



Forage-crop substitutions on dryland units sensitive to shift
by Terry N Norman

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:

Units in spring wheat and winter wheat areas are analyzed for price conditions which would induce shifts between dryland crop and range forage production. Each area is selected on physical characteristics found previously to be significant determinants of "shift-sensitive" situations.

In each situation, a budget is used to synthesize a representative organization of enterprises, resources and practices. Each organization shows the manner in which operators of shift-sensitive units have responded to current production and marketing opportunities.

By means of "break-even price" analysis, estimates are made of price conditions required in beef cattle and wheat, to induce enterprise shifts in the budgeted organizations. To implement the analysis, two sets of assumptions were made: one relating to production relationships and the other to time periods required for enterprise adjustment. (1) A linear production opportunity curve is assumed between two enterprises which compete for a given set of resources common to both. The marginal cost of resources specific to each, is assumed, in each case, to be a linear function of output. (2) Decisions to shift enterprise organizations are assumed to be based on completed adjustment, with no problems in financing the adjustment. It was found that, on a one-year basis, a shift from the current organization to cattle on range developed on shiftable land would require, with wheat at \$2.05 per bushel of winter wheat and \$2.12 per bushel of spring wheat, beef cattle prices of \$29.83 and \$20.47 per cwt., respectively, in the winter and spring wheat areas. Conversely, with cattle at \$16.48 and \$16.01 per cwt., winter wheat and spring wheat could crop as low as \$1.51 and \$1.46 per bushel, respectively, before farms in the winter and spring wheat area would be induced to transfer shiftable land from wheat, its present use, to range forage for beef cattle. On the long-run basis, the comparable, prices are, for beef cattle: \$29.10 and \$19.98 per cwt.; for wheat: \$1.52 and \$1.51 per bushel.

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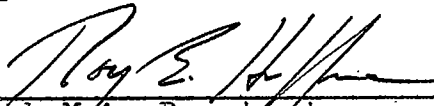
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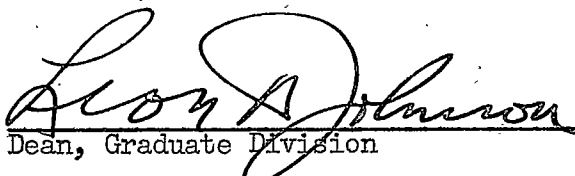
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Although much of this study is based on the contributions of previous and contemporary workers, any errors or deficiencies appearing in this discourse are entirely the responsibility of the author.

ABSTRACT

Units in spring wheat and winter wheat areas are analyzed for price conditions which would induce shifts between dryland crop and range forage production. Each area is selected on physical characteristics found previously to be significant determinants of "shift-sensitive" situations. In each situation, a budget is used to synthesize a representative organization of enterprises, resources and practices. Each organization shows the manner in which operators of shift-sensitive units have responded to current production and marketing opportunities.

By means of "break-even price" analysis, estimates are made of price conditions required in beef cattle and wheat, to induce enterprise shifts in the budgeted organizations. To implement the analysis, two sets of assumptions were made: one relating to production relationships and the other to time periods required for enterprise adjustment. (1) A linear production opportunity curve is assumed between two enterprises which compete for a given set of resources common to both. The marginal cost of resources specific to each, is assumed, in each case, to be a linear function of output. (2) Decisions to shift enterprise organizations are assumed to be based on completed adjustment, with no problems in financing the adjustment. It was found that, on a one-year basis, a shift from the current organization to cattle on range developed on shiftable land would require, with wheat at \$2.05 per bushel of winter wheat and \$2.12 per bushel of spring wheat, beef cattle prices of \$29.83 and \$20.47 per cwt., respectively, in the winter and spring wheat areas. Conversely, with cattle at \$16.48 and \$16.01 per cwt., winter wheat and spring wheat could crop as low as \$1.51 and \$1.46 per bushel, respectively, before farms in the winter and spring wheat area would be induced to transfer shiftable land from wheat, its present use, to range forage for beef cattle. On the long-run basis, the comparable prices are, for beef cattle: \$29.10 and \$19.98 per cwt.; for wheat: \$1.52 and \$1.51 per bushel.

FORAGE-CROP SUBSTITUTIONS
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PART I

THEORETICAL MODEL

Agricultural production involves numerous relationships between resources and commodities during the production period.^{1/} Certain peculiar relationships may be characteristic to a specific type of farming, but the basic form of the input-output relationship to be discussed is common to all production phenomena. This relationship relates the amount of product forthcoming to various quantities and combinations of fixed and variable inputs used in the production process. These relationships in particular cases are called "production functions."

The production process may be organized in several ways by the producer whose job it is (among others) to allocate resources between enterprises such that an "optimum" total product is forthcoming. Problems of intensity arise in respect to the total amount of resources which should be allocated among enterprises. Estimates of input-output relationships are required to resolve these questions.

Any production function may be expressed in equation form:

$$Y_1 = f(X_1 X_2 X_3 X_4 \dots X_n)$$

Where Y_1 refers to the quantity of total product which is produced from the interrelated function (f) and $X_1 X_2 X_3 X_4 \dots X_n$ are quantities of input factors. In special cases, production functions may also be written in

^{1/} The period required to transform resources into products.

the manner $Y_1 = f(X_1 / X_2 X_3 \dots X_n)$ where again Y_1 = total product resulting from various combinations of input factors, X_1 . The "slash" between X_1 and X_2 , however, indicates that all factors to the right of it are fixed ($X_2 X_3 \dots X_n$), while X_1 is the only variable factor. While the output of total product Y will vary depending on the magnitude of resources X_1 through X_n , the changes in total product primarily depend on changes in X_1 for the situation considered, hence $Y_1 = f(X_1)$.

