, the cost of membership in the coalition was more than double at \$6,000. The farm owner pays the Natural Resource Conservation Services agronomist \$30 per week for a weekly read of soil moisture for 32 weeks during the growing season. The total costs of water quality regulation for this grower are 14% of total regulatory costs. The owner noted that these costs are likely to increase with new policies governing water quality.

Pesticide regulatory costs are primarily built into the pesticide fees and the PCA commission. The farm owner does not maintain a PCA license, only an applicator's license as previously discussed. The farm uses a Pest Control Advisor through Crop Protection Services. The farm's PCA estimates that a small percentage of his fees are due to regulatory costs of pesticides – in the costs of maintaining a license, the higher costs of pesticides in California due to regulatory compliance as well as the added costs of adhering to buffer zones and drift issues. Signs must be posted before spraying, which takes about 4 hours per year. Worker safety gear costs about \$170 per year in gloves, overalls and eyewear. The cost of pesticide regulation adds up to 6% of total regulatory costs.

Employee safety requirements, which include worker's compensation, shade canopies, water, restroom facilities and wash stations, are some of the costliest regulations. Worker's compensation costs are \$2,500 per month, while the cost of providing shade canopies, portable toilets and drinking water add up to \$260 per month. The grower was fined \$1,500 for providing tap water that was not considered clean and cold. The per-acre cost of compliance was 18% of total regulatory costs.

The grower has made significant capital investment to stay compliant with air quality regulations. In the last five years, he has spent \$100,000 on two stationary pumps, \$170,000 on three tractors and \$170,000 on an Eliminator. He has also invested in three GPS units at \$30,000 each and purchased an electrostatic spraying system at \$50,000. These costs are reported as out-of-pocket costs; grant programs paid for 40 - 45% of the cost of most of the equipment. These costs are not calculated into the per-acre costs of regulation.

This large cotton grower's cost of regulation in 2012 were 1.% of production costs.

#### Medium Cotton Grower – Central SJV

The cooperating grower is located in Central San Joaquin Valley. The diversified operation grows a variety of field crops including; cotton, onions, alfalfa, parsley, tomatoes, and hay in 2012. The cotton acreage varied widely primarily due to price swings – for example, in 2015, the grower only planted 240 acres, vs. over 3,000 in 2004. All cotton was planted in Pima cotton. The farm employed seven workers plus the manager and office assistant.

Regulatory compliance with respect to labor education and training were handled primarily by an outside contractor through the farm's insurance company or through their labor contractor. The insurance trainer was paid \$2,000, and the workers' time commitment of four meetings per year for four hours for each of the seven workers. A full-time assistant also had responsibility for HR paperwork; spending ½ day for up to 6 days per year. In addition, the manager's time spent staying current with and learning about regulations annually, as well as staying current with continuing education for his private applicator's license, took nearly 100 hours per year. Water issues are expected to be the largest component of these trainings and meetings going forward, as the Sustainable Groundwater Management Act is implemented. The total fees and opportunity cost of time spent in education and training for regulatory compliance amounted to \$8,470.80 or 6.9% of total regulatory costs.

Air quality requirements were much lower for this cotton grower as opposed to the large grower; primarily because he has more paved roads leading to each block of cropland. However, he estimated that he voluntarily spent about \$4 per acre on dust control for quality purposes, not because of regulatory requirements. His reported air quality requirements were only the SJV Valley CMP fee and the burn permit, totaling \$260 or .21% of total regulatory costs.

Water issues provided perhaps the most significant challenge for this cotton producer. A large part of his acreage falls within the Westlands Water District, for which there is a \$41/acre assessment – about 20% of which goes to the water waiver coalition that handles the irrigated lands water quality compliance – a total of \$12,300 for the farm. In addition, 140 acres of cotton production fell into the Westlands mandatory drip irrigation region for water conservation – at an annual cost of \$167.50 per acre for materials and labor. This is prorated in the regulatory cost budget because it represents about 1/3 of the grower's cotton crop. This explains why water regulations are a major cost for this cotton grower, but may not be representative for farms outside of the Westlands. However, water quality/conservation regulatory costs are expected to increase even further as the Nitrogen Management Plans for groundwater quality become mandatory in 2016. Water regulations comprised 79.14% of this grower's regulatory costs. This was an outlier in terms of the case study farms; no other growers were required to use drip irrigation for regulatory compliance.

Pesticide regulations were the second-lowest cost of regulation for this grower, however there are hidden costs that accrue either in the costs of pesticides or in the PCA fee. Direct costs included the assistant's time in filing MSDS (Material Safety Data Sheets) as well as purchasing safety equipment for workers and posting signs for any spray applications were 1.6% of total regulatory costs.

Employee safety requirements in addition to education and training primarily deal with heat regulations; the cost of providing and maintaining shade as well as ice chests, water, protective suits, etc., were 12.2% of this grower's regulatory costs.

The grower benefited from several programs to encourage capital investment for compliance (or pre-compliance) with regulations. The grower received State Water Efficiency and Enhancement Program funds for a weather station/moisture probe; implementation of a drip system and

converting all pumps to variable rate drives. He also received three separate rebates totaling nearly \$150,000 for tractor conversions in 2012, 2013 and 2015 to meet emission requirements. These rebates helped fund about \$350,000 in Tier 3 or 4 tractors. Other capital investments to comply with regulatory requirements included a chemical enclosure and the purchase of shade trailers.

With respect to increased costs of risk management, the grower noted that he outsources more work mostly because of concerns regarding regulatory compliance. He hires more labor contractors, the aforementioned insurance contractor takes care of worker safety/education trainings; he uses an attorney to review all contracts and leases, primarily because of risk management issues.

The medium cotton grower's overall cost of regulation in 2012 was 7.5% of production costs.

#### Stone Fruit

Stone fruit interviews include two stone fruit producers in the San Joaquin Valley, one small and one medium grower.

#### Small Stone Fruit Grower – Central SJV

The cooperating grower is located in Central San Joaquin Valley. The grower has several smaller blocks of land, planted to stone fruit, almonds and grapes in 2012. The grower owns an additional 200 acres but rents to other growers who are planting almonds. He also rents a 50-acre vineyard.

This grower has a full-time, off-farm job, and thus contracts much of the work for his farming operation. Much of the education and labor training for regulatory purposes falls to his contractor, who spends up to 6 hours per month training the work crew. This fee is wrapped up in the 37% commission charged by the contractor, so it was difficult to assess. However, the workers themselves spend 90 hours per year in trainings for regulatory purposes, and the owner also spends 40 hours annually in either workshops, meetings or trainings to stay current with the regulatory environment. The truck driver that hauls the fruit to the cannery participates in a mandatory \$700 annual training. Education and training add up to 14% of his total regulatory costs.

