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Considerations Influencing Utah Farmers in Their Decisions to Produce Sugar Beets

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CONSIDERATIONS INFLUENCING UTAH FARMERS IN THEIR DECISIONS TO PRODUCE SUGAR BEETS

by

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INTRODUCTION AND STATEMENT OF THE PROBLEM

Sugar has been an important commodity down through the ages. In the present day world, there is hardly any corner of the world where sugar is not consumed in one form or another.

Wide variation in per capita consumption of sugar exists among nations. Sugar consumption appears to be related to income level. Sugar in the United States is considered an item of necessity, and its consumption is relatively stable. This is evidenced by low price and income elasticities of demand for sugar which were -0.28 and 0.27 respectively for the period 1921-1956 (1). Consumers thus consume about the same amount of sugar regardless of price changes.

Historically, the United States has been a deficit producer of sugar and dependent upon imports. This does not create any problem in time of peace, but in case of war or other emergency, transportation difficulties immediately threaten to curtail the amount of sugar available for consumption. In 1962, the Sugar Act was amended to provide for considerable expansion of beet sugar production in the country. To facilitate this expansion competitive imports under "global quota" are made subject to an import fee. This fee approximates the premium the United States price is over the world price of raw sugar when such a premium exists (2).

In response to these changes, increased production of sugar was encouraged in the country by removal of acreage allotments. During 1960-1964, acreage restrictions were completely removed and proportionate shares were granted in 1965 on the basis of beet growing history of the

farm for 1962-1964 and requests of growers. Increased plantings of sugar beets create a need for enlargement of sugar processing facilities. This will involve heavy capital investments. The need for an assessment of the potential for expansion in sugar beet producing areas in the country is thus obvious.

In Utah production and processing of sugar beets has been an important part of the economy of the State. During the year 1964, sugar beets contributed about 18 percent to the State's farm income from crop enterprises. Total beet production was 428,270 tons which provided a gross income of $6,327,000 to the growers of the State. Sugar beets were produced on 32,800 acres by 1,323 growers (3) in 12 counties during 1964. About 96 percent of the acreage was concentrated in the northern and central counties of Cache, Box Elder, Weber, Davis, Salt Lake, Utah, Sevier, and Sanpete. The beet sugar processing industry, which is entirely dependent upon beet production and is the only market for beets, is an important part of the local economy of the State. Nationwise, too, Utah is an important sugar beet producing State. During the year 1964, it ranked eleventh and twelfth in the country in acreage harvested and tons produced (4).

During the past 20 years, advances have been made in sugar beet production. Labor requirements of the crop have been reduced. Yields have moved upward steadily (Figure 1). Studies conducted by the Utah Agricultural Experiment Station (5) indicate a continued rise in per acre net returns from the enterprise ($54.13 in 1945 to $74.13 in 1963).

In spite of these favorable trends, acreage and production figures show a downward trend in the State as well as in the eight important counties where most of the sugar beets are produced (Figures 2 and 3).

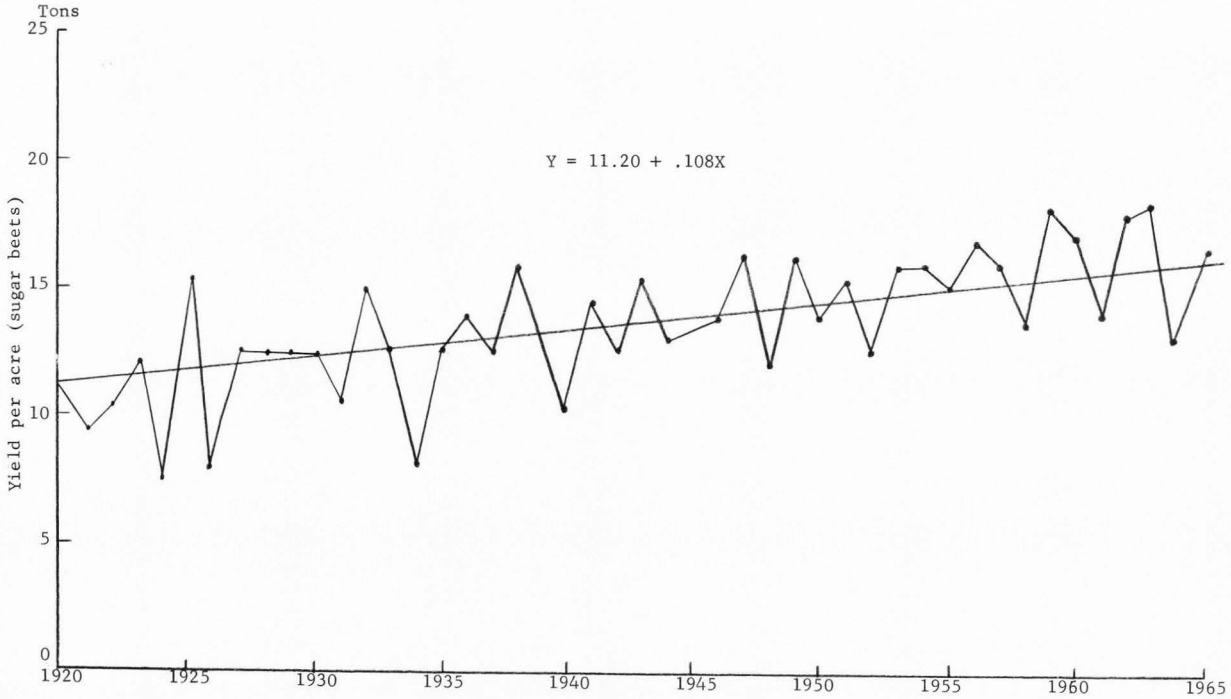

Figure 1. Sugar beet yields in Utah for the period 1920-1965

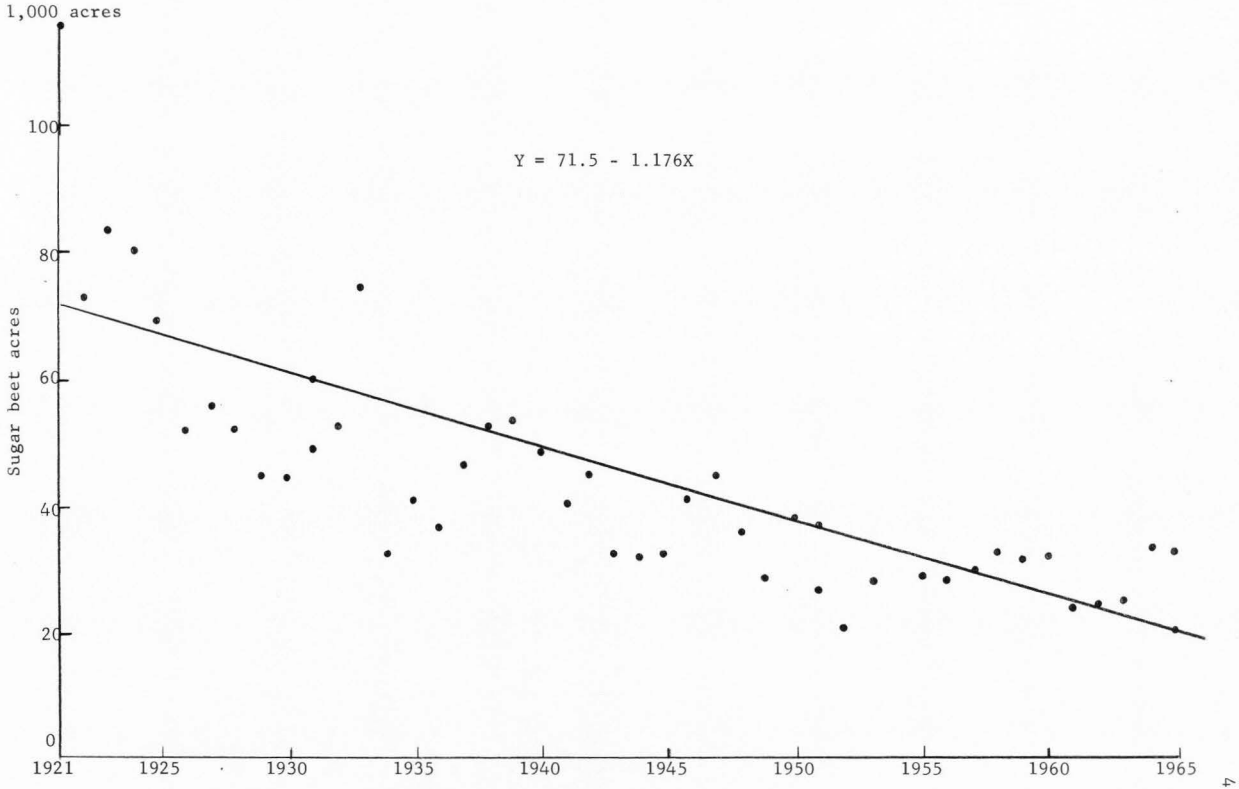

Figure 2. Acres of sugar beets harvested in Utah, 1920-1965

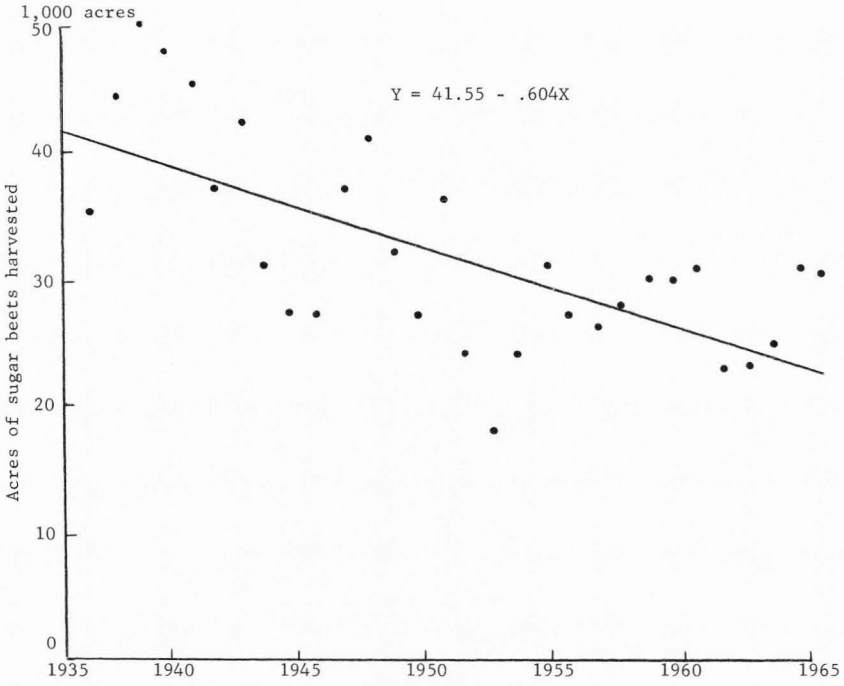

Figure 3. Acres of sugar beets harvested in eight important sugar beet producing counties of Utah, 1935-1965

