## CHAPTER VI

## AN ECONOMIC ASSESSMENT OF CROP LOSSES DUE TO AIR POLLUTION: THE CONSUMING SECTOR

As mentioned earlier, past economic assessments of crop losses due to air pollution were obtained simply by multiplying the estimated reduction in yield by the respective prices associated with each crop. Such an approach **is** not appropriate for most vegetable and specialty crops where prices may be affected by the reduction in supplies, whether due to air pollution or other factors. Thus, variations in quantity produced due to the presence of air pollution may subsequently alter the existing price of that crop.

This chapter describes a simple procedure used in arriving at an economic assessment of crop losses due to air pollution in the study area for some selected vegetable and field crops. The procedure takes into account variations in prices due to yield depression and thus the effect on consumers' well-being. Several steps were involved in the procedure yielding the estimated results presented at the end of this chapter. It should be emphasized that this procedure is only a "first-step" approach; a more elegant and detailed analysis of both the consuming and producing sectors is planned for "Phase 2" as discussed in Chapter VII.

TWO levels of production, the annual average from 1972 to 1976 and that for 1976, were determined by region for each of the included annual vegetable and field crops. These are presented in Table 1.2 and 1.3 of Chapter 1. These levels of production should reflect the effects of air pollution (oxidant/ozone concentrations) in those regions observed during the production periods, given that the values represent actual production. In the absence of such air pollution, one might expect to observe higher production yields, at least for the more sensitive crops. This "potential" level of production can be calculated after determining the percentage of yield reduction due to air pollution for each crop in each region. Such a degree of yield reduction has been calculated and discussed in Chapter IV and is presented in Table 4.7 of that chapter. The "potential" levels of production in the absence of air pollution were then calculated as shown in Table 6.1 of this chapter.

The next step involved is to calculate the changes in production due to air pollution. Such changes, by region and by crop, are derived by

Table 6.1

Production without Air Pollution

| Crop | Unit | Southern Desert 1972-76 (Average) | Southern Desert 1976 | South Coast 1972-76 (Average) | South Coast 1976 | Central Coast 1972-76 (Average) | Central Coast 1976 | Southern San Joaquin 1972-76 (Average) | Southern San Joaquin 1976 |
|---|---|---|---|---|---|---|---|---|---|
| **Vegetable** | | | | | | | | | |
| Pro. Lima Beans | Tons | | | 28,562 | 16,310 | 6,434 | 2,547 | 7,390 | 9,840 |
| Broccoli | Cut. | | | 238,178 | 292,770 | 1,012,180 | 1,207,400 | | - |
| Cantaloupes | Cwt. | 1,199,600 | 1,128,000 | 320,823 | 461,332 | | | 728,400 | 468,000 |
| Carrots | cwt. | 1,703,400 | 2,215,000 | 3,193,959 | 2,908,021 | 1,402,620 | 1,416,800 | 3.220,000 | 3,500.000 |
| Cauliflower | Cwt. | | | 546,599 | 617,877 | 861,370 | 975,850 | | - |
| Celery | cwt. | | | 7,324,125 | 7,292,298 | 4,136,810 | 4,585,478 | | - |
| Lettuce | Cwt. | 11,124,800 | 11,720,000 | 4,503,705 | 4,951,602 | 18,349,364 | 20,535,170 | 1,151,600 | 1.490,000 |
| Onion, Fresh | Cwt. | 464,990 | 374,000 | 610,745 | 282,849 | 388,509 | 598,973 | | |
| Onion, Process | Cwt. | 553,470 | ,300,000 | 1,291,212 | 1,427,840 | 565,806 | 394,838 | 2,146,983 | 2,614,820 |
| Potato | Cwt. | | | 3,141,204 | 3,105,385 | 1,577.930 | 1,434,715 | 9,798,744 | 10.837,879 |
| Tomato, Fresh | Cwt | 388,494 | 384,000 | 4,643,332 | 5,231,337 | 1,203,516 | 875,757 | 687,939 | 411,357 |
| Tomato, Process | Tent | 24,309 | 36,000 | 262,500 | 185.963 | 258,709 | 189,810 | 170.196 | 198,830 |
| **Field Crop** | | | | | | | | | |
| Cotton | Bales | 136,277 | 154,801 | 44,171 | 60,682 | - | | 906,799 | 1,039,883 |
| Sugarbeet | Tons | 1,610,698 | 1,476,000 | 288,836 | 260,804 | 602,149 | 869,991 | 747,334 | 858,768 |

NOTE: Dash indicates no production of that crop in that region.

taking the differences between production with and without air pollution and are given in Table 6.2. These changes in production were then used to calculate changes in price. Such changes in price were obtained by using the price forecasting equations discussed and presented in Chapter V. Seasonal as well as annual quite forecasting equations were required, due to the fact that each region, because of distinct climatic conditions, produces vegetable crops for different market periods. Appropriate seasonal price forecasting equations were assigned to each region based on actual marketing patterns1/ and are given in Table 6.3.

