Supply Responses of Dryland Wheat and Barley Farms in Southeastern Idaho to Alternative Market Prices – 1970

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Summary and Conclusions

The study area with which this research is concerned consists of 13 counties in southeastern Idaho, each of which raised 50,000 or more bushels of dryland hard red winter wheat in 1965. Dryland wheat-barley farms in this area are characterized by the following problems: relatively few economic alternatives, increasing production costs, declining prices for wheat and barley, relatively constant crop yields over the past 20 years, highly variable spring and fall precipitation which influences crop yields, government programs which tend to restrict farming operations and more recently, keener competition from other regions to terminal markets because of freight-rate reductions.

There are about 1.6 million acres suitable for dryland grain production in the 13 counties. Crops have been grown on up to 957,500 acres of this land in one year. The land is quite steep and may have severe erosion problems because of climatic and topographic conditions. Soils are dark colored types of the semiarid and sub-humid regions. Annual precipitation averages from 12 to 16 inches with the majority of the wheat area receiving between 12 and 14 inches.

The cropping pattern usually is one acre of fallow for each acre of planted cropland. Wheat has been the most important crop, with barley increasing significantly in importance with the advent of the wheat allotment program. Machinery investments on farms are estimated to range from \$34,567 for the 1,000 acre representative size farm to \$85,775 for the 3,000 acre farm in 1970. Average total costs of production are estimated to be \$21.78 per acre for wheat and \$23.27 per acre for barley on 1,000 acre farms in 1970. Average costs are estimated to be somewhat lower on 3,000 acre farms in 1970—\$19.21 per acre for wheat and \$20.60 per acre for barley. The average farm in 1970 is expected to be about 1,231 acres in size. Estimates are there will be 1,006 dryland farms in the area by 1970, a reduction of 44 percent since 1949.

Aggregate production function analysis indicated that the area planted, fall precipitation and spring precipitation were all statistically significant factors in determining total production of both wheat and barley. The analysis indicated that fertilizer, new crop varieties and average quarterly temperatures had not been significantly related to increases in total production in the past 20 years. Under average rainfall conditions the production capacity of the study area would be 15.6 million bushels of wheat from 916,077 acres planted. Above or below average rainfall could alter this estimate considerably.

Based on average variable costs of production and the marginal productivity of land in the study area, marginal costs of production were estimated for wheat and barley, assuming both crops were grown independently. Using these relationships, supply functions were also estimated for wheat and barley at low, medium and high prices. Results for both crops showed supply functions to be quite inelastic. At high barley prices, barley may be substituted for wheat; however, at high wheat prices the amount of barley planted and produced becomes a residual.

The inelasticity of supply functions for wheat and barley suggest that prices between 1946 and 1965 had little influence on planning future production. Estimated supply functions based on time series data tend to bear out this hypothesis. In recent years farm programs and weather were the only significant factors associated with supply of wheat and barley.

Dryland farms in the study area can expect continued economic pressure in the 1970's unless prices for wheat and barley increase over recent years or research significantly reduces per unit production costs or introduces new economic alternatives. As long as weather remains such a limiting factor in the production of wheat and barley, it is doubtful that the supply relationships for these crops will change. The obvious problems to farmers are the low prices received for their products. Even higher prices, however, will not relieve all the economic pressures felt by the dryland farmers in southeastern Idaho.

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Introduction

Adjustment Problems

Farmers in southeastern Idaho who operate dryland wheat-barley farms face a number of adjustment problems in terms of their individual farm operations. Major factors contributing to these problems are: (1) the lack of economic opportunities in terms of crop and livestock alternatives; (2) continually increasing costs of the factors of production; (3) declining prices for wheat and barley; (4) relatively constant crop yields over the past 20 years; (5) weather variations that affect dryland crop production; (6) government programs for wheat and feed grains which tend to restrict farming operations; and (7) increased competition from other regions of the United States as the result of transportation cost reductions to terminal markets.

Dryland farmers in this area depend primarily upon two cash crops, hard red winter wheat and spring barley, for their income. Small amounts of hay and oats are also grown, especially where it is possible to produce livestock on the farm. Relatively few livestock are raised on wheat-barley farms, however, primarily because of the lack of feed. Cattle are often not an economical alternative on wheat-barley farms, especially in large numbers.

The costs of inputs have generally been increasing in recent years. Input costs have increased between two and three percent per year. Season average wheat prices, on the other hand, have been declining from a high of $2.22 per bushel in 1947 to $1.26 per bushel in 1965. (The 1965 price does not include any government certificate payments.) Increasing production costs and decreasing prices for wheat have caused farmers in the area either to operate larger units in order to maintain their level of income or to cease their operations.

Aggravating the income problem is the fact that average wheat and barley yields have not increased as crop yields have in other areas. The low precipitation—about 12 inches annually—limits the advantages of new varieties, and the use of fertilizer and other advances in technology.

Not only is annual precipitation low. It is also quite variable. About 25 percent of the annual rainfall normally occurs in the April-June period when it is most beneficial for crop production. When April to June rainfall is extremely low, crop yields decline accordingly.

Two separate federal programs have had substantial impact on dryland farms in southeastern Idaho. In 1954 the wheat allotment program reduced the area planted to wheat by about 200,000 acres. This was a 25 percent reduction from 1953. At the same time, the area planted to barley more than doubled, going from 121,300 acres in 1953 to 260,700 acres in 1954. As a result of the 1962 feed grain program the area planted to barley has also declined. By 1964, 59,292 acres had been diverted from feed grains. The total area planted to wheat and barley declined from 947,900 acres in 1953 to a low of 711,900 acres in 1964. Thus, farm programs have reduced the area planted to wheat and barley by about 263,000 acres or 25 percent of the potential of the area.

Recent reductions in rail freight rates from the Midwest to terminal markets on the Pacific Coast affect the competitive position of southeastern Idaho. This rate reduction may well reduce the market price for both hard winter wheat and barley in southeastern Idaho.

These problems have all had an effect on the dryland farming operations in southeastern Idaho. The purpose of this bulletin is to evaluate the economic effect of each of these factors.

Objectives and Procedures

This study fulfilled both state and regional research needs. Objectives for Idaho were as follows:

(1) To determine the place of wheat in the systems of farming by areas of the state.

(2) To determine costs and returns from alternative enterprise combinations with and without wheat.

(3) To determine at what prices wheat would likely be profitable, and to determine the number of acres which would be economical to shift out of wheat at various price levels.

(4) To estimate what crops would substitute for wheat, and the amount of land that would be shifted to these crops.

(5) To measure the extent to which anticipated resource shifts occur.

(6) To determine what factors retard or prevent shifts which are economically desirable.

Regional objectives of this study were as follows:

(1) To determine individual farm-supply response for alternative price relationships and levels, with emphasis on wheat and feed grains.

(2) To find an aggregate regional supply response function, using the supply responses obtained.

(3) To determine supply-demand equilibrium output for specified commodities in the Western and Great Plains regions.

(4) To determine optimum farm organization and specified adjustments for each subregion at this equilibrium.

Research presented in this bulletin goes somewhat further than that outlined in the initial Idaho objectives, but not as far as that represented by the regional objectives. The results of the regional study will be reported in a separate publication which will include data from the Idaho study.

The organization of dryland wheat-barley farms in southeastern Idaho was determined by survey methods. With the survey data, representative farm budgets were developed for 1960 and 1966 and projected to 1970. Wheat and barley production was then analyzed to determine which factors significantly influenced these crops. The area planted, crop varieties planted, precipitation, and temperature variations were considered to evaluate their effects on crop production levels.

Based on estimated production functions for the area and the variable production costs per acre of cropland, aggregate marginal cost curves were developed for both wheat and barley. Using these relationships, supply curves were estimated for wheat and barley at alternative price levels. These estimates were made for the year 1970, assuming free market conditions (i.e., it was assumed there were no government programs to limit the production of wheat or barley).

Based on this analysis and the physical resources of the area, estimates were also made concerning levels of production under alternative prices and the quantity of resources that would be idle at extremely low wheat and barley prices.