During the past four decades, beet production in the State has been declining both relative to the neighboring areas in the western region and in absolute figures. Beet acreage was at a maximum with 113,000 acres during the year 1920. It declined to a minimum of 20,000 acres in 1952. The acreage for the period 1953 to 1964 was comparatively stable and averaged 28,750 acres. The situation in the processing industry has also shown a downward trend. Processors have reduced the number of factories in the State. These changes are accompanied by some shifts in production areas as well. While the processors reduced the number of plants in Utah, they have at the same time built new plants in other states.

The situation as described above leaves some doubt relative to the future of the sugar beet industry in the State and the feasibility of any possible expansion of processing facilities. There seems to be a lack of adequate knowledge to make meaningful judgments about the future of this important industry. Yet this knowledge is not only desirable for decision-making by the processing industry and the beet growers but is also of importance from the point of view of national policy consideration of producing more sugar within the country. It is thus pertinent that an analysis of problems and potential for expansion of sugar beet production be made.

Keeping this over-all objective in view, this thesis project studied factors which influence the sugar beet growers in Utah in their production decisions about sugar beets.

The two hypotheses advanced to direct the design and conduct of the study were:

1. There exist several physical and economic forces within and

surrounding the farm firms in Utah which weigh heavily in influencing the farmer's decisions to produce sugar beets.

2. Major irrigated crop enterprises grown in Utah compete with sugar beets for the allocation of irrigated land suitable for growing beets, and this is reflected in the differences in per acre returns from these crops.

OBJECTIVES

The specific objectives of the study were:

1. To ascertain the nature and extent of important related reasons responsible for farmers' decisions in producing sugar beets in Utah.

2. To estimate quantitatively the importance of competing crop enterprises affecting yearly variation in sugar beet acreage in Utah.

REVIEW OF LITERATURE

In reviewing literature pertinent to this study, interest was focussed on studies which had employed an analytical approach which could be applied to achieving the objectives of this study. Methods of particular interest were tabular analysis, and those related to the applications of least squares regression models and determination of significant variables.

The United States Department of Agriculture, Bureau of Agricultural Economics (6), conducted a pilot survey in 1947 exploring factors additional to price, motivating hog farmers in their production and marketing. The study was reviewed because of the approach and method of analysis used.

The survey was conducted by interviewing a random sample of 378 hog farmers in the corn hog belt. Reliance was placed on open questions without providing alternative answers for enlisting information from the farmers about why they operate the way they do. The analysis was carried out by attaching percentage weights to answers given by the farmers to various questions. The relative importance of the factors depended upon the magnitude of percentage weights.

Morrison (7) conducted a sugar beet survey in 1945 (unpublished) on attitude of the beet growers towards the industry. The survey was confined to Cache, Box Elder, and Utah Counties. Responses of 161 growers to questions asked about their beet enterprise are summarized in Table 1.

Table 1. Grower response towards sugar beet industry, Cache, Box Elder, and Utah Counties, Utah, 1945

Items checked	Percent of growers showing response
Reason for growing beets	
Profitable	76
Provide pulp	49
Provide labor for family	25
Provide cash crop	81
Important cultural method	40
Reasons for decreased acreage	
Lack of water	0
Lack of family labor	22
Diseases	17
Low income	11
Sugar beets most profitable crop	18
Continue to grow beets	
Yes	92
Future of industry	
Improve	19
No change	42
Decline	39

Christensen and Ward (8) conducted a study to determine how successful dairy cooperatives in Utah have been in controlling producer deliveries of market milk through the use of base-excess pricing plans. Method employed was of correlation techniques. To test the producer response to these plans, percent changes in average daily deliveries of milk from year to year were correlated with base-building incentive ratios for each year, and the correlation coefficients tested for statistical significance.

Williams (9) was interested in finding out the causes that make dairymen change their milk production from year to year. An interview survey was conducted of a random sample of 154 growers belonging to the

Great Basin area in Utah who had increased or decreased their milk production during the 1960-1964 period. Tabular analysis and correlation techniques were used to analyze the reasons for change in milk supply, indicated response to possible changes in price, base-building rules, alternative pricing plans, and pooling methods. Changes in milk production were correlated with several independent variables that were hypothesized to be important in explaining changes in milk production. Cross-sectional data from the survey and from Utah milk cooperatives were used. Partial coefficients of determination, t-test, rank of the standard partial regression coefficients, and the order of dropping of the variable out of the equation were the four criteria used for selection of significant variables.

Gardner and Schick (10) conducted a study at Utah State University in 1964 on "Factors Affecting Consumption of Urban Household Water in Northern Utah." They were interested in the identification of important variables which cause variations in the consumption of household water. They used multiple regression techniques and employed t-test, rank of standard partial regression coefficients, and the size of simple coefficient of determination as criteria for the selection of significant variables.

Schrader (11), using time series data for the period 1927-1928 to 1950-1951, regressed five independent variables assumed as causal factors against yearly hog production expressed as a percentage of the previous year. His interest was to seek an explanation for year to year variations in hog slaughter. Logarithmic regression functions were assumed in this analysis. He approximated two functions by the use of single equation least squares method. The magnitude of the coefficient

of determination was considered as a measure of goodness of the fit. Standard errors were calculated to test the significance of regression coefficients.

Candler (12) conducted a study to explain wheat acreage changes in New Zealand for the period 1920 to 1953. Five independent variables were hypothesized as influencing wheat acreage. He employed the single equation least squares method. The equation derived was:

$$Xa = 155.0 + 0.269Xb - 0.108Xc - 0.145Xi - 3.246Xj + 0.507Xk$$

He, however, expressed difficulty in using the equation for predictive purposes because of a high degree of intercorrelation among his independent variables and because these interrelationships continue to change in the future.

PROCEDURE AND METHOD OF ANALYSIS

Data for the first objective were obtained by interviewing a sample of growers who had grown beets during the year 1965. The sample was stratified by county and was confined to the nine northern and central counties of Box Elder, Cache, Davis, Weber, Salt Lake, Utah, Juab, Sevier, and Sanpete, which have historically grown more than 90 percent of the sugar beet acreage. Interviews were held with 10 percent of the growers in all counties listed above except Juab where the entire population of four beet growers were interviewed. There were 132 growers in the sample (Table 2).

Table 2. Number of growers in the sample from each county, sugar beet survey, Utah, 1966

County	Number of growers, 1965	Number in the sample
	number	number
Box Elder	310	32
Cache	240	24
Utah	194	19
Weber	147	15
Davis	129	13
Salt Lake	114	11
Sevier	82	8
Sanpete	58	6
Juab	4	4
Total	1,278	132

The prime consideration in formulating the questions used during interviews with growers was to obtain detailed information on farmers' reactions about sugar beet production. Most of the questions concerned farmers' past decisions and experiences. Questions to enlist response to hypothetical future situations were limited to price and allotment changes and future production increases.

Questioning with growers was conducted in a friendly and conversational way. For the most part "open" questions were used; that is, the alternative answers from which the growers could choose were not provided. As the objective of the study was to find out why farmers operate their sugar beet enterprise as they do, importance was attached to the reasons put forward by them.

"Why" part of questioning the growers was considered just as important as the "what" part. Both were necessary for purposes of analysis. Any reasons mentioned by farmers for changing or not changing sugar beet plans were taken as valuable reasons from the viewpoint of the study objective. Factors within the farmer's control or beyond his control were both considered important.

A good deal of "probing" was necessary to find out the various reasons that motivate farmers. Yet the questioning had to be of a general character. Specific probing questions were avoided. It was felt that they might merely draw out assenting answers rather than reasons important in the farmer's thinking.

Two methods of analysis were used. Tabular analysis was employed to summarize reasons the farmers gave as a basis for their decisions relative to their 1965 planting of beets. Questions were also asked about their plans for 1966 and how they would respond to assumed

allotment and price changes. Regression analysis was used to correlate the percent change in sugar beet acreage from 1964 to 1965, for the cross-sectional sample data, with 10 independent variables considered to be influencing the change. The criteria used for testing the significance of the variables were the F-test, value of simple partial correlation coefficients, rank of the standard partial regression coefficients, and the order of dropping out of the variables from the regression equation.

If calculated F-values were greater than the tabular F at α .05 level with 1 and 121 degrees of freedom, the hypothesis that $\beta = 0$ was rejected. Partial correlation coefficients explained in percentage figures the contribution of the independent variables in accounting for the variability of the dependent variables when other independent variables are held constant at their average. The rank of the standard partial regression coefficient provided clues as to the relative importance of independent variables, and the order of dropping of the variable out of regression equation in stepwise regression analysis was used as an indicator of their importance. The variable which stayed in the longest was most important.

The variable which was indicated as significant by all the four criteria and also made a considerable contribution to the multiple coefficient of determination (R^2) was considered to be significant. In case of nonsignificance shown by one criteria and a small contribution to R^2, the importance of the variable was judged from the remaining three criteria.