Air quality regulations are one of the largest areas of compliance costs. The primary cost categories fall into dust control on roads as well as tree trimming disposal. The labor, equipment and water costs to control dust on road amounted to nearly \$10 per acre annually. Chipping tree trimmings was far costlier; the combined cost of labor, chipping, hauling and complying with burn permits costs a little more than \$60 per acre. The grower noted that these costs did not reflect the "nuisance costs" of waiting for approval for the burn permit or for the chipper to be scheduled. A few additional requirements to limit emissions from fuel tanks and a report to document tractor use on small farms were also included in the cost of regulation. Air quality compliance comprise 23% of the farm's cost of regulation for stone fruit.

Water quality requirements were relatively minimal; the grower reported only the cost of the water waiver coalition as well as mosquito abatement cost. The grower noted that the water waiver coalition cost was increasing substantially, however; from \$.65/acre in 2012 to \$2.50 per acre in 2016. Water quality compliance cost \$3.86 per acre in 2012, or 1.2% of total regulatory costs.

The primary cost of pesticide regulation for this grower is the training that occurs for safe pesticide applications at jus \$.60 per acre. Though we did not include the following cost in our calculations, the grower noted that he experienced yield loss from switching from Lorsban to a lower VOC chemical. He experiences 3-4% yield loss now from worm damage, compared to zero loss with Lorsban use. That equates to almost \$197 per acre in lost revenue, in 2012 prices. He also estimated that about 15% of his chemical costs were due to regulatory compliance and it costs about \$15 per acre in regulatory requirements for the application of the chemicals. We did not add in those costs as we could not standardize PCA and application estimates across crops. However, the grower thought those were important elements in adding to the cost of regulatory compliance. Pesticide use requirements accounted for .2% of total regulatory costs.

The grower has few additional requirements when it comes to labor; he spends about five additional hours filing paperwork, resulting in an additional \$1.49 cost per acre. This grower's cost of employee safety equipment is minimal as his labor contractor supplies most of this gear; labor costs of compliance comprises barely .5% of his regulatory costs

Though the grower rented much of his mobile equipment or contracted for specific services, he did purchase a \$110,000 Tier 3 tractor and received a \$50,000 grant to offset the cost. He noted that he did this specifically to prepare for future regulations, and financed the remaining \$60,000 of the purchase. He chooses to lease or rent other equipment such as forklifts so that he does not have to worry about keeping up newer equipment to comply with air quality regulations.

Regulatory compliance in 2012 for this small stone fruit grower was 1.7% of production costs.

#### Medium Stone Fruit Grower – Southern SJV

The medium stone fruit case study was located in Southern San Joaquin Valley, and primarily grew for the fresh market, though at harvest some of the crop might be sent for frozen processing depending on the market. They also grew a variety of citrus and almonds.

The owners of the farm are very involved in the daily management and operations, and handle many of the regulatory requirements themselves. The owners take care of the main education and training for their workers three times per year for 1.5 hours each time, plus an additional two hours for all workers for pesticides. The foremen and supervisor also attend annual 8-hour trainings, and tractor drivers take continuing education. Between the worker wages, time spent in training for the supervisors and the value of the owner's time, the education and training for regulatory compliance comprises 13.5% of total regulatory costs.

Air quality regulations provided the highest cost of compliance for this grower. Dust mitigation was a relatively minor cost, as most of the roads were semi-paved and required only minor maintenance and bi-annual oiling. The most significant cost was for chipping tree

prunings/orchard removal; the cost in 2012 was \$400 per acre for those acres removed, including the rebate from the co-generation plant. The typical costs for the burn permit and the Conservation Management Plan, as well as the time the owner spent updating forms were also included. Air quality compliance is 77.2% of this stone fruit grower's regulatory costs.

Water quality regulations have been of minimal concern for this farm, but as Nitrogen Management Plans become a requirement, these costs are expected to increase. For example, in 2014, the owners paid \$6000 for two filtration systems for drinking water for the houses on the property. Otherwise, the primary cost in 2012 was to join the local water waiver coalition for a \$26 flat fee plus \$2.15 per acre. Water allocation is an increasing concern, and these owners have switched from flood irrigation to micro-sprinklers for their tree crops. They received a \$17,000 NCRS grant to help offset the \$38,000 cost. They also invested in a pressure bomb to monitor water efficiency at a cost of \$2,500. They expect more ground water regulations as the Sustainable Groundwater Management Act of 2014 (SGMA) is implemented in the future. The 2012 proportion of water regulations was 7.2% of regulatory costs.

With respect to pesticide regulations, two of the owners maintain their own Qualified Applicator's Licenses and do their own pest scouting. The owners' cost of training is accounted for in the Education and Training category. They get advice from their PCA regarding chemical recommendations. Though they were not able to itemize any specific costs of pesticide regulation, they noted that the new VOC rules for pesticides changes their management decisions. This affects both fumigation as well as chemicals needed for weed and mite control – the growers noted they have a narrower group of tools for cultural and pest control because of increasing restrictions. They contract out any fumigation because of strict regulatory requirements, but at times have to wait beyond their preferred time period because only so much fumigation chemical (Tri-Cal) is allowed per county because of VOC regulations. Protective gear for workers is lumped into the chemical costs from Simplot, so those were not itemized.

Increased risk management costs due to regulatory compliance were only noted as the increased liability insurance on the upgraded equipment; nearly negligible at \$.20 per acre, comprising barely .5% of total regulatory compliance.

A primary difference noted among farms and crops was the food safety regulatory category. Farms that produce fresh food products are more likely to face regulatory compliance in food safety. The stone fruit grower spends about four hours per year monitoring food safety compliance issues in the orchard, and one of the workers collects water samples from wells for E. coli testing. Food safety compliance results in 1.63% of compliance costs.

Overall, this medium stone fruit grower reported .7% of production costs in regulatory compliance, primarily in the area of air quality regulations.

#### **Citrus**

Three citrus growers were interviewed; large, medium and small.

#### Large Citrus Grower - Southern SJV

This farm operation had accounted for many of their regulatory costs in their annual production costs. They farm a large acreage of citrus in the Southern San Joaquin Valley. They had most of the regulatory spreadsheet filled out before we arrived, and in some cases, did not divulge the manner in which they had arrived at the figures, so this narrative may be less descriptive than others.

Education and training for regulatory costs were accounted for in the farm's budget at 2080 hours at a rate of \$160.96 per hour. This rate was to account for managerial time involved in the training as well as continuing education, and equaled \$15.22 per acre. Employee costs for safety and other training were estimated at 10% of total time for the farming, spray operations and the farm shop employees, and at 64 employees in those areas the per acre cost equaled \$26.65. Employee training and safety compliance comprised the second largest regulatory cost category for this farm at 30.6% of regulatory costs.

Air quality is the largest cost category for this farm. One administrative assistant spends 25% of her time on regulatory compliance paperwork for air quality (520 hours); valued at \$14 per hour, and that equals \$.76 per acre. The farm's largest air quality cost is dust control on roads. Between labor, equipment and materials (decomposed granite), the cost of reducing road dust is \$53 per acre. Fees to the SJV Air Pollution Control district are a minor cost at \$.27 per acre, while purchasing air filters for diesel particulates to keep equipment in compliance equals \$.53 per acre. Overall air quality compliance comprises almost 41% of total regulatory costs.

