The Costs of Regulation to California Farmers

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Introduction

Regulations on agricultural production have always been a source of contention. One the one hand regulation can provide benefits to producers, for example, by signaling to consumers that their produce is safe and reliable, however regulations also impose compliance costs on agricultural businesses. While workers benefit from improved safety, and consumers benefit from improved air quality, water quality, and food safety, producers incur costs that are often not factored into their cost of production. 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.

This study completes an analysis of 22 farms in the San Joaquin Valley, as well as compiling information from interviews with mobile agricultural equipment dealers, to quantify regulatory costs relative to the cost of producing different specialty crops. While the sample size of case studies conducted is small relative to the number of farms in the Central Valley of California, it is the largest to date and provides valuable insight into the current regulatory environment faced by farms and a baseline for future work as new regulatory policy is passed. The discussion proceeds as follows: brief overview of the limited existing literature on regulation in California; a review of the case study methodology, followed by a summary of findings across producers. The paper concludes with general insights and suggestions for future work.

Literature Review

Very few studies exist that examine the costs of regulation at the producer level. A study completed in 2006 estimated the total cost of regulatory compliance for specialty crop[1] producers in California to be 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

[1] Specialty crops include fruits, vegetables, nuts, and nurseries.

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 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. Some of the regulations on the use of pesticides also originate 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. The Food and Drug Administration estimates that the annual average cost of compliance for the produce safety rule will range from nearly $3,000 to over $28,000 depending on farm size (FDA 2015).

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, packer-shippers, 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.

Methodology

This study completes an analysis of 22 farms in the San Joaquin Valley to quantify regulatory costs. 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 machinery costs
5. 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 were 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, were 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 could 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.

According to the USDA 2012 Census of Agriculture, the San Joaquin Valley produces over 150 unique agricultural commodities 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. The Department of Water Resources and the California Department of Food and Agriculture typically consider 20 crop groups for aggregate analyses of California agriculture and are summarized 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.

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
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
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 the future.

Each of the seven 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 east-side 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.

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 by size.

Table 2. Farm size and machinery breakdown

% of Farms by Acreage	Fresno	Kern	Kings	Madera	Merced	San 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	17.7	41.2	31.2	22.2	20.1	15.0	12.5	13.5

% of Farms by Value of Machinery	Fresno	Kern	Kings	Madera	Merced	San 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

Source: 2007 Census of Agriculture

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.

Table 3. Case study selection

Commodity Group	Citrus	Stone Fruits	Tree Nuts	Grapes	Cotton	Corn for Silage	Tomatoes
Survey Locations	2 *South, Central*	2 *South, Central*	3 *South, Central, North*	2 *South, North*	2 *South, Central*	3 *South, Central, North*	1 *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**

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. Because the agricultural commodities studied varied substantially by crop and location, harvest extended throughout the year, making it difficult to schedule interviews. In total, 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.

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.

Table 4. Sample Operating Costs

OPERATING CASH COSTS:	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	

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).

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 three 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.

This is the most comprehensive primary analysis of farm regulatory costs in California to date. 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.

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	

Summary of Findings

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 future regulations given an estimated regulatory cost per acre. As such, the information presented illustrates the regulatory environment faced by a sample of farms. While this sample is small relative to the number of farms in the San Joaquin Valley, the general picture illustrated gives insight to 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.

Table 6. Average production costs per acre by commodity

	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 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 5.81 percent.

Table 7. Average annual environmental regulatory costs by crop

	Average Total Cash Costs	Air Quality Requirements	Water Quality Requirements	Pesticide Use Requirements	Total Environmental	Share of Total Cash Costs
			$/acre			(%)
Citrus	$5,862.12	$41.97	$9.16	$15.95	$67.09	1.14%
Cotton	$1,089.76	$0.40	$45.65	$1.84	$47.88	4.39%
Grape	$6,434.18	$21.60	$8.02	$4.97	$34.59	0.54%
Tree Nut	$2,746.40	$57.99	$6.45	$10.81	$75.25	2.74%
Silage	$940.97	$14.58	$10.93	$0.76	$26.27	2.79%
Stone Fruit	$9,035.73	$52.89	$1.98	$197.57	$252.43	2.79%
Tomato	$2,558.47	$36.43	$4.67	$57.34	$98.44	3.85%

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 the initial motivation for this study was to compare regulatory costs across California farms and worker's compensation is compulsory, it was not calculated as 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 1.92 percent.