Table 6.4 contains changes in prices due to air pollution by crop and by region for two periods of time -- the average for the period 1972 to 1976 and the 1976 periods. These are the increases in price per unit due to the reduction of production caused by the adversary effect of air pollution in that area. Table 6.4 is thus a measure of the overall price effect due to air pollution. Such price effects were then used to calculate a measure of consumers' surplus (or compensating variation).2/ Due to the absence of regional consumption data on the study crops, it is assumed that production in each year is totally consumed. Such an assumption does not appear to be unrealistic for most vegetable crops which are highly perishable and thus have to be consumed in a relatively short period of time. However, some vegetable crops are consumed in processing forms and thus have some carryover stock. Nevertheless, total consumption and total production for those crops in each year should be somewhat consistent. Total production for each crop in each region was then used to calculate the compensating variations as given in Table 6.5 (for the mean of 1972-1976) and Table 6.6 (for 1976).

Results obtained in Table 6.5 show that the most severe economic damage is associated with celery (65.6% of the total crop loss), fresh tomatoes (16.9%) and potatoes (11.4%). On a regional basis, as expected, the South Coast region suffers the heaviest crop loss among the study regions, almost 90% of total crop loss. Most of the damage in the Southern San Joaquin Valley is on cotton and potatoes, whereas celery contributes almost all crop losses in the Central Coast region. The Southern Desert (includes only Imperial County in this study) shows very minimal crop loss. The total crop loss per year during 1972 to 1976 is $14.8 million. This loss is about 1.48% of the total value of production for the included crops in the four regions and 0.82% of the value of these crops produced in the entire state.

Table 6.6 shows the total crop loss due to air pollution by crop and county in 1976. As is true in the case of Table 6.5, celery, fresh tomatoes and potatoes contribute most of the losses and are followed by cotton lint. The South Coast and the Southern San Joaquin Valley suffer the most severe crop losses. Total crop loss in 1976 is $11.1 million (0.9% of the value of production in the study regions and 0.48% on the state basis). Note that this total crop loss for 1976 is lower than the crop loss observed for the average of the past five years. This might be due partly to improvement in the air quality in the study regions, especially in the Southern Desert region.

Table 6.2

Changes in Production Due to Air Pollution

| Crop | Unit | Southern Desert 1972-76 | Southern Desert 1976 | South Coast 1972-76 | South Coast 1976 | Central Coast 1972-76 | Central Coast 1976 | Southern San Joaquin 1972-76 | Southern San Joaquin 1976 |
|---|---|---|---|---|---|---|---|---|---|
| **Vegetable** | | | | | | | | | |
| Pro. Cr. Lima Beans | 1000 Tons | | - | 5.306 | 2.223 | .088 | .042 | .626 | .840 |
| Broccoli | 1000 cwt. | | | 0 | 0 | 0 | 0 | | |
| Cantaloupes | 1000 cwt. | 0 | 0 | 0 | 0 | - | | 0 | 0 |
| Carrots | 1000 cwt. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cauliflower | 1000 cwt. | | - | 0 | 0 | 0 | 0 | | |
| Celery | 1000 cwt. | | | 1122.973 | 814.198 | 50.230 | 55.678 | | |
| Lettuce | 1000 cwt. | 0 | 0 | 11.968 | 1.472 | 0 | 0 | 0 | 0 |
| Onion, Fresh | 1000 cwt. | 4.590 | 0 | 38.883 | 5.521 | 1.549 | 2.373 | | |
| Onion, Process | 1000 Cwt. | 5.470 | 0 | 82.212 | 27.840 | 2.256 | 1.578 | 28.583 | 34.820 |
| Potato | 1000 cwt. | - | - | 317.430 | 125.185 | 6.770 | 6.115 | 187.292 | 206.979 |
| Tomato, Fresh | 1000 cwt. | 4.094 | 0 | 469.137 | 210.921 | 5.136 | 3.757 | 13.171 | 7.877 |
| Tomato, Process | 1000 Tons | .249 | 0 | 26.530 | 7.425 | 1.120 | .830 | 3.256 | 3.830 |
| **Field Crop** | | | | | | | | | |
| Cotton | 1000 Bales | 11.709 | 13.301 | 6.959 | 9.560 | | | 58.531 | 67.123 |
| Sugarbeet | 1000 Tons | 12.298 | 0 | 15.531 | 4.170 | 2.047 | 2.971 | 8.060 | 9.130 |

