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An Economic Analysis of Irrigated Agricultural Development

MOUNTAIN HOME DIVISION
SOUTHWEST IDAHO WATER DEVELOPMENT PROJECT

Karl H. Lindeborg
Richard Lee Reid

Agricultural Experiment Station
UNIVERSITY OF IDAHO
College of Agriculture

The Authors — *Dr. Karl H. Lindeborg is professor and agricultural economist, and Richard Lee Reid is research associate, Department of Agricultural Economics.*

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This report results from a joint project of the Agricultural Experiment Station with the Water Resources Research Institute at the University of Idaho and the Idaho Water Resources Board, Boise. The joint study dealt with the multipurpose development of water resources in Southern Idaho.

In 1966 the Bureau of Reclamation submitted a plan for the multipurpose development of water resources in Southern Idaho. These development proposals were designed to meet the present and foreseeable future water needs of an area comprising the projects of Mountain Home, Garden Valley, Bruneau and Weiser River Divisions of the Southwest Idaho Water Development Project. The projects encompass 15,500 square miles, or about 10 million acres, of which about 20 percent are suitable for irrigation.

The Mountain Home Division was singled out for the study. It comprises the units of Guffy, Long Tom, and Hillcrest. The plan of this division is designed to serve the functions of irrigation, flood control, power production, recreation, and municipal and industrial uses. The plan proposes an exchange of water between the Snake River and Boise River. The project will entail the building of the Long Tom Diversion Dam on the South Fork of the Boise River below Anderson Ranch Dam. Here the water will be diverted by the Long Tom Tunnel to canals which will serve the three sections of the Long Tom Unit. One section is located south of Mountain Home. The second section is located southwest of Mountain Home and the Mountain Home Air Force Base. The third unit is northwest of Mountain Home along Highway 80 connecting Boise and Mountain Home (1).

This report deals with the development of irrigated agriculture in the Mountain Home Project for which the available resources are 130,800 acres of land and 470,000 acre-feet of irrigation water.

Objectives of Study

The objectives are to determine the economic benefits generated from the development with special emphasis on the optimum allocation of resources among various farm sizes with varying output prices.

The Study Area

In developing a desert area into irrigated agriculture the problem arises as to which input-output coefficients to use in estimating future production on undeveloped land. This study assumed that the proposed reclamation project would be similar to the areas of Meridian, Kuna, and Melba with respect to type of soil and general farm practices. Primary data were gathered from farm operators in those areas. They were selected through purposive sampling, which means that the managerial abilities of all farm operators in the sample were assumed to be above the average of farmers in the area. Data were gathered from 45 farmers and 39 records were used in the first part of the analysis. In subsequent budget analysis the data were augmented with data collected from 102 farmers in 4 different areas along the Snake River.

Figure 1. Southwestern Idaho study region.

Procedures

Regression analysis was used to estimate a unit cost curve by finding the relationship between cost per dollar of farm income and acres of operation. Linear programming models were used to estimate the distribution of farms of 4 sizes under the condition of maximizing income from 5 crops with various constraints of land, water, labor, and crop rotation.

Assumptions

The conditions under which farm operators make decisions vary from farm to farm. Management itself is an input in the production process similar to the inputs of land, labor and capital. However, because it is difficult to measure management in quantitative terms, managerial abilities were held constant by including in the sample only farm operators with above average abilities. abilities. This assumes that the farm operator's sole objective was maximizing farm income. It also assumes that capital is available in unlimited supply, that the manager employs the production techniques which are most efficient and appropriate for the resources at his disposal, and that average production costs are at a mimimum.

Analysis of Data

Six crops were selected to represent the area in accordance with the most common distribution of crops grown among the sample farmers. The crops were alfalfa, silage corn, mixed grain, mint, potatoes, and sugar beets.

Representative enterprise budgets were developed from primary data collected from the sample farmers. To make comparisons between farms, the budgetary costs were broken down into per-acre variable and fixed costs, and return per acre. The concept of cost per dollar of farm income was used to compare high valued crops with low valued crops on a per acre basis. The relationship between costs and acres is shown in the following regression equation which simulates a long run unit cost curve:

$$Y = \frac{1}{2.25616 + 0.00102X}$$

Where

Y = Ratio of income to costs

X = Size of production measured in acres

The percentage decline in unit costs determined by the regression equation was used to develop basic farm budgets from data obtained in the project area (39 samples) supplemented with data (104 samples) from 4 other areas along the Snake River from Nampa to Twin Falls, Burley, and Rupert. Budgets were developed for 160, 320, 480, and 640 acre farm sizes with alfalfa, corn silage, mixed grain, mint, potatoes, and sugar beets grown in the rotation.

Production Environment

The distribution of crops grown in 32 counties south of Idaho County, excluding Lemhi and Custer counties, was assumed to be representative of the combination of future crops to be grown in the project area.

The 6 crops included in the representative budgets account for 75 percent of the total acres harvested in those 32 counties (Table 1).

