



Financial aspects of investment in livestock and pastures on irrigated farms
by John Reichel

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree
of Master of Science in Agricultural Economics
Montana State University
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Abstract:

The purpose of this study is to develop a method which may be used to determine the effect that alternative degrees of livestock-grassland type of farming would have upon the financial position of an irrigated farm unit.

Part I develops the various aspects of the problem and thus provides a basis for the study. The basic concepts and principles of the theory of the firm are discussed. The relationship that exists between the firm theory and the budget method as a means of making empirical investigations is presented. • The budget method is described in the following pages.

In Part II the results of a previous study are summarized and used as the basis for the analysis upon which the present study is centered. Three selected types of price movement are applied to the "typical" farm organization. Costs and receipts are adjusted by the use of appropriate indexes. The analysis of each alternative for each year are presented in a series of annual budgets. The results of these budgets are used to make comparisons in changes in borrower-creditor equity.

Part III draws the conclusion that any expansion of the livestock organization by the use of borrowed funds would jeopardize the financial position of a farm operator. This part is also concerned with the general implications of the study for individual farmers and agricultural credit agencies. Last, it considers the limitations that can be associated with this type of study.

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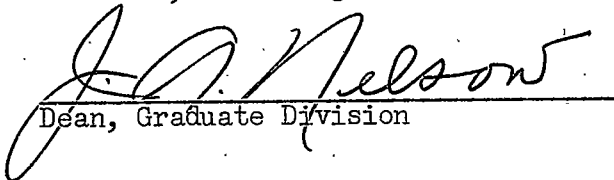
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ABSTRACT

The purpose of this study is to develop a method which may be used to determine the effect that alternative degrees of livestock-grassland type of farming would have upon the financial position of an irrigated farm unit.

Part I develops the various aspects of the problem and thus provides a basis for the study. The basic concepts and principles of the theory of the firm are discussed. The relationship that exists between the firm theory and the budget method as a means of making empirical investigations is presented. The budget method is described in the following pages.

In Part II the results of a previous study are summarized and used as the basis for the analysis upon which the present study is centered. Three selected types of price movement are applied to the "typical" farm organization. Costs and receipts are adjusted by the use of appropriate indexes. The analysis of each alternative for each year are presented in a series of annual budgets. The results of these budgets are used to make comparisons in changes in borrower-creditor equity.

Part III draws the conclusion that any expansion of the livestock organization by the use of borrowed funds would jeopardize the financial position of a farm operator. This part is also concerned with the general implications of the study for individual farmers and agricultural credit agencies. Last, it considers the limitations that can be associated with this type of study.

PART I. INTRODUCTION

The Problem

When a farmer shifts from one enterprise, or system of farming, to another, he runs into a capital problem. He may need additional operating capital, or the adjustment may require new fixed capital outlay. Adding a dairy-hog enterprise often presents the latter capital problem. The purpose of this study is to determine the financial position (level and structure of equity) required, under different kinds of anticipated price and cost relationships, to justify shifts from a cash crop system of farming to alternative degrees of livestock (dairy-hog)-grassland type of farming on irrigated farms.

Variations in yields and/or prices result in low net incomes (or perhaps even a negative income) in some years, and in very high incomes in other years. The wide variations of income relative to the higher fixed costs, plus the indebtedness which may be necessary in shifting to a dairy-hog operation may force the farmer into insolvency during the low income years. The farmer must evaluate his resources accurately in terms of loan value to determine the extent of indebtedness which he may safely incur.

Given an uncertainty setting, the optimum plan for any individual depends, among other things, on his psychological makeup, his capital position and the ends he wishes to maximize. Will "survival of the firm"

or maximization of profits be the ends of production? 1/ Profits constitute a goal intermediate to the attainment of utility on many farms. Among other goals is the desire for security which gives rise to an attempt for continuous or regular income rather than the possibilities of short-run, maximum profits. On the other hand, survival may be regarded as an intermediate end. Survival of the firm in the short-run is a means of maximizing returns over a period of several years. While survival as an end may be competitive with profit maximization in the short-run, short-run survival is complementary with profit maximization in the long-run. Precautionary measures employed by farmers in attempting to guarantee survival may outweigh any small changes in price relationships in the use of resources.

When production and income are variable, two alternatives for planning farm production and family expenditures are open. A plan can be adopted which (1) involves large variations from year to year but allows a greater average net income over time, or (2) results in (a) smaller variations between years, and (b) a lower average income over all years.

