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8 Optimum farm organization for a representative irrigated farm in the Yellowstone Valley

by Gerald Melvin Schaefer

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Abstract:
Agriculture is a dynamic industry which is undergoing continual adjustment. Impetus for adjustment arises from changes in agricultural commodity prices, production technology, input prices, and institutional changes. Farmers attempting to maximize profits make economic adjustments because of these continual changes. The major purpose of this study was to determine what production adjustments would maximize return over variable cost in the Billings area in the event the local sugar beet processing plant were closed, thereby diminishing the profitability of sugar beets.

Nine crop alternatives, eighteen cattle alternatives, and five swine alternatives were considered. Fifteen resource situations were defined for a model farm. These situations were generated by different assumptions concerning labor availability, number of livestock enterprises allowed, and whether sugar beets was a permissible crop enterprise.

Linear programming procedures were used to determine the optimal combination of crops and livestock enterprises to maximize return over variable costs for the model farm. One hundred acres of sugar beets, 100 acres of corn silage, 60 acres of alfalfa, 20 acres of malting barley, and 20 acres of irrigated pasture was the cropping pattern that was most prevalent. Malting barley was usually substituted for sugar beets when sugar beets were not allowed. Livestock alternatives were more sensitive to input-output prices and labor avail-ability. A cattle fattening alternative was always included in the optimum solution. If sufficient labor was available, a swine alternative also appeared in the solution. When the number of livestock alternatives was not restricted, at least two livestock alternatives appeared in the solution. If only one livestock alternative was allowed, return over variable cost was reduced by about $5,000 at 1976-77 prices. Return over variable cost was reduced- by about $3,000 when 1977-78 prices were used.

A restriction disallowing the hiring of seasonal labor reduced return over variable cost by about $7,000.

Return over variable cost was reduced about $4,500 in the model farm when 100 acres of sugar beets were not in the solution. This translates into a net reduction in return over variable cost of approximately $969,000 for the Yellowstone Valley sugar beet growers that presently sell their beets to the Great Western Sugar Company.

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IRRIGATED FARM IN THE YELLOWSTONE VALLEY

by

GERALD MELVIN SCHAEFER

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ABSTRACT

Agriculture is a dynamic industry which is undergoing continual adjustment. Impetus for adjustment arises from changes in agricultural commodity prices, production technology, input prices, and institutional changes. Farmers attempting to maximize profits make economic adjustments because of these continual changes. The major purpose of this study was to determine what production adjustments would maximize return over variable cost in the Billings area in the event the local sugar beet processing plant were closed, thereby diminishing the profitability of sugar beets.

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Return over variable cost was reduced about $4,500 in the model farm when 100 acres of sugar beets were not in the solution. This translates into a net reduction in return over variable cost of approximately $969,000 for the Yellowstone Valley sugar beet growers that presently sell their beets to the Great Western Sugar Company.

Chapter 1

INTRODUCTION

Agriculture is a dynamic industry which is undergoing continual adjustment. Impetus for adjustment arises from several sources. Common sources are changes in agriculture commodity prices, input prices, production technology, and institutions. Farmers attempting to maximize profits make adjustments to these continual changes.

At the present time, two important factors are raising questions regarding the optimal organization of Yellowstone Valley farms. First is the uncertain future of the Great Western Sugar Company's processing plant in Billings. Second is a rapidly changing structure of input and output prices. Presently, at least nine different irrigated crops are grown in the upper Yellowstone Valley. Wintering calves and cattle fattening enterprises are also common, and a few farmers have swine enterprises. The possible closure of the Great Western plant coupled with rapidly fluctuating input and output prices adds serious uncertainty to the Valley farmers' search for optimal combinations of crop and livestock enterprises.

STATEMENT AND BACKGROUND OF THE PROBLEM

Recent uncertainty regarding sugar beet production surfaced during the winter of 1975-1976 when the Great Western Sugar Company and the sugar beet growers' association failed to reach agreement on a contract for 1976. Sugar beet price, purity, and transportation costs were three of many issues on which the Company and growers differed. Both sides argued that increased operating costs necessitated the need for more money to operate their businesses.

As the probability of Great Western not processing sugar beets in 1976 increased, growers began to consider alternatives for processing their beets. They also began to consider alternative enterprises in the event processing should be discontinued.