With reference to Figure 1, below, it is possible to illustrate the production process as one variable factor is applied to several fixed factors: $Y_1 = f(X_1 / X_2 X_3 \dots X_n)$.

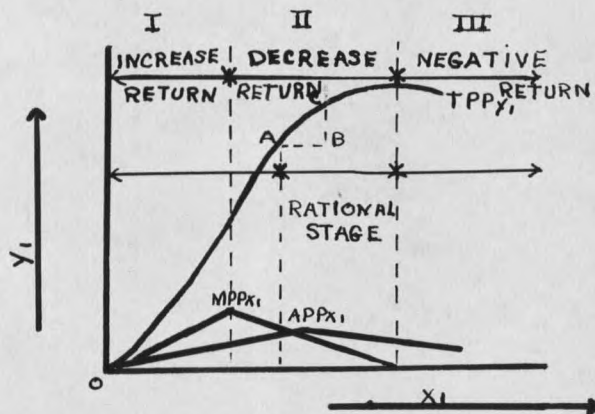


Figure 1. Production stages and resource use.

Here the varying quantity of input X_1 is measured along the horizontal axis while the associated quantity of total product is measured along the vertical axis. It is apparent from curve $TPPY_1$ that total product increases first at an increasing rate (Area 1), but after a point ($MPPX_1$ is at a maximum) the increase is at a decreasing rate. This can be explained by the introduction of two additional concepts, the marginal

product of X_1 (MPP_{X_1} curve) and average product of X_1 (APP_{X_1} curve).^{2/}

Marginal product (MPP_{X_1}) refers to the ratio of change in total output to change in total input of X_1 or stated another way, it is the quantity which each individual unit of factor input adds to the total product, all other factors held constant in quantity, and may be expressed thus, $MPP_{X_1} = \Delta Y_1 / \Delta X_1$, with reference to Figure 1. The marginal productivity curve represents the rate of change (BC / AB in triangle ABC, Figure 1) of the total product curve (TPP_Y). As long as $\Delta Y / \Delta X_1$, or the marginal product of the variable factor, is increasing, the total product must increase at an increasing rate. This is illustrated in Figure 1, Area 1, where the TPP curve is convex to the X axis as long as the marginal product (MPP_{X_1}) is increasing. The marginal product curve (MPP_{X_1}) reaches its maximum at the inflection point on the total product curve TPP_1 .^{3/} Beyond this point the total product continues to increase, but at a decreasing rate as long as the marginal product (MPP_{X_1}) decreases, but is greater than zero. When marginal product (MPP_{X_1}) reaches zero, total product TPP reaches a

^{2/} The curve, APP_{X_1} , refers to the average productivity of the variable resource X_1 and is expressed from the derivation Y_1 / X_1 , where Y_1 equals the total product and X_1 refers to the variable input factor. The average product (APP_{X_1}) is derived by dividing the total output at each level of input by the total number of inputs. Average productivity in Area 1, increases continuously as additional amounts of the variable resource is added to the fixed resource.

^{3/} Inflection point of TPP_Y is where the curvature reverses itself, in this case, from convex to concave relative to the X axis as the marginal product curve (MPP_{X_1}) attains a maximum.

maximum. Beyond this point, the marginal product of variable input X_1 is negative. At this level of input use, the total product starts to decrease.^{4/}

In the analysis of adjustments made on a combination crop-livestock farm which is fixed in acreage and with a fixed stock of services on hand in the form of labor and buildings, a knowledge of the physical laws of production are useful in explaining the basic fundamentals of resource allocation. Although the physical relationships, considered above, define the stages of rational production, they do not specify the exact quantity of variable quantities which should be applied to fixed factors in a plant or a farm as an economic unit.

In this study the basic problem involves the question of allocating resources, (land, labor, management) on a given farm limited in size. What kinds and amounts of livestock (or crop) products should be produced with this stock of limited resources?

In organizing a given stock of resources so as to maximize gross return, the farmer often becomes involved with a second, third, fourth, etc. enterprise, each of which has its own production function. With

^{4/} Ibid., p. 43; (also see Boulding, K. E., Economic Analysis, Harper and Brothers, New York 1948, p. 675.) The above relationship comes under the widely accepted law in economics, called the Law of Diminishing Marginal Productivity or the Law of Variable Proportions which is stated: "As the quantity of one productive service is increased by equal increments with the quantities of other resource services held constant, the increments to total product may increase at first but will decrease after a certain point." This point is where the marginal product curve (MPP_{x_1} , Figure 1) is at a maximum and is identical to the inflection point on the total product curve (TPP_{y_1} , Figure 1).

each of these production functions, it becomes apparent that some resources are unique to one of two competing enterprises, while other resources are common to both of two competing enterprises. Both enterprises may use the same resource (labor), but at different time periods; if this is the case there is no problem of allocation between enterprises. If, however, both processes require a resource at the same period of time, there is a resource allocation problem between enterprises. Our problem rises this second type of situation. The nature of the inter-enterprise relationship will be dependent upon the nature of the production function for each independent enterprise.

Supplemental enterprise relationships exist when output of one product is increased with neither loss nor gain in the other product, again, with common resources held constant in total quantity.

Supplementary enterprise relationships arise usually where time is a factor; for example, crops that can be grown only during specific and limited periods of the year would be considered supplementary.