Multiple and partial correlation techniques were used for accomplishing the second objective. Four crop enterprises (corn silage,

irrigated barley, alfalfa, and irrigated wheat) were considered to be competing with sugar beets for land and other resources. Time series data on sugar beet acreage for the period 1935-1965, from eight important sugar beet producing counties, were correlated with per acre gross returns from the five crop enterprises including sugar beets. The four criteria: the F-test, simple partial correlation coefficients, standard partial regression coefficients, and the order of dropping out of the variables from the regression equation, were used to test the significance of the variables. The approach was the same as in the case of objective 1.

Accuracy of data from published records and obtained through personal interviews was considered of vital importance. The principal sources of data were direct interviews with the sample growers, records of Agricultural Stabilization and Conservation Service, and unpublished records of the Department of Agricultural Economics, Utah State University. Published information concerning acreage figures, production, yields, returns, and policy issues provided secondary information used in this study. Main important sources were United States Department of Agriculture (Sugar Reports, Agricultural Statistics, and Utah ASCS reports), United States Department of Commerce (Census reports), and numerous bulletins and articles published by Utah State Agricultural Experiment Station.

ANALYSIS

(PART I)

Description of the Sample Characteristics

This section presents the results of tabulating the data obtained from the sample of farms. Of the total cropland in the farms in the sample, 85.5 percent was irrigated during the year 1965. Acreage suitable for growing sugar beets was 89.4 percent of the irrigated land and 76.5 percent of the total cropland. Cropland per farm averaged out 147.5 acres with a range of 5 to 1,000 acres. The acreage suitable for raising sugar beets ranged from 5 to 700 acres with an average of 112.9 acres per farm.

Sugar beet allotments for farms included in the sample totaled 3,743 acres. The acreage planted to sugar beets was 3,683. Farmers as a group in Cache, Utah, Salt Lake, Sevier, and Sanpete Counties planted less than their allotments. But the Box Elder County farmers planted more, and net result was only 60 acres planted less than the total allotment.

Average size of the sugar beet operation was 28 acres with a range of 2 to 245 acres. Normal yields per acre as an average of all growers in the sample were 17.8 tons. Yields in Cache, Sevier, Sanpete, and Juab Counties were below average. The yield level in Juab averaged 13 tons and was the lowest average yield in the State.

Nearly 55 percent of the growers in the sample have been growing beets continuously since 1956. About 12 percent started growing beets since 1956. There were about 32.5 percent of the growers in the sample

who did not grow beets during one or more years since 1956. A county-wise analysis of these characteristics is provided in Table 3.

The average age of the operator for the sample was 49.1 years with a range from 17 to 79 years. Only 6 percent of the growers were younger than 30 years of age. More than 45 percent were in the age group of 31-50, 30 percent between 51-60, a little more than 14 percent between 61-70, and 3.7 percent (five growers) were older than 70 years.

For the entire sample there were 3,128 man hours of family labor per day available during the 1965 sugar beet growing season. On an average basis there were 23.7 man hours per day per farm and 0.85 hours per day per acre of planted sugar beets. Maximum man hours on the basis of a county average per farm per day were available in Juab County (33.8 hours), but on per acre basis the same county had the lowest amount of family labor available (0.45 hours).

An analysis of labor requirements showed that on an average 13.5 man hours are needed to thin an acre of beets. Labor needs per acre were highest in Juab County (18.3 man hours) and lowest in Weber County (9.7 man hours). The order of costs for thinning per acre was, however, just reversed, with highest figure of $21.88 in Weber County and the lowest one of $16.86 in Juab. For the sample, thinning costs per acre averaged $19.88. For first and second hoeing operations, labor requirements were not much different and were 6.9 and 6.8 man hours per acre respectively, and the dollar costs per acre for these operations were $8.91 and $6.54.

Eight farmers (6 percent) in the sample employed full time labor during sugar beet growing season. Eight persons were employed on this basis. Most farmers (85 percent), however, hired temporary migratory

Table 3. Characteristics of the sample relating to farm size, beet operation, yield, and percentage of growers concerned with beets during the period 1956-1965, by county, Utah, 1965

Item	Unit	Box Elder	Cache	Utah	Weber	Davis	Salt Lake	Sevier	Sanpete	Juab	Total
Number in the sample	number	32	24	19	15	13	11	8	6	4	132
Total cropland, 1965	acres	4,966	4,674	2,109	1,466	1,952	956	790	884	1,676	19,473
Cropland irrigated, 1965	acres	3,729	3,721	1,982	1,371	1,553	956	790	884	1,676	16,662
Cropland suitable for sugar beets, 1965	acres	3,636	2,908	1,904	1,403	1,279	912	640	879	1,336	14,897
Sugar beets allotment, 1965	acres	1,010	558	421	409	325	277	214	238	291	3,743
Sugar beets planted, 1965	acres	1,104	506	406	408	327	257	167	211	297	3,683
Average size of sugar beet operation, 1965	acres	35	21	21	27	25	23	21	35	74	28
Normal sugar beet yield per acre	tons	18.5	16.4	20.0	21.0	21.0	19.0	16.0	15.3	13.0	17.8
Percent of the total who grew beets continuously since 1956	percent	15.9	9.0	5.3	8.3	6.0	6.0	1.5	2.2	.7	54.9
Percent of the total who started after 1956	percent	3.0	2.2	1.5	.7	.7	.7	0	1.5	1.5	12.1
Percent of the total who did not grow beets during one or more years since 1956	percent	5.3	6.8	7.5	2.2	3.0	1.5	4.5	.7	.7	32.5

labor for sugar beet operations. Of the sample growers, 23 percent had labor housing facilities for this labor. The highest percentage of the growers with housing facilities (6.0 and 5.3) were located in Box Elder and Sevier Counties, whereas growers in Cache and Utah Counties did not have labor housing facilities. Table 4 provides county-wise analysis of the situation regarding operator age and labor.

Total investment in sugar beet machinery and equipment for the entire sample was $287,690 with an average of $2,180 per farm. Sanpete and Box Elder Counties ranked as number one and two with $3,646 and $3,257 per farm respectively, and the Davis County was the lowest with $864 per farm.

In the sample, 68 percent of the growers used custom hiring facilities for their sugar beet operations. Most of them got the drilling, planting, harvesting, and hauling operations which were commonly done on a custom basis. In the sample, 29 percent of the growers did custom work for others. Analysis of investment in sugar beet equipment and custom hiring situation is provided in Table 5.

Out of the entire sample 12 percent of the farmers had plans to stop growing sugar beets during the year 1966, and 7 percent had plans to quit farming in the near future. In addition, 36 percent of the farmers were either working or planned to work off their farms, and 69.4 percent of them (25 percent of the entire sample) thought that their yearly income from nonfarm employment was or could be more than their annual farm income.

Of the entire sample 36 percent of the growers planned to increase sugar beet acreage during the year 1966, whereas 40 percent planned to decrease it. The net result of the over-all changes in their plans for

Table 4. Operator age and family and hired labor situation by county, Utah, 1965

Item	Unit	Box Elder	Cache	Utah	Weber	Davis	Salt Lake	Sevier	Sanpete	Juab	Total
Av. operator age during 1965	years	46.4	50.7	49.5	56.3	48.0	51.9	50.1	45.2	47.0	49.1
Man hrs. of available family labor per day per farm, 1965	hours	21.5	26.5	22.6	31.0	23.0	21.2	16.0	18.7	33.8	23.7
Man hrs. of family labor/day/acre, 1965	hours	.62	1.26	1.06	1.14	.91	.91	.77	.53	.45	.85
Av./acre man hours needed for thinning	hours	12.2	13.5	11.4	9.7	14.5	12.3	12.8	17.0	18.3	13.5
Av. rate/acre for thinning	dollars	19.87	20.42	19.75	21.88	21.22	20.41	20.20	18.23	16.86	19.88
Av./acre man hours for first hoeing	hours	6.5	7.4	6.0	7.4	6.7	6.9	5.3	6.5	9.3	6.9
Av. rate/acre for first hoeing	dollars	7.93	10.45	8.28	8.93	9.47	8.66	9.05	8.42	7.97	8.91
Av./acre man hours for second hoeing	hours	5.2	5.5	5.5	6.5	5.3	0	0	13.0	0	6.8
Av./acre rate for second hoeing	dollars	6.26	7.94	2.83	6.72	7.01	0	7.03	8.00	0	6.54
% employing full time labor during sugar beet growing season	percent	2.2	.7	0	.7	1.5	0	0	.7	0	6.0
Percent hiring migratory labor	percent	20.4	15.1	13.6	8.3	8.3	6.8	6.0	4.5	2.2	85.0
Percent having housing facilities for labor	percent	6.0	0	0	1.5	2.2	3.7	5.3	3.7	.7	23.0

Table 5. Investment in sugar beet machinery and equipment and custom hiring situation by county, Utah, 1965

Item	Unit	Box Elder	Cache	Utah	Weber	Davis	Salt Lake	Sevier	Sanpete	Juab	Total
Investment in sugar beet machinery and equipment	dollars	104,220	32,080	35,805	38,350	11,225	24,630	9,905	21,875	9,600	287,690
Investment in sugar beet machinery and equipment perform	dollars	3,257	1,337	1,885	2,557	864	2,239	10,238	3,646	2,400	2,180
Percent using custom work facilities	percent	15.1	12.1	12.8	5.3	8.3	5.3	4.5	2.2	2.2	6.8
Percent doing custom work for others	percent	8.3	4.5	3.7	2.2	3.0	3.0	.7	3.7	0	2.9

1966 was a decrease of 13.6 percent area under sugar beets from the year 1965. These characteristics of the sample are analyzed county-wise in Table 6.