Water quality regulatory requirements primarily fall under the Irrigated Lands programs, both the Ag Waiver Coalition for surface water testing as well as ground water testing. The farm pays \$7.06 per acre for the Irrigated Land Coalition, and it also costs them \$3.56 per acre for groundwater testing and compliance, primarily for nitrogen issues. One manager spends about 40% of his time on irrigated land water quality compliance; this value is estimated at \$3.56 per acre. Overall, water quality compliance is this farm's third largest regulatory cost, comprising 10.6% of regulatory costs.

Pesticide regulatory costs are comprised primarily of paperwork costs that take up 25% of an administrative assistant's time at a cost of \$.76 per acre. This includes filing pesticide use reports with the county. The farm estimates that their citrus operation requires an additional pest control advisor (PCA) to meet regulatory requirements, amounting to \$11.67 in additional costs per acre. Overall, pesticide regulatory costs are 9.3% of total compliance costs.

Additional employee safety requirements pertain to GAP (Good Agricultural Practices) certification, and include costs to a third-party vendor to lease portable toilets, water sampling and GAP audits, adding up to almost 5% of the regulatory costs.

In terms of capital investment, this farm installed an environmental wash rack to deal with pesticide residues on equipment in 2012. The estimated cost per acre for that investment was \$3.18. The farm has also spent an additional \$40,000 per tractor to upgrade to new Tier 4 equipment, and benefited from some cost-share programs, but these values are not reflected in the regulatory budget. The farm's total capital investment (excluding equipment costs) for regulatory requirements is 2.4% of the total compliance costs.

Because this farm produces citrus for the fresh market, food safety regulations are an additional consideration. Their training costs and the cost of a food safety auditor are 1.4% of total regulatory costs.

Overall, this large citrus producer in the Southern San Joaquin Valley estimates its regulatory costs at 1.4% of production costs, with over 70% of those costs stemming from education/training and air quality regulations.

#### Medium Citrus Grower – Central SJV

The mid-size citrus producer near Fresno also farms almonds and alfalfa, in addition to several varieties of citrus. This case study focused on one of the citrus variety's regulatory costs.

To comply with education and training for the farm's employees, the farm owners used their insurance company's training program. Once per year, all 16 farm employees take five hours of training, which equates to \$1.81 per acre. The manager's time involved annually is about 10 hours, and equals \$.38 per acre. The supervisors hold tailgate meetings with employees for about 15 minutes every two weeks to reinforce safety training, which adds about \$2.57 in costs per acre. The manager and two supervisors also participate in a mandatory two-hour sexual harassment training. Employee education and training for regulatory issues amounts to 10.6% of compliance costs.

Air quality regulatory requirements include a \$417 annual SJV air quality and burn permit. Smog testing on three farm vehicles that serve the citrus operations is minor, \$.18 per acre. The farm manages the dust during the week of harvest, running a water truck about 60 hours. Labor and fuels costs add up to \$6.04 per acre. This cost is an underestimate, as it does not include the pumping costs (primarily electricity costs) to fill the water truck numerous times per day. This grower did not have additional chipping costs as other tree crop growers reported; they are able to shred all of their prunings and incorporate them back into the orchard. However, if the grower estimated that if trees had to be removed and chipped, it would cost \$700-800 per acre, based on his experience with a plum orchard. The air quality regulatory costs are likely lower than other growers reported for these reasons, and are 14.6% of the farm's compliance costs in citrus.

Water quality regulation requires about four hours of the owner's time to attend meetings for the local water coalition. Annual acreage enrollment fees are \$4.30 per acre, bringing water quality control to 9.5% of total compliance costs. These costs are likely to increase, as most of the local watershed is considered a "high vulnerability" area for nitrogen pollution, and further testing and nitrogen management practices are required starting in 2017.

Pesticide regulatory costs are this grower's biggest cost of regulation; an assistant spends about 25% of her time filing pesticide use reports with the county ag commissioner's office; this equals \$18.85 per acre. Other pesticide costs include workers' safety equipment for spraying as well as the cost of the qualified applicators' license. Altogether, pesticide regulations comprise 40.2% of total compliance costs.

Labor health and safety costs of regulation included portable toilets, shade trucks and water, and the grower's costs were estimated at 2.67% of the farm's regulatory costs.

Though capital investments were not included as a line item for the regulatory costs, this grower had gradually replaced tractors in anticipation of future regulation, and had benefited from the ARB's incentive program. Comments regarding the program included the time spent filling out paperwork (about a week's worth of time for the owner), and the fact that it takes about a year total to get a tractor replacement approved. This grower had replaced two tractors under the program; a 100-HP tractor and a 300-HP tractor. The combined cost for the tractors was \$200,000, and the grower received an \$80,000 cost share from ARB. The grower commented that even with the generous incentive, he would hesitate to participate in the program in the future because of the time involved. However, he also noted that he would not have purchased new equipment when he did without the program.

Food safety is an additional regulatory cost for this grower because his products go to the fresh market. The packinghouse requires a GAP (Good Agricultural Practices) audit in order to take the fruit. A certified auditor comes to the farm regularly, and the owner is required to attend GAP trainings at the packinghouse, estimated at four hours annually. A supervisor has to walk the fields before fruit is picked, estimated at two hours per week for the months of harvest. It also takes workers 20 hours to skirt the trees to keep fruit off the ground. These food safety regulatory costs are 22.5% of the total.

Overall, the regulatory costs for this medium citrus grower were estimated to be .71% of per acre production costs.

#### Small Citrus Grower – Southern SJV

This small citrus grower's farm was on the southern side of the San Joaquin Valley. He reported fewer regulatory costs than most growers because the farm is a part-time enterprise, and he contracts out much of the work in the orchard. Therefore, many of the regulatory costs noted by other growers are included in the contract work – but we were unable to document those additional costs from the third-party providers.

Education and training for regulatory requirements consisted of the owner's time spent attending meetings and trainings, including keeping his pesticide use permit current. He estimated this effort took about eight hours per year, and his reported value of time was \$100 per hour. His estimated cost of education and training comprised 35.3% of his regulatory costs.

Air quality regulatory costs for this farm included a burn permit for \$40 annually, and the costs of shredding prunings, which was done every two years. He estimated his annual cost to be \$62.50 per acre for this work. His farm is too small to fall under a Conservation Management

Plan or dust control measures. Per acre costs of air quality regulation were 57% of his total compliance costs.

Water quality regulatory costs were the acreage fees for the local water quality coalition. This was reported as \$8.85 per acre, or 7.8% of regulatory costs.

This grower's cost of regulation for his small citrus operation was estimated at 8.6% of production costs.

#### **Processing Tomatoes**

Two processing tomato growers were interviewed, one large and one medium grower.

#### Large Tomato Grower - Central SJV

This grower is a large, diversified vegetable and field crop producer, with over 5,000 acres of crops. Processing tomatoes comprise about <sup>1</sup>/<sub>4</sub> of their production.