When considering a multi-enterprise combination operation, it becomes apparent that while enterprises may be supplementary or complementary over a certain size range they eventually become competitive. Under this set of peculiar circumstances there exists a series of each type of relationship which causes a production possibility curve to exist for a complementary competitive relationship and a supplementary competitive relationship. In Figure 2 the opportunity curves for both products increase to a point, but beyond, the relationship changes from one of complementary to one of competition. For a given schedule of

resource inputs, an entire family of opportunity curves are possible depending on the varied resource input combinations.

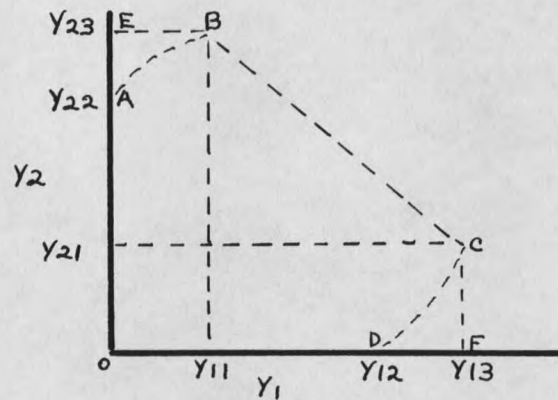


Figure 2. Production possibility with supplementary and complementary range.

Figure 2 illustrates the three types of resource allocation relationships mentioned above. With respect to the complementary relationship in Figure 2, as product Y_1 is increased from 0 to Y_{11} (line AB), product Y_2 simultaneously increases from quantity Y_{22} to quantity Y_{23} . An analogy can be made when considering an increase in product Y_2 . As Y_2 increases from quantity 0 to Y_{21} there is a simultaneous increase in the quantity of Y_1 from an output Y_{12} to Y_{13} .

From the same illustration, Figure 2, the supplementary relationship can be demonstrated. Here the resources used in the production of a given product, Y_1 have no alternative use for yielding a greater quantity of product Y_1 during a given time period. Thus by allocating this fixed stock of resources into the production of another product (Y_2), a greater total product can be realized from the fixed stock of resources. With reference to Figure 2, it is apparent that at an output of Y_{13} of product Y_1 , a certain quantity (Y_{21}) of product Y_2 is forthcoming by reallocating

resources. This type of relationship is possible whenever a stock or flow of resource service is available and cannot be absorbed entirely by one enterprise. In other words, two enterprises bear a supplementary relationship when, with resources held constant, output of one product can be increased with neither gain nor loss to the other product. Thus the opportunity cost for a given stock of resources may be increased from zero to some positive figure by allocating the resources to the production of a second product.

Between points B and C in Figure 2, the relationship of resource allocation becomes competitive between the two products, Y_1 and Y_2 , and is represented by the dotted line BC. Under these conditions, with a fixed stock of resources, an increase in the output of one product (Y_2), due to an increase in use of resources, causes a decrease in the quantity of product Y_1 due to a decrease in the use of resources for production of Y_1 . In considering problems of enterprise competition, estimates are required in the rates at which the resources common to both enterprises substitute for each other. For our purposes, we assume that these resources substitute between competing enterprises at a constant rate. Hence the production opportunity curve will be linear between the two competing enterprises.

Products, like input factors, bear several physical relationships in that they are complementary, supplementary and competitive to each other, either separately or in combination over a given time period. Enterprise relationships of a complementary nature exist when an increase in the output of one product results in an increase in the output of the

other. That is, a shift of resource from crop A to crop B will increase A rather than decrease it while simultaneously increasing B. With reference to Figure 2 this relationship is readily demonstrated.

Figure 3 illustrates a competitive relationship. From this it is apparent that as resources are allocated between two products (e.g. Wheat-Beef), varying quantities of the two products are forthcoming. A given stock of resources may be so allocated as to provide a product of 8 bushels of wheat and no beef; or they may be so allocated as to provide 16 pounds of beef and no wheat. Any variation in the output of one product results in an inverse variation in the output of the other product. Suppose now that it becomes desirable to increase the production of wheat from 4 bushels to 6 bushels. Under a competitive relationship for resource allocation, this increase of the quantity of wheat is possible only at the expense of the resources that are allocated to beef production. As resources are reallocated so that wheat output is increased from 4 bushels to 6 bushels, resources utilized for beef production are withdrawn and pounds of beef produced diminishes from 8 pounds to 4 pounds.

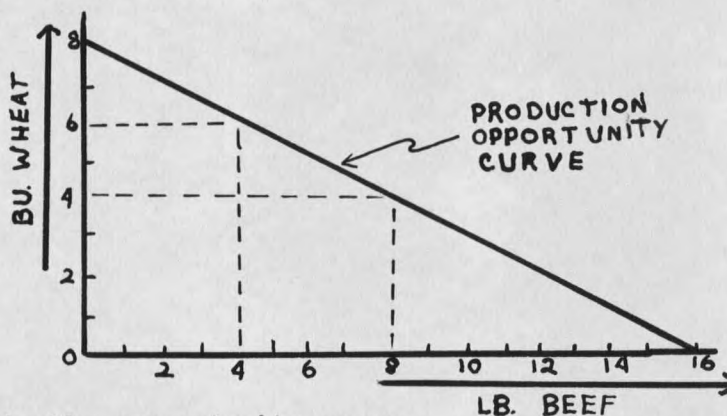


Figure 3. Production opportunity curve.