The selection of the 3 non-cash crops and 3 cash crops was based upon distribution of the crops in the sample data. The non-cash crops — alfalfa, silage corn, and mixed grain — are generally considered to be of more value as intermediate products in the production of animal products such as milk and meat. However, no livestock enterprise was included in the representative budgets because of the difficulties of fitting a proper cattle operation to a given farm size.

Crop yields per acre were held constant for all farm sizes for the specific crops. Sales prices for the crops were based on 1967 average prices received by farmers because 1967 has been used as the base year for many official series of agricultural statistics and as such is considered a normal year.

It may seem that using 1967 prices would not be realistic in 1974 since the price level has increased by about 50 percent since then. However, the results of the analysis will not change if the prices received by farmers have increased in the same proportion as the prices paid by farmers. The prices of inputs and outputs for 1967 and 1974 have increased in the same proportion as indicated in the Parity Ratio which was 79 in 1967 and 78 in 1974.

The yields, average prices and gross income used to develop the representative budgets are given in Table 2.

The costs of most input factors for the representative farms are given in Table 3. These prices also are based on 1967 prices. The costs of irrigation water and management are not included.

The regression equation simulating a long-run unit cost curve was used to adjust the cost data from the 5 areas along the Snake River to indicate economies of size. Four farm sizes were selected, based upon federal laws which stipulate the maximum acres that can be developed under one-man ownership. This maximum depends upon the federal agency that controls the land. Some agencies limit the maximum to 160 acres, other to 320 acres or multiples thereof depending upon how many family members are filing for entry.

Table 1. Distribution of crops harvested in 32 counties in South Idaho, 1969.

Crops	Harvested acres	Percentage distribution of acres
Alfalfa	632,052	29.82
Silage corn	58,150	2.74
Mixed grain	452,532	21.35
Mint	7,132	0.34
Potatoes	268,748	12.68
Sugar beets	171,529	8.09
Others	529,240	24.98
Total	2,119,383	100.00

Source: Idaho Census of Agriculture, 1969.

Table 2. Yields, average prices, and gross income per acre for 6 crops in the study area.

Commodity	Yield	Sales price*	Gross income
Alfalfa	5.4 ton	$19.00*	$103
Silage corn	23.2 ton	5.00+	116
Mixed grain	82.1 bu.	1.07*+	88
Mint	80.2 lb.	5.20*	417
Potatoes	323.3 cwt	1.61*	521
Sugar beets	22.4 ton	15.40+	345

*Source: Idaho Annual Crop Summary, 1967. USDA, SRS.
+Sample data.

Table 3. Total costs per acre for 6 crops and 4 farm sizes.

Crop	Size of farms (acres) 160	320	480	640
Alfalfa	$140	$131	$124	$116
Silage corn	145	136	128	121
Mixed grain	121	114	107	101
Mint	199	182	176	165
Potatoes	343	322	302	285
Sugar beets	289	271	255	240

Net returns per acre resulting from the figures in Tables 2 and 3 are negative for the 3 non-cash crops — alfalfa, silage corn, and mixed grain — but positive for the other 3 crops in the representative farm budgets. To take care of this problem only the variable costs were included in the linear programming analysis. The resulting per acre returns cover the costs of fixed factors, management, and water (Table 4).

Estimates of irrigation water requirements were computed from Idaho Agricultural Experiment Station Bulletin 516 (2). Total irrigation water requirements include consumptive use plus application losses due to seepage. Irrigation efficiency is assumed to be 55 percent in accordance with the estimate of the Bureau of Reclamation. The water requirements by crops are shown in Table 5.

Linear Programming Model

Objective Function

The basic linear programming model was designed to determine distribution of acreage among the 4 farm sizes. The objective function of the model was to maximize the dollar returns to management, water, and fixed input factors (see Table 5).

Acreage Restriction

The project is restricted to 130,800 acres suitable for agricultural production. Assuming a distribution of the 6 crops in the project area similar to that found in Table 1, these percentages were applied to the 130,800 acres. These percentages are included as minimum land restrictions for the 6 crops with 25 percent of the total land not specified for any crop. The upper limit in acres of any crop was established as no more than double the percentages in Table 1. An exception was made for mint, which was allowed to increase to 1,000 acres. Farm sizes were limited because, without limits, all 130,800 acres would be established with 640 acre-unit farms. With its built-in economies of size, this farm unit is the most profitable. The ranges used in the model are given in Table 6.

Lower limits were also included for alfalfa and mixed grain to assure the inclusion of these 2 crops into the solution of each farm size.

Water Restrictions

The amount of water available for agricultural production on the project was estimated to be 470,000 acre-feet. This supply will be available through enlargement of Swan Falls Dam and construction of Guffey Dam. Use of sprinkler irrigation systems was assumed in developing the representative farm budgets.