**NOTE:** Dash indicates no production of that crop in that region. Zero indicates no change in production (due to insignificant effect of air pollution on that crop).

Table 6.3

Seasonal Vegetable Crop Production by Region in California

| Crop | Region: Southern Desert | South Coast | Central Coast | Southern San Joaquin |
|---|---|---|---|---|
| Broccoli | -- | Early Spring | Fall | -- |
| Cantaloupes | Spring | Spring | -- | Summer |
| Carrots | Winter | Late Fall | Early Summer | Early Summer |
| Cauliflower | -- | Late Fall | Early Spring | -- |
| Celery | -- | Winter | Late Fall | -- |
| Lettuce, head | Winter | Early Spring | Summer | Early Spring |
| Onion, fresh | Late Spring | Late Spring | Late Spring | -- |
| Onion, process. | Late Summer | Late Summer | Late Summer | Late Summer |
| Potatoes | -- | Early Summer | Late Summer | Late Spring |
| Tomatoes, fresh | Early Spring | Early Fall | Early Summer | Early Summer |

NOTE: Dash indicates no production in that region.

Table 6.4

Changes in Crop Price Due to Air Pollution, 1972-76 and 1976

| Crop | Unit | Southern Desert | | South Coast | | Central Coast | | Southern San Joaquin | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1972-76 | 1976 | 1972-76 | 1976 | 1972-76 | 1976 | 1972-76 | 1976 |
| Vegetable | | | | | | | | | |
| Pr. Cr. Lima Beans | $/Ton | – | – | .8187158 | .3430089 | .0135784 | .0064806 | .0965918 | .129612 |
| Broccoli | $/Cwt. | – | – | 0 | 0 | 0 | 0 | – | |
| Cantaloupes | $/Cwt. | 0 | 0 | 0 | 0 | – | – | 0 | 0 |
| Carrots | $/Cwt. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cauliflower | $/Cwt. | – | – | 0 | 0 | 0 | 0 | – | – |
| Celery | $/Cwt. | – | – | 1.5160135 | 1.0991673 | .0813726 | .0901983 | – | – |
| Lettuce | $/Cwt. | 0 | 0 | .0151993 | .0018694 | 0 | 0 | 0 | 0 |
| Onion, Fresh | $/Cwt. | .002754 | 0 | .0233298 | .0033126 | .0009294 | .0014238 | – | – |
| Onion, Proc. | $/Cwt. | .0000547 | 0 | .0008221 | .0002784 | .0000225 | .0000157 | .0002858 | .0003482 |
| Potato | $/Cwt. | – | – | 4094847 | 1614886 | .0010155 | .0009172 | .0561876 | .0620937 |
| Tomato, Fresh | $/Cwt. | .022476 | 0 | 5958039 | .2678696 | .0054955 | .0040199 | .0140929 | .0084283 |
| Tomato, Proc. | $/Ton | .0006175 | 0 | .0657944 | 018414 | .0027776 | .0020584 | .0080748 | .0094984 |
| Field Crop | | | | | | | | | |
| Cotton | $/Lb. | .0003512 | .000099 | | .000286 | – | – | .0017559 | .0020136 |
| Sugarbeet | $/Ton | .0033204 | 0 | .0041933 | .0001125 | .0005526 | .0008021 | .0021762 | .0024651 |

NOTE: Dash indicates no production of that crop in that region.
Zero indicates no changes in price due to no effect from air pollution on that crop in that region.