Transportation costs play an important role in the location of sugar beet growing. Great Western paid up to $2.05 per ton plus 38 percent of the balance over $2.05 per ton for transportation of raw beets. As one would expect, $2.05 per ton covers the transportation charge for most of the sugar beets processed at the Billings plant. The exceptions are sugar beets grown in the Hardin and Hathaway areas.[1] If processing at the Billings plant were discontinued, sugar beet growers in the upper Yellowstone Valley would probably have to pay the entire cost of transportation to another factory or simply not grow beets. The processing plants nearest Billings are Holly Sugar in Sidney, Montana and Great Western in Lovell, Wyoming. Both are operating at near capacity and if additional

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[1]Statement by Merle Riggs, Agriculture Manager of the Great Western Sugar refinery at Billings, Personal Interview, September 20, 1976.

production were desired, beet growers much nearer the plants stand ready to increase their acreages. Thus, at this time, shipping beets from the upper Yellowstone Valley to alternative processing plants does not appear feasible.

In September of 1971, 5000 growers contracting with the Great Western Sugar Company began negotiations to purchase the sugar processing subsidiary of Great Western United. In October of 1972 plans were nearly finalized with sale of the subsidiary to the growers anticipated by December, 1972.[2] A proxy fight among the stockholders of Great Western United and the sudden rise in the price of sugar prevented the sale. Farmers continued to pursue purchase but failed in their negotiations with insurance companies on ways to insure and arrange for compensation against unforeseen losses. In a Billings Gazette article on August 3, 1975, Great Western announced that time had expired on the purchase agreement under which the sugar beet growers were to buy the Great Western subsidiary.[3]

In 1971, the Holly Sugar plant in Hardin, Montana was closed without advance warning. On Wednesday morning, January 27, 1971,

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[2] Presentation by Bob Owens, President of Great Western Cooperative (Cooperative that was going to purchase Great Western Sugar) at the Montana Farmers Union Convention, October, 1972.

[3] The Billings Gazette. August 3, 1975, sec. B, p. 3, col. 1-4.

representatives notified local credit institutions and the County Extension Office that the processing plant was being closed. That evening a general meeting of the beetgrowers' association was called to officially announce the closure of the plant. The principal reason given for closure by the company was that they had been operating at a loss for the past two or three years and the plant was too old and inefficient to remodel.[4]

When the Hardin factory closed, 10,000 acres were removed from sugar beet production. There was an annual payroll reduction of nearly a million dollars and an estimated two and a half million dollar reduction in gross income to beet growers in the area.[5] Some of this reduction in gross income would be made up by growing other crops.

When the Holly Sugar processing plant in Hardin closed in 1971, the two questions most frequently asked were: (1) What is the most profitable alternative crop, and (2) What should be done with the investment in sugar beet equipment. Individual farmers traveled hundreds of miles to look at alternative crops. Seeing an opportunity

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[4]Statement by Harold Strobel, Big Horn County Extension Agent at the time of the factory closing, personal interview, September 23, 1976.

[5]Based on personal correspondence between Thomas K. Cowden, Assistant Secretary of Agriculture, USDA, and Torlief S. Aasheim, Director, Montana Cooperative Extension Service.

to make a quick profit, seed salesmen flooded the area selling exotic crops and miracle varieties of seed. Large sums of money were spent by sugar beet growers for seed for alternative crops.

One month after the announcement of the closing of the factory, Montana State University, through the Cooperative Extension Service and the Agriculture Experiment Station, was able to present some feasible production alternatives to beetgrowers.

If the Billings plant is closed, 21,534 acres of cropland would be planted to alternative crops with a reduction of over $11,000,000 in gross income from sugar beets. Thus, the need to make the right decision is paramount.[6] What are the crop alternatives? What crop or crops should be planted to maximize net income? What role will livestock enterprises play in the effort to maintain farm incomes? These are some of the questions that this study is designed to address.

OBJECTIVES OF THE STUDY

The specific objectives of this study are: 1) to develop enterprise costs for crop and livestock alternatives in the Billings area; and 2) to define a representative farm firm in the Billings area of

[6] 1975 average yield and payment per ton were used in making this estimate.

the Yellowstone Valley; and 3) to determine the optimum organization (enterprise mix) for the representative farm firm in order to maximize return over variable cost.

BACKGROUND INFORMATION ABOUT THE UPPER YELLOWSTONE VALLEY

The study area includes those areas of Yellowstone, Stillwater, Carbon, Rosebud, and Treasure Counties that grow sugar beets for processing at the Great Western Sugar Refinery at Billings. The background information given pertains mostly to Yellowstone County, the central county involved in this study.