Labor Restrictions

Labor was divided into monthly restrictions for March through November inclusively. The production coefficients of labor were estimated from the "Annual Farm Labor Report, Idaho." Labor restrictions were not rigorously determined but were set very close to be in ample supply. The complete matrix for the linear programming model is given in Table 7.

Solution of Linear Programming Model

The activities in the linear programming model were the 6 crops subdivided into the 4 farm sizes for each crop. This allows different crops to be grown on the different farm sizes depending upon the minimum and maximum limits placed on the acreage needed or allowed for the crops. The objective function was expressed in terms of dollar returns to fixed input factors and management and water.

The solution of the model is given in Table 8. With a limited amount of water, 10 percent of the 130,800 acres can not be irrigated. This 10 percent idle acres includes land used for roads, ditches, and farmsteads. Original plans of the project area set aside some land for wildlife refuge. The idle land could be used very well for that purpose, though this is not specified in the model. Note that as farm size increases, farmers become more specialized in their farming practices. The $12.9 million dollars in income represents the returns to fixed factors of production in addition to the returns to water and management. This is the amount left over when the costs of variable inputs have been paid.

Table 4. Returns to management, water and fixed factors per acre.

Crop	Size of farms (acres) 160	320	480	640
Alfalfa hay	$ 5.91	$ 14.59	$ 22.43	$ 29.45
Silage corn	16.60	25.25	33.70	40.97
Mixed grain	12.61	20.12	26.91	32.99
Mint	276.30	293.60	299.74	309.70
Potatoes	237.68	258.83	278.05	295.25
Sugar beets	118.83	136.71	152.89	167.36

Table 5. Seasonal irrigation water requirements of 6 crops projected to be grown in the study area.

Crop	Average annual consumptive use	Total required diversion
	(Acre-inch)	(Acre-inch)
Alfalfa	29.1	52.91
Silage corn	21.0	38.18
Mixed grain	23.0	41.82
Mint	19.2	34.91
Potatoes	26.4	48.00
Sugar beets	27.9	50.73

Source: R.J. Sutter and G.L. Corey 1970. Consumptive Irrigation Requirements for Crops in Idaho. Idaho Agr. Exp. Sta. Bull. 516.

Table 6. Limits in acreages for each farm size group.

Theoretical farm size	Acres*	Irrigated Idaho farms*	Farm numbers distribution	Project acres	Project range Lower	Upper
160 acres	140-179	1,734	30.74%	40,208	35,000	45,000
320 acres	260-499	2,414	42.80%	55,982	25,000	35,000
480 acres					25,000	35,000
640 acres	500-999	1,492	26.46%	34,610	30,000	40,000
Totals		5,640	100.00%	130,800		

*Source: Idaho Census of Agriculture, 1969.

Table 7. Linear programming model.