Research Methods

Farm Surveys

Budgets in this study were constructed from survey data collected from 114 farmers in southeastern Idaho in 1960 and 1964. Esmay (1) established costs and returns for three sizes of representative dryland wheat-barley farms. In the spring of 1964, Anderson interviewed 39 additional farmers to update Esmay's work (Jay Anderson, unpublished data). Generally, the dryland farm system has not changed a great deal since 1942 (2). The type of farming carried on is still one of wheat, barley and fallow. One acre is fallowed for each acre of planted cropland.

The survey data were projected to represent the situation in the area in 1970. The types of machinery in use and the costs of production inputs were adjusted to represent current trends. Machinery components and investments for the three representative farms are presented in Appendix Table 4. Farm budgets for 1960 and 1970 are presented in Appendix Tables 5 and 6. Specific changes in farming from 1960 to 1970 are discussed in the section concerned with the organization of producing units.

Supply Analysis

Dryland farmers in southeastern Idaho are restricted to two cash crops. Under past price relationships wheat normally has considerable absolute advantage over barley. In terms of the individual farm manager this means he will plant as much wheat as possible, planting the remainder of his cropland in barley.

In terms of the whole dryland area, total production in any one year is influenced primarily by the area planted to each crop and the amount and timing of rainfall. The total amount of cultivable land in the area suitable for wheat and barley is approximately 1.6 million acres (Table 3) of which about 50 percent is fallow each year. When prices were relatively high and farmers were operating in a market free from acreage restrictions (especially during the Korean War) up to 950,000 acres of dryland wheat and barley were planted.

The supply functions in this study are based on time series production data from 1946-1965, variable costs of production and alternative price levels. The limiting factor is assumed to be the cropland available. While the number of farms in the area has been declining and the average size of farms has been increasing over the past 20 years, the total area of cultivable land has been relatively constant. Consequently, aggregate wheat and barley production is based on the past performance from the land resources available, allowing for variations in the weather and technological advances which affect the total quantity of wheat and barley produced.

Individual farmers are assumed to act in such a manner as to maximize their income, given the resources available to them. The aggregate supply functions developed in this study represent what would be produced under the above conditions.

Table 1. Idaho wheat and barley prices per bushel, 1946-65.[1]

Year	Wheat Price	Barley Price	Year	Wheat Price	Barley Price
1965	$1.26	$ .96	1955	1.85	.83
1964	1.28	.95	1954	1.97	1.01
1963	1.84	.91	1953	1.96	1.06
1962	1.90	.97	1952	1.97	1.35
1961	1.78	.97	1951	1.97	1.26
1960	1.67	.89	1950	1.83	1.02
1959	1.63	.88	1949	1.77	.94
1958	1.63	.89	1948	1.82	1.00
1957	1.80	.80	1947	2.22	1.47
1956	1.84	.92	1946	1.65	1.19

[1]Source: **Agricultural Statistics.** U.S. Department of Agriculture, 1946-1966.

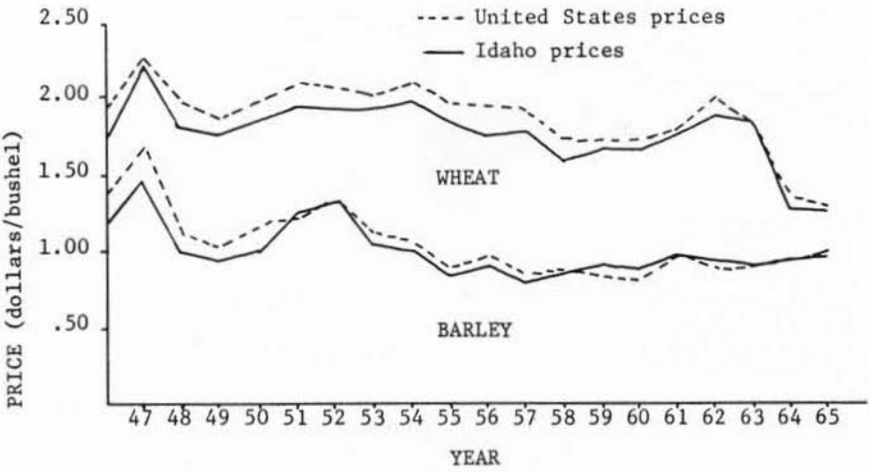

Fig. 1. United States and Idaho prices for wheat and barley, 1946-65. (Source: **Agricultural Statistics,** U. S. Department of Agriculture, 1946-66).

Price Relationships

Prices used in analyzing wheat and barley supply responses were developed from season average prices in Idaho during the 20-year period prior to 1966 (Table 1). Idaho wheat prices varied from a high of \$2.22 per bushel in 1947 to a low of \$1.26 per bushel in 1965, while barley prices went from a high of \$1.47 per bushel in 1947 to a low of \$.80 per bushel in 1957.

Wheat and barley prices in Idaho tend to move with average United States prices (Fig. 1). United States wheat prices were generally 10 to 15 cents higher than Idaho prices until the 1960's. In recent years they have been nearly identical. National and Idaho barley prices have been about the same since 1958. In the future, it is doubtful that Idaho prices will differ greatly from United States prices for wheat and barley.

Representative price levels selected for analysis in this study ranged from \$.90 to \$2.30 per bushel for wheat, and from \$.70 to \$1.50 per bushel for barley. It is unlikely that the price of wheat would ever fall below the price of its feed grain equivalent. For example, if the price of barley was \$.70 per bushel wheat would be worth at least \$.90 per bushel (.70 x 1.3 = .91, where the 1.3 represents the total digestive nutrient relationship between wheat and barley).

Fig. 2. Distribution of dryland wheat production in the 13-county study area, 1965. Figures in parenthesis are in units of 50,000 bushels of wheat. (Source: Statistical Reporting Service, U.S. Department of Agriculture.)

Study Results

The Study Area

Thirteen southeastern Idaho counties which each produced in excess of 50,000 bushels of hard red winter wheat in 1965 make up the area of this study (Fig. 2). In this area, dryland wheat is grown on the cultivable land between the irrigated river valleys and the higher ranges and forests at elevations up to 6,300 feet in northern Fremont County.

In 1965 the study area produced 13.6 million bushels of wheat and 8.2 million bushels of barley. These totals represent about 27.6 percent of the wheat and 26.6 percent of the barley grown in the state. While this is not the most important wheat producing area in Idaho, it is the area that has been most adversely affected by low wheat prices and the acreage allotment program because of the relatively few economic alternatives available to farmers.

Area Resources

Land. The Soil Conservation Service estimates that there are about 2.5 million acres of cultivable land in the study area (Table 2). Dryland wheat and barley are grown primarily on Capability Class III land, and to a lesser degree on Class II and IV land. Generally, Class III land is quite steep for cultivation, has shallow soil, and can suffer from severe wind and water erosion if it is not properly managed. Stubble mulch farming is recommended by the Idaho Agricultural Experiment Station in order to maximize yields and minimize erosion losses (7). Other recommendations include a clover-wheat-fallow rota-

Table 2. Land suited for cultivation, 13 southeastern Idaho study counties.[1]

Land capability class	Description	Area (acres)
I	Very good cultivable land, deep soil, nearly level, little or no erosion, adapted to a wide variety of crops. No special difficulties in farming.	140,300
II	Good cultivable land. Gentle slopes, moderately deep soil. Requires moderate degree of protection.	677,500
III	Moderately good cultivable land. Moderate slopes, steeper than II, shallow soil, moderate to severe erosion, some poor drainage, etc. Needs careful protection from erosion.	1,398,300
IV	Fairly good cultivable land. Suitable for occasional cultivation (1 in every 6 years). Requires special crops under careful management.	363,600
Total	I-IV	2,579,700

[1]Source: **Idaho Soil and Water Conservation Needs Inventory**, The Idaho Conservation Needs Committee, September 1963.

Table 3. Total area involved in dryland cultivation for selected years, southeastern Idaho study area.[1]

Year	Dryland area harvested	Summer fallow	Total area harvested and fallow
	(acres)	(acres)	(acres)
1949	925,142	672,382	1,597,524
1954	902,330	711,647	1,613,977
1959	840,293	669,264	1,509,557
1964	765,869	655,061	1,420,930

[1]Source: **Census of Agriculture,** United States Department of Commerce, Bureau of the Census.

tion in areas where the annual rainfall is 13 to 16 inches, and an alternate wheat-fallow system where rainfall is less than 13 inches (5).