Education and training for regulatory compliance are comprised of a number of line items, including lock out/tag out procedures for equipment safety training for all managers and employees; 10 hours for managers and 60 hours collectively for employees. Managers go through bi-annual CPR and sexual harassment training, as well as heat illness training. Employees are training in heat illness, pesticide safety and respirator fitting/training. The total costs of training for regulatory purposes amount to nearly 6% of compliance costs.

Air quality control regulations are the farm's largest regulatory expense. Most of the permits for operating gas tanks, burning, smog certification and the CMP cost just a few cents per acre. Dust control is the largest expense in this category; the farm waters roads 20 hours per day, six days/week for 7 ½ months. The labor and diesel required for the dust control operation is over \$20 per acre, and that doesn't include overhead costs on the water trucks, nor the cost of pumping water. The grower estimated that he uses 207 acre feet of water annually on dust control. The total cost of air quality regulations comprised 30.4% of regulatory costs.

Water quality regulatory costs in 2012 were primarily associated with the local water quality coalition. Administrative staff spend about eight hours annually filing paperwork regarding registration and the Nitrogen Management Plan. Additionally, the farm pays an annual \$4.30 fee per acre to the coalition. Water quality regulation amounted to 5.7% of compliance costs.

Pesticide use reporting is this farm's second largest regulatory cost. Pesticide use reporting takes 400 hours annually of administrative staff time, and the per acre cost is \$2.76. Posting signs in fields takes both mid-management and employee time, and equals \$.41 per acre. The most significant regulatory cost associated with pesticides is the buffer zones in which additional employee time is necessary for weeding, that area covers <sup>1</sup>/<sub>4</sub> of the tomato crop. The grower estimated that the total cost was \$150 per acre in higher weeding costs on the affected areas. Overall, pesticide regulations were 52.2% of regulatory costs.

Additional employee safety requirements consisted primarily of equipment for heat/illness prevention; such as shade structures, water coolers, and seating areas. Employee monitoring for

illness and signs of heat stress is also added in this area; the grower estimated \$15,000 for this category, or about 3.8% of compliance costs.

Though capital investments were not calculated for the cost of regulation, this grower has made many upgrades to the farm's mobile equipment inventory. The farm purchased nine tractors in 2012 and three in 2011, for a total investment of over \$1.7 million. All equipment was partially funded by the ARB, with a total cost share of nearly \$800,000.

Other regulatory costs of production include food safety protocols, as well as risk management costs. The farm has an attorney on retainer to review any labor contracts and regulatory actions, costing \$3,500 annually; and food safety audits/training cost \$1,590. Other miscellaneous costs of regulation include truck scale weighmaster and device registration, notification to dig to the utilities when ripping fields, and hazardous materials container recycling. These all add up to .8% of the total regulatory costs.

All told, this large processing tomato grower estimated regulatory costs add up to 2.6% of his production costs.

#### Medium Tomato Grower - Central SJV

This farm is a diversified operation, growing wine grapes, almonds, wheat and cotton in addition to processing tomatoes, which comprise about 15% of the operation.

Education and training for regulatory compliance comprise a significant cost for the farm in terms of opportunity costs. To provide required training to employees and for the owner to keep himself and his staff updated on all of the regulatory issues for labor/employment, pesticides, water quality, and food safety takes hundreds of hours per year for the owner, the supervisors and assistant, as well as the time spent training the employees. The grower estimated these costs to equal 12% of the compliance costs.

Air quality compliance is the second largest regulatory expense for this grower, primarily because of the cost of dust control measures. These costs are mostly attributed to the cost per hour for the water truck and wagon, estimated by the grower to be \$95 per hour, inclusive of fuel, water and maintenance costs. Labor is extra, and two shifts of employees operate the water truck 20 hours per day during the summer. A quarter of the total cost of dust control for the farm accrues to the tomato operation. The San Joaquin Valley CMP permit is a very small cost, at \$.14 per acre. Air quality regulations for this grower amount to 33% of the total regulatory costs.

Water quality requirements were less costly in 2012 than they are now; the grower reported costs of \$4.94 per acre for groundwater tests in 2012. In 2016, there is a water coalition surcharge of an additional \$5 per acre, and more regulations concerning nitrogen management are anticipated. Water regulations comprised 3.3% of his total regulatory costs in 2012.

Pesticide regulatory costs were the highest cost category for this grower. The farm reported spending 40 hours of the owners' time and 200 hours of an assistant's time to file paperwork regarding pesticide applications on the tomato crop. The grower estimated this cost at \$24.01 per acre. The farm pays for an in-house pest control consultant at a rate of \$48 per acre for the

tomatoes to make sure all of the pesticide recommendations fall within regulations. The grower noted that he is unable to use his preferred pesticides because of VOC restrictions. The tomato cannery also requires all pesticides to be reported to them pre-harvest for food safety assurance. The grower spends \$2 per acre on hazardous waste container recycling. The total cost of pesticide regulatory requirements comprised 48% of regulatory costs.

Employee safety requirements include safety equipment for workers as well as drinking water. The grower's cost for these items for the tomato crop amount to 2% of the total regulatory costs. The labor contractor provides toilets, shade structures and signage, so those regulatory costs are built into the labor contractor's price.

We did not calculate capital investments as part of the regulatory costs, but this grower switched his diesel irrigation pumps to electric in 2012 at a cost of \$86,000. These pumps will last 15 years. The farm received a rebate of \$16,000 from PG&E for energy savings from using a variable speed drive. The farm also changed out two pressure engines for pressure pumps in 2012 at a cost of \$49,000. This farm's overall regulatory costs are estimated at 7% of production costs.

#### Tree Nut

Four tree nut growers were interviewed; two large, one medium and one small.

#### Large Tree Nut Grower 1 - Northern SJV

This farm in northern San Joaquin Valley farms mostly almonds, with a small acreage of walnuts.

Education and training for regulatory compliance are shared by the liability insurance company as well as the manager and supervisors. The manager spends about 37 hours per year in various training capacities and the two supervisors spend another 30 hours annually. This includes attending the safety meeting each month put on by the liability insurance company, as well as keeping themselves updated and monitoring employee compliance. The 15 employees spend 1-2 hours each month in safety training. All employees also attend a pesticide training once per year, and five employees must attend an annual, one-hour respirator fitting training. These training costs comprise 17.5% of total regulatory costs.

Air quality requirements are the largest regulatory cost category for this farm. The burn permit costs \$.44 per acre, while watering roads for dust control takes the time of one employee five hours per day, seven days per week for two months. The grower estimates the cost to be \$20 per hour for labor, water and equipment, which amounts to \$4.79 per acre for almonds. The grower also estimates the cost of shredding tree prunings to be an additional \$20 per acre more than burning. The total cost of air quality regulations amounts to 39% of compliance costs.

Water quality regulatory costs are the \$4.00 per acre fee to belong to the water quality coalition, accounting for just over 6% of total compliance costs. Pesticide use regulatory costs, in addition to the worker safety training already discussed, are primarily comprised of the owner's time

involved in reporting pesticide use, estimated to be six hours per week for nearly every week of the year. These costs add up to 32% of the overall regulatory costs.