Row Identification	Alfalfa Model Farm Size				Silage Corn Model Farm Size				Mixed Grain Model Farm Size				Mint Model Farm Size				Potatoes Model Farm Size				Sugar Beets Model Farm Size				Resource Supply
	160	320	480	640	160	320	480	640	160	320	480	640	160	320	480	640	160	320	480	640	160	320	480	640	
Land	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	≤ 130,000 acres
Water	52.910	52.910	52.910	52.910	38.180	38.180	38.180	38.180	41.820	41.820	41.820	41.820	34.910	34.910	34.910	34.910	48.000	48.000	48.000	48.000	50.730	50.730	50.730	50.730	≤ 5,640,000 acre-inch
Labor																									
March	0.609	0.420	0.290	0.281	1.121	1.130	0.881	0.848	0.340	0.342	0.267	0.246	3.016	3.040	2.371	2.280	1.627	2.712	2.441	2.414	1.437	2.245	1.639	1.616	≤ 395,000 hours
April	0.435	0.300	0.207	0.201	0.800	0.806	0.629	0.604	0.276	0.277	0.216	0.199	2.497	2.517	1.963	1.880	2.508	4.180	3.762	3.720	2.272	3.550	2.591	2.556	≤ 545,000 hours
May	0.747	0.515	0.355	0.345	0.732	0.738	0.576	0.554	0.431	0.433	0.338	0.312	4.324	4.359	3.400	3.269	2.035	3.391	3.052	3.018	5.738	8.965	6.544	6.455	≤ 1,170,000 hours
June	1.994	1.375	0.949	0.921	1.268	1.278	0.997	0.959	0.745	0.749	0.584	0.539	8.433	8.501	6.631	6.376	1.588	2.646	2.381	2.355	8.744	13.665	9.974	9.837	≤ 1,785,000 hours
July	2.822	1.946	1.343	1.304	3.259	3.285	2.562	2.464	0.926	0.931	0.726	0.670	8.849	8.920	6.957	6.690	3.680	6.133	5.520	5.458	9.307	14.542	10.616	10.470	≤ 1,900,000 hours
August	2.535	1.748	1.206	1.171	3.051	3.076	2.399	2.307	0.576	0.579	0.452	0.417	1.535	1.547	1.207	1.160	3.673	6.121	5.509	5.448	5.874	9.182	6.703	6.611	≤ 1,200,000 hours
September	1.427	0.984	0.679	0.659	1.691	1.705	1.330	1.279	0.164	0.165	0.129	0.119	0.806	0.813	0.634	0.610	3.673	6.121	5.509	5.448	2.607	4.073	2.973	2.933	≤ 800,000 hours
October	0.483	0.323	0.230	0.223	0.355	0.358	0.279	0.268	0.042	0.042	0.033	0.030	0.460	0.464	0.362	0.348	5.552	9.253	8.328	8.235	4.689	7.326	5.348	5.275	≤ 1,200,000 hours
November	0.448	0.309	0.213	0.207	1.466	1.478	1.153	1.108	0.176	0.177	0.138	0.127	1.929	1.945	1.517	1.459	0.617	1.028	0.925	0.915	8.525	13.320	9.724	9.590	≤ 1,740,000 hours
Alfalfa	1.000	1.000	1.000	1.000																					≥ 39,000 acres
Silage corn					1.000	1.000	1.000	1.000																	≥ 3,600 acres
Mixed grain									1.000	1.000	1.000	1.000													≥ 28,000 acres
Mint													1.000	1.000	1.000	1.000									≤ 1,000 acres
Potatoes																	1.000	1.000	1.000	1.000					≥ 16,500 acres
Sugar beets																					1.000	1.000	1.000	1.000	≥ 10,500 acres
Range-1	1.000				1.000				1.000				1.000				1.000				1.000				≤ 45,000 acres
Range-2	1.000				1.000				1.000				1.000				1.000				1.000				≥ 35,000 acres
Range-3		1.000				1.000				1.000				1.000				1.000				1.000			≤ 35,000 acres
Range-4		1.000				1.000				1.000				1.000				1.000				1.000			≥ 25,000 acres
Range-5			1.000				1.000				1.000				1.000				1,000				1.000		≤ 35,000 acres
Range-6			1.000				1.000				1.000				1.000				1.000				1.000		≥ 25,000 acres
Range-7				1.000				1.000				1.000				1.000				1.000				1.000	≤ 40,000 acres
Range-8				1.000				1.000				1.000				1.000				1.000				1.000	≥ 30,000 acres
Crop-1	1.000																								≥ 10,500 acres
Crop-2		1.000																							≥ 7,500 acres
Crop-3			1.000																						≥ 7,500 acres
Crop-4				1.000																					≥ 9,000 acres
Crop-5									1.000																≥ 7,525 acres
Crop-6										1.000															≥ 5,375 acres
Crop-7											1.000														≥ 5,375 acres
Crop-8												1.000													≥ 6,450 acres
Objective Function	5.910	14.590	22.430	29.450	16.600	25.150	33.700	40.970	12.610	20.120	26.910	32.990	276.300	293.600	299.740	309.700	237.680	258.830	278.050	295.250	118.830	136.710	152.890	167.360	

*Note the degeneracy in the model.

Table 8. Solution of linear programming model in crop acreages, number of farms and income by model farm groups.

Crop	Crop acreages: 243 farms of 160 acre-unit	87 farms of 320 acre-unit	58 farms of 480 acre-unit	56 farms of 640 acre-unit	Total acreage for 444 farms
Alfalfa	15,000	7,500	7,500	9,000	39,000
Silage corn	3,600	-	-	-	3,600
Mixed grain	10,000	5,375	5,375	6,450	28,000
Mint	1,000	-	-	-	1,000
Potatoes	-	6,225	12,125	17,078	35,428
Sugar beets	4,600	5,900	-	-	10,500
Idle acres	3,952	2,823	2,823	3,674	13,272
Total acres	38,952	27,823	27,823	36,201	130,800
Income by group of farms (in millions)	$1.1	$2.6	$3.7	$5.5	$12.9

Table 9. Model farm plan solutions for costs and returns by size group.

(160 Acre Model Farm)

Item	Acres of Crop: 62 Alfalfa	15 Silage Corn	44 Mixed Grain	4 Mint	19 Sugar Beets	Total
Income	$6,386	$1,740	$3,872	$1,668	$6,555	$20,221
Variable costs	6,008	1,494	3,312	565	4,308	15,687
Fixed costs	2,688	684	2,023	232	1,187	6,814
Total costs	8,696	2,178	5,335	797	5,495	22,501
Net income	-$2,310	-$ 438	-$1,463	$ 871	$1,060	$ 2,280
Net income per acre	-$37.25	-$29.20	-$33.25	$217.75	$55.80	-$14.25

(320 Acre Model Farm)

Item	Acres of Crop				
	86 Alfalfa	62 Mixed Grain	72 Potatoes	68 Sugar Beets	Total
Income	$8,858	$5,456	$37,512	$23, 460	$75,286
Variable costs	7,554	4,229	18,876	14,191	44,850
Fixed costs	3,728	2,851	4,322	4,249	15,150
Total costs	11,282	7,080	23,198	18,440	60,000
Net income	-$2,424	-$1,624	$14,314	$ 5,020	$15,286
Net income per acre	-$28.18	-$26.20	$198.80	$73.82	$47.77

