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The results of the forecasting effort of the National Water Commission show both how (a) the economic demands for water in irrigated agriculture can be estimated and (b) how water use will be affected by policy decisions and the life styles of U.S. citizens. The importance of varying certain alternative policies and variations in the population growth rate are illustrated for nine alternative futures. Additional evaluations of this type are clearly needed; however, the importance of estimating the economic demands for water and evaluating the sensitivity of policy and life style variations on the use of water and land in agricultural production is established.

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FORECASTING WATER USE IN U. S. IRRIGATED AGRICULTURE WITH DIFFERENT ALTERNATIVE FUTURES*

by

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Background

Previous national forecasts of water use by Wollman (1960), the U. S. Senate Select Committee (1960), Piper of the U. S. Geological Survey (1965), the Water Resources Council (1968), and Wollman and Bonem (1971) project severe shortages in certain regions of the United States. These studies assumed water use will be determined by requirements of users for water and economic-demographic trends.

This assumption implies the following: (1) neither life style decisions of citizens nor policy decisions of the Government will affect significantly either economic and demographic trends or water use; (2) water use is independent of the prices of water, the prices of substitute factors for water, the prices of food and fiber products, and the prices of substitutes for natural food and fiber products; (3) water use is independent of the economics of water and land use in irrigated agriculture, as well as the economics of land use where irrigation is not needed; (4) water use is independent of rates, types, and locations of investments in technological development; (5) water use in irrigated agriculture is independent of the value of water in industry, commercial and residential uses; and (6) water use in irrigated agriculture is independent of desired improvements in water quality.

*Paper prepared for AAAS meetings, San Francisco, February 28, 1974.

The use of requirements for forecasting water use does not provide policy-makers with insights as to how policies may be changed to identify problems before they occur or to alleviate existing problems. Furthermore, with no indication as to what is important and how different variables may directly and indirectly affect water use, policy-makers do not have information for appropriately modifying policy. With an economic evaluation of the important alternatives, policy-makers can design a future of adequate supplies of food and fiber at relatively low prices to consumers and with fair returns to producers. The forecasting effort of the National Water Commission showed how this information can be developed for policy-makers.

The National Water Commission Forecast

The important premises of the National Water Commission forecasting effort for water use in irrigated agriculture were as follows: (1) water use will be determined by the economic demands for water, by policy decisions of the Government, and by the life styles of U. S. citizens; (2) water use will depend on the price of water, the prices of substitute factors for water, the prices of food and fiber products, and the prices of substitutes for natural food and fiber products; (3) water use will depend on the economics of water and land use in irrigated agriculture, as well as the economics of land use where irrigation is not needed; (4) water use will depend on the rate of technological development, the type of technological development, and the location of technology development; (5) water will be transferred from agriculture to higher valued uses in industry, residential, and commercial sectors; (6) water use will be affected by environmental restrictions on the use of purchases inputs and land

in agricultural production.

With a limited amount of time and money, the National Water Commission could not evaluate how water use could be affected by all policy decisions and life styles. The evaluation was limited to an examination of three different rates of population growth (high, medium and low), two different levels of exports (high and low), two different rates of technological development (high and low), two different farm policies (free market and continuation of farm programs), four different prices of water (present prices, $15, $22.50, and $30 per acre foot), and two different types of environmental restrictions (insecticides and land use limitations).

High, medium, and low population growth rates were used as defined by the U. S. Bureau of the Census. Low and high levels of farm exports were evaluated; exports of the nation represented approximately one acre of cropland in five for the low export option and one acre of cropland in three for the high export option. For the low technology option, increases in yields and improvements in feeding efficiency followed the trends of the last fifty years; for the high technology option, both improved feeding efficiences of large animals and increased productivity of the farmlands in the Southeast were assumed. It was assumed that the high level of exports would result in favorable farm prices and stimulate larger investments in agricultural technological developments. Investments in improving the efficiencies of large animal production

and crop yields in the Southeast were regarded by leading technologists as most promising. The water use evaluations made were limited to the alternative futures in Table 1.

Because of the many substitute relationships between the use of water and land in agricultural production, a national mathematical economic structure (model) was used to estimate the economic demands for water and, in turn, to evaluate the effects of different policy decisions and life styles on the use of water in year 2000. Serious evaluations of the strengths and limitations of both the Heady model of Iowa State University and the model of the U. S. Department of Agriculture were made. Within the time and resource limitations of the Commission, it was possible to extend the Heady model to make the evaluations most desired by the National Water Commission. The Heady model had been previously used for farm policy evaluations by the National Advisory Commission on Food and Fiber in 1967.

