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AGRICULTURAL WATER USE AND COSTS IN CALIFORNIA

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It is estimated that 85 percent of the water put to use in California is used for producing the more than 240 crops grown in the state. Water for growing these crops is derived from precipitation stored in reservoirs and moved for later use, or "surface" water, and from water pumped from subterranean aquifers, or "groundwater." In fact, dryland crops normally receive moisture in varying amounts of rain or snow.

Much argument concerning water is centered around two major areas--total use and efficiency of use. Critics charge that agriculture is allocated far too much water and that particular crops use water much more "inefficiently" than others. On the other hand, supporters of the agricultural water use status quo argue that users cannot afford to pay higher costs, that secondary benefits spin off to nonagricultural users and that agricultural water use in total is relatively efficient.

Information is available on this subject in some areas, but lacking in regards to other points of controversy. In order to provide information in regards to two questions, "By what methods are farmers irrigating in California, and how much does it cost?" a survey of 13 major regions was conducted in 1975 with the cooperation of 38 farm advisors in 21 counties, specialists at the University of California and with experts knowledgeable about irrigation practices at the local level. Thirteen producing regions were represented in the study, and three major crop categories were selected for study. These were field crops, fruits and nuts, and vegetables.

The study had three major objectives: (1) to determine the predominant crops in each region, (2) to ascertain the water source (groundwater or surface water) and the irrigation methods used for each crop in each region, and (3) to estimate regional irrigation costs by water source and application method for each crop. The reason that 1975 was used as a base year was that drought year cropping pattern adjustments were avoided.

County Agricultural Commissioner crop reports were evaluated and crops within the three major categories were ordered as a descending share of state production until 90 percent of the acreage in the category was aggregated. Then each region was examined to determine relative importance The most important crop regions were identified and counties within were selected for the conduct of personal interviews. Several counties within each region were visited if acreage warranted.

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University of California and the United States Department of Agriculture cooperating.

As a result of these interviews, weighted regional estimates of sources of agricultural water supplies and irrigation methods were obtained.

Representative regional budgets were developed for the crops concerned and evaluated by means of the Cooperative Extension Budget Generator (CEBG). CEBG is a computerized algorithm capable of quickly assessing changes in water application and electrical power rates, pump sizes and costs, water prices and lift and a myriad of other factors complicating modern irrigation practice. For study purposes, several different methods were analyzed. These were border flooding (flooding of fields between small "dikes,"), flooding without dikes, furrow irrigation, and a weighted average of all sprinkler methods.

The systems employed vary from the traditional hand-move systems to the sophisticated drip irrigation systems which apply water directly to the plants. Other popular systems are hose-drag sprinklers, circular sprinklers, wheel line sprinklers, and other variations on sprinkler systems, all designed to apply less water than traditional furrow or other types of flood irrigation, but surface systems can be as "efficient" as sprinkler systems if they are designed correctly.

SURVEY AND STUDY RESULTS

Water Application Rates. The application of water to California crops is extremely variable from region-to-region, even in comparing the same crops. Within field crop categories, for example, water use varied from about three acre-feet for alfalfa grown on the Central Coast to about 4.5 acre-feet for many of the other regions, and an extreme of eight acre-feet in one particular region. Application of water to cereals also ranged widely. Water application to wheat, for example, varied from less than one acre-foot to more than two acre-feet. Since wheat is a winter crop and the number of applications fluctuates with rainfall, this is expected. Irrigated pasture water use varied from less than 1.5 acre-feet to more than five acre-feet, depending on the region. While rice production requires the highest application of water, water use ranged between seven and eight acre-feet between regions for the five regions surveyed. Similar variation existed within the fruit, nut and crop categories. Water use in the production of oranges, for example, ranged from about 2.5 acre-feet to about six acre-feet in the hotter climatic regions of the state. Water use in grape production varied from 1.3 acre-feet to about 3.7 acre-feet depending on the region. Water used in the production of processing tomatoes varied from about three acre-feet to more than six acre-feet depending on the region in which they are grown. Since these sorts of differences prevailed within crops, one would expect similar variation between crops, as well as indicating differences between regions for the different crops surveyed.

Aggregate Water Use by Crop Category. Although no attempt was made to aggregate acreage evaluated for the three major categories, representative acreages for each of the crops studied was specified. From reviewing these data, the general conclusion is that the majority of water used in California agriculture in the aggregate is used in the production of field crops, followed by the fruit and nut crops and vegetable crops. Within the field crop categories, the highest water using acreages were represented by the forage and cereal crops.