(480 Acre Model Farm)

Item	Acres of Crop			
	130 Alfalfa	93 Mixed Grain	290 Potatoes	Total
Income	$13,390	$8,184	$108,889	$130,463
Variable costs	10,545	5,719	50,668	66,932
Fixed costs	5,636	4,276	12,546	22,458
Total costs	16,181	9,995	63,214	89,390
Net income	-$ 2,791	-$1,811	$ 45,675	$ 41,073
Net income per acre	-$21.47	-$19.47	$218.54	$85.57

(640 Acre Model Farm)

Item	Acres of Crop			
	160 Alfalfa	114 Mixed Grain	302 Potatoes	Total
Income	$16,480	$10,032	$157,342	$183,854
Variable costs	11,624	6,272	67,851	85,747
Fixed costs	6,936	5,242	18,129	30,307
Total costs	18,511	11,479	85,980	115,970
Net income	-$ 2,031	-$ 1,447	$ 71,362	$ 67,884
Net income per acre	-$12.69	-$12.69	$236.30	$106.07

Table 10. Projected income and costs for the entire project and for size group.

Gross income		$31,202,825
Variable costs	$18,260,566	
Fixed costs	5,982,641	$24,243,207
Net income		$ 6,959,618
Income by farm size group:		
243 farms of 160 acre-units		$ -553,998
87 farms of 320 acre-units		$ 1,329,875
58 farms of 480 acre-units		$ 2,382,238
56 farms of 640 acre-units		$ 3,801,503
444 Farms with Net Income		$ 6,959,618

In Table 9 the linear programming solution is broken down into cost components and income for each of the 6 crops under each farm size. Alfalfa and grain are unprofitable in all size farm units. The negative influence of the 2 crops makes the whole 160 acre unit unprofitable. However, no monetary amount was credited to alfalfa for its residual effects in the soil. With the high percentage of alfalfa in the rotation, credit should be given to its soil-building benefits.

Sensitivity analyses of the model showed that the optimum solution was stable within a range of 8 percent for the water resource and 3 percent for the land resource. The objective function was very stable for all enterprises except mint and sugar beets. These were very sensitive to price changes.

Gross income for the entire project was estimated to be about $31 million. Costs were about $24 million, leaving about $7 million to pay for water and management (Table 10).

Using agricultural census data, expenses for hired labor were set at 11.4 percent of gross agricultural income. For the entire project, about $3.6 million would be spent on hired labor. Therefore, costs of primary agricultural production and the associated labor would amount to about $10.6 million under the condition that water is a free commodity.

Value of Water

The marginal value product of water was $6.15 per acre-inch. This is the sum that an additional acre-inch would be worth to the farmer under the production conditions specified in the linear programming model, considering only variable costs. When all the costs of production were considered, the average value of water was estimated to be about $33 per acre.

Parametric Programming

Parametric programming on the objective function was carried out for two of the crops in the model, sugar beets and potatoes. Under this procedure, the sensitivity of the optimum solution can be tested when prices of these crops change but the prices of the other crops remain constant. The model is presented in Table 11.

The objective function coefficients were net returns to the fixed factors of production plus management and water.

Results of variable price programming are presented in a price map (Fig. 2). As the net returns increase for sugar beets and potatoes, they become the dominant crops in the rotations. The border solutions between the 2 crops were determined from the line segments "OB" and "OC" from which the alternative production plans are determined (Table 12). The production mix remains constant within each of these plans. For example in Plan 2 the net returns of potatoes can increase from $32 to $403 before an alternative plan becomes more profitable. On the border lines the adjoining crop plans produce equal income. For example, at point B the plans 2,3,4, and 5 produce the same income. However, when fixed costs are introduced into the analysis the most profitable alternative plans are 3 and 7.