Census data indicate that there are about 1.6 million acres available for growing dryland wheat and barley (Table 3). In 1954 there were 1,613,977 dryland acres cultivated; in 1964, only 1,420,930 acres. The amount of fallowed acres compared to dryland acres harvested has ranged from 42.1 percent in 1949 to 46.1 percent in 1964.

Dryland wheat and barley in the study area are grown on dark colored soils of the semiarid and sub-humid regions.[*] The semiarid soils are located at lower elevations and receive from 12-19 inches of precipitation annually. The sub-humid soil type is located at higher elevations and receives from 14-25 inches of precipitation annually.

Generally, these soils are associated with quite steep topography at relatively high elevations (between 4,100 and 6,300 feet), have a wide range in the variation of precipitation (from 12 inches at lower elevations to 25 inches in the higher areas) and have short growing seasons (from 74 frost-free days at higher elevations to about 130 days at lower elevations). Management problems are concerned with grazing, controlling water and wildlife. In areas where irrigation and dryland farming are not practical these lands are used for grazing, wildlife and recreational purposes. At lower elevations where the growing season is longer, precipitation is a limitation; at higher elevations where rainfall is quite adequate for farming, the short growing season is a limitation. In either case, alternatives to grain farming are few. Cattle are raised in the foothills and breaks of this country and are sometimes found on grain farms with sufficient pasture and range land. Farms tend to be specialized, however, either as grain farms or cattle operations.

Weather. Fig. 3 shows lines of average annual precipitation in the study counties for a period of 20 years. The majority of the dryland farming area receives between 12 and 16 inches of annual rainfall. Precipitation in the area is closely correlated with elevation, with the areas around 4,000 feet receiving about 12 inches and the areas around 6,000 feet receiving about 16 inches. Annual precipitation greater than

[*]For specific and complete descriptions of the soil types relevant to this study area, see soil types C-2, C-8 and D-2 in **Soils of the Western United States** (8).

16 inches is found in certain areas, such as the higher elevations of Fremont County.

An analysis of wheat and barley production and precipitation variations indicated that rainfall received during the fall months of October, November and December and the spring months of April, May and June was most influential in affecting total crop production. Precipitation data for weather reporting stations in the study area are shown in Appendix Table 2; quarterly precipitation data for a 20-year period are shown in Appendix Table 3.

October-to-December precipitation ranged from a low of 1.36 inches to a high of 5.71 inches between 1946 and 1965. April-to-June rainfall during the same period varied from a low of 2.18 inches to a high of 4.91 inches.

The uncertainty of adequate rainfall in any one year influences farming practices in the study area. As a group, farmers do not apply fertilizer to their crops even at relatively low application rates, because a dry spring might mean the loss of this investment and possibly a negative return from the fertilizer.

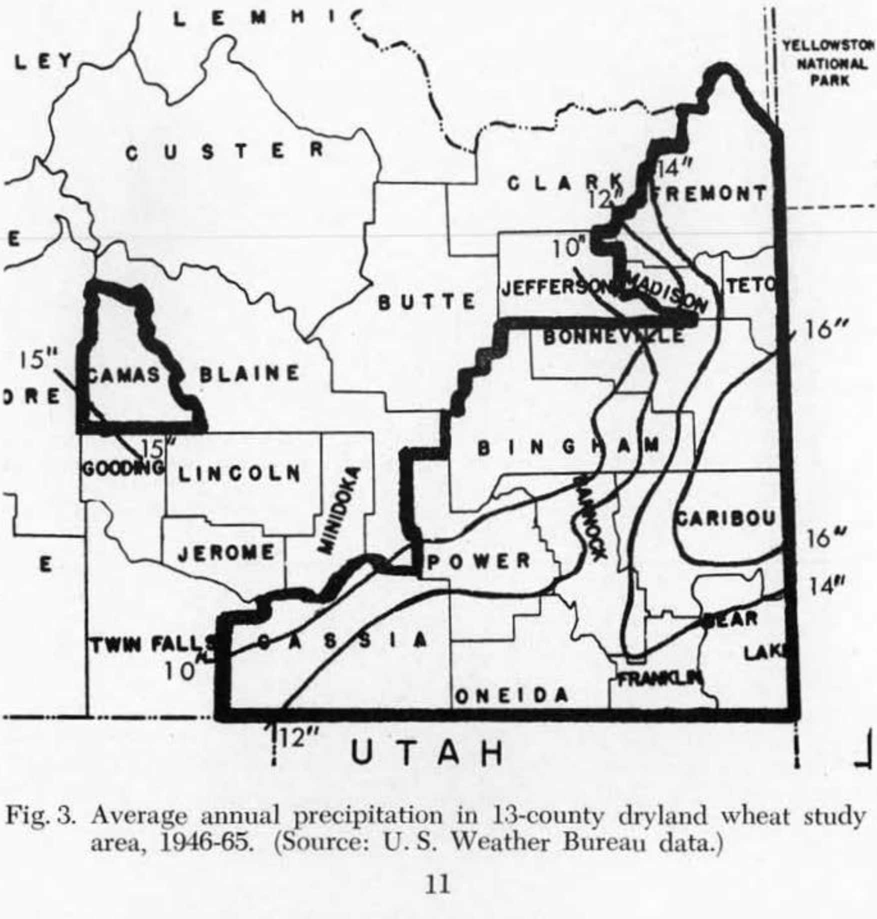

Fig. 3. Average annual precipitation in 13-county dryland wheat study area, 1946-65. (Source: U. S. Weather Bureau data.)

Table 4. Summary of crops harvested, southeastern Idaho study area.[1]

Crop	Total acres harvested	Irrigated acres harvested	Dryland acres harvested	Percentage distribution-dryland acres harvested
Wheat	622,583	135,129	487,454	57.1
Barley	229,435	50,726	248,709	29.1
Oats	29,430	16,880	12,550	1.5
Hay	429,229	331,831	97,398	11.4
Other	234,516	227,290	7,226	0.9
Total	1,615,193	761,856	853,337	100.0

[1]Source: **1959 Census of Agriculture,** United States Department of Commerce, Bureau of Census.

Organization of Producing Units

Cropping Patterns and Rotations. The relative importance of all dryland crops in the study area can best be evaluated from Census data. Wheat, barley and hay accounted for 99.1 percent of all dryland crops in 1959; less than one percent of the acres harvested was in other crops (Table 4). Wheat and barley made up 86.2 percent of dryland area harvested in 1959 and there were about two acres of wheat planted for each acre of barley.

Budgets for this study were developed on the basis that two-thirds of the area planted was in wheat and one-third in barley. Oats and hay were not included because these crops tend to be grown on ranches and the few grain farms with livestock. Farm budgets for 1,000, 2,000 and 3,000 acre dryland wheat-barley farms for 1960 and 1970 are presented in Appendix Tables 5 and 6.

Snow mold is a problem in winter wheat on dryland farms in the study area. The disease has caused farmers in some areas to switch from winter wheat to spring grains (4). Possible control measures for this problem include the use of resistant varieties, early seeding and the use of sweet clover or alfalfa in the rotation.

Numbers and Sizes of Farms. The number of farms in the dryland wheat study area has been decreasing steadily since 1949, and conversely the average size of farms has been increasing. The trends are shown in Table 5.

For the period from 1949 to 1970 it is estimated that the number of dryland wheat farms will decline by one-third and the average size will increase by about 40 percent. When low wheat and barley prices prevail, the only way a farmer can increase his income is to expand his operation.

Table 5. Dryland farm numbers and average farm size in southeastern Idaho for selected years.[1]

Year	Number of dryland farms	Average size of dryland farms
		(acres)
1949	1,784	895
1954	1,674	964
1959	1,376	1,097
1964	1,220	1,164
1970	1,066[2]	1,231[2]

[1]Census of Agriculture data.
[2]Estimated from past trends.

Table 6. Distribution of farms by size groups in southeastern Idaho study area.

Farm size class	Percentage distributions			
	1954[1]	1959[1]	1964[2]	1970[2]
0-500 acres	31.1	16.9	12.7	8.5
500-999 acres	29.6	32.8	33.0	33.2
1,000 acres and over	39.3	50.3	54.3	58.3

[1] Data from Census of Agriculture.