Table 6. Off-farm work and percentage of growers who plan changes in sugar beet enterprise, Utah, 1965

Item	Unit	Box Elder	Cache	Utah	Weber	Davis	Salt Lake	Sevier	Sanpete	Juab	Total
Percent who plan to quit farming in the near future	percent	2.2	1.5	.7	.7	0	.7	.7	0	.7	7.0
Percent who plan to or work off-farm	percent	9.8	6.0	6.0	2.2	3.7	3.0	1.5	3.0	.7	36.0
Percent who think income from alternative employment can be more than net farm income	percent	5.3	6.0	4.5	1.5	3.0	3.0	0	.7	.7	25.0
Percent who plan to increase sugar beet acreage during 1966	percent	5.3	5.3	7.5	5.3	5.3	3.0	2.2	1.5	0	36.0
Percent who plan to decrease sugar beet acreage during 1966	percent	9.8	9.0	3.0	3.7	4.5	3.7	1.5	1.5	3.0	40.0
Percent who plan to stop growing beets	percent	1.5	5.3	.7	1.5	2.2	0	0	0	.7	12.0

Reasons for Not Growing Sugar Beets During the Period 1956-1965

To ascertain the nature and extent of important reasons influencing farmer decisions to grow or not to grow beets, the growers who did not grow beets during one or more years during the 1956-1965 period were identified. There were 59 (44.6 percent) such growers. Forty-three of them (32.5 percent) have grown sugar beets for a long period even prior to 1956 but did not grow for one or more years during this period, and 16 (12.1 percent) started after 1956.

Table 7. Reasons given by sugar beet growers for not growing sugar beets for one or more years during the period 1956-1965

Reason	Percent of 59[a] growers giving a specific reason as number			
	1	2	3	4
	percent	percent	percent	percent
Drought	28.8	1.7	0	0
Started farming after 1956	13.6	0	0	0
Nematodes	6.8	0	0	0
Lack of family labor	6.8	5.1	0	0
Too young	6.8	0	0	0
Rotation	5.1	1.8	0	0
Land problems	11.6	1.7	1.7	0
Off-farm work	5.1	3.4	4.8	0
Freezing	3.1	1.7	0	0
Water shortage	1.7	0	0	0
Health	1.7	0	0	0
Not profitable	3.4	1.7	0	0
Hired labor problems	1.7	3.4	0	0
Other reasons (14)	3.4	6.5	3.4	1.7

[a] In the sample 44.6 percent growers (59 out of 132) did not grow sugar beets for one or more years during the 1956-1965 period.

These growers were asked to give their reasons in order of importance for not growing beets during this period. The reasons which figured as important were drought, lack of family labor, nematodes, rotation, off-farm work, freezing, and lack of suitable land. The single most important reason indicated by 28.8 percent growers was drought. Table 7 provides a summary and relative importance of these and other related reasons.

Profitability Rating of Important Crop Enterprises

In order to find out how profitable the sugar beet crop was considered to be, the growers in the sample were asked to rank their crops in terms of profitability. Sugar beets were mentioned as their most profitable crop by 59 percent of the growers, and hay, corn, and wheat by 9.8, 6.8, and 5.3 percent respectively. Barley, beans, and onions each were rated as the next most profitable enterprises by 3.7 percent of the growers.

Sugar beets were indicated as the second most profitable crop by 21.2 percent of the growers in the sample, and this again is the largest percentage showing their second choice.

Relative profitability rating of these and other crop enterprises grown by the sample growers is summarized in Table 8. It is both interesting and important that results from this part of the survey confirm the generally held view that sugar beets are the most profitable crop grown in Utah. Further discussion on this point is postponed for later sections in the study.

Table 8. Profitability rating of important crop enterprises based on the experience of 132 sample sugar beet growers, Utah, 1965

Crop	Percent of all growers rating profitability as number		
	1	2	3
	percent	percent	percent
Sugar beets	59.0	21.2	15.9
Hay	9.8	19.6	28.7
Corn	6.8	15.9	9.1
Wheat	5.3	18.9	8.3
Barley	3.7	14.3	26.5
Beans	3.7	.8	1.5
Onions	3.7	.8	.8
Tomatoes	3.0	2.2	1.3
Potatoes	1.5	3.7	0
Peas	1.5	0	2.2
Grain	.8	.8	5.3
Asparagus	.8	0	0
Oats	0	.8	0
Pasture	0	.8	0

Reasons for Not Growing More Sugar Beets

All growers in the sample were asked to indicate their reasons for not growing more sugar beets than they do. The purpose was to find out the restricting factors other than sugar beet allotments. Table 9 provides a summary of reasons mentioned by the growers and their relative importance. Rotation, nematodes, and shortage of family labor were the most important reasons mentioned by 47.0, 33.3, and 32.4 percent of the growers respectively. Five other factors which ranked high in restricting beet acreage were: shortage of equipment (12.8 percent), not profitable (11.3 percent), high labor costs (10.6 percent), water shortage (8.3 percent), and dairy as a more paying alternative (8.3 percent). The reasons grouped as other reasons, though less important from the point of view of

the entire sample, but each one of them can have a considerable restricting influence on individual growers.

Table 9. Major reasons given other than acreage allotments for not growing more sugar beets

Reason	Percent of all growers giving a specific reason for not growing more[a]
	percent
Rotation	47.0
Nematodes	33.3
Short of family labor	32.4
Short of equipment	12.8
Not profitable	11.3
Costly labor	10.6
Water shortage	8.3
Dairy more paying	8.3
Lack of land	6.8
Age	6.1
Off-farm work	3.8
Needs feed crops	2.2
Other reasons (15)	12.8

[a]Percentages add up to more than 100 percent because most growers gave more than one reason for not growing more sugar beets.

Natural Hazards Faced in Sugar Beet Production

Natural physical forces are important in the production of most crops, but they are more so in the case of the sugar beet crop. Frequently growers face some kind of natural hazard which reduces per acre yields and affects farmers' future disposition toward sugar beet production. In response to questions about the type of hazards they have to face, frequency of their occurrence, and the percent reduction they cause during the years of occurrence, sugar beet growers mentioned 11 factors.

An analysis of Table 10 shows that frost, nematodes, insect pests, hail, and drought stand as most predominant factors.

Table 10. Major natural hazards faced by growers in the production of sugar beets, frequency of their occurrence, and losses caused

Hazard	Percent growers who faced hazard (in 10 years)	Frequency of occurrence (in 10 years)			Percent reduction in yield in years of occurrence		
		Range	Average	Mode	Range	Average	Mode
	percent	number	number	number	percent	percent	percent
Frost	89.4	1-8	2.36	1&2	8.4-55.6	22.06	20
Nematodes	33.3	1-10	8.82	10	4.0-71.7	29.95	--
Insects pests	22.7	1-10	3.15	2	1.5-57.0	13.70	10
Hail	22.0	1-2	1.18	1	6.6-53.6	17.62	10
Drought	15.1	3-6	2.30	2	15.0-47.6	26.24	10[a]
Wind	7.6	1-3	3.95	--	3.1-23.7	14.96	--
Heavy fall rain	6.0	1-2	1.26	--	15.0-68.0	30.20	--
Excessive spring rain	4.5	1-2	1.37	--	10.0-17.0	13.12	--
Snow	2.3	1-2	1.00	--	20.0-35.0	26.70	--
Flooding	2.3	2-3	2.33	--	10.0-30.0	18.33	--
Black rot	1.5	2-10	6.00	--	1.0- 2.0	1.75	--

[a]Reduction in acreage.

Frost, with regard to the percentage of growers who faced it as a hazard during the past 10 years, predominates strongly over all other factors. Frequency of occurrence as indicated by answers from growers was, however, maximum in case of nematodes with an average of 8.82. The modal value of nematode occurrence shows that they are a problem practically every year. During discussions on this point, beet growers having nematode infestation appeared quite emphatic that unless they fumigate, nematodes are present in the soil every year. As an alternative, a rotation with beets being planted only one out of four or five years

was considered necessary.

As regards losses, in terms of percentage reduction in yields per acre, nematodes again rank as the number one hazard followed very closely by damage from frost. Most growers were highly reluctant and appeared to be unsure about their answers assessing reduction in yields by nematodes.

Labor Problems

The high labor requirements of sugar beet production has been considered one of the most important problems. It has often been suggested that the labor situation has prevented improvement in the competitive position of the beet crop.

Information provided by the sample indicates that on most farms family labor is not enough for sugar beet production. Of the growers 85 percent hired migratory labor, and on an average basis for the entire sample, $26.19 were incurred per acre as labor expense. It was thus considered necessary to find out the problems which sugar beet growers have to face in hiring temporary migratory labor.

Table 11 gives a summary of the difficulties mentioned by sample growers and their relative importance. The percentage of growers who say that they do not face any difficulty with hired labor is fairly high (43 percent). The most important problem mentioned was the low quality of work. Difficulties of high labor costs and procurement ranked next, but growers felt them considerably less important than low quality of work. The rest of the difficulties are in one way or the other quite similar to these three types but are listed independently to show the way growers think about them.

Table 11. Difficulties encountered by sugar beet growers in hiring temporary migratory labor, Utah, 1965

Nature of difficulty	Percent of all growers encountering the specific difficulty[a]
	percent
No difficulty	43.0
Low quality work	34.8
Costly	8.4
Procuring	8.3
Drinking and fighting	3.8
Demand more than contract	3.0
Demand transport to town too often	2.0
Not dependable	2.0
Too much government interference	2.0
Stealing	.8
Wants to hold up work	.8
Needs supervision	.8

[a]Percentages add up to more than 100 percent because frequently growers mentioned more than one difficulty.

Off-Farm Work

Farmers usually strive to maximize returns from their labor. When nonfarm employment possibilities exist, there is a tendency to shift labor from sugar beets to other employment. This can be particularly the case with younger operators. In order to evaluate how far sugar beet growers consider or find that opportunities exist for them to increase the value productivity of their labor either by partly or completely working off-farm, all growers in the sample were questioned about whether they worked or planned to work off-farm. A fairly high percentage of farmers (36 percent) indicated that they do. Table 12 shows the type of alternative employment opportunities available to

these farm operators with hourly or yearly wage rates.

