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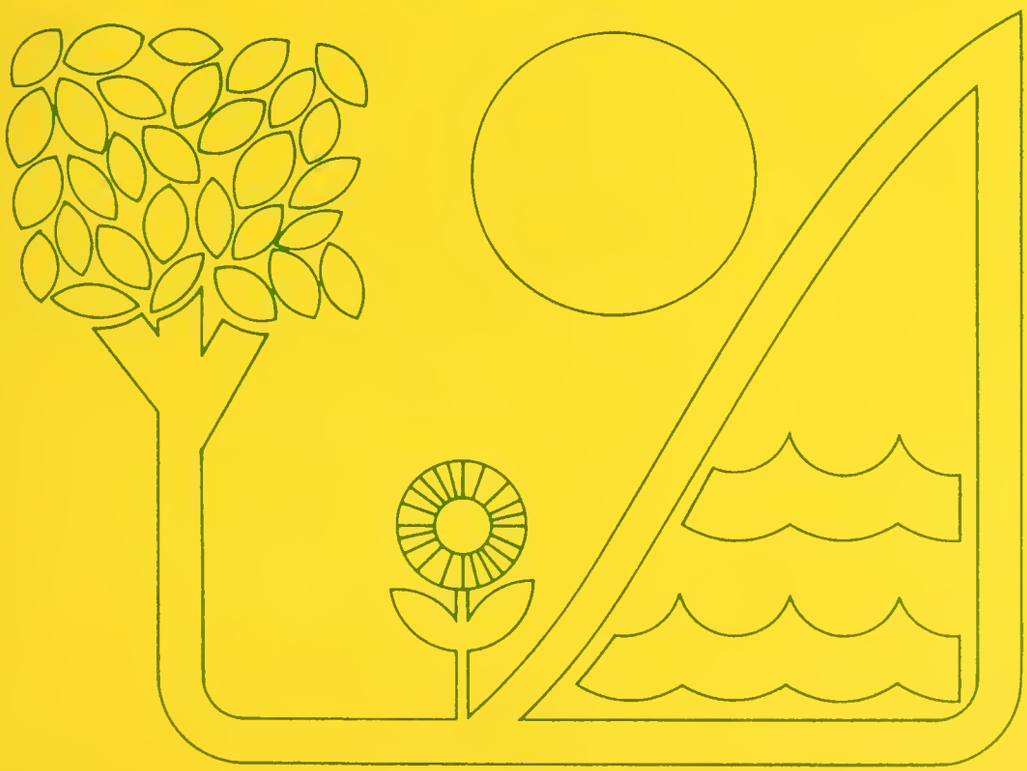

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ANTICIPATED EFFECTS OF THE BUREAU OF RECLAMATION PROGRAM ON AGRICULTURAL PRODUCTION AND PRICES

by
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SETTING AND PURPOSE

This report covers the second phase of an investigation into the anticipated effects of Federal water resource development on U. S. production and prices of major crops. The first phase dealt with the impacts of flood control, drainage and irrigation under the Small Watershed Program of the U. S. Department of Agriculture. 1 / A third phase is planned covering the agricultural impacts of the program of the Corps of Engineers, U. S. Army.

The purpose of the overall investigation is to provide some of the facts needed to resolve a major issue in planning and evaluating Federal water resource projects. The issue concerns the appropriate level of prices to be used in determining the benefits of agricultural production increases from Federal water projects.

There is general agreement that under future conditions of a market economy unrestrained by government production controls, the appropriate prices for valuing agricultural benefits are prices expected to prevail over the life of the project. Further, any single project is unlikely to significantly affect U. S. farm prices. However, it is possible that all projects combined will have significant effect on some crops. If this is found to be true, then some farm prices would be higher without Federal water projects. In this case the "current normalized prices" used in project evaluation would be too low for some commodities. This is so because current normalized prices are based on historical prices and thus have built into them the price lowering effects of Federal water projects. 2 / Under the Principles and Standards of the Water Resources Council, the appropriate price for project evaluation is midway between the price that would exist without continued Federal

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1/ Gertel, Karl and Morris L. Weinberger. Anticipated Effects of Small Watershed Projects on Agricultural Production and Prices. Preliminary draft of progress paper.

2/ U. S. Water Resources Council, Agricultural Price Standards, Guideline No. 2, October 1974. Normalized prices are not projections in the strict sense of the word since they do not go beyond observed data. They are, however, considered to be representative of the future price relationship.

projects and the lower "current normalized price" which assumes continuation of Federal projects. 3 /

The objective of this research is to determine whether the issue posed is a significant one: do all projects combined significantly affect U. S. production and farm prices? If the answer is yes, then a secondary objective is to indicate some of the conceptual questions that need to be answered to derive appropriate prices for evaluating the benefits of increased agricultural production from Federal water projects. A third objective is to propose some interim price adjustments for project evaluation under future conditions of a market economy unrestrained by government production controls.

