The Economic Impacts of Bird and Rodent Damage to California Crops: A Methodology to Select Counties for Input-Output Modeling

Stephanie A. Shwiff, **Katy N. Kirkpatrick**, **Ray T. Sterner**, and **Karen Gebhardt**
USDA APHIS Wildlife Services, National Wildlife Research Center, Fort Collins, Colorado

Abstract: California is the nation's greatest agricultural producer. In 2006, California's gross value of agriculture production was more than $38.3 billion, almost double the value of production for the second most important agriculture state, Texas. The agricultural sector is a fundamental segment of any economy because it not only contributes substantially to the general economy and employment of the region, but it is additionally linked to almost all other sectors in the economy (i.e., manufacturing, retail trade, and accommodation and food service) as a source of inputs. Damage to crops by birds and rodents can reduce total crop yield and increase pest control costs. This ultimately reduces the production output of the agricultural sector and all other linked sectors and could potentially have significant total economic impacts. One method to estimate the total impact to the California economy of a decrease in agricultural yields and increase in pest control costs as a result of bird and rodent damage is an input-output (IO) model. To capture the sub-regional effects of economic changes, IO modeling is done at the county level. For the initial phases of this project, a deductive process was used to systematically rank California counties according to gross value agricultural production, value of production of targeted crops, and concentration of targeted crops. This process was used to identify the 10 leading agricultural counties, out of California's 58, that will be processed for IO modeling to measure economic impact of bird and rodent damage on employment and revenue in each of these counties.

Key Words: agriculture, bird damage, California, economics, input-output modeling, rodent damage

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INTRODUCTION

There are many ways to examine the benefits associated with agricultural production and to measure the impact of agriculture on the economy. Traditionally, the agriculture sector was considered to include only economic production and employment associated with crops, livestock, forestry, fishing, hunting, trapping, and support activities for each of these outputs. Today, many economists take a broader approach and include food processing and marketing as part of the agriculture sector, and some even go as far as to consider restaurants as part of the this sector.

To identify the impact of the agriculture sector on California's economy, one can measure agricultural revenue generated and jobs created. The gross value of California's agricultural production of $38.3 billion in 2006 makes the state the agriculture leader for the U.S. and a top producer in the world (NASS 2007a). The gross value of production includes all farm production, whether sold or used on the farm where it was produced. In addition to generating revenue, agricultural employment in 2002 was more than 2.7 million (13.8% of total employment) in California. Rural agricultural employment (18.5%) was greater than urban agricultural employment (13%) as a percentage of total employment (ERS 2007).

California produces a large variety of crops, but the gross value of farm production is heavily concentrated in 20 top agricultural commodities. These 20 commodities accounted for more than 80% of the state's gross value of farm production in 2006. Eight of these commodities grossed over $1 billion in revenue, including milk and cream ($4.5 b), grapes ($3.7 b), nursery and greenhouse products ($3.1 b), cattle and calves ($2.9 b), almonds ($2.5 b), lettuce ($1.8 b), strawberries ($1.3 b), oranges ($1 b) and hay ($1 b) (NASS 2007a). The state ranks first in the nation for the production of dozens of crops such as avocados, grapes, and processing tomatoes and is the sole producer (>99% of the domestic production) of many of the nation's crops, such as almonds, artichokes, figs, olives, and walnuts (CDFA 2007).

In 2002, more than 27 million acres (27.6% of total land in California) were used for farmland (ERS 2007). Regionally, farmland uses vary across the eight California agriculture statistics districts that include North Coast, North Mountain, Northeast Mountain, Central Mountain, Sacramento Valley, San Joaquin Valley, Sierra Nevada, and Southern California districts. For example, the San Joaquin Valley district produces the majority of the state's production of agriculture and grows much of the state's fruit, nut, and vegetable products, whereas the North Coast district produces a lower dollar amount of agricultural products and specializes in cattle and calves, milk products, and some fruit tree products (NASS 2007a). The value of agricultural output also varies among the 58 counties in California. For example, Fresno County (in the San Joaquin Valley district) alone produces 12.5% of the state's total agricultural output. Many counties, such as Mono or Mariposa, produce less than 1% of the state's output (CDFA 2007).