Table 6.5

Consumers' Surplus at Mean (1972-1976) Consumption
Using the Mean Value (1972-1976) Level of Oxidant Concentration

| Crop | Southern Desert | South Coast | Central Coast | Southern San Joaquin Valley | Total | Percent of Total Consumer Surplus |
|---|---|---|---|---|---|---|
| | | | $ | | | |
| **Vegetable Crops** | | | | | | |
| Beans, Pro. Gr. Lima | | 19,040 | 86 | 653 | 19,779 | 0.13 |
| Broccoli | | 0 | 0 | | 0 | 0 |
| Cantaloupes | 0 | 0 | | 0 | 0 | 0 |
| Carrots | 0 | 0 | 0 | 0 | 0 | 0 |
| Cauliflower | | 0 | 0 | | 0 | 0 |
| Celery | | 9,401,030 | 332,536 | | 9,733,566 | 65.57 |
| Lettuce, Head | 0 | 68,272 | 0 | 0 | 68,272 | .46 |
| Onion, Fresh | 1,268 | 13,341 | 360 | | 14,969 | 0.10 |
| Onion, Processing | 30 | 994 | 13 | 605 | 1,642 | 0.01 |
| Potato | | 1,156,292 | 1,596 | 540,044 | 1,697,932 | 11.44 |
| Tomato, Fresh | 8,640 | 2,487,002 | 6,586 | 9,509 | 2,511,737 | 16.92 |
| Tomato, Processing | 15 | 15,526 | 715 | 1,348 | 17,604 | 0.12 |
| **Field Crops** | | | | | | |
| Cotton, Lint | 22,000 | 4,000 | | 744,500 | 770,500 | 5.19 |
| Sugarbeets | 5,307 | 1,146 | 332 | 1,609 | 8,394 | 0.06 |
| Total | 37,260 | 13,166,643 | 342,224 | 1,298,268 | 14,844,395 | |
| Percent of Total | 0.25 | 88.70 | 2.30 | 8.75 | | 100.00 |

Table 6.6

Consumers' Surplus at 1976 Consumption. Levels, Using the 1976 Level of Oxidant Concentration

| Crop | Region | | | | Total | Percent of Total |
|---|---|---|---|---|---|---|
| | Southern Desert | South Coast | Central Coast | Southern San Joaquin Valley | | |
| | | | $ | | | |
| Vegetable Crops | | | | | | |
| Beans, Pro. Gr. Lima | | 4,832 | 16 | 1,167 | 6,015 | 0.05 |
| Broccoli | | 0 | 0 | - | 0 | 0 |
| Cantaloupes | 0 | 0 | - | 0 | 0 | 0 |
| Carrots | 0 | 0 | 0 | 0 | 0 | 0 |
| Cauliflower | | 0 | 0 | | 0 | 0 |
| Celery | | 7,120,516 | 408,580 | | 7,529,096 | 68.04 |
| Lettuce, Head | 0 | 9,254 | 0 | 0 | 9,254 | 0.08 |
| Onion, Fresh | 0 | 919 | 849 | | 1,768 | 0.02 |
| Onion, Process | 0 | 390 | 6 | 898 | 1,294 | 0.01 |
| Potato | | 481,268 | 1,310 | 660,112 | 1,142,690 | 10.33 |
| Tomato, Fresh | 0 | 1,344,817 | 3,505 | 3,401 | 1,351,723 | 12.22 |
| Tomato, Process | 0 | 3,288 | 389 | 1,852 | 5,529 | 0.05 |
| Field Crops | | | | | | |
| Cotton, Lint | 28,000 | 7,500 | - | 979,500 | 1,015,000 | 9.17 |
| Sugarbeets | 0 | 289 | 695 | 2,094 | 3,078 | 0.03 |
| Total | 28,000 | 8,973,073 | 415,350 | 1,649,024 | 11,065,447 | |
| Percent of Total | 0.25 | 81.09 | 3.76 | 14.90 | | 100.00 |

As a benchmark on the magnitude Of these results, the results obtained can be compared with those obtained by Millecan (1976)3/ although the methodologies used are quite different. In the Millecan study, the total crop loss (obtained by multiplying the reduction in yield with prices (for vegetables4/ due to air pollution in the South Coast region (includes Los Angeles, Orange, Riverside, San Bernardino and Ventura Counties) has an average value of $1,400,308 per annum from 1970 to 1974. Total loss for field crops5/ in that region for the same period is $964,047 per year. For Los Angeles and Orange Counties, the Millecan study did not specify the types of vegetable and field crops included, thus it is not possible to compare results on an individual crop basis. Nevertheless, one common finding is that celery suffers the heaviest loss among included vegetable crops in Ventura County. It should be noted that the Millecan study did not include some counties selected for this study, e.g., Kern, Tulare, Imperial and the Central Coast. The magnitude of the difference in total damages realized under the two approaches suggests that damages (in terms of "costs" to consumers) may be underestimated in earlier research.