During the late 1800's the sugar beet industry was established as a successful manufacturing industry in the United States. Consumption of sugar in the United States in 1895 was 1,950,000 tons with 6,260 tons consumed in Montana.

The gross return from a good crop of sugar beets in 1895 was $45 to $50 an acre compared to $8 an acre for corn. The average price paid per ton was between $4 and $5 for 12 percent sugar content.

The Montana Experiment Station established sugar beet research plots in various parts of the State during the late 1890's, and a feasibility study of the industry in Montana was conducted. This research concluded that sugar beets could be grown in many areas of Montana and it was felt that seven conditions would determine where sugar beet processing plants would be located.

They were:

1. An abundance of beets of standard grade are required.
2. Transportation to the factories must be cheap; the distance cannot be great.
3. An abundance of pure water must be available.
4. Fuel must be cheap.
5. Limestone of good quality must be near at hand.
6. The factories should be located on a railroad, that the product can easily reach the market.
7. There should be a means of disposing of the extracted pulp to stockmen, for use in fattening cattle for market. The stock should be fed on the farms from which the beets are received, in order that the plant food may be returned to the land.[7]

The Billings area was one of several areas where all conditions were met. In 1906 the Great Western Sugar refinery was opened. In 1907 the Huntley Irrigation Project was completed and the sugar beet industry flourished, aided by the establishment of a dependable water supply.

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[7]Traphagen, F. W. The Sugar Beet in Montana. Bulletin 19, Montana Experiment Station, Montana State University, Bozeman, Montana, October 1898, p. 34.

SELECTION OF ANALYTICAL MODEL

Several techniques have been used by farm management educators to determine production adjustments which maximize net farm income under changing conditions. Complete and partial budgeting are two ways that production adjustments can be analyzed. Complete budgets could be prepared for several enterprise combinations. These complete budgets could be compared with each other to determine which one was the "best". Partial budgets could also be prepared for alternative changes in the enterprise mix to see which enterprise would have the greatest positive effect on net farm income.

The limitations of these simple budgeting processes is that they only examine a few alternatives. Resources and enterprises are not allowed to interact with each other to insure limited resources are used in enterprises that produce the greatest net farm income.

Budgeting is not a method to thoroughly analyze problems. For example, with budgeting it is seldom feasible to break labor into subclasses by months or weeks, or soils into different classes. The calculations involved would soon become astronomical. Linear programming is a mathematical technique that allows many enterprise alternatives to be examined, and insures that the profit maximizing use of resources is determined.

There are three quantitative components to linear programming. They are: 1) the objective function, 2) alternative methods or processes for obtaining the objective, and 3) resource or other restrictions.[8] For this problem the objective function is a profit equation that gives the return over variable cost per unit of output for each activity. The objective is to find the maximum profit attainable from the resource base. The alternative activities or processes are different ways of obtaining the objective function. For example, a farmer may grow wheat, barley, and oats to maximize return over variable cost and he might grow each of these crops in several different combinations. Resource restrictions are constraints on the outcome of the problem. They can take the form of limited amounts of labor available during a certain period of time, a limited amount of operating capital, or a limited amount of space available to store harvested grain. Another restriction is that the activities must have non-negative values.

Budgeting and linear programming are normally considered as complements rather than substitutes. Budgeting is normally used when a relatively small number of alternatives are to be considered, or minor adjustments in farming operations are to be made. When several alternatives are being considered or a large scale optimizing problem

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[8] William J. Baumol. Economic Theory and Operation Analysis. (Englewood Cliffs: Prentice-Hall, Inc., 1972), pp. 75-76.

is being analyzed, linear programming offers a more efficient way to obtain a solution. Budgeting or linear programming could be used for either situation but the time factor usually determines which method to use. If only a few alternatives are being considered, there is no reason to set up matrices and perform lengthy calculations to solve the problem. Likewise, when many alternatives are being considered, budgeting would be too time consuming and may not give an optimal solution.

A common concern of people using linear programming as a farm planning tool is how much detail should be put in the model.[9] At several points in the construction of a linear programming model, one must make choices between simplicity and complexity. A trade-off between realism of the model and expediency in getting the problem solved exists. A simplified model may be easy to construct, solve, and interpret, but at the same time it may lack realism. A complex model which results from an attempt to allow interaction of a large number of variables operating in an actual farm situation may be impractical from a cost standpoint, i.e., in terms of time required for construction, codification, solution and interpretation.