[2] Estimated from trends in previous Census years .

Distribution of Farm Sizes. Data on the distribution of farms by size class in the study area are scarce. The Census of Agriculture is one source of this data; however, it is quite inadequate where larger farms (over 1,000 acres) are concerned. Table 6 presents available Census data on the distribution of farm sizes for 1954 and 1959, and estimates for 1964 and 1970.

The number of dryland farms under 500 acres will become very small by 1970, except for the few that have some other enterprise alternatives in addition to wheat and barley to make them an economical unit. Farms with 1,000 acres of cropland had an expected net income of $5,724 in 1960 (1). With costs of production increasing by about two percent per year and yields remaining constant, economic factors indicate continued pressure for larger and larger units for this type of farming.

Area Planted to Wheat and Barley. There are about 1.6 million acres available in the study area for planting wheat and barley. Under a cropland-fallow system where the area is equally divided, about 800,000 acres would be planted each year. Before 1954, without acreage restrictions, farmers planted up to 957,500 acres in wheat and barley in one particular year (Table 7). With the advent of the wheat allotment and feed grain programs, the total area in wheat and barley has declined to as low as 711,900 acres per year.

Net returns per acre from wheat usually exceed those from barley. This explains why the area planted to wheat rose to 853,900 acres in 1952 under free planting conditions, while the area planted to barley was around 100,000 acres. In 1954 wheat acreage dropped to 593,300 acres from 826,600 in 1953—primarily because of allotments. The acres diverted from wheat were planted to barley, as is shown by the increase in the barley area from 121,300 acres in 1953 to the 352,100 acres in 1955. Barley acreage has also declined with the coming of the feed grain program from 278,700 acres in 1962 to 198,600 acres in 1965.

Under a free market system farmers planted as much wheat as they could with the remainder of the land going into barley. When the Wheat Allotment Program was created, typically about two-thirds of the land was in wheat and one-third in barley. With both the wheat and feed grain programs in effect there are about 500,000 acres of wheat planted each year and 200,000 of barley. About 250,000 acres of land are idle, that is, they could be brought into production under free market conditions and sufficiently high prices for wheat and barley. The results of this study are based on the assumption that there were no exogenous incentives to divert land from wheat or barley production.

Machinery Components and Investments. Representative farms in the study were assumed to have the machinery inventory necessary to conduct grain farming operations. Machinery requirements included crawler tractors, self-propelled combines, disks, rodweeders, tool bar, deep-furrow drills, a pickup truck and trucks for hauling, plus a grain auger and shop equipment. Appendix Table 4 presents the equipment component for each representative farm, the number and size of each piece of equipment and its estimated cost in 1970. The machinery inventory represents what was actually found to be typical in the surveys by Esmay and Anderson. Certain custom operations were also hired to complement farm machinery in order to complete the farming operation. Custom spraying, and hauling during harvest were hired to varying degrees, depending on the size of the farm. Additional labor was also hired during harvest time, especially on the larger farms.

Total equipment investments in 1970 were estimated to be $34,567 for the 1,000 acre farm, $61,239 for the 2,000 acre farm and $85,775

Table 7. Acres of dryland wheat and barley planted in southeastern Idaho, 1946-1965.[1]

Year	Dryland wheat planted	Dryland barley planted	Total
	(acres)	(acres)	(acres)
1965	524,100	198,600	722,700
1964	477,400	234,500	711,900
1963	477,400	254,800	732,200
1962	465,100	278,700	743,800
1961	513,800	262,900	776,700
1960	509,000	252,400	761,400
1959	519,500	264,700	784,200
1958	541,600	259,700	801,300
1957	513,500	297,300	810,800
1956	598,200	216,300	814,500
1955	592,800	352,100	944,900
1954	593,300	260,700	854,000
1953	826,600	121,300	947,900
1952	853,900	93,600	947,500
1951	855,600	102,100	957,700
1950	709,500	145,600	855,100
1949	756,200	99,600	855,800
1948	780,700	103,400	884,100
1947	740,600	75,900	816,500
1946	671,800	75,000	746,800

[1]Source: Statistical Reporting Service, United States Department of Agriculture.

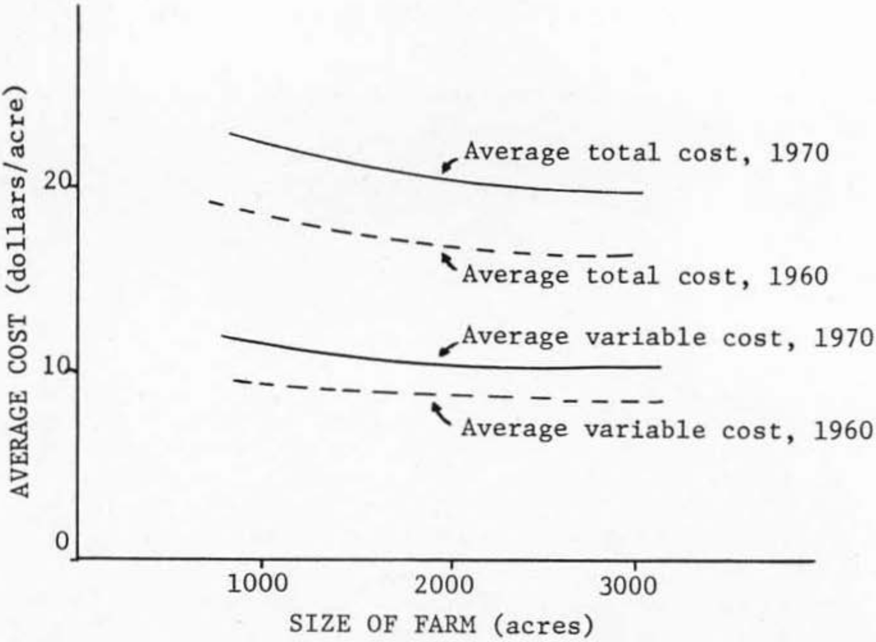

Fig. 4. Average costs of production for southeastern Idaho dryland wheat-barley farms (50 percent crop land), 1960 and 1970.

for the 3,000-acre farm. Machinery investments varied from $34.57 per acre on the 1,000 acre farm to $28.59 for the 3,000 acre farm, and represents the majority of the efficiencies gained from operating larger units. Machinery components that could be utilized to a greater extent on larger farms included the tractors, disks, rodweeders, tool bar, drills and pickup truck. The need for combines and trucks tended to increase in the same proportion as the size of the farm.

Over the period from 1960 to 1970 machinery investments on dryland wheat farms were estimated to increase by 20.8 percent for the 1,000 acre farm and 24.8 percent for the 3,000 acre farm. Estimated investments are based on price trends of machinery items from 1960 to 1966.

Costs of Production. Estimated average variable and total costs of production for dryland wheat-barley farms in southeastern Idaho are expected to increase somewhat by 1970 (Fig. 4). For the 1,000 acre farms, average total production costs in 1960 were $18.33 per acre for wheat and $18.84 for barley. By 1970 these same costs are projected to increase to $21.78 per acre for wheat and $23.27 per acre for barley. Average total costs are higher for barley than for wheat since barley ground usually is disked and rodweeded one more time. The cost of seed, however, is less for barley than for wheat. Spraying costs were assumed to be hired on a custom basis and are identical for all sizes of farms.

The cost of harvesting both wheat and barley is about the same since approximately the same tonnage of grain is harvested per acre for either crop. Principal variations in harvest costs are caused by difference in the need for hired labor in the form of combine drivers and truck drivers.

The labor requirements to grow an acre of wheat or barley vary with the size of the farm. An acre of wheat requires an estimated 2.3 man hours on a 1,000 acre farm, 1.7 and 1.5 man hours respectively are required on 2,000 and 3,000 acre farms. Labor requirements for barley are somewhat greater at 2.7 hours per acre for a 1,000 acre farm, 1.94 hours per acre for a 2,000 acre farm and 1.74 hours per acre for a 3,000 acre farm. Differences in labor requirements are the result of the larger equipment in use on larger farms.

The budgets constructed for this analysis do not include a fertilizer item. Farmers indicated in the surveys they generally have not used fertilizer on their dryland wheat and barley. It is not likely that much fertilizer will be applied so long as water is the limiting growth factor.