Table 8. Annual labor regulatory costs by crop

	Average Total Cash Costs	Education/Training for Regulatory Compliance	Employee Safety Requirements	Total Labor	Share of Total Cash Costs
		$/acre			(%)
Citrus	$5,862.12	$28.62	$3.65	$32.27	0.55%
Cotton	$1,089.76	$6.08	$6.97	$13.05	1.20%
Grape	$6,434.18	$15.53	$10.03	$25.57	0.40%
Tree Nut	$2,746.40	$39.40	$5.21	$44.61	1.62%
Silage	$940.97	$5.41	$2.35	$7.76	0.82%
Stone Fruit	$9,035.73	$25.19	$1.49	$26.68	0.30%
Tomato	$2,558.47	$11.23	$2.99	$14.22	0.56%

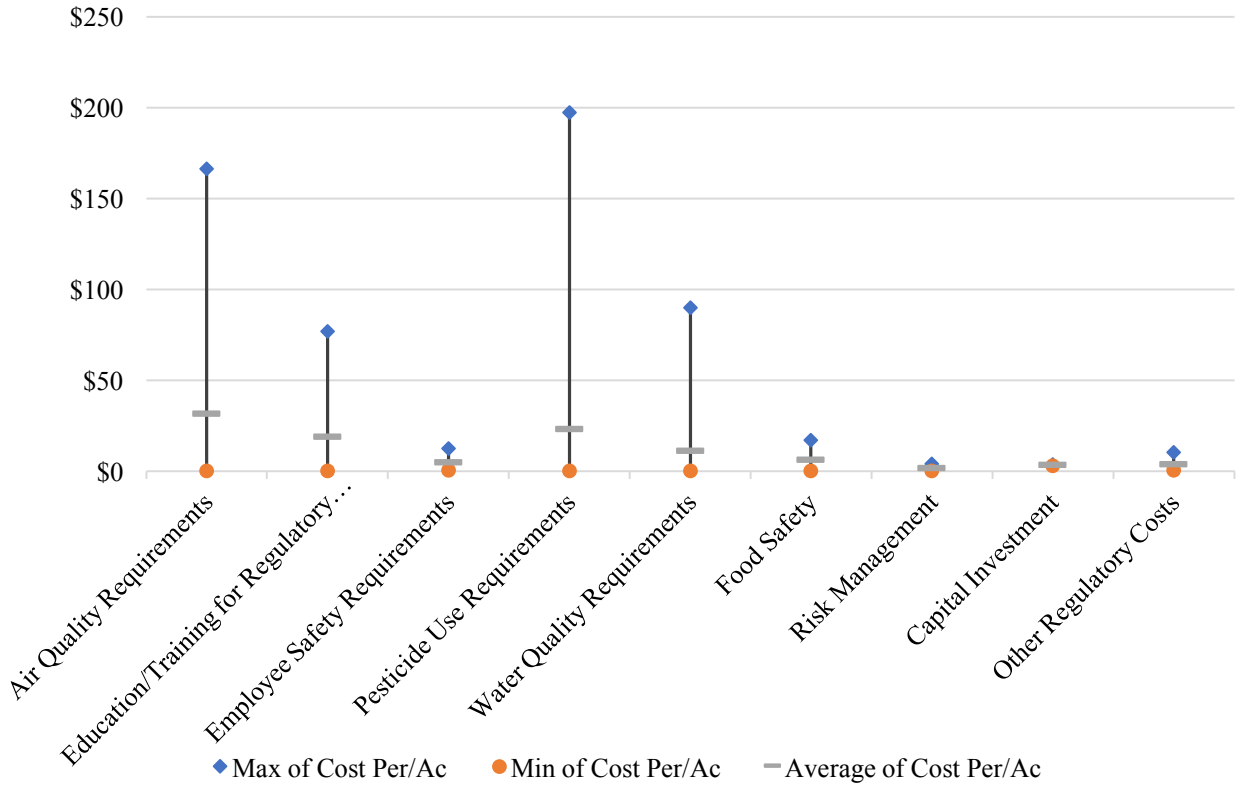
Overall, average total regulatory costs share an important portion of farms' total operating costs, as shown in Table 9.