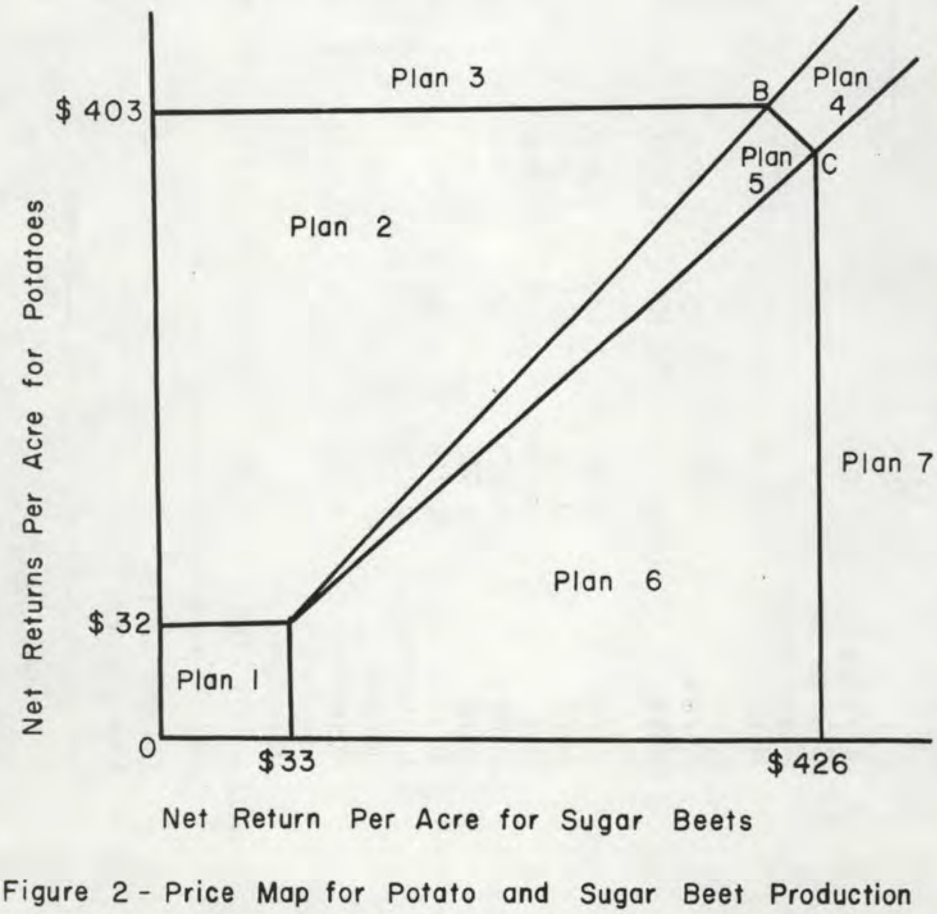

Figure 2 - Price Map for Potato and Sugar Beet Production

Table 11. Parametric Linear Programming Model.

Row Ident.	Alfalfa	Silage Corn	Mixed Grain	Mint	Potatoes	Sugar Beets	Resource Supply
Alfalfa	1.000						≥ 39,000 acres
Silage corn		1.000					≥ 3,600 acres
Mixed grain			1.000				≥ 28,000 acres
Mint				1.000			≤ 1,000 acres
Acres	1.000	1.000	1.000	1.000	1.000	1.000	≤ 130,800 acres
Water	52.910	38.180	41.820	34.910	48.000	50.730	≤ 5,640,000 acre-ins.
March	0.420	1.130	0.342	3.040	2.712	2.245	≤ 395,000 hours
April	0.300	0.806	0.277	2.517	4.180	3.550	≤ 545,000 hours
May	0.515	0.738	0.433	4.359	3.391	8.965	≤ 1,170,000 hours
June	1.375	1.278	0.749	8.501	2.646	13.665	≤ 1,785,000 hours
July	1.946	3.285	0.931	8.920	6.133	14.542	≤ 1,900,000 hours
August	1.748	3.706	0.579	1.547	6.121	9.182	≤ 1,200,000 hours
September	0.984	1.705	0.165	0.813	6.121	4.073	≤ 800,000 hours
October	0.330	0.358	0.042	0.464	9.253	7.326	≤ 1,200,000 hours
November	0.309	1.478	0.177	1.945	1.028	13.320	≤ 1,740,000 hours
Objective function	14.590	25.250	20.120	293.600	0.000	0.000	
Changerow 1					1.057*	1.000	
Changerow 2					0.946*	1.000	

*Rounded

Table 12. Percentage distribution of acres for entire project among alternative plans of production.

Crop	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Plan 6	Plan 7
	Percent of total acres						
Alfalfa	30	33	33	33	33	34	34
Silage corn	48	3	3	3	3	3	3
Mixed grain	21	24	24	24	24	24	24
Mint	1	1	0	0	1	1	0
Potatoes	0	39	40	40	39	0	0
Sugar beets	0	0	0	*	*	38	39
Total Percent	100	100	100	100	100	100	100

*Less than 0.1 percent

Supply Functions

Figs. 3 and 4 are supply functions developed from the parametric programming model. The supply function for potatoes is the amount of production producers are willing to supply at different prices under the conditions that the prices of all the other crops in the program are kept constant. From these graphs, the conclusion is that the production of the 2 crops is quite stable for the given production data. Once the crop enters the production plan, price increases do not significantly change the production acreages committed for the crop.

A logical explanation of this conclusion is the relatively high production costs associated with each crop. Once the crop is included in the production plan; production factors warrant a large acreage of that crop. A large price increase must be realized before the production factors can be justifiably increased. A comparison of the 2 crops indicates that potatoes is the more advantageous crop to produce. This is implied in Fig. 2, plans 4 and 5. Even though prices of both crops are such that the 2 crops are competitive for production acreage, potatoes are chosen on the basis of net returns per acre. This can partially be explained by the high fixed costs of sugar beet production and, more significantly, by the larger irrigation water requirement of sugar beets. In terms of acre-feet of water, more income is realized from potato production.