OVERVIEW OF PROCEDURES

The question addressed concerns projects that will be built in the future, not the effect of existing Federal water projects. The question asked is, will agricultural production and prices be significantly different with or without continued construction of Federal water projects.

What is needed to answer this question is a future time rate of contribution of Federal projects to national output of various crops. A calculation can then be made of the total contribution of Federal projects over a span of years covering two points of time. The first point of time is the present. Conceptually the present is contemporary with the evaluation of new projects. At this time we ask: Will all future projects combined significantly affect agricultural production and prices? The second point of time is the future and conceptually at the mid-point of the useful life of projects being evaluated at the present time, taken here as 50 years from the first year of project operations. The question is: Will agricultural production and prices be significantly different at the future point in time if Federal water projects were terminated now?

The general approach was to estimate net anticipated output for 36 Bureau of Reclamation Projects for which the first crop report was issued in the 10 year period 1963 though 1972. 4 / Net output is project production minus output that would have occurred on project lands without the project. The net increase per 100,000

3/ Water Resources Council, Water and Related Land Resources, Establishment III, September 10, 1973, P. 39. Using diagrammatic illustration the council demonstrates that multiplying increased production from a project by a price midway between with and without project prices approximates the value of the increased production to consumers.

4/ Names of individual projects are given in Appendix 2.

irrigable acres for service was calculated for 36 projects and employed as a sample of the net future contribution of the Reclamation Program per 100,000 irrigable acres. 5/ The sample was then expanded to projected acres developed under the Reclamation Program for a 50 year period from 1970 to 2020, with all yields projected to 2020.

The final step was to compare the contribution of the Reclamation Program to national production. National output of various crops in the year 2020 was taken from the projections jointly developed by the Bureau of Economic Analysis, Department of Commerece and the Economic Research Service (commonly known as OBERS). The level E' Population series was used, which differs from the original level E projection by incorporating a higher level of farm exports and revised estimates of future per capita consumption of farm products. The revised series E projections are currently used in water resource planning. 6 /

Based on a detailed examination of the projects, net contribution per 100,000 acres was calculated for 3 types of projects: projects providing a full irrigation water supply, projects providing a supplemental supply, and projects constructed or improved through loan administered by the Bureau of Reclamation under the Small Reclamation Project Act of 1956. The 36 projects with first crops reports from 1963 through 1972 are distributed as follows:

	NUMBERS	IRRIGABLE ACRES FOR SERVICE
Projects with full water supply	11	234,380
Projects with supplemental supply	10	256,864
Projects developed under the Small Reclamation Projects	17	438,113
TOTAL (excluding overlap)	36	929,357

Following practice in Reclamation statistics, two projects are counted under both the full and supplemental water supply since both categories of supply are important parts of the project. Excluded, because data were unavailable, is the Nevada Irrigation District, developed under the Small Reclamation Project Act with 24,156 irrigable acres for service in 1974.

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5 / Irrigated acreage for service is the area for which water is available and generally exceeds the irrigated area of harvested crops and pasture. The latter was 83.4 percent of the irrigable acreage for service by the Reclamation Program in 1974.

6 / Water Resources Council, 1972 OBERS Projection, Series E' Supplement, May 1975.

To project future irrigation development from 1970 through 2020 historical data were analyzed as were projections furnished by the Bureau of Reclamation for the 1972 OBERS projections and for the 1975 National Water Assessment. After examining all available evidence the most likely future increases of irrigated acres for service were taken as the acreage under projects authorized and funded as of December 1971. For acreage developed under the Small Reclamation Project Act additions were calculated at two-thirds of the historical rate from 1964 to 1974. The need and opportunities for rehabilitation and expansion of works in existing irrigation districts makes continuation of operations under the Small Reclamation Project Act or an equivalent program likely. However, some sizable projects which came under the program in recent years may not be representative of the future.

An alternative future was developed based on historical growth from 1964 through 1974. Irrigable acres for service added for the 50 year period from 1970 through 2020 are summarized as follows:

IRRIGABLE ACRES FOR SERVICE
Acres Added 1970 through 2020

	Most Likely Future	Rate 64 thru 74
Projects with a full water supply	1,375,000	1,223,000
Projects with a supplemental supply	1,739,000	6,257,000
TOTAL (full and supplemental)	3,114,000	7,480,000
Developed under the Small Project Reclamation Act	1,682,000	2,523,000

The geographic distribution of future irrigable acres was also based on two alternative futures. The first is the actual geographic distribution of the sample with first crops reports from 1963 through 1972, at full maturity. For projects constructed by the Bureau, this distribution is heavily weighted toward the Great Plains and Mountain States, with limited representation from the Pacific Northwest and none from Arizona and California (Appendix 2). The alternative distribution assumes that one third of the irrigated acreage of Bureau projects would be distributed as were projects developed under the Small Reclamations Act and would have output per acre similar to them.