It should also be noted that the results of this study, as presented in this section, do not include effects of air pollution on producers (growers). Such effects may be reflected in higher cost of production and/or lower revenue, depending upon the price elasticity for each crop. These effects will be addressed in the second phase of the analysis via the mathematical model presented earlier. In addition, this study includes only selected types of vegetable and field crops; thus, the value of crop losses derived above represents only a portion of total crop losses in these regions. One would expect to have a much higher value of crop losses if other types of agricultural crops, such as citrus and horticultural crops, were also included in the analysis.

## FOOTNOTES : CHAPTER VI

1/ For details see Johnston and Dean (1969).

2/ The concept of compensating variation (or price compensating) popularized by R. Hicks, is the amount of money the consumer of a commodity would have to gain (lose) in order to offset the loss (gain) in utility due to the rise (fall) in price of that commodity (caused by, say, reduction in quantity supplied due to yield depression in the presence of air pollution) in order to be as well off as before. It differs from "equivalent variation" (or price equivalent) in that the level of utility, after being compensated, in the case of compensating variation is unchanged whereas in the case of equivalent variation, it is the amount of money paid to (or received from) the consumer in order to make him as well off as before after the changes in utility level caused by the rise (or fall) in price of that commodity.

3/ Details of that study had already been discussed in Chapter II of this analysis.

4/,5/ The mix of vegetable and field crops included in the Millecan study do not coincide with those in this study. Also, Millecan includes more crops in the analysis.

# CHAPTER VII

## IMPLEMENTATION OF THE COMPLETE MODEL: AN ASSESSMENT

The preceding six chapters have dealt with numerous conceptual and empirical issues relevant to the assessment of air pollution damages to crops. As is evident, the analysis to date has not integrated and empiricized the complete set of components. Specifically, the eccnomic costs at the producer's level have not been measured. Included under this general area of producer's impacts are such issues as changes in cropping mix and location in response to air pollution, substitution effects on the input side and other mitigative strategies. Also, impacts of air pollution on non-included crops (e.g., perennials and horticultural crops) are not addressed. This concluding chapter will deal with these areas, with an emphasis on detailing the approaches to be used in their assessment in the second phase of the agricultural impact study.

### 7.1 Production Adjustments

Agricultural producers are capable of modifying their production decisions and/or plans in the face of change. California agriculture has demonstrated a high degree of resilency in dealing with such adjustments as energy shortages, labor disruptions or natural phenomena such as drought. Typical response patterns have been reflected in adjustments in cropping patterns and input use to minimize the effects of the "shock" to the agricultural system. Similar mitigative procedures would be expected in the presence of air quality degradation. While increasing levels of oxidants may not be viewed as a "shock," the response pattern should be similar, if somewhat more gradual. As an indication of such adjustments, it appears that producers of vegetable crops are planting crop varieties with greater resistance to certain air pollutants.

The range of mitigative procedures open to producers within southern California includes the following set of responses:

1. in situ adjustments in cropping mix, substituting more resistant crops into current cropping systems;

2. in situ increase in input use rates to offset adverse effects of air pollution (reflected in an increase in firm's cost structure); and

3. locational adjustments in production whereby production is shifted from areas of high oxidant levels to areas of relatively low levels (timing of such adjustments will obviously be determined by land market considerations).

In addition to such mitigative procedures, which entail either increased costs or reduced returns for total produce sold, producers also face the possibility of revenue losses due to quality degradation, even in the absence of yield reductions. As a result of quality degradation, prices received for selected commodities may be discounted. A further decision-affecting phenomenon associated with air pollution is the effect on producer risk-bearing. If ambient air quality experiences a continuous or abrupt degradation over time, crop yield variation (a major source of farm risk) may be increased. Thus, the inherent riskiness of crop production decisions may be exacerbated.

It should be noted that the potential exists for net increases in the revenue of producers in the face of yield reductions, given the price elasticity of demand for some agricultural crops. Such an outcome would be dependent upon the price elasticity of each crop in the crop mix and the magnitude of changes in the firm's cost structure due to mitigation.. Given the price endogenous nature of the proposed mathematical model, this potential outcome would be tested directly within the analysis.

The mathematical model formulated in Chapter III of this report is intended to deal with the production decision variables outlined above. The data for such an analysis has been obtained and risk measures have been calculated. The overall integration effort will be discussed below.