The marginal value product (MVP) of water verifies this conclusion. With irrigation supply being the most restrictive resource, the MVP per acre-inch of water for potato production is 1.10091. This translates into a $1.10091 increase in net returns to the fixed factors of production, management, and water for every additional acre of potato production included in the production plan. The MVP of water per acre-inch for sugar beet production is 0.98561. In other words, the producer is gaining slightly more than 11.5 cents in net returns for each acre of potato production he substitutes for sugar beet production.

Project Effect, Labor and Population

The objective of the study was to determine the optimum allocation of resources among various farm sizes with varying output prices.

The number of farms and sizes of operations were determined by the linear programming model. However, 444 farms were the optimum combination with the given restraints in this model. The number of farms actually established in the area may depend upon factors not included in the present model. But if the number of farms estimated in the previous section is used the direct effect on the labor force and population amounts to an additional employment for 8 to 10 thousand people.

The increase is estimated in the following manner. Settlement of the area is based on the assumption that each farm must initially be managed by a single household, and that the average farm family is composed of 4 members. The initial farm family population would then be 1,776 persons.

Population changes would also result from the off-farm labor needed to assist the farm families to produce agricultural commodities.

Total labor demand for the entire project (Table 13) shows a demand for 2,825 workers during peak season. Included in this total is operator and family labor which amounts to 72 percent (4) for the year 1970. Family labor is defined as those operators contributing 1 hour and all other family members contributing 15 hours or more of work each week to the farm but not receiving cash wages for their services.

The hired labor portion would be 28 percent or 635 workers. These labor positions would be filled from off-farm labor supplies if the definition for family labor is applied.

Carrying further the assumption that the average family size of 4 members applies to all families, a possible maximum population increase of 2,540 persons would result from the labor demands for primary agricultural production on project lands. This is assuming only one member of each family fills these farm labor positions. Applying this linear programming solution to population predictions, the project could sustain 4,316 persons, or 1,079 families. This would be an increase due to just the primary agricultural effect of opening and settling the project lands.

Table 13. Labor demand for the entire project.

Month	Total labor needs*	Avg work time by all labor**	Total labor
	(hrs.)	(hours/mo.)	(number)
March	140,133	177.32	790
April	190,987	187.91	1,016
May	560,598	198.44	2,825
June	293,718	193.93	1,515
July	449,471	203.28	2,212
August	376,822	202.40	1,643
September	284,782	173.29	1,643
October	380,266	172.92	2,199
November	175,161	149.21	1,174
Total accumulated workers			15,236
Average workers by month			1,692

*Source: The optimum solution

**Source: Farm Labor. Statistical Reporting Service, Boise. Annual Farm Labor Report. Department of Employment, Boise.

Summary and Conclusions

Primary data were collected in the Boise Valley from which a unit cost curve was estimated by regression analyses. The estimated unit cost curve was used to develop farm budgets for 4 different farm sizes by using physical and economic data obtained from 5 different areas along the Snake River.

Linear programming was used to allocate the scarce resources among the 4 farm sizes. Variables included in the economic model were crop rotation for 6 crops, labor, water supply, and restraints on acreage.

The results of the economic model were that 444 farms could be established on the project under the given restraints of the model. Gross income was estimated to be about $31 million with costs of about $24 million. That would leave about $7 million to pay for irrigation water and management of the farmer. These estimates are only valid with the restrictions put on farm sizes. If these restrictions were relaxed, fewer but larger farms would result with higher income. The value of water under the conditions of the model was estimated on the average to be $33 per acre. The Marginal Value Product of water was estimated to be about $16 per acre foot.

Parametric programming was conducted on the objective function for potatoes and sugar beets. The results are presented in a price map and also in supply functions for these crops. Potatoes and sugar beets are quite insensitive to price changes; large price changes are necessary to generate a moderate change in the production plans of either.

The estimated increase in population resulting from primary agricultural production, including both farm families and hired farm workers, was 4,316 persons. The net income of about $7 million from agricultural production and the hired workers contribution of $3.5 in wages make a total of $10.5 million generated from primary agricultural production of the project.