Thus output and price effects were calculated for four alternative futures of expansion of irrigable acres under the Reclamation Program: two different acreage levels each having two alternative geographic distributions. The most likely future for the year 2020 was judged to be 3.1 million acres added by Reclamation Project Act. For the most likely future, the geographic distribution of two thirds of the 3.1 million acres added by Bureau

projects was taken to be the same as the actual distribution of Bureau projects with first crop report from 1963 through 1972. The remaining one third was taken to have a geographic distribution and production effects similar to projects developed under the Small Project Reclamation Act from 1963 through 1972.

Calculations of net increases in agricultural production requires estimates of future land use and yields with and without the project in each of the 36 projects examined. Details of calculations and procedures are given in Appendix 1. Estimates were based on information given in the Definite Plan Reports and in the Loan Application Reports for projects built under the Small Reclamation Projects Act. This information was supplemented by the 1973 Crop Report giving actual production and yields. For those projects considered insufficiently matured in 1973 the data were further supplemented by 1973 yield data reported for nearby projects. Future yields were obtained by using OBERS yield projections.

While the projections of land use may be incorrect for individual projects, the author believes that a reasonable degree of confidence can be placed in the combined results for all projects. Consistent with OBERS, yields are projected to increase at a decreasing rate. Projections of yields without irrigation are more open to question than irrigated yields because yield growth rates were computed by state averages, neglecting intrastate variation in subhumid regions. Future expansion of Reclamation acres may well differ from that assumed, both in amount and geographic distribution. However, the results are presented in a way that permits alternative assumptions, and a broad range of alternative futures is displayed for sensitivity analysis.

Five of the projects developed under the Small Reclamation Project Act provided no estimates of increased agricultural production. These projects consisted of improvements of existing works, such as canals, drains, or spillways, or provision of water to reduce groundwater overdraft. For these projects 80 percent of the projected output was included as the net contribution of the project. While the short term effect of these projects would be mainly reduced operating costs, most of them would fall into disuse without improvement. A similar rule was adopted for a Bureau of Reclamation Project which would become inoperable without improvement through Bureau constructed works.

The analysis of price impacts is planned after completion of estimates of agricultural production impacts of the Corps of Engineers. The estimated price impacts given in this report are preliminary.

FINDINGS

Estimated production per 100,000 acres developed in the future under the Reclamation Program is given in Table 1 for the year 2020.

Table 1. Estimated Net Production per 100,000 acres Developed in the Future under the Reclamation Program, Yields Projected to 2020. 1/

Commodity	Unit	Type of Irrigation: Full Water Supply	Supplemental Water Supply	Developed Under Small Reclamation Project Act
		1000	1000	1000
Feed Grains	Bu.	4020.8	259.1	169.1
Wheat	Bu.	-559.3	1.8	97.3
Roughages Incl. Pasture	Tons Hay Equiv.	137.5	136.1	189.4
Rice	Cwt.	0.0	0.0	31.3
Soybeans	Bu.	6.6	0.0	0.0
Potatoes	Cwt.	20.8	18.2	428.2
Cotton	Bales	2.6	0.0	7.9
Sugarbeets	Tons	12.0	3.1	25.1
Drybeans	Cwt.	0.0	0.0	7.4
Vegetables	Cwt.	171.4	46.3	633.1
Citrus Fruits	Cwt.	34.0	0.0	472.7
Non Citrus Fruits and Nuts	Tons	19.1	4.6	51.1
Hay Seeds	Cwt.	4.7	0.05	3.3

1/ For yield projection procedures see Appendix 1.

These figures are the net of production that would occur without the Reclamation Program, including lands inundated by major reservoirs constructed for irrigation.

The irrigated crops produced vary with type of project and reflect geographic variation. The major contribution of feed grains comes from full water supply projects concentrated in the Great Plains; most vegetables and fruits come from some full water supply projects in the Lower Rio Grande and the Pacific Northwest. While wheat is produced on most full supply projects, net production is negative due to shifts from wheat to more intensive crops and displacement from reservoirs. Most supplemental water supply projects are in the Mountain States, where the main production is roughages and feed crops. The more intensive crops such as vegetables, fruits, potatoes, sugarbeets, and cotton are produced on all types of projects but, per 100,000 acres, significantly more of these crops are projected for Small Reclamation Projects Act projects. This is to be expected since these projects are located mainly in California, Arizona and the Lower Rio Grande Valley in Texas, where high value crops are characteristic of irrigated agriculture. Production of roughages, mainly alfalfa hay and irrigated pasture, is important on all types of projects.