Table 12. Alternative employment opportunities available to the sample sugar beet growers, Utah, 1965

Nature of employment	Percent of all growers who can or work partly off-farm	Hourly or yearly wage rate (average)
	percent	dollars
A.		
Sugar factory labor	6.00	2.05/hour
Plant operator	3.00	3.18/hour
Postal letter carrier	1.50	2.99/hour
Carpenter	1.50	2.25/hour
Part-time cattle feeding	.75	1.25/hour
Equipment assembly	.75	1.50/hour
Cone maker at foundary	.75	3.00/hour
Hillfield operator	.75	2.76/hour
House mover during winter	.75	2.00/hour
Heavy duty operator	.75	3.00/hour
Canal water master	.75	2.00/hour
Farm work	.75	2.00/hour
Making rubber hose	.75	3.15/hour
Utah State University custodian	.75	1.90/hour
B.		
Private trucking	3.00	8,500/year
High school teacher	2.30	6,550/year
County commissioner	1.50	6,600/year
Machine shop	1.50	5,600/year
School bus driver	1.50	4,000/year
Hay baling	.75	600/year
Equipment assembly	.75	1,500/year
City patrolman	.75	4,800/year
Mill wright	.75	9,200/year
Chemist at St. Mill	.75	7,000/year
Machine tester	.75	6,500/year
Carpenter	.75	5,000/year
Civil Service	.75	6,600/year
Refrigerator engineer at Moroni Feed	.75	3,000/year
Total	36.05	

In order to find out if these opportunities could be a causal factor for changes in sugar beet production by attracting labor away from the farm, growers were further asked if their yearly earnings from off-farm employment are or could be more than their annual net farm income. In response to that question, 69 percent of them (25 percent of the entire sample) answered positively.

Reasons for Planned Increase or Decrease in Sugar Beet Acreage

All farmers in the sample were asked about their plans to plant sugar beets during 1966. About 36 percent of the farmers planned to increase their sugar beet acreage, but a little more than 40 had plans to decrease with the net result of a 13.65 percent decrease in beet acreage over 1965.

When asked about the reasons in order of importance for planned increase in beet acreage, a fairly high percentage (40.4 percent) indicated field size was the most important reason. A need to follow a rotation was given as the number one reason by 15 percent of the growers. About 15 percent said that sugar beets are profitable. Need for full use of family labor and owned equipment and availability of more land were also given as important reasons by some growers. Field size and rotation which figured as most important reasons are related one to another. Growers mentioning field size as an important reason have rotation in their minds because without need for rotation, field size remains unchanged. Put together, these two reasons were mentioned by 55.3 percent of the growers who had plans to increase beet acreage. Thus it appears that plans to increase sugar beet acreage are only incidental because of the necessity of rotating the crop even though

the profitability aspect influences a fairly high percentage of growers. Table 13 provides a summary statement of all the reasons mentioned by growers and order of their importance.

Table 13. Reasons given for planned increase in sugar beet acreage in Utah during the year 1966, over 1965

Reason	Percent of 47[a] growers giving a specific reason for the planned increase, as number		
	1	2	3
	percent	percent	percent
Field size	40.4	2.1	0
Rotation	14.9	12.8	2.1
More profitable	14.9	2.1	4.2
Full use of farm labor & equipment	12.5	10.5	2.0
More land available	6.3	6.3	0
Beets easier as part-time farmer	2.1	0	0
To maintain allotment	2.1	0	0
Other reasons (12)	6.3	21.2	21.2

[a]35.6 percent (47 out of 132) planned some increase in their sugar beet planting for 1966, over 1965.

When asked about reasons in order of importance about their planned decrease in sugar beet acreage, nematodes stand as number one reason followed closely by rotation and field size. Again these three reasons are very closely related to each other. Need for rotation being necessitated by nematodes and field size is a reason only because of the necessity of rotation. These three reasons put together were mentioned by 43.3 percent of the growers planning to decrease their beet acreage. Importance of dairy feed ranked as next in importance being mentioned by 13.2 percent as the most important reason. Lack of irrigation water

or variability in the amount of water available did not figure as an important reason. Only one person each mentioned them as number one and number two reasons. Table 14 provides a summary of all important reasons for planned decrease and order of their importance.

Table 14. Reasons given for planned decrease in sugar beet acreage in Utah during the year 1966, over 1965

Reason	Percent of 53[a] growers giving a specific reason for the planned decrease, as number		
	1	2	3
	percent	percent	percent
Nematodes	17.0	1.9	0
Rotation	15.0	3.8	0
Dairy feed more important	13.2	7.6	1.9
Field size	11.3	0	0
Not enough land	11.3	7.6	0
Decrease in allotment[b]	5.7	1.9	0
Short of family labor	7.6	7.5	1.9
Not profitable	5.7	7.5	0
Hired labor problem	1.9	1.9	5.7
Health and age	1.9	3.8	1.9
Off-farm job	1.9	1.9	3.8
Not sure of spring water	1.9	1.9	0
Additional risk	0	0	1.9
Other reasons (12)	5.7	9.5	1.9

[a] 40.2 percent (53 out of 132) growers planned for some decrease in sugar beet acreage during 1966, over 1965.

[b] Possible only in case of rented allotment being taken away.

Need for Expansion in Factors of Production

In order to identify the factors of production which could be restrictive to expansion in sugar beet acreage and the extent of their restrictive influence, growers were asked to indicate their need for

expansion of various factors for 5, 10, and 25 percent increase in sugar beet acreage. Table 15 provides a summary of their answers. An analysis of this table shows that for a 5 to 10 percent increase in sugar beet acreage, only a small percentage of growers need more labor, capital, machinery, and housing for labor. Expansion in cropland is needed by 15 percent of the growers. But for a 25 percent increase in beet acreage, total cropland, labor, and machinery become restrictive for a fairly good percentage of growers. By far the most important restriction was cropland, with 56 percent of the growers indicating that they would need to expand farm size if they expanded their beet planting. Capital and housing for labor affect only a very small percentage of growers even for 25 percentage increase in acreage.

Table 15. The need for expansion in factors of production in order to increase sugar beet production, Utah, 1965

Factors	Percent of all growers who will need to expand if sugar beet acreage was to increase by		
	5	10	25
	percent	percent	percent
Total cropland in farm	8	15	56
Labor	5	5	19
Operating capital	1	2	2
Machinery and equipment	2	3	17
Housing for labor	1	2	2

Response to Changes in Sugar Beet Acreage Allotments and Price

Growers in the sample were asked what changes they would make in

their sugar beet acreage assuming specified changes in sugar beet allotments and prices. Their response is shown in Table 16.

Table 16. Response to assumed changes in sugar beet allotments and price, Utah, 1965

Assumed nature of change during 1966	Percent change over 1965
	percent
If price decreased 10 percent	-45.85
Allotments as growers expect (no change in price)	-13.65
If allotment increased 10 percent (no change in price)	-26.14
If allotment increased 25 percent (no change in price)	-12.19
If allotments were free (no change in price)	- 1.90
If allotments were free and (price increased 10 percent)	+10.53

[a]Sugar beets allotment for 1965, 3,743 acres.
Sugar beets planted during 1965, 3,683 acres.
Plan for 1966, 3,180 acres.

Interviews with the growers were conducted during the months of February and March, 1966, when they had their sugar beet operation already planned based on their expectation of the anticipated allotment.

All sugar beet growers in the sample were asked how many acres of sugar beets they would plant if they were permitted a 10 percent increase in their allotments over the year 1965. A 10 percent increase does not seem to allow enough leeway to those individual beet growers who want to increase their beet acreage so that planned decreases by other growers can be compensated. Answers to this question for the sample as

a whole indicate that sugar beet acreage would decrease by about 26 percent.

Sugar beet growers were also asked how many acres of sugar beets they would plant if they were allowed an increase of 25 percent over their 1965 allotments and if allotments were made free. Answers to these questions indicate about 12 percent and 2 percent decrease respectively over 1965. Based on their expected allotments, a 13.65 percent decrease over 1965 was planned by the sample growers as a whole.

Price was not mentioned as an important factor for planned increases or decreases in sugar beet acreage in Tables 13 and 14. However, Table 16 indicates that farmers are quite responsive to assumed price changes. A 10 percent assumed decrease in price created a 45.85 percent negative change in beet acreage over the year 1965. Further questioning indicated that by 1967 the acreage planted to beets would drop by 70 percent of 1965 figure if price dropped 10 percent.

In case of assumed 10 percent increase in price and free allotments, the beet grower's response indicated a 10.53 percent positive change in beet acreage over 1965. These figures suggest that beet growers may be quite sensitive to sugar beet prices.

Statistical Analysis

A. Selection and Development of Variables

In order to test the hypothesis that several factors influence sugar beet growers in Utah in their decisions to produce sugar beets, variables from sample data were studied using linear regression analysis. The analysis provided information about the importance of

selected variables in explaining yearly changes in sugar beet acreage. The model used was:

$$Y = a + b_1X_1 + b_2X_2 + \ldots\ldots\ldots\ldots b_{10}X_{10}$$

where:

Y = percent change in sugar beet acreage from 1964 to 1965.

X_1 = percent change in alfalfa acreage from 1964 to 1965.

X_2 = percent change in acreage of irrigated barley from 1964 to 1965.

X_3 = percent change in acreage of irrigated wheat from 1964 to 1965.

X_4 = percent change in acreage of corn for silage from 1964 to 1965.

X_5 = age of the operator (years).

X_6 = acres of irrigated cropland operated (1965).

X_7 = acres suitable for sugar beets (1965).

X_8 = per day man hours of family labor (1965).

X_9 = per acre expenditure of hired labor (dollars)(1965).