Additional costs for employee safety requirements include providing portable toilets as well as safety equipment for the employees. These costs add up to 5.4% of total compliance costs.

The farm did participate in the diesel engine cost share, and also switched irrigation motors to propane from diesel. However, these capital costs are not calculated into the regulatory cost per acre. The owner did note that keeping Tier 4 equipment running was a challenge. The hotburning nature of the engines was not very compatible with the way equipment is used in the field at low speeds. He commented about having to replace engines much more frequently than with the older engines.

Overall, this grower's total cost of regulatory compliance was estimated to be 2.5% of production costs.

#### Large Tree Nut Grower 2 - Southern SJV

This large grower farms several thousand acres of almonds along with several hundred acres of pistachios.

Education and training regulatory compliance activities are handled in large part by a safety consultant hired by the farm. The grower estimates this cost at \$10 per acre. One of the partners in the farm spends about 25% of his time on regulatory issues regarding worker safety and training; the partner's salary and benefits are valued at \$150,000 annually; the cost per acre for his time on regulatory activities for the almonds is \$12.50. The farm's three foremen spend about 10 hours per week in safety training with the crews, pulling nitrogen management reports and engine hours reports; each foreman's salary and benefits is \$130,000 annually. The time spent on these activities is estimated to cost \$22.45 per acre. The grower estimated that the employee time spent in training activities was about two weeks' worth of time annually for each of the farm's 47 employees, which costs \$21.18 per acre. Overall, the employee training for regulatory cost category.

Air quality compliance is the farm's second largest regulatory cost category. Dust control and shredding prunings encompass the biggest expenses; custom application of dust suppressant costs \$5.46 per acre while the labor to run the water trucks an average of 35 hours/week all year costs \$13.01 per acre. The grower estimates that the cost difference between shredding the almond prunings and burning them is \$20 per acre. Small fees for the SJV Air District CMP plan add \$.25 per acre. Overall, the farm spends 28.6% of its total almond regulatory costs on air quality regulations.

Water quality regulatory costs are based in the cost to join the water waiver coalition as well as testing fees for nitrogen management and other water quality issues. These costs amount to nearly 9% of the total compliance costs.

Pesticide use requirements were reported as primarily the work of the foremen posting signs when pesticides or fumigants are being used; the grower estimated this took about two hours per

month, or about 0.9% of the total compliance costs. Additional employee safety requirements include safety equipment for the workers as well as shade structures and water jugs. These costs for labor regulations comprise 7.3% of the total regulatory expenses.

The farm has also incurred costs of capital investment and risk management for regulatory purposes. The farm replaced several engines on trucks and harvesting equipment to meet air quality requirements, at an estimated cost of \$3.67 per acre. All pumps had monitoring systems installed in 2012; the cost is \$25 per month or \$.10 per acre. Capital investment for regulatory compliance amounts to just under 3% of the total costs of compliance. With respect to risk management, the farm pays a \$12,000 premium specifically to insure against pesticide drift; this comes to about 3% of the total regulatory costs.

This large almond farm's overall cost of regulatory compliance is estimated at 3.89% of production costs.

#### Medium Tree Nut Grower – Central SJV

This medium-sized tree nut farm also grows other stone fruits, citrus and melons; almonds comprise about 60% of the farming enterprise.

Regulatory compliance for education and training is primarily the owners' time spent on pesticide and fertilizer safety training. The farm is a family operated business with no outside employees other than the family members, who are also owners. They estimate they spend 25 hours per year at \$20 per hour for training for the whole farm, and the almond portion of that regulatory expense amounts to 1.7% of regulatory costs. This includes costs of maintaining an applicators' license as well as attending pesticide trainings at industry conferences.

Air quality regulatory costs comprise the largest category of regulatory costs for the farm. The owners constructed gravel road to reduce dust pollution; the annual cost apportionment is \$13.66 per acre. The owners spent about 16 hours annually to maintain the roads, equaling \$1.98 per acre. The burn permit and CMP fee to the San Joaquin Valley air district equals \$.88 per acre. The owners estimate the cost of shredding the prunings to be \$60 per acre, and when 30 acres of almonds were taken out in 2012, the cost to shred/chip the trees was \$90 per acre. Air quality compliance for the almond crop in 2012 was 91.4% of the total regulatory costs.

Water quality compliance is primarily the cost of belonging to the local water quality coalition at \$4.63 per acre. The owners spend two hours per year on additional paperwork, estimated at \$.25 per acre. The total cost of water quality compliance was estimated at 2.7% of regulatory costs; this cost is expected to increase as the Nitrogen Management Plans become mandatory in 2017.

Pesticide use regulatory costs arise from completing compliance paperwork and filing pesticide use reports, estimated at four hours per month or 3.3% of regulatory costs. The farm now uses a PCA, but those costs are included in the cost of production and the regulatory portion is not easily separated. The farm also spends money on safety equipment that is required when using certain farm chemicals; this cost is estimated at 1% of regulatory cost.

Though food safety and capital investment regulatory expenses are not itemized as costs, the owners noted that food safety requirements are coming down to the farm level for almonds; animals are to be kept out of the orchards, for example. The farm also participated in the ARB cost share program and upgraded a tractor to a Tier 4.

This medium almond farm's regulatory cost of production per acre was estimated at 7.5% of production costs.

#### Small Tree Nut Grower - Southern SJV

This small tree nut producer grows less than 50 acres of almonds, and the rest of the farm is dedicated to stone fruit and citrus.

Education and training for regulatory compliance are the grower's biggest regulatory expense category; the farm has four employees who spend about seven hours in mandatory training per year off site (the training is in Spanish for the employees) while three of the employees who drive tractors are fitted for masks for pesticide use and receive further training on forklifts, tractors and PTO equipment. Employee time spent in training adds \$17.65 per acre. The rest of the education and training costs are accrued by the owners in terms of their own time spent either attending training/education sessions or in providing such sessions to the employees. The topics cover OSHA employment and safety topics, heat stress and illness and workers' compensation. The owners also participate in additional training for pesticide/fertilizer safety as well as water quality regulations. Because the owners are also PCAs, they must have safety training for hauling chemicals as well. Education and training for the small almond grower comprise 73.6% of the total cost of regulatory compliance.

Air quality requirements for the almond grower are relatively minimal with only the burn permit and time required to call in the burn permit for tree prunings; these costs are estimated at 1.4% of the farm's overall regulatory costs.

Water quality regulations include the local water quality coalition at \$3.01 per acre, and groundwater nitrogen testing that adds \$1.91 per acre. Water quality compliance makes up 4.7% of the total regulatory expenses for the farm.

Additional pesticide use regulations, in addition to the education/training already documented, include filing paperwork and record keeping, as well as making sure employees are in compliance with safety equipment and practices. An annual fee of \$12 to haul chemicals is also included, and pesticide use regulations comprise nearly 15% of the total regulatory costs.

Other labor costs related to regulation include a compliance bucket with safety items that the farm keeps stocked at all times. Keeping portable toilets serviced is an additional expense; these costs are 5.4% of the regulatory total.