## 7.2 Consumer Impacts

Chapter VI of this report presented a somewhat simplistic assessment of consumer effects of air pollution. The economic cost of air pollution (compensating variation) was captured via the use of price forecasting equations for each included crop. However, given that production adjustments in the form of cropping mix changes or relocation will also affect quantities supplied, an integration of producer and consumer sectors is desired and needed to capture future economic effects of air pollution. This can be accomplished through the price endogenous model outlined in Chapter III.

Indirect impacts on a third group, input suppliers, could also be substantial, if the derived demand for inputs were altered as a result of such mitagative procedures as changes in cropping mix or input use. Major crop adjustments could also portend significant disruptions to agricultural land markets as well as the demand for irrigation water, given a differential in production coefficients across crops. While input suppliers are not included within the scope of this analysis, the resource usage and shadow price values generated by the model should suggest potential input supply disruptions.

## 7.3 The Integrated Model

As discussed in Chapter III, the complete model will assess a wide range of possible outcomes associated with actual and projected levels of air pollution, with emphasis on approximating current damages (under actual air quality parameters) as well as potential damages under a range of possible air quality changes.

The model output will feature the surplus maximizing (producer's and consumer's) levels of commodity production (for the included crops) in the face of alternative levels of oxidant concentration. The programming algorithm employed will optimize, based on the relationship between commodity prices, yield sensitivity and resource availabilities. Additional output from the model should be regional production, equilibrium prices, resource usage and resource shadow prices as well as the relevant surpluses.

While most data necessary for the construction of the model has been collected, additional programming assistance is needed to develop subroutines for existing software. This programming is needed to:

1. allow for multiple regions in the analysis (test of locational adjustments in production between the South Coast and the three contiguous regions);

2. introduce risk directly into the objective function; and

3. include cost vectors directly in the objective function.

While current economic damages can be approximated in the absence of the programming effort, the full general equilibrium flavor of the analysis will be lacking without such an effort.

## 7.4 Related Research Needs

The yield-oxidant relationships used in this analysis have been outlined in Chapter IV. The correlation analysis and production function estimation serve to establish a possible negative relationship between oxidants and selected crops, over the last 20 years. The significance and signs attached to oxidants suggest a range of sensitivities across crops. However, to further test the relationship and to establish consistency with results obtained under controlled conditions, a more complete production function is required. A more complete specification of the production function would serve to further define the nature and magnitude of the oxidant-yield interface under actual production conditions.

The included crops in this study have been limited to annual vegetables and field crops. Some measure of damages experienced by perennials such as fruits and nuts, as well as horticultural crops, is needed to complete the analysis. While their complex time horizons make assessment more difficult (in a dynamic sense), damages can be approximated via more pedestrian approaches such as survey techniques. These results would be needed for a complete agricultural assessment.

7.5 Concluding Comment

The primary purpose of the agricultural assessment component of the EPA Benefits project is to address some conceptual and empirical limitations of earlier studies concerning agricultural damages. The first specific objective of the agricultural study is to define a methodology capable of dealing with some of the weaknesses inherent in previous research. Thus, this study should not be viewed as a definitive empirical assessment of agricultural damages within southern California, but rather an initial inquiry into crop damage assessment methodologies.

The analytical framework, conceptual issues and preliminary results reported in this report offer support to the use of more complete models in the measurement of air pollution damages/benefits. While this report and results obtained in the next phase of the project will not resolve all relevant issues in assessment methodologies, it is hoped that the study output will be suggestive of more fertile areas for investigation.

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;. ABSTRACT

This volume of a five volume study of the economic benefits of air pollution control investigates the economic benefits that would accrue from reductions in oxidant/ozone air pollution-induced damages to 14 annual vegetable and field crops in southern California. Southern California production of many of these crops constitutes the bulk of national production.

Using the analytical perspective of economics, the study provides an up-to-date review of the literature on the physical and economic damages to agricultural crops from air pollution. In addition, methodologies are developed permitting estimation of the impact of air pollution-induced price effects, input and output substitution effects, and risk effects upon producer and consumer losses. Estimates of the extent to which price effects contribute to consumer losses are provided. These consumer losses are estimated to have amounted to $14.8 million per year from 1972 to 1976. This loss is about 1.48% of the total value of production for the included crops in the area and 0.82% of the value of these crops produced in the State of California. Celery, fresh tomatoes, and potatoes are the sources of most of these losses.

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