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RESEARCH TECHNICAL COMPLETION REPORT

PROJECT A-017-IDA

Economic Value of Water in Different Uses Within Agriculture

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Abstract

Studies of the economic value of irrigation water in alternative uses within agriculture in Idaho were conducted using two different approaches of economic analysis. The first approach was to estimate the economic value of water through cost function analysis. The value of water in this approach is a proportion of the cost of producing a dollar value of output. This approach does not yield the value of an incremental acre foot of water, but yields a weighted average of all the increments of water over the whole range of production.

The other approach of economic analysis was the application of linear programming in estimating the value of an incremental unit of water. Three irrigation areas along the Snake River were included in the study. Costs of producing different crops were computed and representative farms of the three areas were constructed. These farm operations were assumed to be typical of the areas, and under given resource allocation restrictions, the economic return to the input of water would indicate the value of an incremental unit of water in the production of agricultural products.

Objectives and Purpose

Agriculture has always been the largest consumer of water in Idaho and will continue to exert strong demand for available water supplies. However, other uses, such as industrial uses and recreational uses, are increasing rapidly which may come in direct competition with agriculture.

The state of Idaho has in general a well-developed, workable set of laws regulating the use and ownership of surface as well as ground water. In spite of this, there exist some outmoded regulations and old-fashioned interpretations of laws which may hamper progress in water development and allocation within the state. It is without question that the laws must give security to existing water rights but at the same time must not be so rigid that they prevent transfer of water rights from one use to another where economic reasons might demand a transfer.

There are some basic economic considerations in optimizing the use of water in Idaho of which the allocation problem plays a major part. This is this problem this project has been geared toward solving under the premise that if economic development is to be maximized with scarce water supplies, water should be allocated according to the equal marginal return to an increment of water in different uses and among users. When water supplies move toward more economic uses, some water users and localities will suffer wealth losses while others will experience gains.

The objectives of the study were concentrated around the determination of the value productivities of irrigation water (1) among crops in a given area, (2) among crops between areas; and (3) between areas for different size farm enterprises.

Procedure

The first phase of the study was conducted and completed on Project A-002-IDA in a newly established irrigation project in which water was lifted around 600 feet from the Snake River to the fields on the overlying plateaus. The main purpose of this phase of the study was to find the maximum that farms of various sizes could pay for irrigation water if, at the same time, all other factors of production were adequately rewarded. This, to some degree, would indicate the maximum value of water if irrigation is its highest use. The value of water was estimated through cost function analysis. The relationship between the value of output and the cost of producing the output was assumed to follow the curvilinear regression equation $Y' = \frac{1}{a + bX}$, where X is the number of acres for which Y is being estimated. The variable Y is the cost to produce a dollar value of output. The result of this type of analysis is a weighted average marginal value of water. This information then became a part of the second phase of the study.

The second phase of the study was conducted in three areas along the Snake River Valley in South Central Idaho and Southwest Idaho. Costs and returns of producing different crops in those areas were the basis for the economic analysis. The method of analysis in this phase was linear programming. The result of this type of analysis yields the value of an incremental unit of water.

Results and Conclusion

Model farms developed from the input-output data, in the first phase of the study, indicated size economies in the farm operations. In a long-run situation the model farm average total cost curve indicated that small size economies can be attained by increasing size up to 2400 acres. After this size is reached, size increases bring size diseconomies rather than economies. Consequently, 2400 acres was taken to be the most efficient farm size in the study area. However, it should be pointed out that there was only a three percent difference between costs on the most efficient farm size and costs on the least efficient one. The conclusion of this study is that in a long-run situation larger farms do have a slight cost advantage. This means that large farms have more capability to pay for water because economies of size exist within the individual enterprise and because management is able to combine the enterprises in such a way that these size economies are utilized.

The second phase of the study, in which the economic value of water was estimated by means of linear programming; was based on input-output data from three distinct areas along the Snake River. The data were analyzed in three linear programming models. The first model analyzed a representative farm from each of the three areas under a fixed water supply situation. The marginal value of water in this program is $14.82 per acre-foot. This value is common to the three areas because the assumption was that irrigation water could be transferred between the areas according to the most economically beneficial use.