Because a competitive type of enterprise relationship is the most common in areas sensitive to shift, it will be discussed in more detail. Although complementary or supplementary relationships may exist with any pair of products, problems are assumed to be most important in the competitive range of product combination. Hence, the problem under consideration deals with two enterprises which vary inversely in the quantity of total physical product forthcoming from a given quantity of resource as resources are allocated between the two enterprises.

A linear iso-resource relationship indicates that the marginal rate of substitution of one product for the other is a constant: for each 1-unit gain in one commodity, a constant amount of another must be sacrificed. Although two commodities with linear production functions always give rise to linear opportunity curves, linear production functions are not necessary for constant rates of product substitution. Production opportunity curves may be linear when the production function for Y_1 is the mere image of Y_2 .

The problem in production is one of making a choice among uses of resources and production processes which will maximize the relevant end. The optimum pattern of resource use varies because of three changes: (1) a change in the rate at which products substitute, (2) a change in the slope of the production function brought about by changes in techniques for each commodity and (3) price changes. When two products, Y_1 and Y_2 , substitute at constant marginal rates, and the production opportunity curve is linear, only one product results in maximum returns above the cost of those resources common to the two products. When the substitution

and price ratio are not equal, a producer will increase returns if he specializes in one or the other of two products. Any one of several combinations will bring the same revenue if the substitution and price ratio is equal. When two products, Y_1 and Y_2 are being compared, substitution of Y_2 and Y_1 is profitable as long as the marginal rate of substitution, $\Delta Y_1 / \Delta Y_2$, is less than the price ratio, $\Delta PY_2 / \Delta PY_1$.

An increase in the size of a given enterprise usually entails an increase in costs. An increase in returns would be expected to induce such an expansion. The difference, the increase in net revenue, can be expressed by a "net marginal revenue," given by:

$$NMR_b = P_b - MC_b \text{ and } NMR_w = P_w - MC_w$$

where P_b and P_w = the price of beef and wheat respectively and MC_b & MC_w = the marginal cost for beef and wheat.

Because the farmer is assumed to be operating with a restricted quantity of resources, he must allocate them in such manner that the net marginal revenue from any enterprise is the same as for any other enterprise in his organization. Until this "point of balance" is reached, it will be possible for him to increase net farm income by shifting resources from an enterprise with a low net marginal revenue to an enterprise with a relatively higher net marginal revenue, thus reducing the size of the first (and raising its net marginal revenue) while expanding the second (reducing its net marginal revenue.)^{5/}

^{5/} Baker, C. B., Principles of Farm Management, Unpublished paper given at conference of Montana Extension Specialists, Bozeman, Montana, February, 1953. The marginal cost, discussed herein, is based on data contained in this work.

Farmers are typically unable to influence the price they receive by varying the quantity of product they market. Hence the value of an increase in enterprise output is simply the price at which the product is sold, i.e., price is assumed to be a constant with respect to variations in enterprise output. The marginal costs represent increments to cost from the use of resources specific to the individual enterprises. It is assumed that such costs are linear functions of output for that enterprise.

PART II

NORTHERN GREAT PLAINS

Location

About 21 percent of the land area in the United States is used for crop production.^{1/} Although the largest acreage in wheat and cereal grains is located in the Great Plains, the concentration is slightly greater in the corn belt with corn, cereal and sorghums being the more common crops. About 50% of the land in the corn belt is cropped. Approximately one-half of the crop failure land in 1944 was located in the Great Plains area. More than half of the idle fallow cropland was located in the seventeen western states.

The Plains are bounded on the east by the 100th meridian, on the south by a line which starts at the Red River between Texas and Oklahoma and continues diagonally across the lower Panhandle area of Texas to include about the eastern 1/3 of New Mexico, on the west by the foothill Rocky Mountain chain and on the north by the Canadian border. The area includes the western half of North and South Dakota, Nebraska and the western 1/3 of Kansas including the Panhandle area of Oklahoma and Texas, the eastern 1/3 of New Mexico, Colorado, and Wyoming and the eastern 2/3 of Montana. Crop failure land mounted to 36% here of all the land planted in 1934, 12% in 1939 and 4% in 1946.^{2/}

^{1/} Inventory of Major Land Uses in the United States, Misc. Pub. No. 663, U.S.D.A. BAE Washington D. C. 1943.

^{2/} Ibid.

Physical Features

This vast acreage of the Great Plains region, encompassing a physical area of 359,306,093 acres,^{3/} has a wide variety of grasses and forage plants and also includes some scattered trees. The diversity in vegetative types, climate and topography are accompanied by great diversities in the use of the land. Because of the extremes of climate and natural factors, this region is divided again into subregions and these are further subdivided into types of farming areas.

Such a classification system enables us to focus our attention further on the area referred to as the Northern Great Plains prairie area. Here we are concerned specifically with an area which grows hundreds of forage species on approximately 176,000,000 acres.^{4/} It is bounded on the east by the 100th meridian; on the north by the Canadian border. (The Great Plains extend over about 150,000 square miles in Canada). States included within these boundaries are the western 1/2 of North and South Dakota, Nebraska, the eastern 2/3 of Montana, the eastern 1/3 of Wyoming and the northeastern 1/10 of Colorado.^{5/}

Within this local region, agriculture is divided roughly into four subregions based on the major type of farming. They are the spring wheat area, the wheat-range area, the corn area, and the range area. Actually

^{3/} The Future of the Great Plains; Report of the Great Plains Committee, December, 1936. U.S. Printing Office, Washington D. C., p. 39.

^{4/} Hurt, L. C. "The Type of Plains Vegetation," Grass, U.S.D.A. Agr. Yearbook, 1948, p. 484.