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

	Average Total Cash Costs	Average Total Regulatory Costs	Share of Total Cash Costs
	$/acre		(%)
Citrus	$5,862	$98	1.67%
Cotton	$1,090	$61	5.59%
Grape	$6,434	$63	0.98%
Tree Nut	$2,746	$122	4.43%
Silage	$941	$33	3.55%
Stone Fruit	$9,036	$180	1.99%
Tomato	$2,558	$113	4.43%

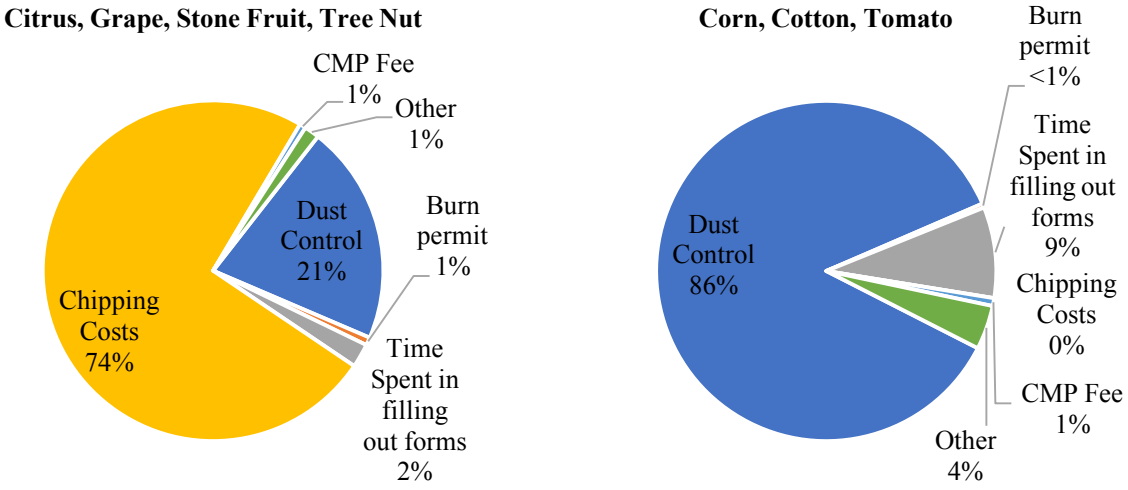
Figure 1 illustrates the variability in different regulatory costs. Plotted are the minimum, average, and maximum assessed total regulatory costs for each category. Not all farms incurred all categories of costs; for example, food safety regulation is not relevant for cotton or silage farmers. However, 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.

Figure 2. Breakdown of air quality regulatory costs by general category for farms.



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, while the remaining costs were 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