Aggregate Surface Water Use by Irrigation Method. The aggregation of the regional crop irrigation estimates indicates that about 4.74 million acres are irrigated by surface water. Of this total, about 4.2 percent was irrigated by flooding and most of this was in the Mountain region. Nearly 43 percent was border flooded, and about 35 percent was

furrow irrigated. About 15 percent of total irrigated acreage was by sprinkler and less than one percent was drip irrigated.

Aggregate Groundwater Use by Irrigation Method. According to this study, estimated aggregate groundwater use in irrigated crops amounted to about 3.1 million acres. Of this total, about 10 percent was flood irrigated, 29 percent was border flooded, 31 percent was furrow irrigated, 29 percent sprinkler irrigated, while about 1.1 percent of total acreage was drip irrigated.

Changes in Application Methods. Since this survey was the first systematic attempt to measure water use by application method, solid comparative data is lacking comparing changes in application methods over time. However, a survey by Stewert in 1972, evaluating different methods of applying water, indicated much less use of drip, sprinkler and other systems. At that time flood, border and furrow irrigation accounted for 82 percent of total irrigation methods; sprinkler 17 percent; and drip irrigation was used on only .3 percent of all acreage.

Cost of Applying Irrigation Water. The cost of applying irrigation water to California crops relates to several key variables. These are the "price" or unit rate, and this can be represented by the irrigation district charge to farmers for delivering water from surface storage systems to the farm. The second factor is the choice of technology and management which contribute to the cost of applying delivered water to crops. Generally, when the price of water is relatively low, farmers substitute water for labor or capital. These conditional factors are all interrelated when evaluating the cost of applying groundwater. The "price" of electricity must be determined from the appropriate electrical rate table and related to the total kilowattage used. Typically, the rate declines as the amount of electricity used increases. The amount of electricity used is determined by the pump size and the distance it must be lifted. And this is impacted by the amount of water to be delivered to the crops concerned. Once the water is lifted to the surface, it still must be applied to the crop by the most appropriate method.

Selecting the appropriate irrigation system is conditioned by the type of crop grown and the accompanying technology, labor and energy requirements. These factors affect the resulting capital and operating costs. For example, sprinkler systems cannot be easily used for growing tomatoes in the late stages of production due to the type of mold which can result. By the same token, the choice is more limited if corn is to be sprinkler irrigated because of its heighth at maturity. In general terms, it is safe to say that traditional adaptation of water saving systems has moved at a more rapid rate in California's more intensive crops or in regions in which water availability may be a problem. But beyond that, information is lacking.

Using CEBG and the information generated in the survey, a crop-by-crop evaluation of water costs (at the point of application) was coupled with water application rates (in acre feet) and with application costs (costs associated with the application of water) to obtain total regional irrigation costs by application method. While the results are too extensive and variable to summarize here, some highlights are worth noting. If we think of total water cost at the point of application, we can intuitively see that its cost will be much higher for groundwater than for surface water. The results as calculated by CEBG, for the most part, indicated this fact. The cost of water varied from less than $2 per acre-foot to more than $70 for groundwater, depending on the region and method considered. Another fact is worth noting. The cost of water, as compared to application costs, is much higher proportionately when surface irrigation from groundwater sources is used than when surface irrigation from

surface water sources is utilized since the cost of "delivering" water from underground storage to the point of application has traditionally been higher. In addition, irrigation costs are higher for many of the groundwater irrigated field crops than for most of the fruit and nuts and vegetable crops.

While the information developed in this survey may not be absolutely exact, the relative differences are worth noting. More importantly, the capability of quickly evaluating the impact of physical and economic relationships by computer will be useful in periodic future studies.

EMERGING ISSUES

Several issues emanating from the current economic situation impact the relationships measured in this study. Some of these seem to be:

How will the rising cost of energy affect system selection and operation in the future including the choice between surface and sprinkler systems in cases where system design can result in equally efficient systems and energy use becomes the main determinant?

How will the rising cost of energy affect profitability and resulting crop combinations planned in the future?

How do conjunctive use of both ground and surface water systems within the same farming operation alter study results?

This newsletter is taken from a forthcoming Information Series, Agricultural Water Use and Costs in California, by A. Highstreet, C. Nuckton, and G. Horner.

We hope this newsletter will be useful to you and invite your comments and suggestions. The address is Cooperative Extension, University of California, Davis 95616.

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