^{5/} Rogler, G. A. E., Hurt, L. C., "Where Elbow Room is Ample," Grass, U.S.D.A. Agr. Yearbook, 1948, p. 477.

these types of farming areas are the sum of the agriculture of the region. Consequently, the components of these groupings vary where the physical and economic conditions that affect farming differ.

Climatically, the area is one of extremes. Across the area in an east-west direction, cultivation merges from an intensely cropped area in the more humid east to extensive range livestock operations in the semiarid western part. As one travels from north to south in this vast expanse of prairie, the area changes from one of long winters and short summers with wheat and small grains to one of longer summers and shorter winters with corn and sorghums being more intensively cropped. Even the range forage grown on these millions of acres is disposed of differently as the area's climatic conditions vary. Livestock feeding practices carried on in the northern area finds the managers handling their herds on a seasonal nonmigratory basis with supplemental winter forage feeding. In the southern sections migratory seasonal grazing is possible with only limited supplemental feeding.

The climate is largely semiarid, but has widely varying extremes where average precipitation is 27 inches in the eastern part and drops to below 10 inches in some sections of the western part. Frequency of drought hovers so closely, and every drop of growing season rainfall is needed, that the slightest variation can mean disaster to the livestock and wheat producer. Lack of water in most sections limits crop production where moisture comes in the form of a sprinkle, gentle rains, cloudbursts, hail and even blizzards. Temperature ranges have varied as much as 178°F between summer highs and winter lows with

Medicine Lake, Montana recording a 117°F summer high^{6/} and the Fort Logan weather station recording a 61°F below zero low.^{7/} Growing season within the area varies from 160 days in the south to 116 days in the northern sections. Many production advantages in the area are compromised because the amount and distribution of precipitation and the range and distribution of temperatures, so necessary for plant growth, are not available for use by the land.

Under these widely varying conditions, it does not seem strange that only about 1/4 of the area, about 44 million acres, is under cultivation and that this cropland is not evenly distributed geographically. In some counties well over three-fourths of the land is cultivated. In others, less than 1 percent is tilled. Almost as the mountain uplifts of the Black Hills in South Dakota and the Bear Paws in Montana could be identified from an airplane, so do many of the intensely cultivated "islands" of specialized agriculture appear in the Northern Great Plains.

Even though striking examples of intensive cultivation are apparent over the area, it takes on a rather "crazy-quilt" pattern which leaves over 75% of the grassland area to be utilized for a range livestock operation. Much of the pasture and rangeland in this area have very high carrying capacities compared with the forage producing areas of some regions.

^{6/} U.S.D.A. Weather Bureau, Climatology Data, Montana. Section, July, 1937, Vol. XL, No. 7 Medicine Lake Weather Station, Sheridan County, Montana.

^{7/} Ibid., February, 1899, Fort Logan, Meagher County, Montana. 60°F below zero was also recorded in 1905 at Grayling, Gallatin County, Montana.

Many species, mostly grasses but including shrubs and weeds, make up a basic raw material for livestock production in the Northern Great Plains. The native vegetation is made up of 5 types, based on native vegetation found on the 176 million acres before 1/4 of it was plowed.^{8/} These include (1) the northern short grasses (mixed prairie), (2) tall prairie type, (3) the sand hills type, (4) sagebrush - saltbush grass land type (two closely associated browse types are considered together) and (5) open-forest type (in foothill areas). Much of eastern Montana and adjacent parts of the Dakotas and Wyoming are covered with the northern mixed prairie type of short grasses covering some 228,000 square miles.

Seven species of grasses provide about 75% of the total range forage including blue gramma, bluestem wheat grass, needle-and-thread and green needlegrass, buffalo grass, Sandberg bluegrass, and threadleaf sedge. The remaining 25% of the range grows shrubby browse plants such as big, silver and funged sagebrush, grease wood and saltbush on rolling plains, badlands, semi-badlands, and roughs of broken topography.

Important soil groups of the region include largely the dark brown soils developed on unconsolidated, calcareous sands, silts and clays (Scobey, Rosebud). These soils develop under mixed tall and short grasses in a temperate to cool semiarid climate. The profile grades from a dark brown surface soil into a whitish calcareous horizon at a depth of 1 1/2 to 3 feet. Not so widely dispersed, are chiefly northern brown.

^{8/} Hurt, L. C., op. cit. p. 484.

loams, developed largely on unconsolidated sands, silts and clays (Joplin, Weld). Here again the profile is developed in a temperate to cool, semiarid climate, but under short bunch grasses, and shrubs. Still less prominent, but important, are rough mountainous (azonal) soils, sands associated with bogs (azonal Valentine sand) and rough broken land including Pierre soils. These last three soils may possess one of two general types of profile: (a) the profile may be too immature to express a zonal type; (b) the profile may express a local condition as drainage or parent material rather than the zonal profile of the region.^{9/}

Although these physical soil types have a dominant influence on varied types of farming within the area, they, like climate, are only a part of the geographical picture. Unlike many agricultural regions, much of the Northern Great Plains area is situated long distances from markets and centers of consumption.

Improvements in production, transportation and marketing technology, however, have greatly reduced this handicap. A tendency for freight rate zones and other institutional factors to be imposed, cause many of the technological and marketing improvements to be compromised. Certainly, many problem conditions existing in this Northern Great Plains region are peculiar only to this area; or, if not completely confined here, do present themselves with a "bigness" that is characteristic to the region.