The Method

Comparisons are made between the effect that three selected type of price movements would have upon the income and solvency of the farmer of

1/ Schickele defines "farm survival end" in operational terms in this way: "To manage production, inventories, cash reserves and access to outside funds so as to minimize the probability of a risk loss large enough to render the farmer insolvent". See Rainer Schickele, "Farmers' Adaptations to Income Uncertainty", Journal of Farm Economics, XXXII, August, 1950, p. 363.

three different alternative farm organizations. The "original" organization was the one found to be the most prevalent in the area of study. The alternative organizations selected are concerned with varying degrees of increase in livestock organization, which required additional operating costs and new fixed capital outlays.

From alternative farm budgets previously organized 1/ an attempt will be made to determine the effect different types of price movements would have had upon the net farm income for the particular type and size of farms considered. Any additional investment in pastures, livestock and equipment had been made in 1948-'49. It will be assumed that any additional investment would be made through the use of borrowed capital. The effect of varying net farm incomes upon the equity position will be noted to determine whether the entity of the firm 2/ can be maintained with the type of price movements applied.

The Theory of the Firm 3/

The basic concepts and principles of the theory of the firm provide

1/ See Clarence W. Jensen, The Economics of Pasture Integration on Irrigated Farms, Montana State College Experiment Station, Mimeograph Cir. 67, Bozeman, Montana, July, 1952.

2/ The entity of the firm may be defined in terms of maintaining the value of the firm as expressed by the difference between total assets value and outstanding liabilities. For an elaboration on this point, see C. B. Baker, Government Participation in the Supply of Short Term Credit for Agriculture, Unpublished Ph.D. thesis, University of California, pp. 192-3.

3/ For a more detailed discussion of the theory, see Appendix A.

tools for determining the optimum allocation of resources. Since an irrigated farm, characteristically, is in a purely competitive position with regard to other agricultural firms for the purchase of inputs and sale of outputs, the discussion may be limited to a firm in pure competition. A set of functional relationships may be derived from various combinations of factors for the production of a product or products. The functional relationship of a variable factor in combination with certain fixed factors in the production of a product is eventually subject to the law of diminishing returns. The application of prices to the marginal analysis derived from the theory provides a basis for making a choice between alternatives which is based on certain maximizing and minimizing conditions. The maximizing condition is that marginal cost must be equated to price of output. The minimizing condition is that the proportionate combination of factors must be the cheapest combination of factors that yield a given quantity of product. ^{1/}

Where the choice involves the allocation of given resources between competing products, maximum value product (net of the variable resource cost) is attained when the marginal rate of product substitution is inversely equal to the product price ratio.

The brief discussion above presents the case for the allocation of given resources and maximization of profits where perfect knowledge exists. The assumption of a fixed quantity of resources and perfect knowledge must be lifted to analyze the problem. Yields and prices in

^{1/} See Appendix A for an elaboration of these conditions.

agriculture are uncertain and vary from year to year. The effect of adding another variable factor (borrowed funds) upon (1) the costs, (2) the revenue, (3) the output of products, and (4) the new equilibrium position with respect to the proportioning of variable factors between products must be analyzed with some degree of subjective probability.

The effect of subsequent price variations, especially where capital is borrowed, becomes important in maintaining entity of the firm, as well as maximization of profits. The extension of capital by lenders is dependent upon certain attributes of the borrower as well as the economic position of the lenders. "The principle of increasing risk" ^{1/} places a limitation upon the use of borrowed capital. This "principle" is reflected in two phenomena associated with uncertainty. One, risk aversion, is the situation in which limitations are imposed internally to the acquisition and use of resources. The other, capital rationing, is the situation in which limitations are imposed externally to the acquisition and use of resources.

Relation Between the Budget and the Theory of the Firm

The theory of the firm is difficult to use empirically. However, the marginal analysis as developed in the theory of the firm provides a basis for making a comparison of costs and returns in any enterprise through the budget method. The theory does not provide a simple accounting technique, but it does provide a method of reasoning that can be

^{1/} M. Kalecki, "Essays in the Theory of Economic Fluctuations", Allen & Urwin, London, 1939, pp. 95-106.

incorporated into the budget analysis. The discussion of the budget method and the method of substitution in the budgeting process is contained in the section following.

The budget method is a means for testing combinations of available resources in terms of the prospective income flows that can be derived from alternative organizations. This is consistent with the basic assumption of the theory of the firm in the sense that profits constitute one of the entrepreneurial goals.

The testing of different combinations of resources is analogous to determining the marginal rate of substitution of factors and minimization of cost for any level of output as set up by the theory of the firm. Use of the marginal analysis presents some difficulties as applied in the method of substitution. The theory assumes that inputs can be applied in infinitesimal amounts. This assumption is not completely applicable to some factors of production in agriculture, such as buildings and equipment. This situation can be somewhat alleviated by the addition of smaller size units.