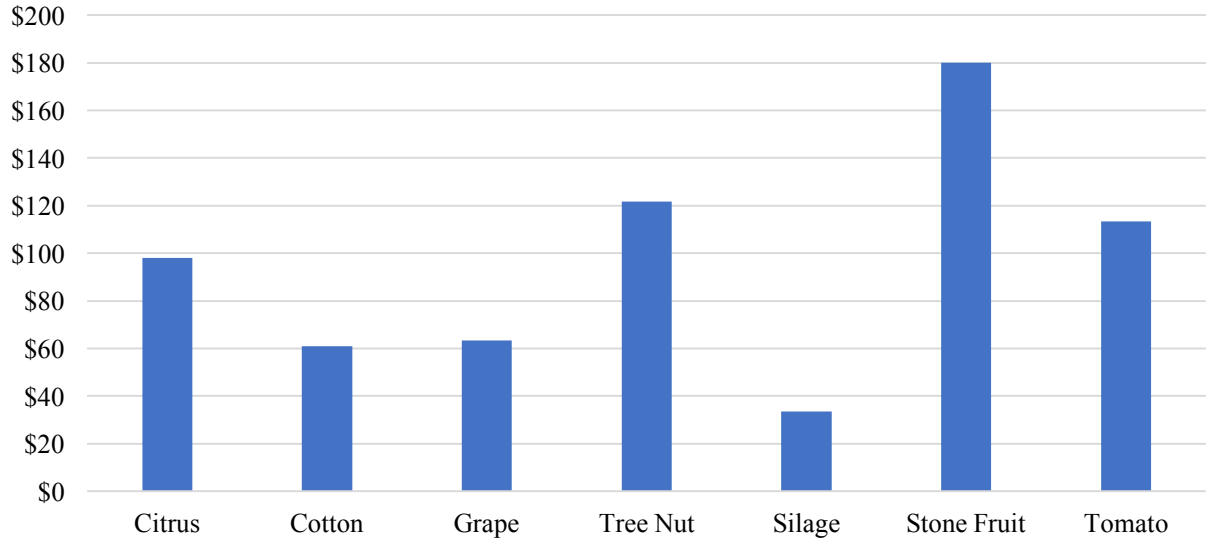
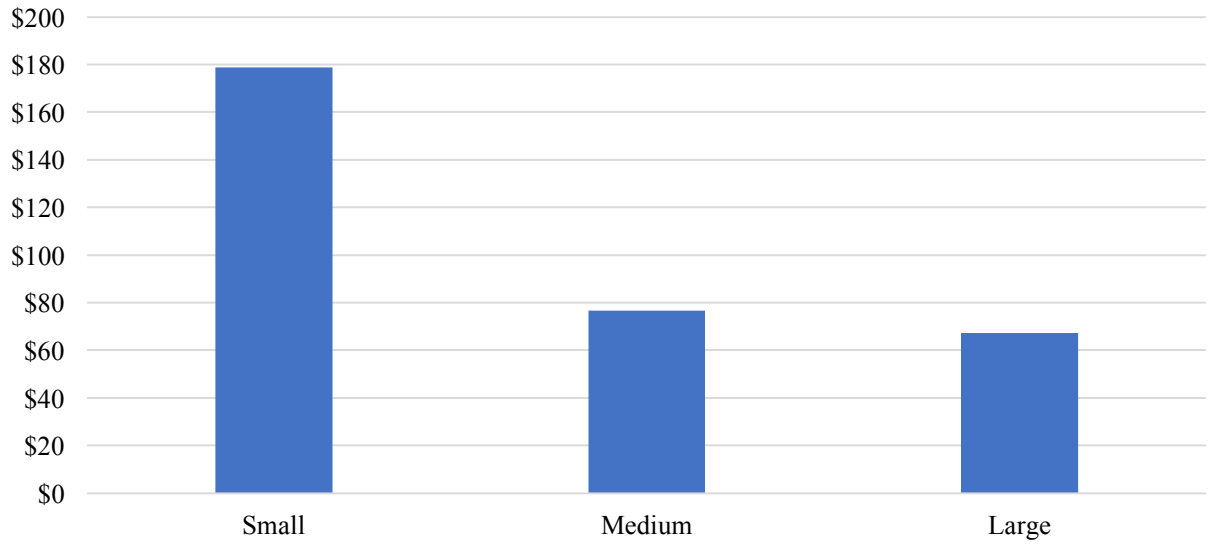