^{9/} Misc. Pub. No. 663, U.S.D.A. BAE. op. cit. p. 5

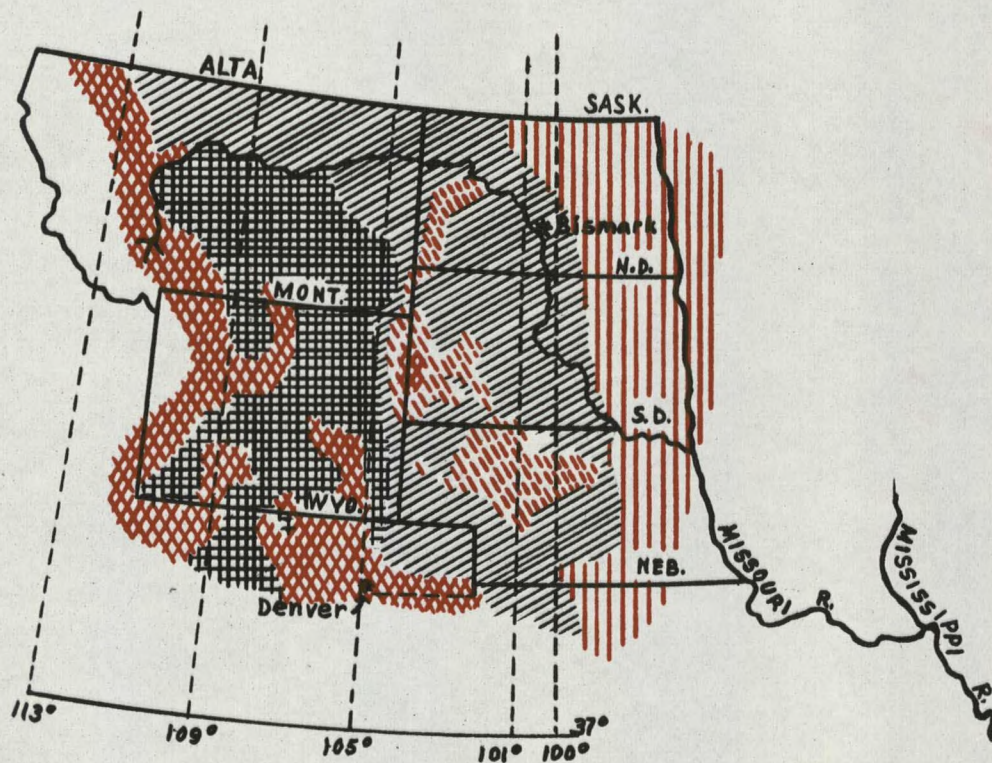
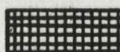


Figure 4. Northern Great Plains, important soil groups.

LEGEND

-  Rough, mountainous, Azonal
-  Joplin, Weld; Brown Northern
-  Scobey, Rosebud; Dark brown Chestnut
-  Rough broken, Pierre soils, gumbo clay & sand
-  Black Loams, Northern Chernozem.

Historical Setting

Historically, as homesteading spread into the range area, the grasslands suffered from over extension of cultivation and overgrazing. Paradoxically, this great movement of settlers occurred during periods of high rainfall. With an optimism hard to condemn, the westward tide of settlers was accelerated by a succession of wet years and good harvests. The illusion spread as speculators, land-grant railroads, even states and the Federal Government itself, through its homesteading policy, encouraged wholesale dispersion of public lands. Homesteaders were obligated to put their 160-acre tracts under plow regardless of whether or not the land was suited to cultivation. Not until about 1910 was the homestead tract increased in size from 160 to 320 acres, later to be enlarged to 640 acres in 1916. Provisions were made that these larger units be devoted solely to grazing and stock raising. These provisions often caused the homesteader to plow, when plowing may have been harmful to the land and forbid him to plow when it might have been more beneficial and profitable.

Immediately after 1890, and up to about 1915, there were only slight increases in range cattle numbers on the Northern Great Plains, but while grazing reached a temporary peak, the area of cultivation steadily expanded westward, expanding during and after wet years, contracting somewhat as farms were abandoned in dry periods. On the whole, however, cultivated land continued to grow at the expense of the range. The pressure on the land continued to grow until drought, depression, and high taxes, coupled with the ensuing World Wars, caused a considerable

reduction in the number of operating units. Undersized farms were sold to farmers remaining who were encouraged by the improved market for agriculture. Although the number of individual units diminished in number, it is unlikely that the actual number of acres cropped were reduced. Conversely some previously abandoned land was brought back into cultivation because of an increased demand for cash grain crops after the war. The volume and value of the agriculture production from this area has been enormous in recent years. But it appears still to be a problem to determine how much of the area should be devoted to grassland and how much to crops.

PART III

SELECTION OF THE SAMPLE AREA

Previous Research

One of the many problems in studying enterprise alternatives is to isolate conditions conducive to shift sensitivity. In a previous study ^{1/} of the Northern Great Plains, the Montana Agricultural Experiment Station reported a method for estimating and isolating areas sensitive to shift between dryland cropping and range forage production. Using non-price variables, the study established criteria for selecting units considered to be sensitive to shift between range forage and wheat production. From observations made on 156 wheat farms and 118 cattle ranches a function Z was derived:^{2/}

$$Z = X_1 - 63.92209 X_2 - 1881.479 X_3$$

where Z = a type of index number for discriminating between groups according to departure from a critical value of Z, determined in the analysis;

X_1 = total acres operated,

X_2 = ratio of leased to owned land, and

X_3 = total annual precipitation in inches.