The substitution of alternative organizations and comparing the net farm incomes of different combinations of enterprises can be compared to the principle in the theory that sets forth the conditions for maximizing profits from competing products that are produced by a given set of resources. The budget method does not present simple unquestioned solution, but it does imply rough estimates of product substitution.

In spite of the empirical shortcomings that may exist between the theory and the budget method, the concept of the theory of the firm is

invaluable as a guide to organizing a budget. With this relation in mind the next step shall be to develop a methodology for determining the effect that indebtedness and varying amounts of net farm income with alternative degrees of livestock organization will have upon the equity position, net worth, and solvency of the firm. This will be accomplished by the use of the budget method.

The Production Method or Production Plan

A budget plan is a definite plan for the use of resources during some future period of time. The specific purpose of the budget is to estimate returns most likely under a given system of organizing or managing a farm. The plan should be organized to achieve any goals "appropriate" to a given situation, and thus maximize the "surpluses", in terms of these goals, produced by the resources over a period of several years. ^{1/}

The budget is the planning phase of farming carried out beforehand on paper or in the mind. Results of the plan are measured in terms of some net income. The farmer does not plan to produce a certain dollar's worth of a crop, but estimates that a certain number of acres will yield a certain physical quantity of product. The criteria of choice between competing enterprises are the level, and with proper application, variation of net income from the available resources.

The Use of the Budget Method

The budget method is a tool used in farm management for testing

^{1/} Time period varies with the problem.

combinations of resources in terms of the prospective income flows that can be derived from alternative organizations. The budget method may be used to compare (1) alternative plans of a new farm business, or (2) alternative organizations for a "going" farm business. 1/ An organizational change may be constituted by a different proportion of enterprises, different practices and methods of production, different schemes for soil conservation, or net additions to the total quantity of resources employed, together with the various means by which they may be acquired. Enterprises may produce competitive independent products with constant or increasing rates of substitution; they may also produce complementary or supplementary products. The method of substitution is generally the method used to select between competing enterprises. 2/

The substitution method consists of completely or partially substituting for an existing enterprise organization a different combination of enterprises and checking the value of the results upon the total net income flows of the farm. Since only variable costs are relevant to current management decisions, it is only necessary to consider the variable costs in the method of substitution. The farmer must sometimes make a choice or compromise between the level of income and the stability

1/ Andrew Boss and George A. Pond, Modern Farm Management Principles and Practice, The Webb Publishing Co., St. Paul, Minn., 1947, pp. 198-222.

2/ Other methods of farm planning are the (1) method of direct comparison, and (2) standard comparison of farm enterprises. For a discussion of these methods, see G. W. Forester, Farm Organization and Management, Prentice-Hall, Inc., New York, 1949, pp. 97-150.

which he desires when he makes decisions regarding the absolute and relative size of enterprises.

Divisions of the Farm Budget

Generally the farm budget is broken down in the three following divisions, viz., the crop plan, the livestock plan, and the indirect and fixed expenses. ^{1/} These parts are then summarized into an aggregate in the budget summary. The organization of competing enterprises within the crops and livestock enterprises and between these enterprises should be so arranged that the "net marginal return" from each is equal for all of the resources employed.

Information Needed for the Budget

The information needed for budget analysis can be classified into the two broad categories of production data and price data. On the production side, the farmer must consider the technical possibilities of production between competing, complementary, or supplementary enterprises from the extent and condition of available farm resources--land, labor, capital, equipment, and entrepreneurial ability. The input-output relationship of crops and livestock represent expectations for a time span relevant to the problem at hand. The production functions are uncertain, but they may be based upon average yields for the past 5 or 10 years, or they may be based on some "normal" year. Whatever method is adopted, the information should be reliable and adaptable to the quality and quantity of resources

^{1/} John A. Hopkins, Elements of Farm Management, Prentice-Hall, Inc., New York, 1947, pp. 113-4.

(expected to be) available through time.

The category of price data is concerned with putting prices on the inputs and the outputs. Since future prices are uncertain, the expected price becomes a "subjective prediction" on the part of the farmer with a probability distribution that is conditioned by the general economic conditions and government price support programs 1/, and enters the decision function subject to the individual's psychological makeup, his financial position, and the ends to be maximized. Although prices applied to inputs and outputs in budgeting are always "expectations" rather than "actual", they may be based on historical price behavior. It is important that the price relationship between, as well as within, the input-output relationships is consistent. It will be the relative yields, prices, and costs taken together which determine the most profitable crop and livestock enterprises. 2/ The movement of prices is a subject which must be given particular attention by the farmer if a wise choice of enterprise is to be made.