The farm has invested in a pressure bomb to check for water content of the crops in order to use less water, but no value was provided for the capital investment. This investment would be in anticipation of future regulations under SGMA, and not reflective of the regulatory environment

in 2012. The farm has also purchased insurance to protect against pesticide drift claims, but no premium value was provided.

Overall, the cost of regulation for this small almond farm was estimated to be 5.1% of production costs.

#### Grapes

Four grape farmers were interviewed; a large and medium wine grape grower, a large table grape grower and a small raisin grower.

#### Large Table Grape Grower - Southern SJV

This grape grower has about 80% of its production in table grapes, but also grows tree fruit and vegetable crops.

Education and training for regulatory issues include a full day for all 70 employees three times per year, covering topics such as tractor safety, confined space safety, heat illness and pesticide safety. The trainer is paid \$1,500 for each session. Food safety is an increasing issue for employee training; 150 seasonal employees are provided a full day training at \$100 per person. The food safety training costs \$5,000. The cost of regulatory compliance for employee training is 12.3% of the total.

Air quality is the largest regulatory cost category for the farm. Dust control on roads is the primary expense; spreading oil, running a water truck and paying the labor all cost \$16.73 per acre. Additional costs include renting large trucks to haul equipment to and from fields (the farm doesn't own compliant large trucks). The farm also received a \$1,500 fine for running non-compliant engines in 2012. Maintaining air quality compliance is 29.1% of the farm's total regulatory cost.

Water quality requirements include joining the ag water waiver coalition, but the grower did not report any costs associated with this organization in 2012. As of 2014, there were costs of \$5 per acre, and by some estimates, the total costs will be as high as \$15-20 per acre when nitrogen management is included in 2017. As of 2012, however, there was no additional cost of regulation for water quality.

Pesticide regulatory requirements include using a PCA, and the grower estimates that 5 - 10% of the PCA costs deal with regulatory costs. The PCA fee is \$35 per acre, and that responsible for 4% of total compliance costs for the grape operation. The grower also noted that the loss of Lorsban as a chemical will have impacts in the future.

Employee safety requirements that fell under regulatory compliance include a full-time HR staff person to document compliance issues, as well as the purchase of personal protective equipment such as Tyvek suits, masks and gloves. The total cost of the additional employee safety compliance is estimated at 12.2% of regulatory costs.

Other regulatory costs for the farm include a full time environmental compliance manager to stay abreast of the environmental regulations in the farming operation, as well hiring an

environmental lawyer to analyze the environmental impact reports. These costs comprise nearly 16% to the regulatory costs for grapes.

Food safety is the second largest compliance cost category; the farm hires a field auditor from Primus Labs that does six audits per year at a cost of \$2000 for each audit. Residue level testing on the grapes costs \$30,000 per year, and a full-time staff member handles retail audits. Food safety compliance is responsible for 26.4% of the total regulatory expenses.

The overall costs of regulatory compliance for this large grape grower in 2012 was .42% of production costs.

#### Large Wine Grape Grower - Northern SJV

This large wine grape grower also raised tree nuts, and the grapes comprised about 50% of the operation.

Education and training comprise the second largest regulatory cost for this grape grower. The grower has 6 to 7 permanent employees in the grape operation. About <sup>1</sup>/<sub>4</sub> of the total cost is for employee training, and the rest goes to the owner's opportunity costs for staying abreast of training. Employees are trained on required OSHA issues as well as pesticide safety; the training fee is \$750 for an outside trainer. The owner also invests approximately 200 hours of time in staying up to date on labor & employment issues, pesticide regulations and water quality. Forty hours of that time is to maintain a pesticide applicator's license. The total cost of labor and employment regulations comes to 31.8% of the overall regulatory costs.

Air quality requirements are the largest regulatory cost for this wine grape grower. Dust control measures are the largest portion of these costs; for 20 weeks per year, a truck is running 25 hours per week; oil and sand are the primary dust control materials. The cost of labor and running the equipment is reported as \$31 per hour. These costs add up to about \$24 per acre. The annual CMP fee, the burn permit and time spent in filling out forms also add to the cost of air quality compliance, and the category accounts for 43.2% of the total regulatory expenses for the wine grape operation.

Water quality regulations are comprised of the fees for the local water quality coalitions; resulting in \$3.60 per acre. The owner's time spent in filing permits and paperwork to comply with groundwater quality regulations as well as well testing fees bring the total water quality cost of regulation to 12.2% of overall regulatory costs.

Pesticide use regulatory costs are primarily comprised of additional paperwork and recordkeeping, which the owner estimates at 90 hours per year. The pesticide regulatory costs are nearly 13% of the overall regulatory expenses. The owner noted other regulatory costs that are not documented, but that add to the cost of production - for example, biologically based pesticides take 10% longer to apply, and he estimates that regulatory costs add 20-25% to the cost of pesticides.

Though this grower had not used any cost share program to upgrade his mobile equipment, he did note that the newer equipment is less fuel efficient and has higher cost of ownership.

Overall, this large wine grape grower estimated that his regulatory costs are 1.9% of production costs.

#### Medium Wine Grape Grower - Northern SJV

This wine grape operation produces several hundred acres of wine grapes, along with tree nuts and stone fruit. The wine grapes comprise about 50% of the enterprise.

Education and training for regulatory compliance are this farm's largest regulatory cost category. The owner and managers spend about 240 hours annually, or 20 hours per month on training, both with workers as well as continuing education for themselves on employment regulations. Employees spend about 10 hours per year on labor/employment/safety training, while six employees spend about 25 hours per year on pesticide safety training. The owner spends about 25 hours per year on water quality education and training. Altogether, the costs of education and training for the wine grape enterprise make up 41.2% of the total regulatory expense.

Air quality requirements involve dust control, with only 15 hours of labor spent on this effort in 2012 – as compared to 250 hours spent in 2015. Labor and equipment costs for dust control contribute nearly \$3 per acre in 2012. These expenses, along with additional costs for the burn permit, smog tests on vehicles and the time spent for smog control contribute to 6.2% of the total regulatory costs.

Water quality requirements are the second largest cost category; the cost to join the water waiver coalition is \$5 per acre, while the groundwater protection act adds \$10 per acre. The documentation for the wells and mapping adds \$.41 per acre. Water quality regulation comprises 25.3% of overall regulatory costs.

Pesticide regulatory costs were reported as filing paperwork and recordkeeping, as well as recycling used containers. These costs contribute 10% to the overall cost of regulation. The owner noted additional costs for fumigants, which are the most regulated of pesticides, but did not specify the extra costs for their use as those costs are included in the fumigant contractor's fee.

Other employee safety cost requirements include portable toilets, water jugs, an icemaker and shade tents, as well as safety gear such as chemical suits, gloves and goggles. These labor regulatory costs are estimated at 16.7% of the overall compliance expenses.

This medium wine grape grower's overall regulatory costs for 2012 were 2.25% of production costs.

#### Small Raisin Grape Grower – Central SJV

This raisin grape grower has less than 100 acres of raisin grapes, along with almonds. Raisin grapes comprise about 45% of the farming enterprise.