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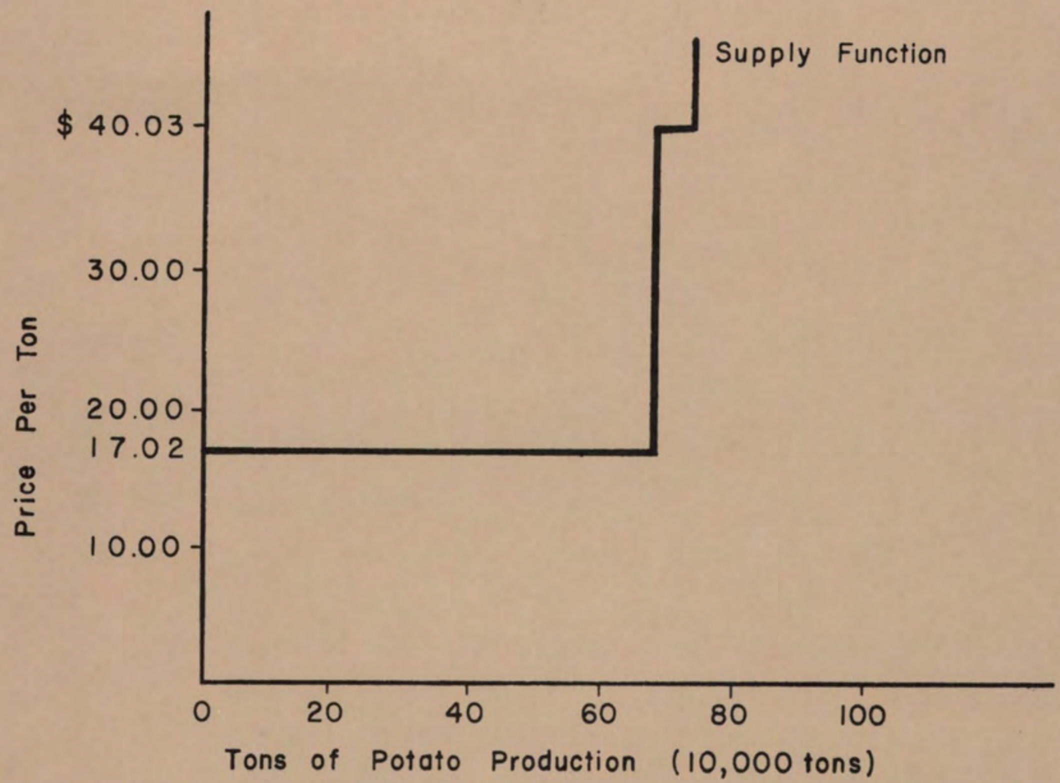

Figure 3 - Potato Supply Function For Entire Project

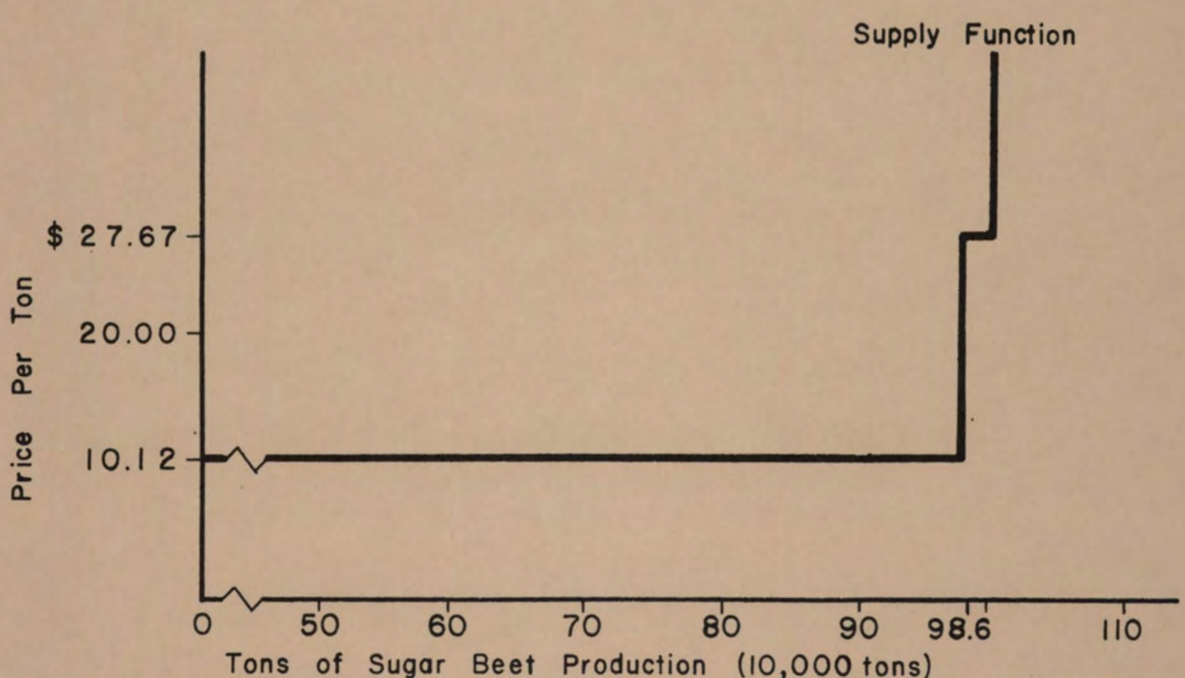

Figure 4 - Sugar Beet Supply Function For Entire Project