X_{10} = investment in sugar beet machinery and equipment (dollars) (December, 1965).

Dependent variable, Y

The dependent variable, percent change in sugar beet acreage from the year 1964-1965 was calculated for each observation in the sample from the interview schedules. Information was available on acres of sugar beets planted during the years 1964 and 1965. The differential of 1965 acreage minus 1964 acreage was divided by 1964 acreage and multiplied by 100 to get the percentage change.

Percent change in acreage of alfalfa, irrigated barley, irrigated wheat, and corn silage from 1964 to 1965 (variables X_1, X_2, X_3, and X_4 respectively)

Forage and grain production on irrigated cropland is important in Utah. Alfalfa and corn silage are important forage crops and irrigated barley and wheat are the two most important grain crops. Because of their requirement for irrigated land, they compete with sugar beets for land, water, and other resources. Information on acres of these crops grown during 1964 and 1965 was available from the interview schedules and the percentage change between the two years was calculated as in case of Y.

Age of the operator, X_5

Younger operators may not be well equipped financially and in managerial skills for sugar beet production. On the other hand, older farmers who may have enough capital and experience with sugar beet growing may not be anxious to make investments in beet machinery. Also physical capacity to cope with sugar beet labor requirements is expected to decline as their age advances. Age of operator was thus considered to be a causal factor in decisions to produce more or less beets. Age of every grower was recorded at the time of interviewing and was available for each observation in the sample.

Acres of irrigated cropland operated (1965), X_6

Size of the farm was considered an important determinant of how big a sugar beet operation was possible. Growers with a large acreage of irrigated cropland operated should be able to make greater changes in

their beet operation. This information was obtained from each grower in the sample and the data were used as a variable in the analysis.

Acres suitable for sugar beets (1965), X_7

All irrigated cropland may not be suitable for growing sugar beets even though it may be used for growing other crops. Irrigated cropland suitable for growing beets during the year 1965 was thus considered as another important variable in determining the size of the sugar beet operation. Growers were asked how much land out of their total irrigated cropland was suitable for growing sugar beets, and the information was thus available for each observation from the interview schedules.

Per day man hours of family labor (1965), X_8

Family labor has always been considered an important determinant of the size of sugar beet operation. Each grower in the sample was asked to indicate the ages of family members who worked on sugar beet operations during the year 1965. The following schedule was used to convert the available family labor into man hours per day for each farm.

Age		Equivalent man hours per day
16 years or above	=	10.00
15 years	=	8.75
14 years	=	7.50
13 years	=	6.25
12 years	=	5.00
11 years	=	3.75
10 years	=	2.50
9 years	=	1.25
8 years or below	=	0

The labor of a full grown person of 16 years of age or above was considered to be equivalent to 10 man hours per day. For each younger

member, a reduction of one-eighth man equivalent per year was made. Total man hours for each farm were thus calculated.

Per acre expenditure of hired labor (1965) X_9

Historically, family labor has never been enough and hired labor costs have always constituted a considerable share of total costs of production of sugar beets. Studies conducted by the Utah State University staff (5) for the years 1945, 1951, 1959, and 1963, indicate that hired labor costs were 26.1, 16.9, 19.1, and 16.6 percent respectively of the total costs of production of the crop.

These costs vary for each individual farm depending upon the amount of available family labor and owned sugar beet machinery and equipment. Each grower in the sample was questioned as to the sugar beet operations performed by hired labor during the year 1965, and the per acre payments made for these operations. Thus, data on per acre expenditures for hired labor were available for each observation in the sample from interview schedules.

Investment in sugar beet machinery and equipment (dollars) (December, 1965), X_{10}

Investment in specialized machinery and equipment for sugar beets may be an important variable affecting size of the sugar beet operations. Owning considerable beet machinery or lack of it can affect one's capacity to make changes in beet acreage. Also, growers with considerable fixed investments will want to increase beet acreage to make full use of the resources and reduce unit costs.

An inventory of sugar beet machinery and equipment was obtained for each grower in the sample as of December 31, 1965. In order to have a uniform basis of comparison, dollar values were placed on each inventory

item depending upon its age, condition, and expected sale price (a subjective estimate by the grower). Total dollar figures were treated as a variable representing investment in sugar beet machinery and equipment.

B. Analysis, Results, and Determination of Significant Variables

The analysis assumed a linear regression model. There were 132 observations in the study. With 10 independent variables and one dependent variable, the degrees of freedom for F-test were 1 and 121. Using these degrees of freedom F-values from the table were 1.32 at 25 percent, 2.71 at 10 percent, 3.92 at 5 percent, 5.02 at 2.5 percent, 6.84 at 1 percent, and 7.88 at .5 percent levels of significance. Calculated F-values were compared with these values to determine significance.

The program used was stepwise regression. The computer output for this program showed the order in which the variables fell out of the model. Those contributing the least fell out first. The results of the regression equation were:

$$\begin{array}{lccccc} Y = 796.005 & - .2489X_1 & - .7384X_2 & + 1.2177X_3 & - .2973X_4 & - 3.174X_5 \\ F & (0.705) & (1.014) & (1.885) & (0.409) & (0.675) \end{array}$$

$$\begin{array}{lccccc} + .0188X_6 & - 8.4549X_7 & + 21.5585X_8 & - .0882X_9 & + .0647X_{10} \\ F \quad (0.050) & (3.16) & (12.81) & (1.455) & (1.555) \end{array}$$

The values in parentheses under the regression coefficients are calculated F-values. The multiple coefficient of determination (R^2) for the model was 28.31 percent.

Simple partial correlation coefficients are presented in Table 17. These coefficients are tabulated only for correlation between the

dependent and independent variables, YXi.

Table 17. Simple partial correlation coefficients, sugar beet study, Utah, 1965

Independent variable	Dependent variable	Simple partial correlation coefficients
X_1, percent change in alfalfa acreage from 1964 to 1965	Y	-.119
X_2, percent change in barley acreage from 1964 to 1965	Y	-.039
X_3, percent change in wheat acreage from 1964 to 1965	Y	.019
X_4, percent change in corn silage acreage from 1964 to 1965	Y	-.090
X_5, age of operator	Y	-.074
X_6, total irrigated acreage (1965)	Y	.155
X_7, acreage suitable for beets (1965)	Y	.383
X_8, man hours of family labor (1965)	Y	.470
X_9, hired labor expense per acre (1965)	Y	-.175
X_{10}, machinery and equipment investment (December, 1965)	Y	.164

Standard partial regression coefficients and the order of dropping of the independent variables from the regression equation are placed in Table 18. Figures in parentheses represent rank of the standard partial regression coefficients.

Table 18. Standard partial regression coefficients and order of dropping of the independent variables, sugar beet study, Utah, 1965

Independent variable	Standard partial regression coefficient	Order in which variables dropped out of the equation
X_1, percent change in alfalfa acreage from 1964 to 1965	$-.0715^{(7)}$[a]	4[b]
X_2, percent change in barley acreage from 1964 to 1965	$-.1595^{(4)}$	7
X_3, percent change in wheat acreage from 1964 to 1965	$.2120^{(3)}$	8
X_4, percent change in corn silage acreage from 1964 to 1965	$-.0509^{(9)}$	2
X_5, age of operator	$-.0647^{(8)}$	3
X_6, total irrigated acreage (1965)	$.0185^{(10)}$	1
X_7, acreage suitable for beets (1965)	$-.3919^{(2)}$	9
X_8, man hours of family labor (1965)	$.7885^{(1)}$	10
X_9, hired labor expense/acre (1965)	$-.0983^{(5)}$	5
X_{10}, machinery and equipment investment (December, 1965)	$-.0857^{(6)}$	6

[a]The numbers in parentheses refer to the rank (magnitude) of each variable arrayed from one to 10.
[b]The higher the number the longer the term stayed in the equation.

Determination of Significance of Variables

For purposes of determining the level of significance of independent variables, calculated F-values, partial correlation coefficients, standard partial regression coefficients, and the order of dropping of the variables from the equation in stepwise regression program were tabulated

together in Table 19. Each variable was analyzed separately with the help of this data.

Table 19. Criteria for determining significant independent variables, sugar beet study, Utah, 1965

Independent variable	Calculated F	Simple partial correlation coefficient	Standard partial regression coefficient	Order in which variables dropped out of regression equation
X_1, percent change in alfalfa acreage from 1964 to 1965	00.705	-.119	-.0715(7)[b]	4[c]
X_2, percent change in barley acreage from 1964 to 1965	01.014	-.039	-.1595(4)	7
X_3, percent change in wheat acreage from 1964 to 1965	01.885	.019	.2120(3)	8
X_4, percent change in corn silage acreage from 1964 to 1965	00.409	-.090	-.0509(9)	2
X_5, age of operator	00.675	-.074	-.0647(8)	3
X_6, total irrigated operated acreage (1965)	00.050	.155	.0185(10)	1
X_7, acres suitable for sugar beets (1965)	03.160	.383	-.3919(2)	9
X_8, man hours of available family labor/day (1965)	12.810[a]	.470	.7885(1)	10
X_9, per acre hired labor expense on beets (1965)	01.455	-.175	-.0983(5)	5
X_{10}, investment in sugar beet equipment (December, 1965)	01.155	.164	-.0857(6)	6

[a] Significant F-value when compared with tabular F $\alpha_{.005} = 7.88$.
[b] Number in parentheses is the rank of coefficient.
[c] The higher the number the longer the term stayed in the equation.

Percent change in alfalfa acreage

Calculated F-value, .705, was not significant even at $\alpha_{.25}$ level. The partial correlation coefficient was .119, which shows that the variable has some significance even though the significance is very weak. This was also born out by the rank of standard partial regression coefficient which was seventh in comparison to the other nine variables, and the order of dropping of the variables out of the equation which was fourth out of 10. The algebraic sign for the partial regression coefficient of this variable is negative, which indicates that as the acreage under alfalfa increases, sugar beet acreage decreases. But this relationship is concluded to be not significant.