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[9] Larry I. Bitney. "Constructing the L.P. Model -- How Much Detail?" Research Report 10, Department of Agricultural Economics, University of Nebraska, Lincoln, May 1970, p. 1.

A study by Huffman and Stanton compared farm plans resulting from a simplified programming matrix (20 x 20) with those of detailed matrices (60 x 60).[10] The simplified matrix did not give acceptable results when compared to the detailed matrix. They concluded the detailed matrix was the best estimate of the optimum organization. One thing which may have biased the result against the simplified matrix was that standard input-output coefficients were used for the simplified matrix rather than those provided by the farmer for the detailed matrix.

Brant also did a study comparing solutions from a simplified programming process and a detailed matrix.[11] The simplified programming process involved a linear interpolation of two or more optimum plans for benchmark farms in a given area. This simplified programming process yielded solutions similar to those of the detailed matrices when the user accurately categorized the land resource of the test farms.

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[10]Donald C. Huffman and Lynn A. Stanton. "Application of Linear Programming to Individual Farm Planning." American Journal of Agricultural Economics, Vol. 51 (1969), pp. 1168 - 1171.

[11]William Lewis Brant. "Analysis of the Representative Farm Concept As A Tool in Area Supply Response Research and Farm Management Education." (Unpublished Doctorate dissertation, Oklahoma State University, 1967), pp. 41-47.

The sequence of steps for linear programming, regardless of the problem being considered is 1) build detailed enterprise budgets; 2) select potentially profitable processes; 3) select the limiting factors of production, after a complete inventory of resources is made; 4) specify the requirements of each process for the limiting factors; 5) cost the inputs; and 6) solve the problem.[12]

ANALYTICAL TECHNIQUE USED

Linear programming was selected as the technique because of the size and complexity of the system being analyzed. Many alternatives each with different resource requirements were considered in the search for optimum production and adjustments. The integer capability of linear programming was also desirable in considering the livestock alternatives.

The linear program used for this study was developed by R. Shareshian of the IBM Corporation. The program employs a branch and bound algorithm based upon the Land and Doig method[13] to solve the mixed integer programming problem. The program solves for an optimal solution without regard to the integer constraints. The

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[12] Chester O. McCorkle, Jr. "Linear Programming as a Tool in Farm Management Analysis." American Journal of Agricultural Economics, Vol. 37 (1955), p. 1231.

[13] A. H. Land and A. G. Doig, "An Automatic Method of Solving Discrete Programming Problems," Econometrica, July, 1960, Volume 28, Number

program then proceeds to solve the problem with the integer restrictions and gives the optimal solution.

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13 continued
3, pp. 497-520.

Chapter 2

METHODOLOGY

This chapter discusses the procedure used to analyze the production adjustment problem. The method of data collection is described. The Oklahoma State University Crop Budget Generator was used to process enterprise data and generate enterprise budgets for the analysis. Assumptions relating to the representative farm firm are presented. Summaries of the feasible production alternatives (enterprise budgets) are presented along with the assumed input and output prices.

METHOD OF DATA COLLECTION

Data used to construct the enterprise budgets were obtained from farmer panels in the summer and fall of 1976. These panels were selected by the Yellowstone County Extension Agent. Farmers selected possessed an above average level of management, had a knowledge of input costs, were from different parts of the study area, and were familiar with farming practices in their area.

The farmer panel was selected to provide data representative of a typical 320 acre irrigated farm in the Billings area. A resource base was developed for the farm. Cultural practices and sequence of operations were specified for each crop. Tractor size, implement size, and timing of the operations were specified by the panel.

Performance rates and amounts and costs of materials were also included.

Machinery prices were obtained from local dealers. Prices for similar models were averaged and then checked against actual sales to determine if discounts were being given to farmers.

Similar methods were used to collect the livestock enterprise data. However, because some feasible livestock enterprises are not common in the area, some of the necessary data were collected in other areas of the State. Enterprise budgets for wintering calves in the feedlot and raising yearlings on irrigated pasture are based on information obtained from the Billings area. Data on feeding yearlings to slaughter weight were obtained from the Billings and Forsyth area. Data for ten sows farrowing once a year was obtained in the Plevna area of southeastern Montana. Data for raising weaner pigs were obtained from Whitehall. Data for a 60 sow confinement hog operation was obtained in the Bozeman area and data for a 90 sow confinement operation were obtained from enterprise cost studies done in Illinois and adjusted to Montana conditions. Cultural practices and costs for a cow-calf enterprise were obtained in the Bozeman and Miles City area.