Flexibility of Production

The emphasis in the budget method has been upon the balance needed to maximize the net farm income. But when production and income are variable, due to the uncertainty of prices and yields, the farmer may follow a more conservative plan in order to guarantee survival. A plan may be

1/ D. B. Williams, "Price Expectations and Reactions to Uncertainty by Farmers in Illinois", Journal of Farm Economics, Vol. XXXIII, Feb. 1951, p. 237.

2/ John A. Hopkins and Earl O. Heady, Farm Records, Third Edition, Iowa State College Press, Ames, Iowa, 1949, pp. 14-15.

adopted which results in smaller variations between years even if it provides a lower income over all years. The farmer may sacrifice level of income for stability of income. Different combinations of capital, with regard to liquidity, will result in firms with different degrees of flexibility. Liquidity in asset structure may also be considered a form of financial flexibility. Liquidity can be used to counteract economic shocks. Cash or credit is also needed in order to carry on current production and otherwise facilitate current operation.

Flexibility can be provided by establishing a type of plant that allows for greater substitution of enterprises. Production possibilities open after selection of a specialized plan are limited in the short-run, due to the technical limitations of specialized resources. The adoption of a flexible plan allows the firm to adjust production to changing price ratios. A short-lived resource provides a greater time flexibility than a durable resource. If a change in plans is brought about by a change in the prices of competing products, the operator does not sacrifice as great an investment in the short-lived resource as he may in the durable resource. It is assumed that the durable resource has a higher initial total cost. A good example of product flexibility is the selection of dual purpose cows instead of dairy cows to allow a switch between beef and butterfat as price ratios vary. Some types of livestock production have less flexibility than do some of the annual crops.

In addition to a flexible multiple-product plant, diversification can be accomplished by selecting enterprises in fixed proportions over time. The premise of this idea is that if the returns are low in one

crop, the returns in another may be high, due to the relative price changes of products over time and changes of yields of products.

PART II. EMPIRICAL INVESTIGATION

Summary of Results of Previous Study

The present study is based on a previous study made to determine the most profitable proportion of pastures and cash crops in an irrigated farm organization. ^{1/} Thirty sample farms were drawn from those having seeded irrigated pastures along the Yellowstone River in Stillwater and Yellowstone counties of Montana. On the average, as of 1948, these farms contained about 120 acres of irrigated land. This was the size that was used as the "typical" farm. The irrigated land was used for crop and pasture in the following proportions:

Sugar beets -----	32 per cent
Hay and pasture-----	31 per cent
Grain-----	28 per cent
Fence lines, roads, irrigation ditches, farmstead, etc.-----	9 per cent

Farm returns and costs were calculated on the basis of average prices for 1948-'49. These averages were applied to a farm "typical" of the area. This organization was then used as a basis for comparing alternative organizations which might be set up in the area. Increased yields derived from having forages in the rotation were not calculated for the alternative organizations. Since dairying was found to be the major livestock enterprise, it was used in the budgets for the alternative farm organizations. Comparison of incomes from alternative organizations based on

^{1/} Jensen, op. cit., p. 17.

prices and costs was then made. The budget summaries for the original and three alternative organizations are given in Table I. ^{1/}

Table I. Budget Summaries of Receipts and Expenses for Original and Three Alternative Farm Organizations.

Organization	Receipts	Expenses
Original Farm Organization	Crops \$ 6,773	Crops \$ 4,067
	Dairy-Hog 4,025	Dairy-Hog 549
	Home Consumed 502	Indirect and Fixed 2,613
	TOTAL \$11,300	TOTAL \$ 7,229
		NET FARM INCOME \$ 4,071
Alternative No. I	Crops \$ 215	Crops \$ 487
	Dairy-Hog 13,461	Dairy-Hog 3,859
	Home Consumed 502	Indirect and Fixed 4,824
	TOTAL \$14,133	TOTAL \$ 8,400
		NET FARM INCOME \$ 5,733
Alternative No. II	Crops \$13,704	Crops \$ 7,502
	Dairy-Hog ----	Dairy-Hog 143
	Home Consumed 280	Indirect and Fixed 2,983
	TOTAL \$13,984	TOTAL \$10,628
		NET FARM INCOME \$ 3,356
Alternative No. III	Crops \$ 2,974	Crops \$ 2,101
	Dairy-Hog 14,304	Dairy-Hog 3,286
	Home Consumed 502	Indirect and Fixed 6,158
	TOTAL \$17,780	TOTAL \$11,545
		NET FARM INCOME \$ 6,235

The original crop and pasture organization was made up of the proportion of crop acres as given above. The livestock enterprise was composed

^{1/} Ibid., Table XIV, p. 71.

of 10 dairy cows, from which butterfat and yearlings were marketed, and a hog enterprise of 3 sows which produced 18 pigs for market.