As with other small growers in this study, this farm contracts out a large proportion of the work, so some regulatory costs were covered by contractors and are not specified here.

Education and training for regulatory compliance are primarily the owner's time attending training workshops and meetings. The owner estimated that he spent 32 hours annually on trainings for labor & employment, pesticide and water quality issues. He also pays \$300 for an agricultural association compliance assistance membership, which provides workshops and assistance on regulatory issues. The cost for this category is estimated to be 14.4% of overall regulatory expenses.

Air quality requirements comprise the largest category for this farm. Dust control measures cost nearly \$9 per acre, while filing CMP plans and other permits and paperwork cost nearly \$5 per acre. He pays a contractor for five days of chipping; between labor and equipment the cost is \$350 per hour; adding up to over \$24 per acre. Overall, the cost of air quality regulatory measures is 56.6% of the compliance expenses.

Water quality requirements are the cost to join the water waiver coalition at \$1.20 per acre; water quality comprises 1.8% of regulatory costs. New regulations in 2016 will add additional requirements for ground water quality, but those weren't relevant in 2012. Pesticide use requirements are primarily filing paperwork and pesticide use forms; those were estimated at 4.4% of overall regulatory costs. There may be additional pesticide requirements in 2016 because of new VOC rules and water quality restrictions – for example, atrazine products are banned.

Additional employee safety regulatory costs are estimated at 2% of the labor contractor's bill to cover items such as shade, water, portable toilets, etc. This accounts for 18.2% of regulatory expenses, the second largest regulatory cost for this raisin grower.

Other regulatory costs include waste oil recycling and disposal costs for plastic chemical containers, which come to 4.6% of overall compliance costs. The overall costs of regulation for the raisin grower are 1.54% of production costs.

#### Corn Silage

Five silage growers were interviewed; two large and three medium in various regions of the San Joaquin Valley.

#### Large Silage Grower 1 - Central SJV

This large silage grower farms multiple crops, both annual and permanent. The silage accounts for about 20% of the farm's acreage. All silage is fed to the dairy cattle.

Education and training are minimal regulatory costs for this grower. All of the silage work is mechanized, but the five farm employees must go through annual safety, tractor and heat stress training for six hours annually. The supervisor is also involved in the training as well as preparation. Six employees also must take sexual harassment training every other year. The training does not include pesticide application training because the farm now outsources all pesticide applications as a result of regulatory costs and potential liability. Thus, the farm costs of education and training are very low, and comprise 1.2% of their regulatory costs.

Air quality regulatory costs are the largest expense for this grower, but are still minimal compared to other farms in the study. Dust control on the farm roads is the largest cost; the farm runs a water truck six days per week for 10 hours per day for four months per year, plus two or three times per week in the spring and fall per the farm's CMP. The equipment and labor costs for this effort are nearly \$4 per acre. Fees and permits for the San Joaquin Valley Air District add nearly another \$.40 per acre, and the time for an employee to record equipment emissions for  $\frac{1}{2}$  hour per day adds \$.16 per acre. The farm also upgraded its natural gas engines in 2012; that equipment modification added \$.46 per acre. The cost of air quality regulations comprises 84.4% of this farm's silage operation.

Water quality issues are primarily the local water quality coalition fees, which in 2012 was \$.85 per acre for the silage operation. Those fees increased significantly in 2015, to \$2.15 per acre, and are expected to increase even further in the future. In 2012, the farm used a part-time accountant to file water quality reports. Now, however the farm has hired a full-time, \$50,000/year position plus benefits to take care of regulatory issues, including water. In 2012, the costs of water quality compliance were 3% of overall regulatory costs for the farm.

Pesticide regulatory costs were minimized for this grower because the spraying is outsourced, and the regulatory costs are included in the spray contract. The workers' equipment and the  $\frac{1}{2}$  day required for maintaining the pesticide use permit amount to 0.9% of the overall compliance costs.

Other regulatory costs include a manager's time for record keeping as well as part-time employee whose main role is to assist with compliance. These expenses comprise 10.6% of the total regulatory costs.

Overall, the costs of regulation for this large silage grower were .62% of production costs in 2012.

#### Large Silage Grower 2 - Central SJV

This large silage grower produces over 2,000 acres of field crops, with nearly 50% of the annual crop committed to corn silage. All silage is fed to the farm's dairy cattle.

Education and labor requirements include aerial spray training and annual pesticide training for 10 farm employees. The farm also conducts four safety meetings per year with all of the employees, which takes 1.5 hours each time. The employees and managers' time involved adds up to a little over \$1.50 per acre. The foreman spends about ½ hour each day, 300 days per year, to ensure workers are in compliance with safety regulations. In addition, one HR staff person spends about 250 hours each year staying updated with employment and safety regulations, as well as filing compliance reports. Finally, the farm owners maintain a pesticide applicator's license, which takes 15 hours of training plus the fees to take the exam. The total cost of education and labor requirements comprised 10% of overall regulatory costs.

Air quality is the farm's second largest regulatory cost. As with many farms in this study, dust control is the largest component of regulatory compliance. Running a water truck takes 600 hours of farm employee time annually, and the equipment cost is estimated at \$8,000. The oil

and sand spread on the roads costs \$6,000, and the maintenance on the truck is estimated at \$5,000 annually. The burn permit and CMP fees on the north and south farms are relatively minimal and add less than \$2 per acre to the cost of compliance. Overall, air quality regulatory costs are 37% of total compliance costs.

Water quality requirements are the farm's largest regulatory cost. The fee to join the Central Valley Dairy Representative Monitoring Plan is \$.90 per acre. As with many regulatory requirements, the primary cost is the cost of staff time in monitoring compliance. Because the silage is fertilized with dairy lagoon water, additional monitoring is required. An office employee spends 600 hours annually, or about 40% of her time, reporting water quality monitoring reports from the field, and a farm employee spends about 1,500 hours per year taking water samples from the field to maintain compliance. These monitoring costs add \$20.71 per acre. Seven farm employees attend monthly meetings on lagoon water monitoring and field application, which adds \$.30 per acre. The farm also pays over \$13,000 annually to a nitrogen and ground water consultant to help maintain ground water quality. The overall cost of water quality regulations for this farm's silage operation are 51% of the total regulatory costs.

Pesticide use requirements involve equipment costs for spraying, as well as the applicator's permit. An office staff member files a monthly report on pesticide use. The overall cost of pesticide compliance for the farm is 1.2% of the total regulatory costs.

Additional regulatory costs include labor health and safety requirements; portable shades, ice, coolers and water are included in this cost. These items account for 1% of the total regulatory expenses. The farm also reported having a mandatory flood insurance premium, but the cost of this insurance was not provided for the study.

This large silage farm's overall regulatory costs were 6.8% of production costs in 2012.