Budgets for the livestock alternatives were hand calculated. The format used was similar to the computations done by the computer for the crop budgets. Fixed and variable costs were separated and itemized.

All enterprise budget data were then summarized to obtain the technical coefficients for the linear programming model.

MODEL FARM

Size of Farm

The representative farm chosen for this study contains 320 acres. Twenty acres are assumed to be in ditches, fences, roadways, and farmstead. The remaining 300 acres are irrigated. A panel of irrigated farmers and Yellowstone County Extension Agent, John Ranney, described this as a "typical sized" farm in the Yellowstone Valley irrigated area. In this study no additional acres can be acquired by the representative farm.

Soil Productivity

Soil productivity is an important factor influencing enterprise selection, method of operation, and ultimate returns on a given farm. Soil types and, consequently, variations in productivity do not necessarily coincide with farm boundaries. The soil resources of a farm are typically a composite of several soil types. Bureau of Reclamation data show that 25 percent of the irrigated land in the Huntley Project is not suitable for crop production. Other parts of the Yellowstone Valley are more suitable for crop production. This study assumes that 280 acres can grow any type of crop alternative and the remaining 20 acres are limited to irrigated pasture.

Management

An above average level of management is assumed for this study. The level of management is reflected in yields and input usage, such as amount of fertilizer used, chemicals applied, seed varieties planted, type of farm machinery owned and care and maintenance of machinery.

No management fee is charged to any crop or livestock alternative. The returns from each enterprise are returns to the fixed resources. For the purpose of this study, land, management, machinery and buildings that are presently being used in the farming operation and operator labor are fixed resources.

Fixed Resources

Every farmer in the Yellowstone Valley has an inventory of tractors and implements sufficient to produce the crops currently being grown. Since this analysis is concerned with production adjustments necessary to maximize farm income if sugar beet production is lost, the current inventory is considered a sunk cost, and thus not included as a cost for each crop enterprise. Table 1 lists an inventory of machinery on the representative farm with the respective fixed and variable costs per hour of use. Grain storage for 4000

Table 1

AN INVENTORY OF MACHINERY OWNED ON AN IRRIGATED FARM IN THE UPPER YELLOWSTONE VALLEY WITH THEIR RESPECTIVE FIXED AND VARIABLE COSTS[1]

Machine	Size	Price	Fixed Costs Per Hour	Variable Costs Per Hour
Tractor	125 HP	$24,100	$ 6.40	$4.70
Tractor	90 HP	8,500	2.26	3.21
Tractor	70 HP	13,700	2.96	2.76
Tractor	60 HP	4,500	2.19	1.98
Truck	18 FT	11,000	9.26	3.65
Truck	16 FT	5,000	4.25	2.96
Truck	14 FT	1,000	.85	2.49
Tandem Disk	12 FT	2,700	13.60	.19
Farmhand	------	2,200	2.37	.41
Manure Spreader	------	4,500	34.10	1.24
Plow	4-16	3,300	3.33	3.03
Mulcher	15 FT	3,800	4.42	1.35
Land Plane	12 FT	4,200	3.53	1.93
Field Cultivator	18 FT	2,200	6.65	.36
Beet Planter	6 ROW	2,800	5.28	1.46
Incorporator	12 FT	1,100	2.08	.32
Ditch Burner	------	675	8.42	.36
Ditcher	------	850	2.57	.17
Beet Cultivator	6 ROW	2,200	1.11	1.52
Roller Packer	12 FT	2,850	8.61	.47
Beet Thinner	6 ROW	10,600	32.02	1.40
Ditch Closer	------	550	1.66	.11
Top Saver	6 ROW	10,300	17.22	2.50
Beet Digger	3 ROW	17,000	25.68	3.10
Combine	12 FT	5,000	13.83	2.34
Bean Cutter	6 ROW	2,000	10.07	2.51
Bean Windrower	4 ROW	3,200	16.11	.24
Corn Planter	6 ROW	2,800	12.09	.89
Band Sprayer	6 ROW	1,850	7.99	.79
Sprayer	30 FT	885	6.68	.24
Corn Cultivator	6 ROW	1,800	3.88	.39
Corn Chopper	2 ROW	6,850	13.67	1.31
Dozer Blade	10 FT	1,500	2.83	.24
Swather	10 FT	10,250	14.32	7.46
Drill	12 FT	3,400	25.68	.61
Harrow	12 FT	220	1.66	.01
PTO Baler	------	4,750	10.06	1.43
Wagon	------	600	.54	.08
Harrow	30 FT	550	4.16	.03