The basic equation is useful as a tool for establishing a linear function or combination of the variables which will distinguish between the situations favorable to the two types of resource organizations for

^{1/} Blood, D. M., Delineating Farms Sensitive to Shift Between Wheat and Range Forage. Mimeograph circular 84, Montana State College, Bozeman Montana, September, 1954.

^{2/} Ibid., p. 52 through 56; for a more complete treatment, refer to this work.

two samples of observations, N_1 and N_2 , upon which a given number of variables, $X_1 \dots X_p$ can be measured in each sample, and with variables separated into two groups: N_1 , dryland crop acres and N_2 , range livestock acres. Since $X_1 \dots X_p$ variables are common to both samples, two means can be computed from these data:

$$(1) \bar{X}_{1w} = \frac{1}{N_1} \sum_{i=1}^{N_1} X_{1i}; \text{ and } \bar{X}_{1c} = \frac{1}{N_2} \sum_{J=1}^{N_2} X_{1J}$$

$$(2) \bar{X}_{pw} = \frac{1}{N_1} \sum_{i=1}^{N_1} X_{pi}; \quad \bar{X}_{pc} = \frac{1}{N_2} \sum_{J=1}^{N_2} X_{pJ}$$

where subscripts "w" and "c" represent the "ith" and "jth" variables related respectively to wheat and cattle.

The discriminant function analysis, as a classification tool, takes into account the interrelationship of several variables which tends to reduce the amount of overlap between two phenomena. When considering the task of finite classification, the consideration of only one variable tends to cause an overlap so great that accurate classification is impossible. Although discriminate analysis is able to accomodate three variables in classifying shift sensitive areas, it is not completely "fool-proof" since many variables responsible for shifts are unmeasurable. Too, other variables that are measurable may not be included.

Results from the study indicate that 26% of the cattle ranches in the area with an average of (1) 17.1" precipitation, (2) a ratio of 35.2% in leased vers owned land, and (3) 3,672 acres of land were found

susceptible to shifts toward dryland crop production. Similarly, about 21% of the wheat farms, with comparable averages of (1) 15" precipitation, (2) 28.4% in leased vers owned land and up to 3,975 total acres were found susceptible to shifts toward range forage production. The study also indicates the necessity for considering each farm in its own internal and external environment in reaching ultimate shifting decisions. Results of these calculations appear in Figure 5.

The Method

Assuming these criteria are adequate as functional limits for selecting units subject to marginal shift problems, they provide a basis for isolating shift-sensitive areas. Utilizing these limits, it has been possible to select a sample area of farms which meet two of the above specifications; they are: (1) precipitation (15" minimum and 17.1" maximum) and, (2) size (2,068 acres minimum acreage, 4,770 maximum acreage). Actual selection of the farm units considered sensitive to shift was accomplished by first utilizing the precipitation criteria established by the earlier discriminant analysis limits: 15" low, 17.1" high. With reference to the yearly climatology publication for Montana weather conditions, it was possible to "pin point" areas which fell within the 15" to 17.1" precipitation range. Local weather stations throughout the state, consistently reporting precipitation within the range limits, established areas which met the precipitation criteria and hence could be considered for further study.

Over the twenty year period, 1932 to 1952, quite a large number of weather stations were able to report average annual precipitation within the established limits for several years. Although this provided a large