In Alternative No. I, nearly all land was shifted to the production of forage. The size of the dairy enterprise was increased from 10 to 30 cows, and the hog enterprise from 3 sows to 9 sows. This required an additional outlay of \$4,600 for livestock and \$1,725 for sufficient buildings and equipment to handle them.

In Alternative No. II, all land was shifted to cash crops -- 75.5 acres of sugar beets and 33.5 acres of wheat. This alternative has no livestock in the farm organization. Since this study is concerned with shifting to varying degrees of increases in livestock organization in comparison to the "original" organization, this alternative provides no basis of concern here; therefore, it will not be considered further.

Alternative organization No. III was made up of about 1/3 cash crops (sugar beets) and 2/3 forage and pasture. The dairy enterprise was increased to 28 cows, and the hog enterprise was increased to 18 sows. This organization would have required an additional outlay of \$2,100 for buildings and equipment and \$4,500 more for livestock investments.

The conclusion that can be drawn from these budgets is that with prices for livestock and livestock products at 1948-49 levels, the average farmer in the Billings area could have improved his income by shifting to the production of more forage and livestock.

But variation as well as level of net farm income is critical to most farmers. The variation in net farm income was greater for the two livestock alternatives than it was for the original or the all cash crop

alternative. Certain statistical measures were used to determine the relative net income vulnerability of an average farmer under the organizations planned. The basis for comparing the variations in income among the alternatives was the price coefficient of net income variation. The coefficient of variation may be defined as the standard deviation of a sample divided by the mean value of the items in the sample. That is, variability is expressed as a certain per cent of the mean. Since the coefficient of variability measures relative dispersion, it is useful in comparing alternative organizations.

The first step in the calculation of the gross income variation was to calculate the coefficient of price variation for the five major marketable commodities--sugar beets, wheat, butterfat, beef and hogs for the years 1920-1948. The coefficient of price variation arrived at here gave the percentage which the price could be expected to vary from the mean in two years out of three. The coefficient of price variation figures are as follows: sugar beets, .273; wheat, .451; butterfat, .402; beef, .512; and pork, .495. ^{1/}

The next step consisted of weighting the coefficients of price variation by the proportion that each commodity contributed to the gross farm income. The summation of each weighted coefficient of price variation for each enterprise divided by 100 in each organization gives a comparison of gross farm income variation among the alternatives. The gross income

^{1/} Ibid., p. 75.

coefficient of variation for each alternative is as follows: 1/

Original-----	.3516
Alternative No. I-----	.4700
Alternative No. II-----	.2956
Alternative No. III-----	.4415

Since variation in net farm income is the critical income figure, it was necessary to combine the gross income coefficient of variation with farm expenses to secure a comparison of the price vulnerability of net farm income among the different organizations. In combining the gross income coefficient of variation with expenses, the assumption was made that there will be no significant difference in expense variation over time among alternative organizations. With this assumption, the ratio of the gross income coefficient of variation to the difference between average gross income and total expenses ($\frac{V}{I - E/I}$) permits a comparison of the price vulnerability of net farm income among the different organizations. The net income vulnerability for the different organizations budget are as follows: 2/

Original-----	.9759
Alternative No. I-----	1.1588
Alternative No. II-----	1.2317
Alternative No. III-----	1.2589

1/ Ibid., p. 76.

2/ See Jensen, Ibid., for determination of net income vulnerability and figures.

Budget Synthesis

The "original" organization based on 1948-'49 averages as shown in the previous study is presented in detail in order to reflect the yields and specific costs associated with each enterprise. Since it is not possible to determine the specific land use of Alternatives I and III, the "original" organization will be used as a basis for estimating the results of the alternative organizations. The budgets for crop and livestock production are presented in Tables II and III. Yields are averages for Yellowstone and Stillwater counties in 1948-'49. 1/ The prices applied to these production averages were the average prices received by Montana farmers in 1948-'49. 2/

1/ Montana Agricultural Statistics, Montana Department of Agriculture and Labor Industry cooperating with United States Department of Agriculture, Bureau of Agricultural Economics, Helena, Montana, Vol. III, December, 1950, pp. 95 and 103.

2/ Ibid., pp. 95 and 103.