[1]Schaefer, Jerry and LeRoy D. Luft, Enterprise Costs of Irrigated Crops in South Central Montana, Bulletin 1151, Cooperative Extension Service, Montana State University, June, 1976.

bushels is located on the representative farm. Machine storage and shop area of 3200 square feet are also assumed to exist on the farm. The farm has feedlot capacity for 170 head. One feed storage tank and feed mixer are owned for use with the feedlot.

If new machinery is purchased or buildings erected as a result of production adjustments, the costs are treated as variable costs. The costs which become annual fixed costs are assigned to the enterprise since the farmer decides whether or not it is to his benefit to incur additional annual cost. Prior to acquisition the ownership costs are variable costs because their commitment to production is at the farmer's discretion.

Fixed Costs

Every farm has some fixed costs that must be paid each year regardless of whether or not production takes place. Taxes on real estate and buildings of $6.28 per irrigated acre[14] must be paid. A water charge of $6.00 per acre must be paid or the right to use the water passes to other producers.

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[15]Schaefer, Jerry and LeRoy D. Luft, Enterprise Costs of Irrigated Crops in South Central Montana, Bulletin 1151, Cooperative Extension Service, Montana State University, Bozeman, June, 1976.

Labor

The owner-operator provides labor for the farm business. It is assumed the operator will work ten hours a day for twenty five days a month year around. One full time man can be hired to work the same number of hours as the owner. Some alternatives will allow the hiring of part time seasonal labor to supplement owner operator labor. Not all the labor available can be used for field work due to weather and climatic conditions.

Critical labor periods for this study are defined as: December 1-February 28, March 1-May 31, June 1-August 31, and September 1-November 30. Data concerning days available for field work in the triangle area has been published by the Montana Agricultural Experiment Station.[15] Soil types, climatic conditions, and weather data were used to estimate days available for field work. Although the triangle area and the Billings area are not located near each other, the data was applied to the Billings area because it is the best data available. The date for beginning spring field work and average rainfall were similar for both areas: 74 percent of the days (555 hours) in the March 1-May 31 period were available for field

[15] Yager, William A. and R. Clyde Greer. Estimating Days Suitable for Fieldwork, Research Report 67, Montana Agricultural Experiment Station, Montana State University, Bozeman, December, 1974.

work: 83 percent of the days (622 hours) in the June 1-August 31 period were available for field work; and 93 percent of the days (697 hours) in the September 1-November 30 period were available for field work.

It was assumed that weather would not hinder the labor operations associated with livestock. Therefore, the labor available for livestock enterprises can be equal to the total labor supply for each period.

Capital

Capital requirements for an irrigated farm are high. Most producers have some long term debt as well as an operating capital loan. A real estate debt of $100,000 was assumed. The operating capital loan was assumed not to exceed $80,000 at any one time during the growing season. Enterprise cash receipts and expenses occur at different points in time, so total annual capital requirements can be larger than the operating loan the farmer has with his lender.

Time Period

The time period being considered is a short-run adjustment period. This would be from one to five years in length. The time period is long enough for new capital investment items such as buildings and livestock equipment to be considered variable costs.

Technology

Technology is continually changing on an irrigated farm. This study assumes a level of technology for the livestock alternatives that would exist on the best 10 to 15 percent of the farms in the Upper Yellowstone Valley. Crop alternatives assumed a level of technology that was above average.

ACTIVITIES

The production year for all alternative activities was divided into four periods. These four periods were the same as the critical labor periods: December 1-February 28, March 1-May 31, June 1-August 31, and September 1-November 30.

Crop Activities

Nine different crop alternatives were considered in this analysis. The crop alternatives considered were sugar beets, beans, corn silage, corn grain, spring wheat, feed barley, malting barley, alfalfa hay, and irrigated pasture. Sugar beets were included in this analysis to determine the change in net farm income resulting from the possible loss of this enterprise.

All crop alternatives include only the variable costs, since it was assumed that the farmer already owns the machinery inventory listed in Table 1. Table 2 lists the yields and resource requirements