Before proceeding with the results of aggregate production and price effects it is necessary to address an important question: for benefit evaluation should price adjustment for the aggregate effect of Federal projects be limited to Federally constructed projects or should the projects developed through loans under the Small Project Reclamation Act also be included? The author's judgment is that only Federally-constructed projects should be considered, since Federal water resource planning is concerned with projection and price effects of Federally-built projects. Construction of projects under the loan program is based on decisions independent of Federal water resources planning and would be the same with or without Federally-built projects. Since this conclusion may be challenged, results are also given for the total Reclamation Program including projects developed under loan.

In Table 2, the combined net effect of Bureau-constructed projects from 1970 through 2020 is given as a percent of U. S. total production for the year 2020. U. S. production is based on series E population growth and a high level of exports, as developed by the OBERS projection system and currently recommended for planning by the Water Resources Council. Both the most likely and low alternative futures project the addition of 3,114,000 million acres from 1970 through 2020. While the low

Table 2 Annual Production Projected to 2020, U. S. Total and Contribution of New Development from Projects Constructed by Bureau of Reclamation, 1970 through 2020

Commodity	Units	U. S. Total 1/ 1000	Alternative Futures 2/ Most Likely 3/ Percent	Low 4/ Percent	High 5/ Percent
Feed Grains	Bu. corn equiv.	12,722,000	0.3	0.5	0.4
Wheat	Bushels	2,211,620	-0.2	-0.3	-0.1
Roughages	Ton hay equiv.	818,907	0.6	0.5	1.4
Rice	Cwt.	170,698	0.2	0.0	0.4
Soybeans	Bushels	3,232,685	0.0	0.0	0.0
Potatoes	Cwt.	471,047	1.0	0.1	2.4
Cotton	Bales	11,558	1.0	0.3	2.0
Sugarbeets	Tons	48,777	0.8	0.4	1.8
Dry beans and peas	Cwt.	23,073	0.3	0.0	0.7
Vegetables	Cwt.	748,508	1.1	0.4	2.6
Citrus fruits	Cwt.	366,565	1.4	0.1	3.8
Noncitrus fruits	Cwt.	253,345	6.0	2.7	12.8

1/ OBERS series E. population projections, revised to incorporate a higher level of exports.
2/ Based on production per 100,000 irrigable acres for service given in Table 1.
3/ Irrigable acres for service: 1,375,000 full water supply, 1,739,000 supplemental. Geographic distribution of projects in sample adjusted by taking one-third of all acres to have the same production effects as projects developed under the Small Reclamation Project Act.
4/ Acres same as most likely, geographic distribution same as projects in sample.
5/ Irrigable acres for service 1,223,000 full water supply 6,257,000 supplemental Geographic distribution of projects in sample adjusted by taking one-third of all acres to have the same production effects as projects developed under the Small Reclamation Project Act.

level takes the distribution of Bureau-constructed projects to be the same as Bureau-constructed projects with first crop reports from 1963 through 1972, the most likely future adjusts this base sample by taking one-third of the acreage to have the same production effects as lands developed under the Small Reclamation Project Act. The high alternative takes acreage at 7,480,000 and represents the rate of expansion from 1964 through 1974. The geographic distribution is adjusted by taking one-third of all acres to have production effects similar to that of lands developed under the Small Reclamation Project Act.

To limit the number of comparisons, the results of the fourth alternative future, 7,480,000 irrigable acres for service and geographic distributions as in the sample, is not presented. The results of this alternative fall within the range of the three alternative futures displayed.

For the most likely alternative future, production effects are less than one percent for feed crop, wheat, rice, dry beans and peas. Except for roughages this conclusion holds for all alternative futures. For potatoes, cotton, sugarbeets, vegetables, and citrus fruits, production effects are about 1 percent for the most likely future and range from about 2 percent for sugar beets, potatoes, and cotton to 4 percent for citrus fruits for the high alternative future. For non-citrus fruits, production effects are 6 percent for the most likely future and close to 13 percent for the high alternative.

The results for the total Reclamation Program, including projects developed under loan, are displayed in Table 3. Again, for the most likely future, production effects are less than one percent for feed crops, except for roughages, and for wheat, rice and dry beans and peas. These findings generally hold for alternative futures. Production contributed by the total Reclamation Program is projected from about 2 to 3 percent for potatoes, cotton, sugarbeets, vegetables, and citrus fruits, and close to 13 percent for noncitrus fruits and nuts. For these more intensive crops significant production effects are registered for all alternative futures but the amount varies significantly.

We conclude that whether only Bureau-constructed projects or the total Reclamation Program is considered and over a very broad range of assumptions about the future, production effects are likely to be small for grains and soybeans. For most of the more intensive crops, production effects will be more significant, the outcome depending on whether only Bureau-constructed projects or the total program is considered, and what assumptions are made about the future.

