ADJUSTMENTS IN CROPPING PATTERNS AS A MEANS OF SAVING WATER

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"Water - There is no Substitute" is the theme of this year's Water Conference. True, we cannot substitute crude oil, blow sand or any other substance to meet the physical requirements of crops for water. However, water is not a particularly unique resource, and economic substitution is possible. Certain substitutions can be made for water when it becomes scarce or costly. The same management techniques that are used in allocating other scarce resources can be used to allocate water. When labor costs increased drastically following World War II, cotton farmers substituted capital in the form of mechanical cotton pickers for the increasingly costly labor resource. In water management, capital has been substituted for water by investment in concrete lined irrigation ditches, underground pipes and sprinkler systems. Labor has been substituted for water by hiring more and better irrigators. In effect, land is substituted for water when irrigable land is dried up so that scarce water can be utilized on the remaining acres. An additional strategy used by farmers when water is limited or costly is through adjustments in the crops they produce, and the amount of water they apply to these crops.

The irrigated crop farmer is faced with the problem of how to utilize his entire bundle of resources, which includes water, in a cropping pattern which will maximize his farm's net return. Basically the economic planner is faced with much the same problem in his attempt to plot the development of an area or basin. However, it is possible for an area planner's optimum solution to differ from the cropping pattern which would result from aggregating the individual producer's best alternatives. This is possible because the areas resources are not evenly distributed between farm units, and the time period for optimization may be somewhat shorter than that used for the area approach.

Determining the most profitable cropping pattern can become quite difficult when there are many different crops under consideration, with a variety of water management practices, coupled with different levels of production and price. This complexity is increased when limits are placed on the resources available and restrictions such as governmental acreage controls, must be considered. Because of this complexity, techniques such as linear programming prove most useful in studying the many different alternatives. The use of linear programming in the Water Resources Research Institute study of the Roswell-Artesia Basin is an excellent example of how this tool can be used in the determination of the effects of different cropping patterns.

This same linear programming technique has merit as a management tool for individual farm units.

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Certainly, linear programming techniques of resource allocation is not without its weaknesses. When input-output coefficients are inaccurate, optimum solutions may be grossly in error. Poorly defined restrictions and imprecise levels of available resources may establish unrealistic perimeters. In addition, the program itself may not be constructed to adequately test all of the feasible alternatives. Usually the linear manipulation of the program does not consider the effects of economies or dis-economies of scale. Often the indivisibility of inputs or outputs can also contribute to unrealistic solutions. Other valid criticisms can be made of some linear programming techniques.

In my estimation, the linear programming techniques used in the study of Irrigation Water Requirements for Crop Production, Roswell-Artesian Basin[1], illustrates the effective use of economic models in determining the probable results of different cropping pattern strategies.

In this study, three different linear programming models were used with seven varying quantities of irrigation water, to determine optimum cropping patterns for 12 case study farms. Basically, Model A assumed no increase in irrigation efficiency, and a cropping program typical to that actually being followed on the case study farms in 1967. Model B did not contain provisions for a crop rotation program but did assume a 5% increase in irrigation efficiency. Model C provided for a crop rotation program which would include a minimum of one-third of each farm in producing alfalfa. In the three models, restrictions on irrigation water per acre were tested at levels of 2.50, 2.75, 3.00, 3.25, 3.50, 3.75, 4.00 acre-feet per acre. An average of 3.27 acre-feet of water per water-right acre was actually diverted on the 12 case study farms in 1967.

Of the 21 linear program solutions calculated, only one, Model C with a 2.50 acre feet restriction, produced a lower net return than the actual average of the 12 case study farms. The average net return per acre would have decreased 6.4% or $5.86 per acre at the 2.50 acre-feet level under Model C. A major contribution to the higher net returns shown in the model solutions was caused by the increase in planted cotton acreage from 80% to 95% of the cotton allotment. 1967 cotton returns were apparently higher than most area cotton farmers expected. Generally speaking, alfalfa acreages were reduced and grain sorghum and castor bean acreage increased as the available water was reduced. Fallow acreage did not increase significantly except in Model C when water was reduced below the 3.50 acre-feet level.

Linear programming models can be used by farm managers to determine the most profitable cropping patterns for their farm. I suggest that basin models be refined and updated to assist in the determination of optimum development of an area. I further suggest that linear programming techniques be investigated as a management tool for individual farm units.

Refinements need include: models which determine the effect on cropping patterns of commodity price, varying yields, cost of water. At what price per ton would alfalfa replacd grain sorghum in the cropping pattern? At what level of production would grain sorghum drop out of the program? What would be the value of the addition of one acre foot of irrigation water to the farm?

Valid solutions will be possible only if farmers can accurately determine present input-output information for their farms, and if they can delineate the effective perimeters of their production resources.

It will also be necessary for them to be open minded in their consideration of potentially feasible alternatives. To be an effective management tool, the model must be able to simulate future conditions, situations, and their probable effect upon income.

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1 Irrigation Water Requirements for Crop production, Roswell-Artesian Basin, November 1969, New Mexico State University, Robert R. Lansford, Carl E. Barnes, Bobby J. Creel, Eldon G. Hanson, Harold E. Dregne, Evan Carroon, H. R. Stucky