The fertilizer recommendation for southeastern Idaho areas with less than 15 inches of rainfall is 30 pounds of nitrogen per acre, where soil nitrogen is deficient (5). Careful use of nitrogen should increase wheat quality (protein content) and yield (3). However, excessive use of this fertilizer leads to wasteful use of water by plants, increases costs of production without corresponding increase in yields and, in dry seasons, may cause considerable damage to the crop.

Production Relationships

Method of Estimation. To estimate aggregate production relationships for southeastern Idaho dryland wheat, data were analyzed for the period from 1946 to 1965.

Multiple regression analysis was used to establish relationships between factors of production and total output in the study area. Data were subjected to linear, quadratic and logarithmic equations to determine which situation was most appropriate.

For both wheat and barley, the statistically significant variables were found to be the area planted, October through December precipitation and April through June precipitation. Neither monthly temperatures nor the introduction of new varieties was statistically significant in its relationship to total production. Other factors such as late frosts, disease problems and the use of new farming methods may also affect total production but were not included in the analysis.

Production Function for Wheat. Results of the analysis for wheat indicated the quadratic regression equation gave the best results in terms of the coefficient of determination, standard errors and t-ratio values. The resulting equation was as follows:

$$Y_w = -14{,}035{,}000 + 54.69527X_2 - .000029853X_2^2$$

standard error	(20.18729)	(.000015151)
t–ratio	(2.70939)	(1.97030)

$$+579{,}750X_3 + 709{,}870X_4$$

(191,560)	(145,350)
(3.02635)	(4.88385)

Where:

Y_w = total production of wheat in bushels
X_2 = acres planted
X_3 = October-December precipitation in inches (preceding year)
X_4 = April-June precipitation in inches

Coefficient of Determination = .89325

Fig. 5 presents the relationship between total production of dryland wheat and the area planted with the October-December and April-June precipitation held constant at their average levels. The production function is drawn over the range of acres planted encountered in the data. All variables in the above equation were significant at the 5 percent level.

At the level of technology in use from 1946 to 1965, diminishing returns were encountered as the area planted increased toward 850,000 acres. Table 8 summarizes the average and marginal production relationships of the function in Fig. 5. These relationships might change significantly if a new technology (such as the adoption of some new fertilizer) came into general use in the study area.

Production Function for Barley. Production analysis for barley closely followed that for wheat in that the same variables were statistically significant, and the quadratic form gave the best results. The final regression equation took the following form:

$$Y_b = -608{,}630 + 55.38468X_2 - .000078049X_2^2 + 487{,}580X_3 + 628{,}500X_4$$

standard error	(6.90752)	(.000017674)	(111,150)	(70,826)
t–ratio	(8.01802)	(4.41589)	(4.38654)	(8.87390)

Where:

Y_b = total production of barley in bushels
X_2 = acres planted
X_3 = October-December precipitation in inches (preceding year)
X_4 = April-June precipitation in inches

Coefficient of Determination = .97464

Fig. 6 and Table 9 again summarize the production relationships between the area planted and total production, while holding fall

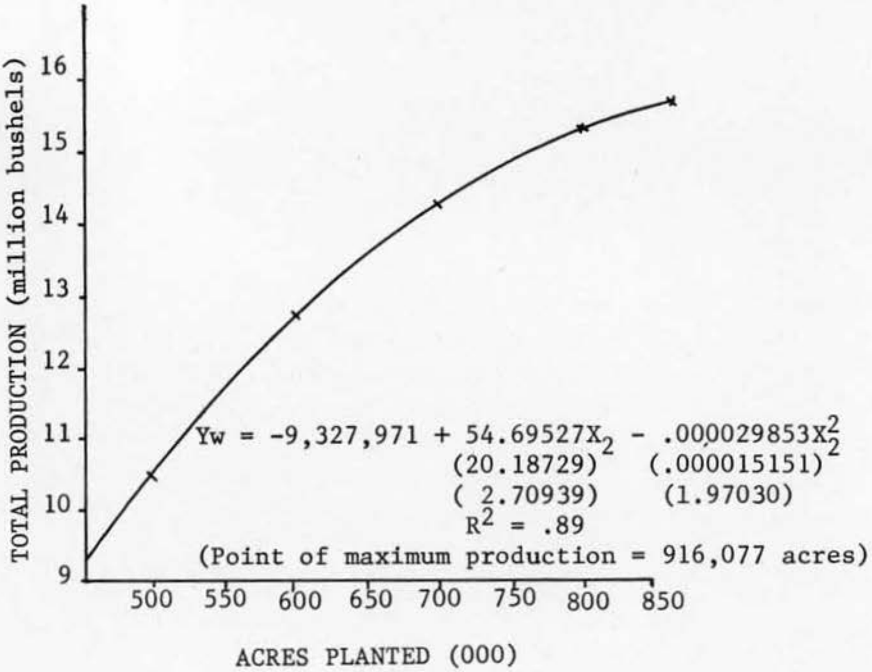

Fig. 5. Production function for dryland hard winter wheat in southeastern Idaho.

Table 8. Production relationships for dryland hard winter wheat in southeastern Idaho.

Area planted (acres)	Total production (bu.)	Average production (bu./acre)	Marginal product (bu./acre)
450,000	9,239,669	20.5	27.9
500,000	10,556,414	21.1	24.9
600,000	12,742,111	21.2	18.9
700,000	14,330,748	20.5	12.9
800,000	15,332,325	19.2	6.9
850,000	15,594,217	18.3	3.9

Table 9. Production relationships for dryland barley in southeastern Idaho.

Area planted (acres)	Total production (bu.)	Average production (bu./acre)	Marginal product (bu./acre)
75,000	1,710,334	22.8	43.7
100,000	2,753,486	27.5	39.8
200,000	5,950,484	29.8	24.2
300,000	7,586,502	25.3	8.6
350,000	7,819,144	22.3	0.8

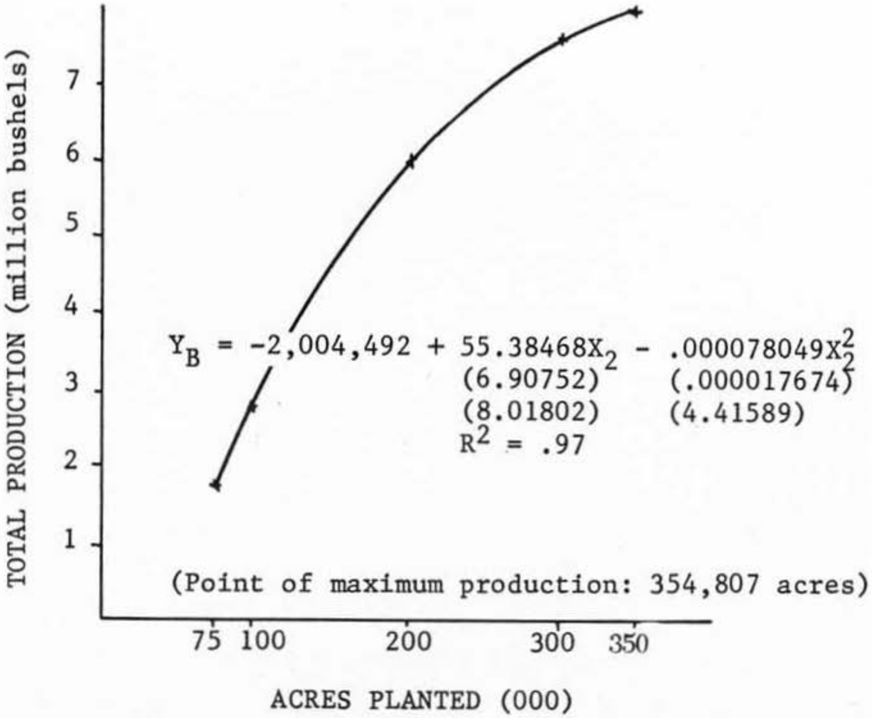

Fig. 6. Production function for dryland barley in southeastern Idaho.

and spring rainfall constant at their average levels. Comparison of the regression coefficients of the wheat and barley analysis indicates the independent variables have quite similar effects on the production of both these grains.