Table 3 Contribution in the year 2020 of new development under the total Reclamation Program 1970 through 2020 1/

Commodity	Alternative futures 2/		
	Most Likely	Low	High
	percent	percent	percent
Feed Grains	0.3	0.5	0.4
Wheat	-0.1	-0.2	-0.2
Roughages, inc. pasture	1.0	0.9	1.8
Rice	0.5	0.3	0.9
Soybeans	0.0	0.0	0.0
Potatoes	2.5	1.6	4.7
Cotton	2.2	1.5	3.8
Sugarbeets	1.7	1.3	3.2
Dry beans and peas	0.8	0.5	1.5
Vegetables	2.5	1.8	4.7
Citrus fruits	3.5	2.2	6.9
Noncitrus fruits and nuts	12.8	9.5	23.0

1/ Based on total U. S. production projected to 2020 by OBERS, series E, revised population projections, shown in Table 2 and production per 1000,000 irrigable acres for service given in Table 1.

2/ Irrigable acres for service of Bureau-constructed projects as given in footnotes to Table 2. Irrigable acres for service for projects developed under Small Reclamation Project Act 1,682,000 for most likely and low levels and 2,523,000 for high level.

Before proceeding with the discussion of price impact, several facts should be noted. The first is that the contribution of the Reclamation Program shown in Tables 2 and 3 is not directly comparable to the production statistics reported for all Bureau projects. The estimates in Tables 2 and 3 are production, net of "without project" output from future projects; the Reclamation statistics report gross output from all projects and production increases between any two periods include increased yields from older projects as well as the contribution of new projects.

The second fact to note is that the contribution of the Reclamation Program consists not only in raising crop production but in preventing decline from existing levels. The latter type of contribution is especially important for intensive crop production. For the most likely alternative future, the estimated share of the total Reclamation contribution from projects where the primary effect is prevention of decline in production is nearly 20 percent for vegetables and from 30 to 40 percent for potatoes, cotton and sugarbeets. This share is almost 90 percent for citrus fruits and over 60 percent for other fruits and nuts. Calculations were not made for feed grains and roughages but estimates are that the share of reclamation production consisting of prevention of declines in output is about 1 percent for feed grains and well below 10 percent for roughages.

The third fact is that estimates for vegetables, fruits and to some extent potatoes, are based on aggregation by weight of a variety of products. The contribution of the Reclamation Program to a particular product may vary considerably from that shown for the aggregate. Production of roughages is aggregated, primarily from pasture, hay and silage. These products are mostly locally consumed and the contribution of the Reclamation Program in a given locality will be significantly greater than the national contribution.

PRICE IMPACTS.

The price response to additional agricultural production from public projects is extremely complex since it involves not only the added projects output but supply responses of other producers. In this preliminary analysis only the price effect of additional project output is estimated. This results in an overestimate of price impacts since supply response by non-project producers lessen price impacts.

Price effects of increased production are measured by elasticity of demand. Elasticity is the percentage changes in quantity demanded associated with a percentage change in price. Elasticities of demand for most farm products are estimated below 1.0 indicating

that a 1 percent reduction in price will result in an increase of less than 1 percent of the quantity demanded.

The effect of increased production on price is estimated as the inverse of the elasticity of demand. For example, if the elasticity of demand at -0.36 for feed grains, a 1 percent increase in the supply of feed grain would result in a decline in the price feed by 1 ÷ 0.36 or approximately 2.75 percent.

Most studies determine short term elasticities. In general, demand for a commodity is more elastic in the long run because consumers have greater opportunity to alter habits. Likewise, all studies were made when farm prices were considerably below present levels and exports more stable and smaller. If farm prices and exports remain substantially higher the elasticities of demand for farm products are likely to rise. Higher elasticities mean a smaller price change in response to increased production.

Working in the opposite direction is that water resource development increases the supply of several crops. Elasticity is defined in terms of change of quantity of only one crop with the amounts of other crops remaining the same. Price response to increased production is likely to be greater if it occurs for several products.

Table 4 summarizes estimates of demand elasticities for several specialty crops that are important on Reclamation Projects. The data from George and King were calculated for the farm price level (except sugar) while those from Dean and King apply to the retail level. The wide range in demand elasticities for vegetables reflects the difference in elasticities for different types of vegetables.

For estimating price effects, the elasticity estimates of George and King were applied to the production effects given in Tables 5 and 6. For vegetables the midpoint of the range was used, and for sugar an elasticity of -0.20 was employed, since the estimate of -0.24 is for the retail level. For feed grains, wheat and cotton, preliminary estimates prepared for national agricultural policy simulation were employed. 7/ These are -0.36 for feed grains, -0.42 for wheat and -0.44 for cotton.

For rice an elasticity estimate of -0.15 was used. 8/ Price

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7 / User's Manual for National Agricultural Policy Simulator (Polysim), Research Report p. 727, Ag. Exp. Sta. Oklahoma State University, November 1975, p. 30, pp. 46-52. Estimates are given as price flexibilities which are the inverse of price elasticities.

8 / Grant, Warren R. and D. S. Moore. Alternative Government Rice Programs, An Economic Evaluation. Ag. Econ. Rep. 187, ERS, USDA. June 1970, p. 22.