Agriculture has always been negatively impacted by pests whose feeding and/or other damage can lead to a loss of agricultural output or reduction in output relative to potential output (Sexton et al. 2007). Pests in California agriculture are diverse and include vertebrates, such as coyotes, rodents, birds, and feral hogs; invertebrates, such as the glassy-winged sharpshooter, avocado thrip and the Mediterranean fruit fly; plants, fungi, and other pathogens. It has been estimated vertebrate pests alone cause $944 million in damage to U.S. agriculture annually (NASS 2002).

The agriculture sector is fundamental to regional economies because it not only contributes substantially to the general economy and employment of the region, but it is additionally linked to almost all other sectors in the economy (i.e., manufacturing, retail trade, and accommodation and food service) as a source of inputs. Given the strong linkages between the agriculture sector and the other sectors of the economy, it is important to not only estimate the direct effects of pest damage but also the multiplier (indirect and induced) effects, because damage to crops by birds and rodents reduces the output of the agriculture sector and all other linked sectors.

In general, the economic effects of a change in producer costs are usually broken down into three different categories: direct, indirect, and induced effects. The direct effect of a lower yield can be measured by the revenue lost that the grower would have earned from sale of that acre and the increase cost of pest control. For example, the direct effect of bird damage to an almond orchard would be the value of the damaged and eaten nuts and the farmer's control costs. However, the revenue of individual growers supports other industries in the economy. Growers create jobs for shop owners, restaurant staff, police, fire, etc., which must also be measured when examining the total economic effect. These additional non-direct or multiplier effects are called secondary economic impacts and are composed of indirect and induced effects. Several studies exist that use IO models to estimate the total impact (direct, indirect, and induced) of California agriculture to the state economy (Carter and Goldman 1997, Hueth et al. 1997, Sumner et al. 2004, Shwiff et al. 2006), but no study exists using this model to analyze specifically the total impact of bird and rodent damage to these crops.

This paper details the initial determination of the counties and crops that will be used in an IO model to estimate the total economic impact of a group of pests, birds and rodents, on California agriculture. The results of this study is a list of counties that will represent a segment of California's agricultural production that has a high value and concentration of crops that are susceptible to bird and rodent damage. Ultimately, in subsequent phases of this study, IO modeling will determine the loss of employment and revenue to the regional economy created by birds and rodents.

COUNTY SELECTION METHODOLGY

Input-output modeling is typically conducted at the county level. Due to funding limitations, it was determined that for this project, a maximum of 10 leading agricultural counties would be included in the model. To identify these counties, a 3-step process was taken. The following methodology was applied to the 20 counties in California that have the largest gross value of production for all agricultural outputs (Table 1). All data is from the California County Commissioners' Data 2007 detailed report of agriculture in 2006 (NASS 2007b).

Table 1. California county rank by gross value of agriculture production, 2006.

County	Value ($1,000)	Rank
Fresno	4,845,438	1
Tulare	3,872,062	2
Monterey	3,489,923	3
Kern	3,476,860	4
Merced	2,284,463	5
Stanislaus	2,148,152	6
San Joaquin	1,684,879	7
Ventura	1,505,604	8
San Diego	1,461,485	9
Imperial	1,307,615	10
Kings	1,289,186	11
Riverside	1,102,445	12
Madera	1,032,902	13
Santa Barbara	1,016,735	14
San Luis Obispo	621,558	15
Sonoma	596,942	16
Napa	477,787	17
Butte	454,203	18
San Bernardino	436,662	19
Colusa	422,675	20

Table 2. Total California gross value of production of targeted crops, 2006.

Targeted crop	Value ($1,000)
Grapes, all	3,707,097
Nursery products, all	3,095,717
Almonds	2,522,886
Lettuce, all	1,712,261
Strawberries, all	1,340,047
Hay, all	1,287,553
Tomatoes, all	1,188,597
Oranges, all	1,055,666
Cotton lint and seed	735,825
Walnuts	660,845
Rice, all	617,467
Broccoli, all	545,689
Carrots, all	535,363
Pistachio	531,250
Peaches, all	482,015
Corn	375,166
Onions	363,392
Lemons	356,040
Avocados	341,492
Celery	323,938
Melons	302,334
Pasture, forage, irrigated and range	300,688
Spinach	186,780
Artichokes	84,661
Forest products	32,921

Table 3. Top 10 California counties for each gross value of agricultural production, gross value of targeted crops, and concentration of targeted crops, 2006.