The equation in Figs. 5 and 6 represent production relationships encountered when wheat and barley are grown on dryland farms in southeastern Idaho. In the study counties, winter wheat is planted in the fall and the remainder of the area is planted to barley the following spring. The barley relationship would probably be somewhat different than that presented in Fig. 6 if no wheat were grown in the study area.

In addition, a new variety of barley called Piroline was introduced in 1965 which will increase yields above past levels (6).

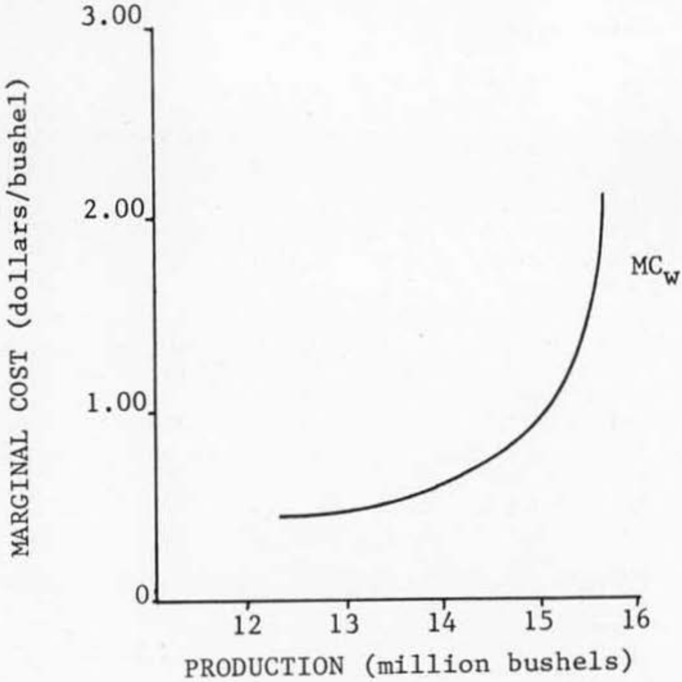

Fig. 7. Marginal cost of producing dryland hard red winter wheat in southeastern Idaho, 1970.

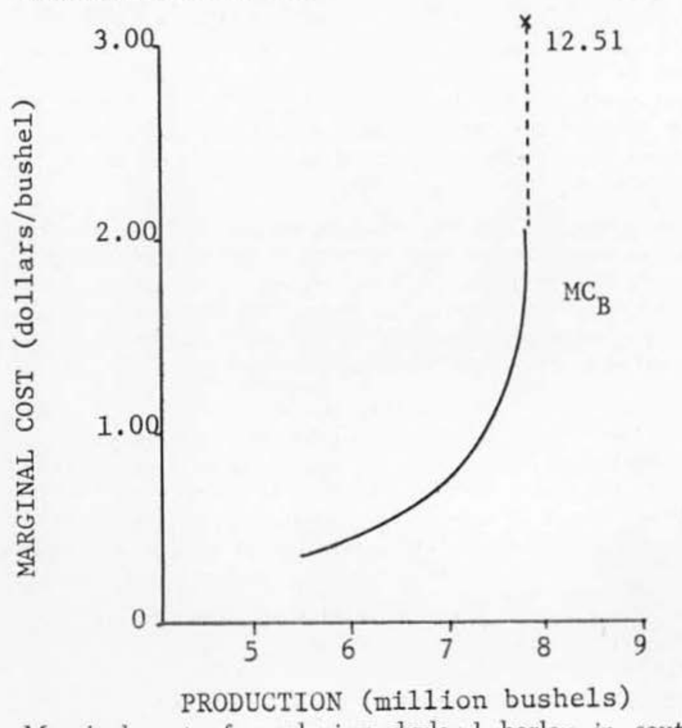

Fig. 8. Marginal cost of producing dryland barley in southeastern Idaho, 1970.

Supply Relationships

Method of Estimation. Aggregate marginal cost functions for wheat and barley were estimated for the study area based on the production functions in Figs. 5 and 6 and the enterprise budgets for 1970 (Appendix Table 6).

Marginal returns per acre of planted cropland in the study area were estimated from the first derivative of production functions for wheat and barley, under average weather conditions. Thus, above or below average rainfall in fall or spring would alter the results presented here. However, it is assumed that farmers would base their plans on the average year rather than good or bad years. Variable costs of production for wheat and barley were obtained from the 1,000 acre representative farm budget. The average size of dryland farms was estimated to be 1,231 acres in 1970 (Table 5). Consequently the 1,000 acre representative farm was selected as being closest to the most typical farm in that year. From the respective marginal product functions and variable costs of production, aggregate marginal cost functions for the two principal crops in the study area were derived.

Each aggregate marginal cost function was derived independently, allocating all resources to the production of wheat or barley. Farmers as a group were assumed to act in such a way as to maximize their profits. At each level of production they would reduce costs as much as possible in order to maximize potential profits.

Aggregate Marginal Cost Functions. Figs. 7 and 8 show the estimated marginal cost functions for the production of dryland wheat and barley. It was assumed that a maximum of 957,500 acres of cropland is available for planting in any one year, which is consistent with the situation observed during the Korean War. Under the technology in use up to 1965 it is doubtful that the study area can produce more than 15.6 million bushels of wheat or 7.8 million bushels of barley from the dryland acreage in a single year.

Farmers would not be expected to produce at a price which would not cover their average variable costs of production per acre. At an average annual yield of 20.3 bushels per acre for wheat and 27.0 bushels per acre for barley, the price of wheat would have to be at least $.47 per bushel and the price of barley at least $.37 per bushel to cover variable costs and justify production.

Above prices of $1.30 per bushel for wheat and $1.00 per bushel for barley, the potential supply curves for both crops are relatively inelastic (assuming farmers as a group tend to equate marginal cost and price). Under free market conditions for these crops, approximately 15.4 million bushels of wheat or 7.4 million bushels of barley would be produced at these prices. Actual production would be something less than this because the two crops compete with each other for cropland.

In the long run, it was estimated that wheat prices must average $1.57 per bushel and barley prices must average $.86 per bushel to cover average total costs on 1,000 acre farms in 1970 with average yields. At prices below these levels certain fixed costs will not be

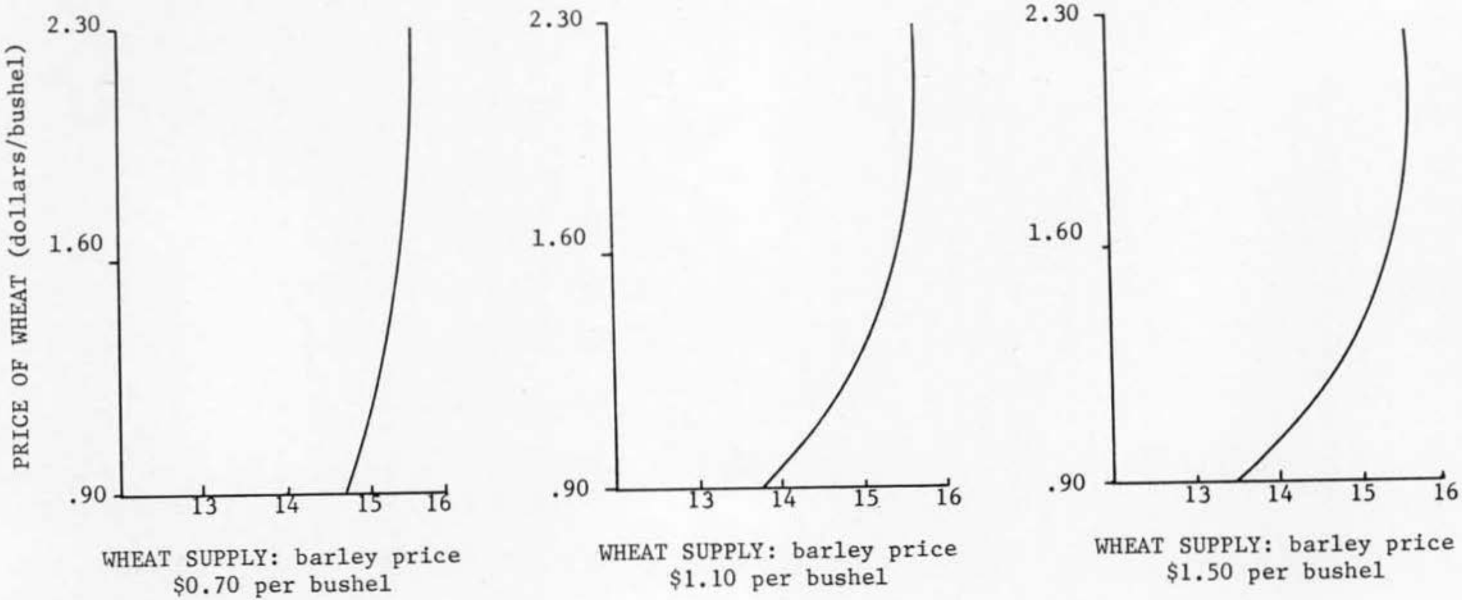

Fig. 9. Southeastern Idaho supply of wheat (millions of bushels) at alternative barley prices, 1970.

paid, nor is there a return to the farm manager for his efforts. Even at average market prices in recent years there is considerable economic pressure for the smaller farmers either to enlarge their operations or sell out.