Figure 4. Average total regulatory costs per acre by farm size

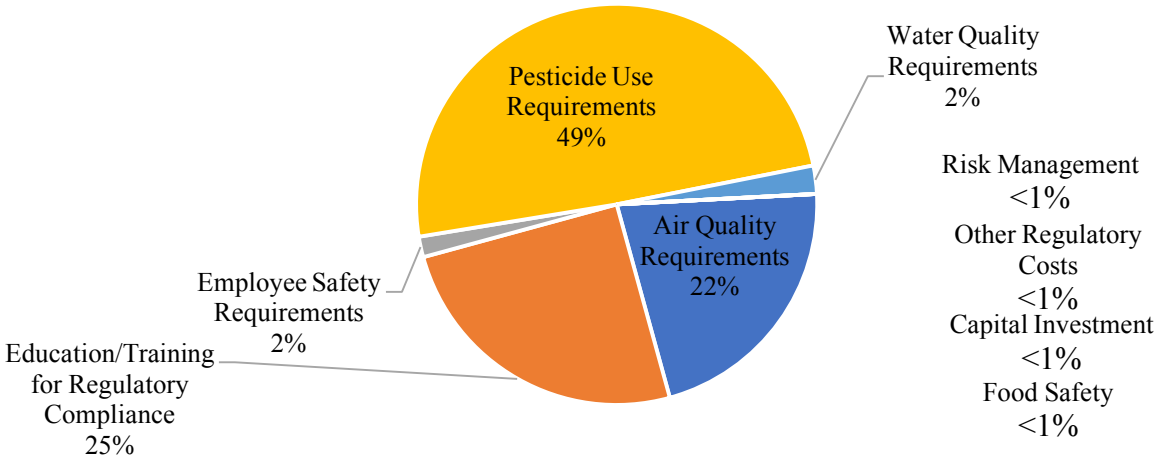


On average, the total cost of regulation per acre diminishes as farm size increases. This primarily is due to economies of scale in labor. Labor use and farm size are not linearly related so the per acre labor costs diminish with increased farm size as do regulatory costs associated with education and 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

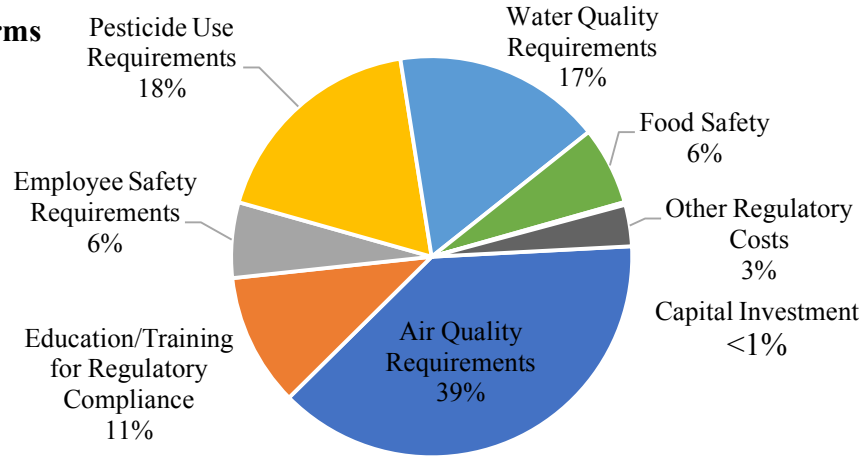
breakdown of regulatory costs by category across farm size. One of the driving reasons for the different mix of costs can be attributed to the commodities sampled for each size group, see Table 3.