Gross value of agricultural production			Gross value of targeted crops			Concentration of targeted crops		
Rank	*County*	*($1,000)*	*Rank*	*County*	*($1,000)*	*Rank*	*County*	*(%)*
1	Fresno	4,845,438	1	Fresno	2,847,067	1	Napa	98.99
2	Tulare	3,872,062	2	Monterey	2,676,530	2	Riverside	92.09
3	Monterey	3,489,923	3	Kern	1,892,843	3	Colusa	83.09
4	Kern	3,476,860	4	Tulare	1,654,234	4	Ventura	80.66
5	Merced	2,284,463	5	Ventura	1,214,337	5	Butte	80.61
6	Stanislaus	2,148,152	6	Riverside	1,015,185	6	Sonoma	77.79
7	San Joaquin	1,684,879	7	San Joaquin	923,630	7	Monterey	76.69
8	Ventura	1,505,604	8	Stanislaus	866,706	8	Santa Barbara	71.48
9	San Diego	1,461,485	9	San Diego	831,171	9	San Luis Obispo	66.54
10	Imperial	1,307,615	10	Merced	749,988	10	Madera	64.71

First, the 10 counties that lead the state in total agricultural production were identified and ranked 1 through 10. This ranking identifies the important agricultural producing counties (see Tables 1 and 3). Second, a total of 25 crops were designated as "targeted" crops, meaning that these crops have a large value of production and recorded pest damage caused by birds and rodents (Table 2), and the 10 counties that had the highest gross values from these targeted crops were identified and ranked 1 through 10. Third, the 10 counties that have the highest percentage (or concentration) of targeted crops as compared to gross value of agriculture were identified and also ranked 1 through 10. These rankings are summarized in Table 3.

RESULTS

To identify the 10 counties to be included in the IO model, each county's rank in gross value of agricultural production, gross value of targeted crops, and concentration of targeted crops was summed to give a final number. The 10 counties that have the lowest number (Table 4), which represents an importance in the three measures cumulatively, were chosen to be included in the IO modeling.

Only two counties, Monterey and Ventura, were on all lists of the top 10 counties in terms of ranking of gross value agricultural production, highest gross value of targeted crops, and concentration of targeted crops. Many counties may have been important agricultural producers but the agricultural output is from non-targeted products. For example, Kings County did not make the final county list. While Kings County is important to the state with more than $1.3 billion in agricultural production, the county produces less then $540 million in targeted crops. In Kings County, more than $500 million in agricultural revenue is from the production of milk and cattle, which are non-targeted agricultural outputs. In contrast, Napa County produces less than half of Kings County total dollar value of agriculture production, but it was included in the final list because nearly 100% of agriculture production (more than $472 million) in that county is from targeted crops.

Table 4. County ranking and final county list.

∑ ranking	County
12	Monterey
13	Fresno
17	Ventura
20	Riverside
21	Kern
22	Tulare
27	San Joaquin
30	San Diego
32	Stanislaus
33	Napa

DISCUSSION

Identification and accurate measurement of bird and rodent damage to crops has progressed; however, pest arrival, density, and potential and real damage to crops is still an uncertain event at the farm level. Additionally, pesticide use and productivity varies across time and space (Sexton et al. 2007). To more effectively limit pest damage, increased use of Integrated Pest Management (IPM) tools in California agriculture suggest that California's pesticide use levels for most crops are low relative to the rest of the United States (Zilberman et al. 1991).

There are several important outcomes that emerge from this research on the economic impact of bird and rodent damage to California crops. A useful way to quantify the economic effects, which are likely to occur within the region as a result of change in agriculture expenditures resulting from increased costs and decreased yield due to bird and rodent damage, is through IO modeling. Many governments, agricultural associations, and others benefit from IO modeling but face limited budgets. The methodology presented in this paper is useful for the narrowing of an economic analysis, so that the regions or counties chosen for the analysis provide the most pertinent and valuable results for the stakeholder. Additionally, the results of this economic research can be used at the state level to advocate, in revenue and jobs lost terms, for additional and more effective pest control options.

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