Percent change in barley acreage

Calculated F-value of 1.014 was not significant at $\alpha_{.25}$ level, the partial correlation coefficient is low, the rank of the standard partial regression coefficient is fourth, and the order of dropping out of the equation was seventh. None of these tests indicate any strong significance for this variable. It was, therefore, concluded that changes in acreage of barley do not have any importance for changes in beet acreage.

Percent change in wheat acreage

Value of calculated F was not significant up to $\alpha_{.10}$ level, but was significant at $\alpha_{.25}$ level. The partial correlation coefficient was very low, but the rank of standard partial regression coefficient is third compared to nine other variables, and the order of dropping of the variable was eighth. The last two criteria and somewhat significant F-value indicate that the variable has some slight significance. But the

results of partial correlation coefficient are not consistent with this, and also the significance being shown by positive results is very weak to support the conclusion that the variable is significant. Acreage changes in wheat thus did not affect changes in sugar beet acreage.

Percent change in corn silage acreage

Calculated F-value was not significant even at $\alpha_{.25}$ level, the partial correlation coefficient was low, the standard partial correlation coefficient ranked ninth as compared with nine other variables, and the variable dropped at number two out of the regression equation. None of the criteria indicate any significance for this variable, and it was concluded that changes in corn silage acreage did not influence changes in sugar beet acreage.

Age of the operator

Age of the operator was found to be of little importance in explaining changes in sugar beet acreage. The calculated F-value was not significant even at $\alpha_{.25}$ level, the size of the partial correlation coefficient was small, the standard partial regression coefficient ranked eighth as compared with nine others, and the order of dropping out of the variable from the equation was third.

Total irrigated operated acreage

The calculated F-value was not significant. The partial correlation coefficient was in the medium category, but the standard partial regression coefficient ranked last, and the variable dropped out of the equation first of all. Total irrigated acreage operated, therefore, was not an important variable in this analysis.

Acres suitable for growing sugar beets

Calculated F-value was significant at $\alpha_{.1}$ level, the partial correlation coefficient is high (.383), the standard partial regression coefficient ranked number two as compared with nine others, and the order of dropping of the variable out of the equation was next to last. From these results it was concluded that the variable was significant and that suitability of land for growing sugar beets was an important determinant explaining change of sugar beet acreage.

Man hours of available family labor

The calculated F-value was highly significant even at $\alpha_{.005}$ level (12.81), the size of the partial correlation coefficient was the highest (.470), the standard partial regression coefficient was ranked number one, and this was the last variable which stayed in the equation. All criteria point out for a strong significance of the variable, and it is concluded that the amount of available family labor during sugar beet growing season was an important factor in explaining change of beet acreage.

Per acre hired labor expense on beets

The calculated F is significant at $\alpha_{.25}$ level only, the partial correlation coefficient has a fairly high value (-.175), but the standard partial regression coefficient ranked number five when compared with nine other variables, and the variable dropped out of the equation at number five. The first two criteria indicate that the variable has some significance in explaining changes in sugar beet acreage, but the results are not supported by the last two criteria. Per acre expense on hired labor was thus not concluded as an important variable.

Investment in sugar beet equipment

The calculated F-value was not significant even at $\alpha_{.25}$ level, the size of the partial correlation coefficient was fairly high (.164), the rank of the standard partial regression coefficient was fifth, and the variable dropped out of the model at number six. The first and the last two criteria are contrary to and do not provide support for any significance to the variable. Investment in sugar beet machinery and equipment were thus concluded not to be an important determinant in explaining changes in sugar beet acreage.

C. Results of Statistical Tests

Two variables, man hours of available family labor during sugar beet growing season and suitable acreage for growing sugar beets, were found to be consistently significant by all criteria. They are thus considered important variables in explaining changes in sugar beet acreage. The rest of the eight variables, which were also tested, did not appear to be significant from the analysis of this study. They were changes in acreage of alfalfa, irrigated barley, irrigated wheat, and corn silage crops, and age of the operator, total irrigated cropland, per acre expense on hired labor for beets, and dollar investment in sugar beet machinery and equipment.

An additional proof that these eight variables were not significant was provided by a very small drop (3.74 percent) in the multiple coefficient of determination (R^2) when in the stepwise regression program, all these variables were dropped from the model.

Results of the partial intercorrelation coefficients are presented in Table 20. Because most of these coefficients are very low, it was

not felt necessary to introduce interaction terms in the model. The low multiple coefficient of determination (R^2) for the model is understandable, because several important factors like drought, weather, etc., were not in the model. These variables could not be quantified for the cross-sectional sample data but weigh quite heavily in the grower's decision-making framework as is evidenced from the tabular analysis of previous sections.

Table 20. Partial intercorrelation between independent variables, sugar beet study, Utah, 1965

	Partial intercorrelation coefficients		Partial intercorrelation coefficients
r1.2	.387	r4.5	-.034
r1.3	.334	r4.6	-.083
r1.4	.121	r4.7	.035
r1.5	-.084	r4.8	-.032
r1.6	-.080	r4.9	-.070
r1.7	-.087	r4.10	.007
r1.8	-.108		
r1.9	.117	r5.6	-.098
r1.10	-.053	r5.7	.022
		r5.8	-.007
r2.3	.861	r5.9	-.058
r2.4	.017	r5.10	-.121
r2.5	-.047		
r2.6	-.071	r6.7	.247
r2.7	-.041	r6.8	.248
r2.8	-.034	r6.9	.036
r2.9	.224	r6.10	.128
r2.10	-.019		
		r7.8	.933
r3.4	.015	r7.9	-.207
r3.5	-.020	r7.10	.151
r3.6	.015		
r3.7	-.046	r8.9	-.200
r3.8	-.033	r8.10	.173
r3.9	.194		
r3.10	-.061	r9.10	-.054

(PART II)

It was hypothesized that major irrigated crop enterprises compete with sugar beets for irrigated land in Utah, and that as per acre receipts from these crops go up relative to the receipts from sugar beets, the acreage of sugar beets will decline. Four crops: corn for silage, barley, alfalfa, and wheat, which are grown under irrigated conditions, were considered important for this purpose. A least squares regression model used was:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5$$

where:

Y = yearly acreage of sugar beets.

X_1 = per acre receipts from corn silage (lagged).

X_2 = per acre receipts from irrigated barley (lagged).

X_3 = per acre receipts from alfalfa (lagged).

X_4 = per acre receipts from irrigated wheat (lagged).

X_5 = per acre receipts from sugar beets (lagged).

Data used in this analysis were for the period 1935-1965. The equation presented above has sugar beet acreage as the dependent variable which is considered to be the result of production decision affected by the per acre receipts of the previous year of five independent variables including sugar beets. The independent variables were used with a one year lag because the sugar beet acreage decision, which is made before or at the time of planting, can be affected only by the previous years receipts from competing crops.

Further, it was considered inappropriate to use the over-all state

figures because sugar beet acreage has been concentrated over the entire period of study in the eight northern and central counties. It was assumed that changes in crop acreages might have been happening in the rest of the counties in the State affecting per acre yields and returns. To eliminate the effect of these changes, the analysis was confined only to the eight important sugar beet growing counties. Acreage and gross returns data for each county were available only for census years. Ratios were calculated relating acreage and receipts for the eight counties to the state totals for census years. These ratios were used to generate adjusted data for this eight-county area for each year during the period 1935-1965. Per acre receipts for each crop were calculated by dividing acreage figures into the total receipts from each respective crop.

The Variables Used

The acreage under sugar beets rather than tons of beets produced was taken as the dependent variable. It was considered to provide a better estimate of farmers' intentions relative to sugar beet production.

The five independent variables considered were: average per acre receipts from corn silage, irrigated barley, alfalfa, irrigated wheat, and sugar beets. It is realized that net returns per acre from various enterprises should have a more powerful influence on the mind of a grower in shaping his subsequent production decisions as compared to gross per acre receipts. It was not possible, however, to calculate net returns per acre for such a long period. The analysis, therefore, assumed total per acre receipts as reflecting the competitive position of these enterprises. Justification for this assumption was that the

index numbers of cost rates and prices paid by farmers, weighted by the respective percentage cost shares of input structure of these crops for the period 1935-1965, moved up very closely together. A fairly high percentage of farm costs are made up of fixed costs. The farmer's main interest is to increase his net income for the farm as a whole. This can be better served by expanding an enterprise which helps in spreading these fixed costs even though per acre returns over cash costs are not increased. This strengthens the view that the use of total receipts per acre should be all right for the analysis.

Analysis, Results, and Determination of Significant Variables

The analysis proceeded using stepwise regression. The computer output showed the order in which the variables fell out of the model and provided the following regression equation:

$$Y = -17.98 + 1.00X_1 + .186X_2 - .217X_3 + .373X_4 + 2.61X_5$$
$$F \qquad\qquad (.655) \quad (.230) \quad (.070) \quad (.199) \quad (17.714)$$

The values in parentheses under the regression coefficients are calculated F-values. The multiple coefficient of determination (R^2) for the model was 85 percent. Also, as part of the computer output, data were provided, simple partial correlation coefficients, and standard partial correlation coefficients which along with the order of dropping of the variables out of the equation and the F-test, were used as criteria in the determination of significance of the variables. These criteria are tabulated in Table 21.

Table 21. Criteria for determining significant independent variables, sugar beet study, Utah, 1965

Independent variable	Calculated F	Simple partial correlation coefficients	Standard partial regression coefficients	Order in which variables dropped out of regression equation
X_1, per acre receipts from corn silage	.6554	-.633	.1184(2)[b]	3[c]
X_2, per acre receipts from irrigated barley	.2297	.844	.1090(3)	4
X_3, per acre receipts from alfalfa	.0703	.735	-.045(5)	1
X_4, per acre receipts from irrigated wheat	.1992	.748	.1057(5)	2
X_5, per acre receipts from sugar beets	17.7139[a]	.916	.8548(1)	5

[a] Significant F-value when compared with tabular F $\alpha_{.005}$ level, = 9.48.
[b] Number in parentheses is the rank of the coefficient.
[c] The order in which terms dropped from the equation.