Table 4. Estimated Demand Elasticities for Selected Commodities

Commodity	George and King 1/	Dean and King 2/
Potatoes	-.15	-.31
Dry Beans	-.23	-.48
Vegetables	-.09 to -.45	-.14 to -1.0
Oranges	-.46	-.66
Other fruits	-.68 (apples)	-.23 to -.10
Tree Nuts	NA	-1.3
Sugar	-.24 3/	NA

1/ P. S. George and G. A. King. Consumer Demand for Food Commodities in the United States with Projections to 1980. Giannini Foundation Monograph 26, Cal. Agric. Exp. Sta. March 1971, Tables 5 and 11, calculated at the farm level except for sugar.

2/ G. W. Dean and G. A. King. Projection of California Agriculture 1980--2000. Giannini Foundation Research Report 312, September 1970, Tables 24 and 25. This report cites demand elasticities from other research studies, which are calculated for the retail level. The retail level of demand elasticity is generally higher than when calculated at the farm level.

3/ Calculated for the retail level.

Table 5 Price Impacts in 2020 of New Development from Projects Constructed by the Bureau of Reclamation 1970 through 2020

Commodity	Alternative Futures 1/		
	Most Likely	Low	High
	Percent	Percent	Percent
Feed grains	0.8	1.4	1.1
Wheat	-0.5	-0.7	-0.3
Rice	1.3	0.0	2.7
Soybeans	0.0	0.0	0.0
Potatoes	6.7	0.7	16.0
Cotton	2.3	0.7	4.6
Sugar	1.4	0.7	3.2
Dry beans and peas	1.3	0.0	3.0
Vegetables	4.1	1.5	9.6
Citrus fruits	3.0	0.2	8.3
Noncitrus fruits	8.6	3.8	18.3

1/ Based on production impacts given in Table 2 and price elasticities discussed on pages 11 and 12.

Table 6 Price Impacts in 2020 of New Development, Total Reclamation Program 1970 through 2020.

Commodity	Alternative futures 1/		
	Most Likely	Low	High
	Percent	Percent	Percent
Feed grains	0.8	1.4	1.1
Wheat	-0.2	-0.5	-0.5
Rice	3.3	2.0	6.0
Soybeans	0.0	0.0	0.0
Potatoes	16.7	10.7	31.3
Cotton	5.0	3.4	8.6
Sugar	3.0	2.3	5.8
Dry beans and peas	3.5	2.2	6.5
Vegetables	9.3	6.7	17.4
Citrus fruits	7.6	4.8	15.0
Noncitrus fruit	18.3	13.6	32.8

1/ Based on production impacts given in table 3 and price elasticities given on pages 11 and 12.

effects of additional roughage production were not evaluated since elasticities of price response to additional production of hay and pasture are not available. The effects are likely to be limited nationally.

The results for Bureau-constructed projects are given in Table 5. For the most likely future, the price effects for Bureau-constructed projects added from 1970 through 2020 are approximately 2 percent or less for all crops except potatoes, vegetables, and fruits. Keeping in mind that the recommended price adjustment is half of the price effect of public projects, the appropriate price adjustment for all crops except potatoes, vegetables and fruits would be about one percent or less. Given the uncertainties of future estimates that characterize all planning, it is questionable that the added effort of such refinement in evaluation procedures is warranted.

For citrus fruits and vegetables, price impacts under the most likely future range from 3 to 4 percent and much larger for the high alternatives. For these two commodities an upward adjustment of prices by 2 percent would be appropriate. For potatoes, and noncitrus fruit for which price effects of the most likely future range from 6.7 to 8.6 percent, an upward adjustment by 4 percent is indicated.

The position of this paper, is that only Bureau-constructed projects should be considered in evaluating price impacts of Federal water resource projects. If this conclusion is disputed, then the price impacts to consider are those given in Table 6, which gives the effects of the total Reclamation Program, including lands irrigated under the Small Reclamation Project Act.

For the total program, price impacts for feed grains, wheat and soybeans are too small to be considered. For rice, cotton, sugar, and dry beans and peas, price effects are from 3 to 5 percent at the most likely level. For these crops the appropriate upward adjustment of normalized prices to the midpoint between prices with and without the Reclamation Program is 2 percent. For vegetables and citrus fruits an adjustment of 4 percent should be made and for potatoes and noncitrus fruit and nuts, adjusted normalized prices should be raised by 9 percent.

SUMMARY AND CONCLUSIONS

The objective of the overall research effort is to determine if agricultural production added by future Federal water resource development is likely to affect national production of crops and farm prices significantly. If the answer is yes then a further objective is to identify issues that need to be resolved to derive

appropriate prices for evaluating the benefit of increased agricultural production from Federal water projects. A third objective is to propose some interim price adjustments for project evaluation.