Production Levels Under Alternative Prices. Wheat and barley compete for the same resources in terms of land and other farm inputs. In a particular year farmers must decide how much of each crop to plant. Wheat has had definite economic advantages over barley in the past. In fact, barley has been grown in excess of 100,000 acres per year only when wheat allotments were imposed by government programs.

Winter wheat has two basic advantages over spring barley. The costs of production for wheat are lower, by an estimated $1.49 per acre in 1970, primarily because there is less field work. And the price of wheat has been relatively higher than the price of barley, so greater net returns are expected from growing wheat. In 1955, a year after the wheat allotment program began, farmers planted 352,100 acres of barley in an effort to substitute this grain on the diverted wheat acreage. Barley planting has never exceeded 300,000 acres since then, and time series data indicate maximum barley production is achieved at about 354,000 acres when planted after fall wheat. Thus, the production of wheat has a considerable absolute advantage over barley in economic terms.

Because of this competitive situation, farmers tend to favor planting wheat over barley. Prior to the wheat allotment program there was only 1 acre of barley planted to every 7 or 8 acres of wheat. In the program-free economy, wheat was planted to as much land as possible and the remainder was planted to barley. It is expected that this situation would prevail again in 1970 if there were no wheat or feed grain programs.

To show the response of producers to alternative wheat and barley prices, supply curves were developed for wheat and barley at low, medium and high prices for the competing crop. The results of this analysis are presented in Figs. 9 and 10.

Fig. 9 shows supply response curves for wheat at alternative barley prices. At a low barley price ($.70 per bushel) the estimated supply curve for wheat is nearly perfectly inelastic. At successively higher barley prices the supply curve for wheat becomes relatively more and more elastic; however, at prices above $1.30 for wheat the supply function is always highly inelastic. These curves reflect the fact that barley can be substituted for wheat at quite high barley prices, but the degree of that substitution is definitely limited.

Fig. 10 shows estimated barley supply curves at alternative wheat prices. At an exceedingly low wheat price ($.90 per bushel) the supply of barley is somewhat responsive to increased prices. At higher wheat prices ($1.60 or $2.30 per bushel), the amount of barley produced is simply a residual. Land that is suitable only for barley or that cannot be planted to wheat is put into barley. The maximum quantity of barley produced declined steadily as the price of wheat increased,

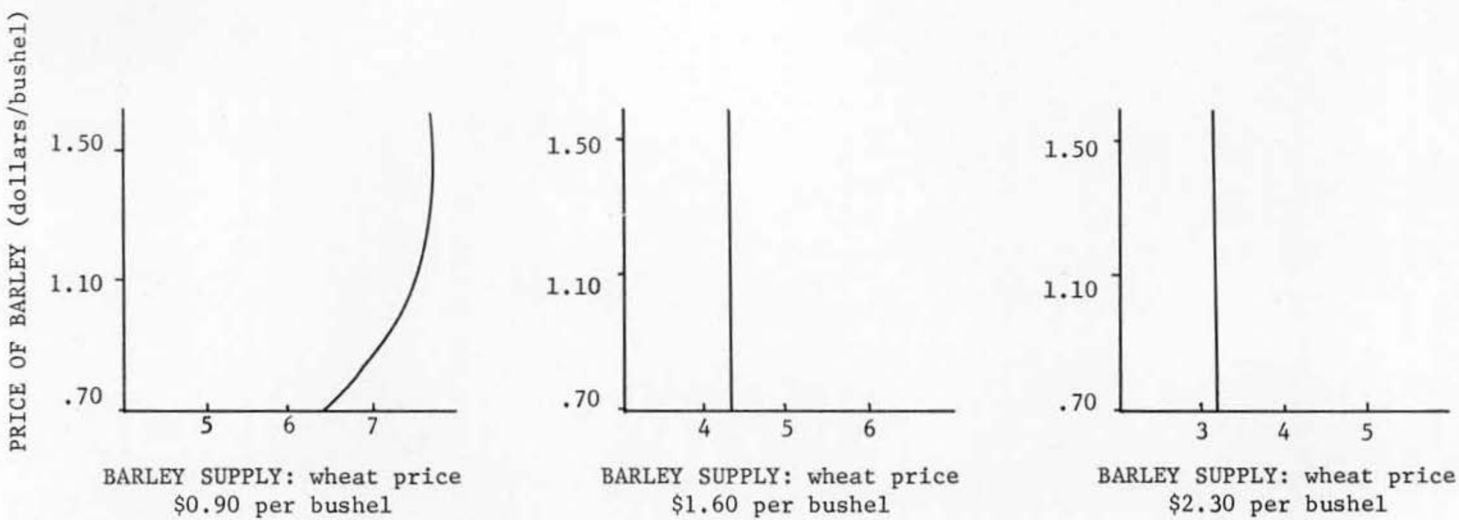

Fig. 10. Southeastern Idaho supply of barley (millions of bushels) at alternative wheat prices, 1970.

from an estimated 7.6 million bushels at a wheat price of \$.90 per bushel to only 3.2 million bushels at a wheat price of \$2.30 per bushel.

Supply functions for both grains are quite inelastic because of the lack of economic alternatives in the area and the high investments in land and machinery. If farms in the area continue to grow in size, increasing fixed costs relative to variable costs, supply relationships are not likely to become any more elastic in the future. Unless technology provides new and better varieties or other economic alternatives, farmers in the dryland area will continue to be quite inflexible in the crops they produce.

Significance of Wheat and Barley Prices. This effort to establish supply response curves for dryland wheat and barley in southeastern Idaho indicates supply functions are relatively inelastic for both crops. These results suggest the hypothesis that the prices for wheat and barley play a minor role in planning agricultural output in the study area. The lack of alternatives and heavy equipment investments tend to commit farm resources to maximizing output regardless of prices.

Relationships between actual prices for wheat and barley and the supply of these crops tend to confirm this hypothesis. Regression analysis on the relationship between crop prices and production levels showed that relative prices for wheat and barley in the previous year were not statistically related to output. Regression equations were estimated using 20 years of data.

Results of the estimated supply regression equation for wheat was as follows:

$$Y_w^s = 8{,}777{,}400 - 1{,}987{,}500 \left[\frac{P_w}{P_b}\right]_{t-1} + 904{,}750\, S_w$$

standard error	(1,370,100)	(1,879,200)
t-ratio	(1.45066)	(.48143)

$$-47{,}483\, I + 100.17531\, A_1 + 649{,}720\, R_1 + 472{,}390\, R_2$$

(48,584)	(49.16046)	(276,040)	(192,410)
(.97732)	(2.03772)	(2.35365)	(2.45512)

Where:

Y_w^s = quantity of wheat produced in bushels

$(Pw/Pb)_{t-1}$ = price ratio of wheat to barley in previous year

S_w = support price for wheat

I = index of production costs

A_1 = United States acreage allotment for wheat

R_1 = Fall rainfall

R_2 = Spring rainfall

Coefficient of Determination = .82538

The rainfall and wheat allotment variables were found to be statistically significant, while the remaining variables were not significant,

The results for barley were somewhat similar and are indicated below:

$$Y_b^s = 10{,}488{,}000 - 2{,}431{,}100 \left[\frac{P_b}{P_w}\right]_{t-1} + 2{,}150{,}000\ S_b$$

standard error	(3,086,680)	(2,395,300)
t-ratio	(.78757)	(.89757)

$$+\ 25{,}426\ I - 172.07492\ A_1 - 6{,}650.662\ A_2 + 32{,}593\ R_1 + 658{,}880\ R_2$$

(38,002)	(40.77123)	(10,217)	(235,560)	(197,010)
(.66907)	(4.22049)	(.65090)	(.13836)	(3.34427)

Where:

Y_b^s = quantity of barley produced in bushels

$(Pb/Pw)_{t-1}$ = price ratio of barley to wheat in previous year

S_b = support price for barley

I = index of production costs

A_1 = United States acreage allotment for wheat

A_2 = acreage of barley diverted in Idaho

R_1 = Fall rainfall

R_2 = Spring rainfall

Coefficient of Determination = .92893

In wheat as in barley, rainfall and the wheat program were the only statistically significant factors in the estimated supply equations. In both equations the sign of the regression coefficient for the price ratio variable was negative, or the opposite from what one might expect. These results tend to emphasize the conclusion that prices have little influence on the quantity of wheat or barley supplied from the study area.