The second model analyzes the same representative farms but with a variable water supply situation. That means, that each farm can use as much water as the crop enterprise requires for the optimum solution. Water is still considered a scarce resource, but the difference between this model and the first model is that all optimum plans can be determined as the supply of water varies from zero to an amount sufficient to satisfy the requirements for the crop enterprises in the optimum solution. Each step in the continuous solution reveals the opportunity cost of water in alternative uses among the crop enterprises.

The results of analysis of the second model are shown in table 1.

The value of an additional acre-foot of water is not fixed for the three areas. The values depend upon the degree of water scarcity and upon the crop enterprises of the areas. When the water supply is scarce, the marginal value product is high, because then only the high valued crops will be produced. As the supply of water increases the marginal value product decreases because less profitable crops are grown. When enough water is available the value of an additional acre-foot is zero under the given situation.

The third model is also one with a variable water supply situation. It deals with Area I alone and ~~is comparing~~ compares the results from the cost function analysis with the results from linear programming. The results of this model show that the average marginal value products estimated by linear programming are approximately

Table 1.

MARGINAL VALUE PRODUCT OF DIFFERENT QUANTITIES OF WATER IN EACH AREA

Area	Quantity of Water Available (Acre Feet)	Marginal Value Product (Dollars Per Acre Foot)
I	0 - 624.6	50.10
(Dry Lake)	624.6 - 760.2	32.89
	760.2 -1028.6	25.81
	1028.6 and Over	0
II	0 - 109.6	48.26
(Minidoka)	109.6 - 511.0	43.22
	511.0 - 622.2	37.6
	622.2 - 735.0	27.24
	735.0 - 834.6	14.82
	834.6 - and Over	0
III	0 - 109.6	48.26
(Twin Falls)	109.6 - 511.0	46.11
	511.0 - 622.0	37.6
	622.2 - 735.0	27.24
	735.0 - 834.6	2.89
	834.6 and Over	0

Table 2.

MARGINAL VALUE PRODUCT OF DIFFERENT QUANTITIES OF WATER AND AVERAGE MARGINAL VALUE PER ACRE-FOOT OF WATER ON DIFFERENT SIZED FARMS IN AREA I

	Quantity of Water Used	Marginal Value Product Per Acre-Foot in Dollars	Average Marginal Value Product Per Acre-Foot in Dollars	Average[a] Marginal Value Product of Water Per Acre-Foot in Dollars
Farm I	0 - 347.0	35.15		
	347 - 692.6	14.89		
	692.6 - 828.2	7.08		
	828.2 - 981.4	6.82		
	981.4 and over	0	19.71	16.64
Farm II	0 - 694.0	35.46		
	694.0 - 1385.2	15.8		
	1385.2 - 1656.4	7.62		
	1656.4 - 1962.8	6.82		
	1962.8 and over		20.22	17.03
Farm III	0 - 1388.0	35.86		
	1388.0 - 2770.4	19.3		
	2770.4 - 3312.8	7.46		
	3312.8 - 3925.6	6.82		
	3925.6 and over		21.57	18.48

[a]Determined by Coffing. Progress Report No. 112, University of Idaho Agricultural Experimental Station (Moscow, Idaho, 1966), pp. 22-24.

equal to the average marginal products estimated by cost functions analysis. See table 2.

The project investigator believes that the major objective has been accomplished. However, the second part of the objectives which were to estimate the impact of water transfers on the distribution of wealth and income between individual water users and between the affected areas has not been investigated at all.

The principal investigator has been on sabbatic leave for one year in Norway which has caused the activity on the project to be nill in 1968.

List of Publications

1. Coffing, Arthur Lee. The Relationship of Farm Size to Ability to Pay for Irrigation Water in the Dry Lake Area of Canyon County, Idaho. Master's Thesis. The University of Idaho, 1965.

2. Coffing, A. L. and Karl Lindeborg, Relationship Between Farm Size and Ability to Pay for Irrigation Water. Progress Report No. 112, Agricultural Experiment Station. University of Idaho, 1966.

3. Maher, Matthew Joseph. The Economic Value of Water in Different Uses Within Agriculture. Master's Thesis. The University of Idaho, 1967.