Estimates of production effects were developed from a sample containing Bureau of Reclamation projects with first crop reports from 1963 through 1972. Using plan reports and crop reports of matured projects, production, net of dryland production displaced, was estimated with yields projected to the year 2020. The contribution of irrigated land developed from 1970 through 2020 was estimated for three alternative future levels of irrigation development. These estimates reflect a range in acres developed from 1970 through 2020, as well as variation in geographic distribution of irrigated lands. The medium or most likely level consists of 3.1 million irrigable acres under Bureau-constructed projects and 1.7 million acres under projects constructed through loans to irrigation districts. The geographic distribution was adjusted from the sample of projects with first reports from 1963 through 1972 to reflect a more intensive cropping pattern for approximately 1 million acres under Bureau-constructed projects.

The position taken in this paper is that only Federal constructed projects should be considered, since projects financed by loans to existing irrigation districts are independent of Federal water resource planning, and would be the same with or without Federally built projects. Some readers may differ from this position so results are also given for the entire Reclamation Program, including projects developed through loans under the Small Reclamation Project Act.

Considering only Bureau-constructed projects and the most likely future, the constribution of land developed from 1970 through 2020 to national production in 2020 would be less than 1 percent for feed crops and grains, and about 1 percent for potatoes, cotton, sugarbeets, vegetables, and citrus fruits, and 6 percent for non-citrus fruits and nuts. Except for potatoes, vegetables, and fruits and nuts, price effects would vary from zero to 2.3 percent under the most likely future and from zero to 4.6 percent under the alternative future representing a high level of future Reclamation activity. The Principles and Standards of the Water Resource Council require that the price for calculating benefits be midway between the prevailing price, and the price that would exist without the program. Thus, the appropriate price adjustment for the most likely future would be 1 percent or less for all crops except potatoes, vegetables, fruits and nuts. Give the uncertainties of planning such refinement appears unwarranted.

Vegetables and citrus fruit prices under the most likely future would be 3 to 4 percent higher in 2020 without future development of Bureau-constructed projects. Since the current normalized prices

recommended by the Water Resources Council assume continued project development, normalized prices would be 3 to 4 percent higher if adjusted to reflect a future without additional Bureau-constructed projects. Taking the midpoint of the "with and without" future the appropriate upward price adjustment of the normalized price standard, is estimated at 2 percent for vegetables and citrus fruits.

Under the most likely future, prices of potatoes and noncitrus fruits and nuts would be some 7 to 9 percent higher in the absence of further Bureau-constructed projects. The recommended upward adjustment of the normalized prices for potatoes and noncitrus fruits and nuts is 4 percent.

For readers who differ from the position that only Bureau-constructed projects should be considered, the relevant production and price impacts are those of the total Reclamation Program, including projects developed under loan to irrigation districts. Under the most likely future the contribution of new development from 1970 would account for 1 percent or less of total output of feed crops, rice and roughages by the year 2020. Contribution to national production of potatoes, cotton, sugarbeets, vegetables and fruits would range from 1.7 to 3.5 percent and contribution to production of noncitrus fruit and nuts would be near 13 percent. Estimated price impacts for rice, cotton, sugar, and dry beans and peas would range from 3 to 5 percent. For these commodities an upward adjustment of 2 percent of the normalized price is recommended. For vegetables and citrus fruit the recommended upward adjustment is 4 percent. For potatoes and noncitrus fruits and nuts, it is 9 percent.

APPENDIX 1

PROCEDURES FOR ESTIMATING LAND USE AND YIELDS

Land Use with the Reclamation Program-

Based on the year in which the crop report appeared, the development period to maturity allowed in the Definite Plan Reports, and judgment, 19 of the 36 projects were considered sufficiently mature to use the 1973 crop report as an indication of future land use. These 19 projects are identified in Tables 7 and 8 in which all 36 projects are listed. For the remaining 17 projects, future land use was taken as estimated in the Definite Plan Reports and Loan Application Reports for Projects under the Small Reclamation Project Act. 1 / For these projects a comparison was made between estimated future land use, land use emerging, land use on nearby projects and the general agriculture of the region. It was concluded that the land use pattern anticipated in the planning document was generally realistic.

Based on statistics for the 19 projects considered matured, the area of irrigated cropland harvested and irrigated pasture was taken at 84.7 percent to 86.9 percent of the area to be developed for irrigation service.

Crops Yields with the Reclamation Program

Projected crop yields for the year 2000 were developed as follows:

1) Base yields were established for the 1971-1973 period by use of the crop reports for matured projects and crop reports from older projects in the same region for the remaining projects.

2) State average yields for irrigated crops for the1971-1973 period were obtained from the Crop and Livestock Reporting Service, USDA. Corresponding yields, projected to the year 2020 were available from the OBERS projection system.