Figure 5. Percent of regulatory costs by category across the three farm sizes

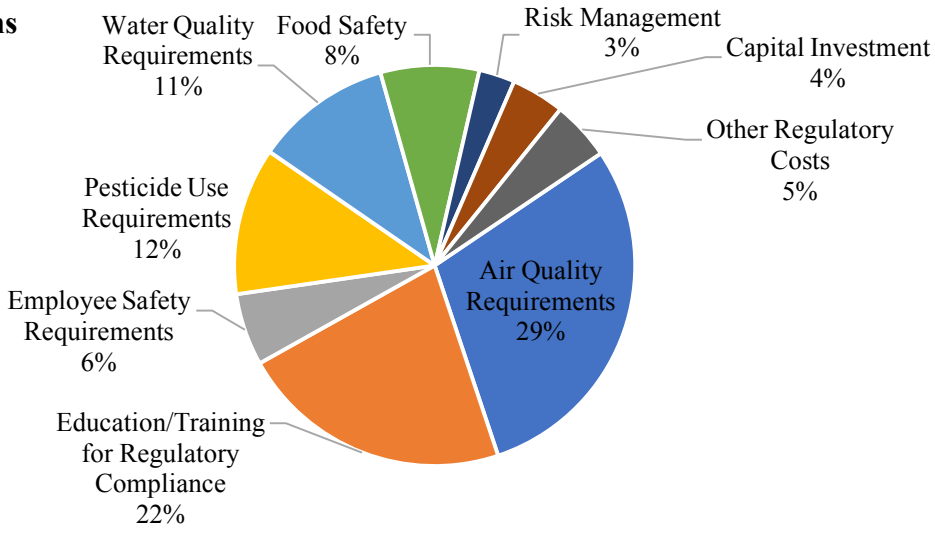
Small Farms



Medium Farms



Large Farms



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.

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

Regulatory Categories	Citrus	Cotton	Grape	Nut	Silage	Stone Fruit	Tomato
Air Quality Requirements	38.6%	0.7%	25.7%	45.4%	42.1%	18.9%	31.9%
Education/Training for Regulatory Compliance	26.3%	10.0%	18.5%	30.9%	15.6%	9.0%	9.8%
Employee Safety Requirements	3.4%	11.4%	12.0%	4.1%	6.8%	0.5%	2.6%
Pesticide Use Requirements	14.7%	3.0%	5.9%	8.5%	2.2%	70.6%	50.2%
Water Quality Requirements	8.4%	74.9%	9.6%	5.1%	31.5%	0.7%	4.1%
Food Safety	5.7%	0.0%	20.4%	0.0%	0.0%	0.2%	0.3%
Risk Management	0.0%	0.0%	0.0%	3.1%	0.0%	0.1%	0.6%
Capital Investment	2.9%	0.0%	0.0%	3.0%	0.0%	0.0%	0.0%
Other Regulatory Costs	0.0%	0.0%	7.9%	0.0%	1.8%	0.0%	0.5%
Total	100%	100%	100%	100%	100%	100%	100%

Given the magnitude of differences in production costs among the crops studied (e.g. $941 average production cost per acre for silage vs. an average of $9,036 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 1-2% of operating costs for fruit growers as opposed to 4-7% of operating costs for field crops (see Table 9.

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 subsidy program. Each grower noted that without the subsidy 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.

Regulatory Implications for Farm Equipment Manufacturers

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. 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 subsidy program, 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 subsidy 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 subsidy program allowed farm operators to plan their equipment purchases, as one feature of program is the months-long approval and processing timeline. The equipment dealers noted that the subsidy allowed farmers to replace equipment before the point of failure, and that without the subsidy, farmers would wait much longer to replace non-compliant equipment. The dealers noted that some air districts have much higher subsidies available; up to 80% in Southern California. The San Joaquin Valley dealers (and growers participating in the case studies) reported 40 – 50% subsidies.

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 2016). Banks lending to growers report higher collateral requirements because of lower commodity prices as well as softer land values (Newman 2016). 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 in 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 subsidy 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. 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 costs.

Concluding remarks

The regulatory environment faced by California farmers is quite complex. The findings from the case studies and equipment dealers are indications of the level of complexity and how varied the burden of regulation is depending on farm size, location, and commodity grown. While this study focused on farms within the San Joaquin Valley of California, the methodology can easily be applied to farms in other regions for comparison. Indeed, farms located in areas of

differing environmental or social concern can be expected to experience considerably different regulatory burdens. For example, air quality is of primary interest in the San Joaquin Valley, while water quality is of particular concern to farms located in coastal regions of California.

The regulatory environment is likely to become more complex in the future. As climate change and population growth impact farm operations, regulatory policy will try to keep the pace. While regulatory policy is typically enacted to correct negative externalities of agricultural production, it may create additional negative social externalities. The duplication of effort across regulatory agencies increases costs to producers and regulators alike. Transaction costs would decrease immensely if producers' documentation and reporting tasks were streamlined. Case study participants commonly employed third parties to reduce the documentation burden of regulation, particularly with water quality and pesticide use reporting. Future studies, using this work as a baseline, can estimate the marginal impact of additional regulations or use this as a template to compare the regulatory environment within and/or between states.

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