PROCEEDINGS OF THE SYMPOSIUM ON WATER POLICIES ON U.S. IRRIGATED AGRICULTURE: ARE INCREASED ACREAGES NEEDED TO MEET DOMESTIC OR WORLD NEEDS?

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FORECASTING WATER USE IN US IRRIGATED AGRICULTURE

WITH DIFFERENT ALTERNATIVE FUTURES

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Background

Previous national forecasts of water use by Piper of the U. S. Geological Survey (1965) and the Water Resources Council (1968) project severe shortages in certain regions of the United States. Studies by Wollman (1960, the U.S. Senate Select Committee) and Wollman and Bonem (1971), which take into account the economics of supply and certain water quality factors, suggest the possibility of severe water shortages in certain regions of the United States. All of these studies suffer from the assumption that water use will be determined by requirements of users for water and economic-demographic trends.

In general, 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 will be 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 will be 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 will be independent of rates, types, and locations of investments in technological development; (5) water use in irrigated agriculture will be independent of the value of water in industry, commerical and residential uses; and (6) water use in irrigated agriculture will be independent

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of desired improvements in water quality.

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 purchased 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), two levels of fertilizer use (55 lbs./acre and 110 lbs./acre), and increased substitution of vegetable protein for animal protein.

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 efficiencies 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. See Table 1 for seven of the alternative futures evaluated and discussed below.

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.

Selected Highlights of the Heady Model

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 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 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: 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 would occur with higher water prices.

3. With water prices at present 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 indicated value of land in central Iowa 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, the following results were obtained: 64 million acre feet of water consumed in irrigated agriculture, 26 million acres of irrigated land farmed and 1,192 million acres of land farmed where irrigation is not needed. With a continuation of government price supports, the following results were obtained: 69 million acre feet of water consumed in irrigated agriculture, 29 million acres of irrigated land farmed, and 1,197 million acres of land 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: 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 prices to an average of $15 an acre foot, the model shows water consumption in irrigated agriculture decreasing 11 million acre feet; with increases in water prices from an average of $15 an acre foot to $22.50 an acre foot, the model shows water consumption in irrigated agriculture decreasing an additional 14 million acre feet; and with increases in water prices from an average of $22.50 to $30 an acre foot, the model shows water consumption in irrigated agriculture decreasing another 11 million acre feet. Enormous quantities of water presently used in low-valued irrigated hay, pasture, and feed grain production could clearly be available at relatively low transfer prices for industrial, residential, and commercial uses in the 17 Western states.

Summary

The results of the forecasting effort of the National Water Commission show both (a) how 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.