3) The ratio of irrigated yields by states, projected to the year 2020, to the average yield in 1971-1973 was calculated for each crop. This ratio was applied to the 1971 through 1973 average yields for the projects to obtain estimated project yields for the years 2000 and 2020. The assumption underlying this procedure is that yields on reclamation projects will experience the same trend as irrigated yields in the state in which they are located. In some cases, where yield projections for a particular crop was unavailable for a given state, the ratios were developed for adjoining states. In a few cases ratios were developed for related crops in the same state, primarily hay in place of irrigated pasture.

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1 / Hence referred to as the "planning documents".

Land Use Without the Reclamation Program

Future land use in the absence of a project was taken from the estimated "without" future land use given in the planning documents. The proportion of irrigable acres of dryland that would be displaced was calculated from the 19 projects considered sufficiently matured. It was taken as the proportion that the area irrigated, as given in the crop report, is of the total irrigable area, as given in the planning document. This proportion varied from 78.5 percent to 99.7 percent and averaged 90.6 percent.

For lands within projects served by a non-Bureau source of water supply, future land use without the supplemental water supply furnished by the Bureau was also derived from the planning documents. For 6 projects in the Upper Colorado Basin and the Vernal Unit of the Central Utah project, relatively minor changes in the land use pattern were projected in the planning documents. Actual land use on mature projects also indicated that essentially the same cropping pattern was maintained on these 7 supplemental projects. Therefore, the same cropping pattern with and without supplemental irrigation water was adopted for calculating net production effects for these projects. In calculating without production the acreage irrigated without the supplemental irrigation water supply in the absence of the Reclamation program was taken to be the same as the acreage to which supplemental water supply was furnished by the program.

Land use and acres of lands inundated by reservoirs was determined from the Definite Plan Reports. Land Use and acreages inundated were unavailable for projects developed under these Small Reclamation Project Act, however, only about a third of these projects include reservoirs, mostly small in size.

Crop and Pasture Yields without the Reclamation Program

Anticipated drylands yields in the absence of the Reclamation Program were given in the planning document. In a few cases, dryland yields were not reported for the project area but obtained from the planning reports of nearby areas. Comparison of yields in the planning documents with state dryland yields, compiled by the Statistical Reporting Service, and the general lack of upward trend in dryland yields at the time the plans were prepared, indicated that anticipated yields were close to the contemporary dryland yields. Therefore, to derive projected yields for 2020, dryland yields given in the planning documents were multiplied by the ratio of state projected dryland yields to state yields (adjusted for abnormal years) that were contemporary with the year in which the planning report was prepared.

For example, given a project planned in 1966 and dryland wheat yields for the state in which the project is located at 22 bushels in 1966 and projected by OBERS to rise to 47 bushels in 2020. The without dryland yield for wheat in the planning document would be adjusted by the ratio of 47 ÷ 22 or a factor of 2.14.

APPENDIX II

PROJECTS EXAMINED

Table 7 Projects with first Bureau of Reclamation Crop Report 1963 through 1972 and included in sample of future net production increase per 100,000 acres developed for service. 1 /

WITH FULL WATER SUPPLY	WITH SUPPLEMENTAL WATER SUPPLY
Ainsworth, Nebraska *	Bonneville, Utah 1 /
Almena, Kansas *	Bostwick Park, Colorado
Bonneville, Utah 1 /	East Bench, Montana * 1/
Cedar Bluff, Kansas *	Emery County, Utah
East Bench, Montana * 1 /	Florida, Colorado *
Farwell, Nebraska *	Lyman, Wyoming
La Feria, Texas *	Mann Creek, Idaho *
San Angelo, Texas	Silt, Colorado *
Spokane Valley, Washington *	Smith Fork, Colorado *
The Dalles, Oregon *	Vernal Unit, Utah *
Washita, Oklahoma	

1 / Lands served with full water supply and supplemental water supply analyzed and compiled separately.

* Projects considered sufficiently matured to use 1973 Crop Report as the best available indicator of future production.

Table 8 Projects developed under the Small Reclamation Project Act of 1956, with first crop report 1963 through 1972 and included in sample of future net production increase per 100,000 acres developed for service. 1 /

Brown Canal Co., California

Brown Valley Irrigation District, California

Byron-Bethany Irrigation District, California

Cameron County Water Control and Improvement District No. 1, Texas *

Camrosa County Water District, California

Donna Irrigation District, Hidalgo County No. 1, Texas *

Eastern Municipal Water District, California

Jackson Valley Irrigation District, California

King Hill Irrigation District, Idaho *

Malad Valley Irrigation Co., Idaho

Roosevelt Irrigation District, California *

Roosevelt Water Conservation District, California *

Settlement Canyon Irrigation Co., Utah *

South San Joachin Irrigation District, California

South Sutter Water District, California

St. John Irrigation Company, Idaho

Walker Irrigation District, Nevada

1 / Excluded because data were unavailable is the Nevada Irrigation District.

* Project considered sufficiently matured to use the 1973 Crop Report as best available indicator of future production.