#### Medium Silage Grower 1 - North Central SJV

This medium silage grower produces corn silage and tree nuts on less than 1,000 acres. The corn silage comprises over 60% of the total farm acreage. All silage is fed to the farm's dairy cattle. Education and training for regulatory compliance includes quarterly meetings for the five employees for an hour each time; lunch is included in these meetings. Two managers conduct these meetings, and the per-acre cost to hold these trainings is \$.64. Pesticide safety training takes two hours per year for each employee and manager, this cost is \$.15 per acre. The farm manager spends about 20 hours each year maintaining currency with the regulatory changes and compliance. The overall cost of education and training for regulatory compliance amounts to 4.2% of the overall costs of regulation for silage.

Air quality compliance is the farm's largest regulatory cost, primarily for dust control on the farm roads. The inclusive costs of running the water truck are over \$8,000 annually, which adds \$15.36 per acre. The farm contracts with a consulting company to report both air and water quality monitoring; the crop portion of the farm accounts for 65% of this cost at \$6.10 per acre. The SJV Air Quality and burn permit fee are \$1.27 per acre. Air quality compliance comprised 56% of the total regulatory costs in 2012.

Water quality is the second highest regulatory expense for this silage operation. Central Valley Dairy Representative Monitoring Plan is a quarterly fee of nearly \$250, which adds \$1.13 per acre. The largest cost of compliance in this category comes from the consulting group that takes care of soil and water testing for the farm's regulatory compliance; this costs \$9.34 per acre. Additional costs are generated from employees taking samples of harvested feed to test for nitrogen content; this takes 30 hours of time annually and adds \$.82 per acre. The total cost of water quality compliance for this farm in 2012 is estimated to be 27.7% of the overall regulatory costs.

Additional regulatory costs were incurred with pesticide use requirements and employee safety regulations. Filing paperwork for pesticide reporting was estimated to cost \$1.60 per acre for the manager's time. Providing required shade structures, water jugs, gloves and coveralls for the five employees annually was estimated at 8.4% of overall compliance costs.

No capital investment was reported for regulatory compliance in 2012, but the farm owner noted that in 2013, they installed a one-mile pipeline from the dairy lagoon to the farm operation at a cost of over \$35,000. The farm also turned in four Tier 1 and 2 tractors for the equipment upgrade program and purchased four new Tier 4 tractors as replacements. The farm received about a 50% cost share on each tractor.

This medium-size silage farm's overall cost of regulatory compliance in 2012 was estimated at 5.3% of production costs.

#### Medium Silage Grower 2 - Northern SJV

This farm grows over 1,000 acres of crops, including silage, grapes and tree nuts. The corn silage comprises just over 50% of the farm acreage.

Education and labor requirements involve safety training for employees and managers; trainings are held twice per year for three to four hours each time. The farm hires an outside consultant, Cal Ag Safety, to assist with the compliance paperwork, at \$150 per month. In addition to trainings, the managers' and employees' time spent for reminders and compliance updates for safety issues is estimated at about an hour per month per person. These costs add up to over \$8 per acre. Pesticide and fertilizer safety and training for employees takes eight hours per year for each of the five employees, and the owner and manager each spend about 3.5 hours per year maintaining their pesticide applicator's certification. The farm manager also spends about one hour per month meeting with city officials regarding water quality and crops because the farm's location falls within city limits. The total cost of education and labor regulations for this farm amount to 24% of the overall regulatory costs.

Air quality requirements are the largest cost of regulation for this farm; dust control is the primary component of this compliance cost. The farm waters roads six days per week for five months; the total cost is \$18,000 for labor. Fuel costs and maintenance on the roads add another \$2,750, this adds up to 39.2% of overall compliance costs for the silage operation. The crop portion of the farm does not incur any air quality permit fees; those are assessed on the dairy portion of the operation and are not accounted for here.

Water quality requirements include the fee to the local water quality coalition, which is \$81 per month. The farm pays an outside consultant \$525 per month for compliance reporting and testing. The farm manager spends two hours per year testing and sampling for water quality, and the cost of testing soil, plant and water samples for nitrates is \$6,000 annually. Water quality compliance costs were 25.3% of the overall regulatory costs.

The farm reported no additional costs for pesticide regulatory compliance; the owner noted that those costs were built into the costs of chemicals and would be difficult to divide out the regulatory portion. Employee safety requirements included protective gear and equipment such as masks, gloves and coveralls; the farm also provides water, Gatorade, ice, etc., to the employees. The cost of employee safety compliance was 11.5% of the total regulatory expenses.

The overall cost of regulatory compliance for this medium silage farm in 2012 was 3.5% of production costs.

#### Medium Silage Grower 3 – Southern SJV

This medium size silage farm grows over 2,000 acres of field crops; nearly 50% of the acreage is devoted to corn silage. All silage is fed to the farm's dairy cattle.

Education and training are this farm's largest cost of regulatory compliance. New employees spend 1.5 hours in initial training, plus quarterly meetings on heat stress and other safety issues of 30-45 minutes. In addition, the foreman spends about 30 minutes daily with all employees emphasizing heat stress and other safety issues. The farm uses webinar trainings to keep up with new regulations. The farm manager also keeps up his pesticide applicator's license, which takes three hours of training per year. The farm owner also attends four hours of water quality training per year from the Water Board. Education and training comprise 41% of the overall regulatory costs.

Air quality compliance is the second largest regulatory cost for this farm with the largest component being dust control. A water truck runs for 12 weeks, 10 hours per day, six days per week. Equipment and water costs are estimated at \$10,000 annually; the labor costs bring the total to nearly \$19,000 for dust control. Air quality and burn permits, mapping for the CMP, diesel engine and gas permits cost over \$3,500 per year. Annual air quality regulatory compliance for the silage operation is estimated at 36.7% of total regulatory costs.

Water quality regulatory costs are primarily the annual fee to the water board of nearly \$5000, and fees paid to a consulting company for water quality sampling, testing and compliance reports. The consulting fees are over \$5,600 per year. Additional farm manager, owner and employee time for manure and plant tissue sampling, as well as the water board inspection add nearly \$2,000 more in annual regulatory costs. Overall, the farm's cost of water quality compliance is 19.6% of the total regulatory expenses.

The farm reported no additional costs of pesticide regulation; it contracts with an outside pesticide applicator that bears all of the costs of regulation. Dividing out the regulatory portion was not possible in this case study. The farm does keep a 150-foot buffer zone around each of its 13 wells; there is likely lost silage production in those areas but it was not calculated.

The farm does incur additional costs of employee safety compliance in providing worker safety gear at a cost of \$300 per year; and each employee is given a stipend of \$150 per year to purchase coveralls for work. Water jugs are provided at a cost of \$140. These additional labor requirements are 2.7% of the overall compliance costs.

Though we did not include a cost of capital investment for 2012, the farm did incur capital investments in 2013 for to convert two irrigation pumps from diesel to electric. The cost was \$18,000 per pump, with additional cost of \$53,000 for electric line extensions to the pumps. The farm did qualify for a cost share program to fund these improvements. The farm also participated in a tractor replacement program and purchased a Tier 4 tractor for \$212,450 with a \$91,000 cost-share grant from the San Joaquin Valley Air Pollution Control District.

This medium silage farm's overall cost of regulation in 2012 was 2.3% of production costs.