Determination of Significance of Variables

There were five independent variables and one dependent variable. The data used pertained to a 31-year period. This provided 1 and 25 degrees of freedom for F-test. The tabular F-values using these degrees of freedom are: 1.39 at 25 percent, 2.92 at 10 percent, 4.24 at 5 percent, 5.69 at 2.5 percent, 7.77 at 1 percent, and 9.48 at .5 percent levels of significance.

Per acre receipts from corn silage variable

The simple partial correlation coefficient between per acre returns from corn silage and sugar beet acreage has a negative sign. This shows that high sugar beet acreage has been associated with low receipts from corn silage and high receipts from corn silage have had the effect of reducing acreage in sugar beets. But the variable was not found to be significant when subjected to all the four test criteria. Calculated F-value was not significant even at $\alpha_{.25}$ level.

Per acre receipts from irrigated barley variable

The calculated F-value was not significant even at $\alpha_{.25}$ level. The rank of the standard partial regression coefficient was third, and the variable dropped out of the equation at number four but with very small contribution to the multiple coefficient of determination (R^2), 0.3 percent. The size of the simple partial correlation coefficient was high because of the overlap among the independent variables. Judging from all these criteria, the variable was not found significant and the per acre receipts from irrigated barley were concluded not to be affecting sugar beet acreage.

Per acre receipts from alfalfa variable

Rank of the standard partial regression coefficient was last, the variable dropped out of the equation at number one, the calculated F-value was not significant even at $\alpha_{.25}$ level, and the size of the simple partial correlation coefficient was not important because of high overlap among the independent variables. All the criteria pointed out that the variable was not significant and thus receipts from alfalfa were concluded not to be affecting sugar beet acreage.

Per acre receipts from irrigated wheat variable

None of the test criteria indicated any significance for this variable. The rank of the standard partial regression coefficient was fourth, and the variable dropped out of the equation at number two. The calculated F-value was not significant even at $\alpha_{.25}$ level, and the size of the simple partial correlation coefficient was not important because of the overlap. So the per acre receipts from irrigated wheat were not considered as an important variable affecting sugar beet acreage.

Per acre receipts from sugar beets variable

All the four test criteria showed high significance for this variable. The calculated value of F was highly significant even at $\alpha_{.005}$ level. Simple partial correlation coefficient was the highest. Standard partial regression coefficient ranked number one, and the variable did not drop out of the regression equation until the end. It is thus concluded that per acre receipts from sugar beets themselves are an important factor influencing the sugar beet acreage.

Additional Test

The multiple coefficient of determination (R^2) for the model was 84.6 percent, but the contribution of the four variables was not found to be significant. Receipts per acre from corn silage, irrigated barley, alfalfa, and irrigated wheat accounted for only .73 percent, which indicates that these variables are not important in influencing sugar beet acreage. On the other hand, receipts from sugar beets contributed 83.8 percent to the multiple coefficient of determination which indicates its importance in influencing the sugar beet acreage.

Multicollinearity

Table 22 shows that there is considerable intercorrelation among the independent variable, i.e., that they are multicollinear. This could mean that one or more of the independent variables could be suppressed. But it was interesting to observe that not only each one of the independent variables found insignificant contributed very little individually to the multiple coefficient of determination (R^2), but even their combined contribution was only .73 percent. The high values of simple partial correlation coefficients for these variables are only because of considerable overlap among them. This led to their rejection as having any explanatory power and to the conclusion that only X_5, the per acre returns from sugar beets, was an important variable.

Table 22. Partial intercorrelations among the independent variables, sugar beet study, Utah, 1965

	X_1	X_2	X_3	X_4	X_5	Y
X_1	1.000	-.737	-.609	-.804	.718	-.633
X_2		1.000	.779	.874	.895	.844
X_3			1.000	.840	.794	.735
X_4				1.000	.796	.748
X_5					1.000	.916

Autocorrelation of the Residual

The resulting relationship with the only significant variable of sugar beet returns per acre X_5, when all other variables dropped out of

the equation, was:

$$Y = 29.467 + 2.791X_5; \ (R^2) = 83.8$$

A test for autocorrelation indicated that the residuals about the regression line were autocorrelated and nonrandom. Predictions from the equation would be inefficient as a result.

It was, therefore, necessary to alter the model to make allowance for autocorrelation so that the relationship would be satisfactory as a predictive equation. Both variables, Y and X_5, were transformed by the use of an estimated coefficient r of a first order autoregressive scheme for the residuals (13). The new relationship was obtained first by applying least squares to these transformed variables which provided:

$$Y = .192 + .04X'_t \quad . \quad . \quad . \quad . \quad . \qquad (a)$$

The constant .192 is an estimate of α (1 - r) and the relation (a) above can be stated in terms of the original variables as:

$$Y' = 10.726 + .04X_t$$

An autocorrelation test for this model indicated that the residuals were random and the effect of serial correlation from the original variables was removed. But the calculated value of F was smaller than the tabular F at $\alpha_{.05}$ level with 1 and 27 degrees of freedom and the coefficient of determination was only 12.4 percent. The conclusion was that the sugar beet returns per acre as well do not affect acreage of beets in an important way.

Results of Statistical Tests

The conclusion of this section is that variations in per acre yearly returns from the four crops which were hypothesized as competitive with sugar beets do not have any explanatory significance for variations

in yearly sugar beet acreage. These crops are: alfalfa, irrigated barley and wheat, and corn for silage. Yearly per acre receipts from sugar beets, however, appear to have some affect on sugar beet acreage. When the data were not corrected for autocorrelation of the residuals, this variable did not drop out of the equation up to the end. Coefficient of determination was high, 83.8 percent. After the data was corrected for autocorrelation, it explained about 12.4 percent variation in beet acreage. Thus, the variable appears to have some importance.

SUMMARY

Procedures

Beet production in Utah has been declining during the past four decades creating some doubt relative to the future of the sugar beet industry in the State. This study was aimed at ascertaining the reasons responsible for farmers' decisions in producing sugar beets.

A 10 percent random sample of 132 beet growers was drawn from a list of sugar beet growers. The sample was stratified by county. Growers in the nine important sugar beet growing counties were interviewed to generate data used in this study. Questions were asked pertaining to their decisions relative to 1965 planting of beets, plans for 1966, and how they would respond to allotment and price changes. Empirical data also came from time series information relative to the eight important sugar beet growing counties.

Part I provides analysis of the sample characteristics, and tabular and regression analysis of the sample data. A section on sample characteristics presents all the pertinent information about the sample on a county basis. Box Elder County was the most important county for sugar beet production. It has the largest beet acreage and number of growers. Average size of the beet operation was larger than in six other important counties. Only Sanpete and Juab Counties have larger beet operations, but they are relatively less important because of a smaller total acreage of beets.

An analysis relative to grower decisions about their beet planting in 1965, plans for 1966, and responses to the future price and allotment

changes is presented in Tables 7 through 16. This analysis summarizes the answers of beet growers to questions asked during the personal interviews.

In the statistical analysis section, percent change in sugar beet acreage from 1964 to 1965 for the sample data was correlated with 10 independent variables considered to be influencing the change. The criteria used for determining the significance of the independent variables were the F-test, value of simple partial correlation coefficients, rank of the standard partial regression coefficients, and the order of dropping out from the regression equation.

In Part II, time series data for the period 1935-1965 on yearly sugar beet acreage was correlated with per acre returns from irrigated alfalfa, barley, wheat, corn for silage, and sugar beets. The analysis was confined to eight northern and central sugar beet growing counties. The significance of the variables was tested using the same test criteria as for sample data. These tests established receipts from sugar beet variable as significant. A test for autocorrelation indicated the residuals were not randomly distributed. The data were corrected for autocorrelation and the subsequent regression results indicated that sugar beet receipts variable was also not statistically significant but was of some importance.

Findings

The salient findings of the study are: most sugar beet growers find sugar beets as their most profitable crop. Major reasons restricting expansion of sugar beet acreage are rotation, nematodes, shortage of family labor, equipment, water, and land suitable for beet production.

The principal reasons for rotation plans are to check the effect of nematodes and the need for forage crops because of the importance of livestock in Utah. Both these reasons are important enough to make sugar beets in rotation with other crops a must. The rotation pattern thus appears to be a deterrent for flexible sugar beet acreage.

Results of empirical tests appear to validate the generally held view that a shortage of family labor is a deterrent to the expansion of beet acreage. These tests indicate, also, that suitability of land for beet cultivation has an important influence on changes of beet acreage.

These considerations also offer an explanation for a downtrend in beet acreage in the past. Rising profits from the livestock industry in combination with need for rotation and labor problems made a shift of land away from beets necessary. This shift seems to have served better the farmer's main objectives of increasing his returns from the whole farm as a unit, even though sugar beets are more profitable than other competing crops on per acre returns basis. For the last 10 years, however, this trend has leveled off.

The results of the time series analysis indicate that alfalfa, corn silage, irrigated barley, and wheat crops do not compete with sugar beets on the basis of per acre receipts. The variations in yearly receipts from sugar beets explain some of the fluctuations in sugar beet acreage. But the test indicated that the "b" value was not significant. The conclusion thus was that variations in sugar beet receipts are not an important factor in causing variations in sugar beet acreage. This seems to be logical in view of the fact that receipts from sugar beets have been greater than the competing crops throughout the period of study.

Acreage allotments do not allow enough leeway to those who want to expand to compensate for the decreases made by others. On the whole their effect is restrictive to the expansion of sugar beet acreage. Receipts from beets in the past have been high enough to maintain a favorable competitive position for the crop. The results of this study indicate that future price increases accompanied by free allotments will be favorable for expansion of sugar beet acreage.

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