Highlights of the Heady Study

1. Nationally adequate supplies of land and water resources are presently developed (or being developed) to produce projected demands for food and fiber in 2000; however, additional water resource development may be needed for industrial, residential, and commercial uses in the abundantly endowed water basins of east Texas. Water supplies will continue to be scarce but adequate in the Lower Colorado, Great Basin, and Rio Grande River basins.

2. Water consumption in the seventeen Western states was 97, 86, 72, and 61 million acre feet per year with prices at present low levels, $15, $22.50, and $30 an acre foot. Irrigated agriculture consumed

annually 68, 57, 43, and 32 million acre feet at these respective prices. Two points are noteworthy: (1) the consumption of water in irrigated agriculture dominates the total consumption of water in the 17 Western states; considerable conservation of water in irrigated agriculture will occur with higher water prices.

3. With water prices at present low levels, $15, $22.50, and $30 an acre foot, total irrigated acreage in 17 Western states was 27, 23, 17, and 12 million acre feet; and the total acreage of land farmed where irrigation was not needed was 1,227, 1,232, 1,238, and 1,242 millions of acres. With higher water prices, less food and fiber will be produced on irrigated land; more food and fiber will be produced on lands where irrigation is not needed. The "~~bid~~ value prices" of land in central Iowa ~~are~~ is $150 per acre higher at a water price of $30 per acre than at present water prices.

4. With a free market for agricultural products 64 million acre feet of water are consumed in irrigated agriculture, and 26 million acres are irrigated and 1,192 million acres of land are farmed where irrigation is not needed; with a continuation of government price supports 69 million acre feet are consumed in irrigated agriculture, 29 million acres are irrigated, and 1,197 million acres of land are farmed where irrigation is not needed. With the government program, more water is consumed in irrigated agriculture, more land is irrigated in irrigated agriculture, and more land is farmed where irrigation is not needed to produce the same projected demands for food and fiber. The government program increases the total cost of producing the nation's projected demand for food and fiber by $1.9 billion per year.

5. The nation may increase food and fiber production to satisfy increased demands for food and fiber in a number of alternative ways, e.g., the nation may invest in restoring the productivity of the depleted lands in the Southeast; the nation may invest in improved livestock feeding efficiencies; the nation may invest in increasing crop yields or the nation may invest in increasing water supplies for irrigated agriculture. The results of the analysis show that high levels of domestic and export demands for food and fiber can be produced from presently developed land and water supplies with investments in improved livestock feeding efficiencies and restoration of the productivity of the depleted farmlands in the Southeast.

6. With increases in water prices from present low prices to $15 an acre foot, water consumption in irrigated agriculture decreases 11 million acre feet; with increases in water prices from $15 an acre foot to $22.50 an acre foot, water consumption in irrigated agriculture decreases an additional 14 million acre feet; and with increases in water prices from $22.50 to $30 an acre foot, water consumption in irrigated agriculture decreases another 11 million acre feet. Enormous quantities of water presently used in low-valued irrigated hay, pasture, and feed grain production ~~will~~ could clearly be available at relatively low transfer prices for industrial, residential, and commercial uses in the 17 Western states.

7. Environmental restrictions on the use of insecticides in crop production and in the farming of lands subject to considerable water and air erosion resulted in slight increases in water consumption and irrigated acreage; restrictions on the use of insecticides resulted

in slight increases in the acreage of lands farmed where irrigation was not needed; restrictions on the farming use of land subject to considerable erosion results in a great decrease (541 million acres) in the use of lands for wild hay and pasture where irrigation is

Summary

The results of the forecasting effort of the National Water Commission show both how (a) the economic demands for water in irrigated agriculture can be estimated and (b) how water use will be affected by policy decisions and the life styles of U. S. citizens. The importance of varying certain alternative policies and variations in the population growth rate are illustrated for nine alternative futures. Additional evaluations of this type are clearly needed; however, the importance of estimating the economic demands for water and evaluating the sensitivity of policy and life style variations on the use of water and land in agricultural production is established.

Table 1 Alternative Futures Evaluated by Heady

Alternative Future	Factors					
	Population	Farm Policy	Exports	Technology	Water Price	Environmental Restrictions
1.	Medium	Free market	Low	Low	Low	None
2.	Medium	Free market	Low	Low	$15.00	None
3.	Medium	Free market	Low	Low	$22.50	None
4.	Medium	Free market	Low	Low	$30.00	None
5.	Low	Free market	Low	Low	Low	None
6.	Low	Government price	Low	Low	Low	None
7.	High	Free market	High	High	Low	None
8.	Low	Free market	Low	Low	Low	Limited use of insecticides
9.	Low	Free market	Low	Low	Low	Fragile lands removed