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Appendix

Table A-1. Dryland wheat and barley production in southeast Idaho study area, 1946-65.[1]

Year	Total wheat production	Total barley production
	(bu.)	(bu.)
1965	13,679,800	8,244,000
1964	11,566,600	8,111,500
1963	12,417,600	8,787,500
1962	9,886,800	7,883,800
1961	9,922,400	5,815,400
1960	8,728,200	4,917,900
1959	11,330,500	6,233,900
1958	11,088,300	7,336,000
1957	11,932,100	9,132,500
1956	12,151,900	5,440,600
1955	11,451,300	6,962,200
1954	10,482,000	6,357,100
1953	15,958,200	3,073,500
1952	14,364,300	2,684,800
1951	15,362,600	2,236,200
1950	14,704,100	3,985,300
1949	13,826,700	2,728,400
1948	15,183,500	2,638,300
1947	16,953,700	2,280,800
1946	14,461,300	1,857,400

[1]Source: Statistical Reporting Service, United States Department of Agriculture.

Table A-2. Average annual precipitation at primary weather reporting stations, southeastern Idaho, 1946-1965.

County	Weather reporting station	Average annual precipitation (inches)
Bear Lake	Lifton Pumping Station	9.88
Bingham	Aberdeen Experiment Station	7.94
Bingham	Fort Hall Indian Agency	10.16
Bonneville	Idaho Falls Airport	8.37
Camas	Hill City	15.64
Caribou	Grace	14.38
Cassia	Burley Airport	9.89
Cassia	Oakley	11.09
Fremont	Ashton	17.49
Fremont	St. Anthony	14.69
Madison	Sugar	12.10
Oneida	Malad	13.89
Oneida	Malad City Airport	12.46
Power	Pocatello Airport	10.28
Teton	Driggs	14.98

[1]Source: Weather Bureau data.

Table A-3. Average quarterly and annual precipitation for the 13 study counties, southeastern Idaho, 1946-1965.[1]

	Quarterly Precipitation (inches)				Annual Precipitation (inches)
Year	January-March	April-June	July-September	October-December	
1965	2.23	5.46	3.47	2.90	14.06
1964	2.82	6.42	.91	5.71	15.86
1963	3.47	7.85	3.06	3.67	18.05
1962	3.80	3.62	2.41	1.82	11.65
1961	2.54	2.21	4.43	3.89	13.07
1960	3.80	2.32	1.66	3.36	11.14
1959	2.85	3.60	2.87	1.36	10.68
1958	3.80	2.76	1.79	2.54	10.89
1957	3.18	6.11	1.36	3.21	13.86
1956	3.31	2.89	.93	3.21	10.34
1955	2.62	4.12	2.75	4.59	14.08
1954	3.17	3.67	1.31	2.42	10.57
1953	3.04	4.49	.82	2.29	10.64
1952	4.03	3.13	1.65	2.13	10.99
1951	3.61	3.04	3.45	4.48	14.58
1950	4.91	3.26	2.43	3.47	14.07
1949	3.83	4.00	1.52	4.02	13.37
1948	2.75	4.40	2.16	3.88	13.19
1947	2.18	4.98	2.64	3.29	13.09
1946	3.73	2.89	1.82	4.67	13.11

[1]Source: U.S. Weather Bureau data from 18 stations located in the study area.

Table A-4. Machinery and equipment investment for three representative farms, southeastern Idaho study area, 1970.

Machinery or Equipment Item	1,000 acre farm		2,000 acre farm		3,000 acre farm	
	No.	Initial cost	No.	Initial cost	No.	Initial cost
Tractor, 30-50 hp	1	$ 7,560			1	$ 7,560
Tractor, 60-90 hp			1	$14,256	1	14,256
Combine, 16 ft S.P.	1	10,368	2	20,736	3	31,104
Disks, 10 ft tandem	2	2,160	3	3,395	3	3,395
Rodweeders, 12 ft	2	1,202	3	1,803	5	3,005
Tool bar, 14 ft	1	1,313				
Tool bar, 21 ft			1	1,970	1	1,970
Drills, 12 ft	2	2,664	3	3,996	3	3,996
Trucks, 1½ ton	1	5,351	2	10,702	3	16,054
Pickups, ½ ton	1	3,085	1	3,085	1	3,085
Grain auger	1	324	2	648	2	648
Shop equipment		540		648		702
Total investment		$34,567		$61,239		$85,775
Investment per acre		34.57		30.62		28.59

Table A-5. Dryland farm budgets for southeastern Idaho, 1960.[1]

Item	1,000 acre farm		2,000 acre farm		3,000 acre farm	
	Wheat	Barley	Wheat	Barley	Wheat	Barley
			(dollars per acre)			
Preharvest costs:						
Seed	2.10	1.00	1.69	1.37	1.69	1.37
Spray	.76	.76	.76	.76	.76	.76
Machinery: Fuel, Lub.	1.26	1.48	.104	1.23	.76	.95
Repair	1.85	2.22	2.04	2.51	1.58	2.07
Harvest costs:						
Combine: Fuel, Lub.	.29	.29	.29	.29	.29	.29
Repairs	.97	.97	1.26	1.26	1.26	1.26
Auger: Repairs	.01	.01	.01	.01	.01	.01
Hauling: Fuel, Lub.	.13	.13	.20	.20	.20	.20
Repairs	.09	.09	.12	.12	.12	.12
Custom hire: Truck	.75	.75	.68	.68	1.18	1.18
Interest:						
Operating capital	.62	.58	.57	.67	.55	.64
Fixed costs:						
Machinery	7.46	8.52	7.28	8.09	6.84	7.78
Taxes and building depreciation	2.04	2.04	4.03	4.03	3.97	3.97
Total costs per acre	18.33	18.84	19.97	21.22	19.21	20.60

[1]For a more detailed explanation of this budget, see Esmay (1).

Table A-6. Dryland farm budgets for southeastern Idaho, 1970.

Item	1,000 acre farm		2,000 acre farm		3,000 acre farm	
	Wheat	Barley	Wheat	Barley	Wheat	Barley
			(dollars per acre)			
Preharvest costs:						
Seed	1.69	1.37	2.10	1.00	2.10	1.00
Spray	.76	.76	.76	.76	.76	.76
Machinery: Fuel, Lub.	1.29	1.51	1.03	1.23	.75	.95
Repair	2.34	2.85	1.60	1.97	1.27	1.62
Harvest Costs:						
Combine: Fuel, Lub.	.29	.29	.29	.29	.29	.29
Repairs	1.26	1.26	.99	.99	.99	.99
Auger: Repairs	.01	.01	.01	.01	.01	.01
Hauling: Fuel, Lub.	.20	.20	.13	.13	.13	.13
Repairs	.12	.12	.09	.09	.10	.10
Custom hire: Truck	.93	.93	.78	.78	1.29	1.29
Interest:						
Operating capital	.62	.72	.59	.55	.58	.54
Fixed costs:						
Machinery	8.10	9.08	6.57	7.41	6.31	7.34
Taxes and building depreciation	4.17	4.17	2.04	2.04	2.04	2.04
Total costs per acre	21.78	23.27	16.98	17.25	16.62	17.06