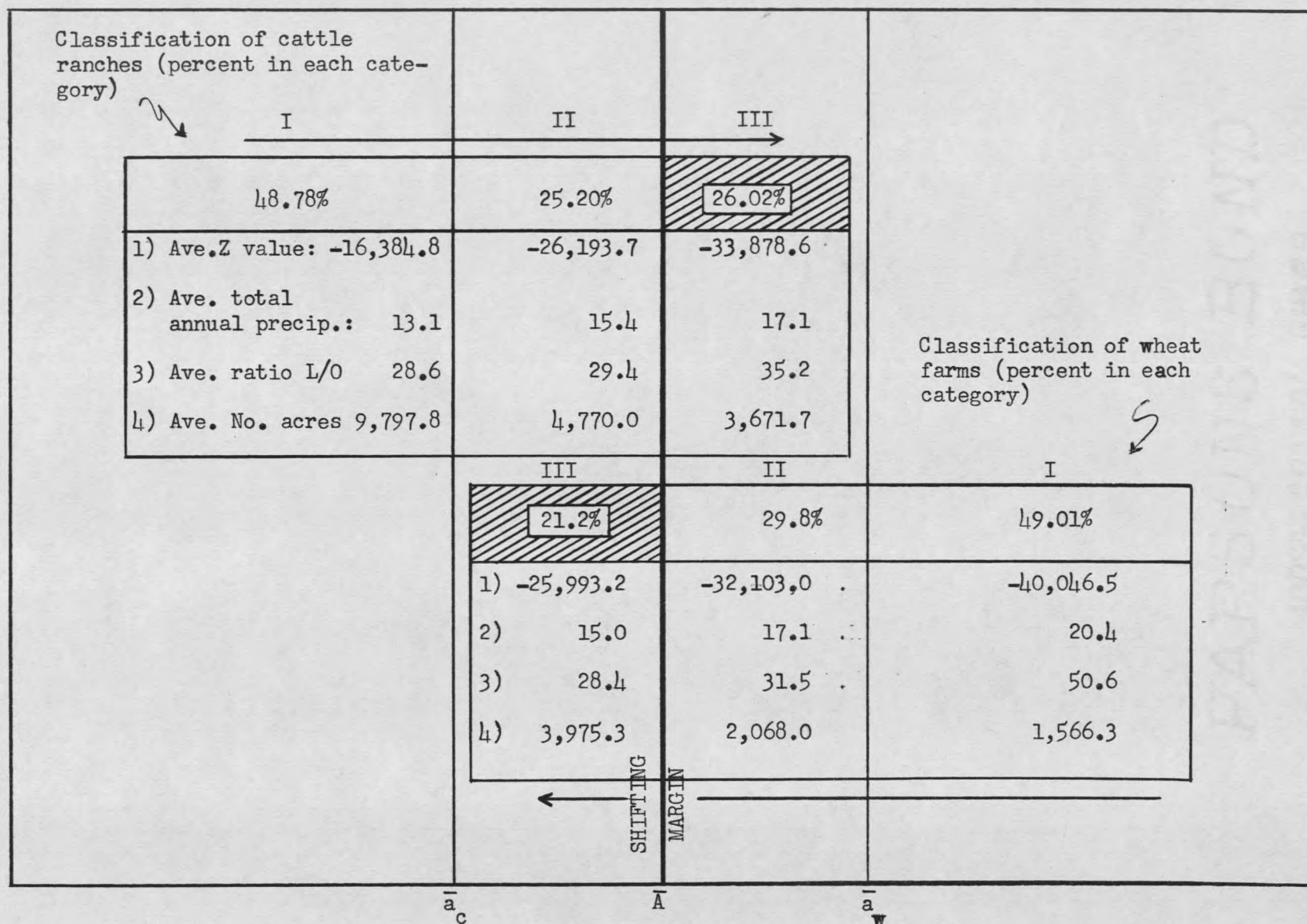


Figure 5. Classification of 274 sample ranches on the basis of their calculated Z values.

cross section of the state to be considered in the initial area selection, the twenty year time span was later reduced to five years (1948 to 1952). This five year period was chosen to provide weather data because it is felt the period fairly well represents a period of weather conditions under which enterprise decisions were made on the cattle and wheat units used in the previous study (discriminant analysis). The five year period chosen in this study draws weather data from a three year period before and one year after 1951 (1948-1952) which gives a broader weather picture. Also this period represents current weather conditions which can be more closely associated with the current shifting problems. At least the weather conditions of the years indicated (1948-1950) possibly have a more direct effect upon current farmer decisions and trends during this given time period.

With the reduction of the period from twenty to five years, many of the weather stations, (areas) reporting an average annual precipitation within the required range, were removed from the sample area.

Because so few weather stations reported precipitation within the specified range enough times during the five year period to consider them as representative, the range was widened. The minimum level was reduced .5" from 15" to 14.5" and the upper limits were increased .4" from 17.1" to 17.5". By so widening the precipitation range it was possible to draw in a larger number of weather stations (areas) while at the same time retaining the five year period (1948-1952) considered as being a representative period which was influential on the current situation. Actually it was possible to increase the number of stations,

reporting in two of the five years, from thirteen to thirty-seven stations by widening the precipitation range 14.5" to 17.5". Thus, it was possible to draw in twenty-four more weather stations (areas) for consideration in the preliminary selection of the sample area.

In order for a weather bureau station (area) to be considered as representative of a shift area based on precipitation criteria, however, it was decided that the station must report an average annual precipitation within the required range for at least three of the five years being considered. On this basis it was possible to select five areas within the state (See Table I).

TABLE I. FIVE YEAR PRECIPITATION READINGS, BY WEATHER STATION AND COUNTY.

WEATHER STATION	COUNTY	TIMES REPORTING	5 YEAR PERIOD				
			1948	1949	1950	1951	1952
1. Big Timber	Sweetgrass	3	16.12"		14.48"	14.93"	
2. Colstrip	Rosebud	3	16.42"		14.55"	14.78"	
3. Denton	Fergus	3	15.45"	14.54		14.63"	
4. Hinsdale	Valley	3	15.88"		17.44"	14.53"	
5. Livingston	Park	5	15.11"	15.68"	17.39"	14.97"	15.39"

Using the precipitation criterion as a preliminary basis for selecting shift-sensitive areas it was possible to establish specific areas for further study. With areas selected in this manner then, it was now possible to utilize the size limitation as a second criterion for selecting actual units sensitive to shift. The upper and lower limits are 4,770 acres and 2,068 acres respectively.

The total acres, owner, operator, crop acres, pasture acres, and community location by farm, were given by records in the state office of the Montana Agricultural Stabilization Corporation.

The Sample

After compiling the data necessary for selecting individual units from within the 5 specified areas, a total of 218 units fell within the sample area. Upon further investigation of these 218 units, it was discovered that many of the farms had a large portion of the acreage devoted to either cropping or solely to pasture; in some cases the entire acreage was devoted to pasture and hay management. A further limitation was imposed for selection purposes. For a unit to be sensitive to shift, it was thought likely that at least $1/4$ of the acreage must be devoted to a pasture livestock (crop) operation with the remaining $3/4$ of the acreage being devoted to cropping (pasture-livestock). Such a unit, it is felt, is more sensitive to shift because the operator has more experience in allocating his given stock of resources between two enterprises than if he had to devote all the stock of resources to one enterprise.

By imposing this $1/4$, $3/4$ limitation for units to be included in the sample area, three things were accomplished: (1) Units appearing in the sample area tended to more nearly approach shift-sensitivity; (2) the number of units being considered was reduced from the original 218 in the five established areas to 63 in the same areas; and (3) Rosebud county was eliminated from the sample area because the ranches, falling within the required size specification, were largely devoted to a pasture

livestock type of operation. Too, although some of the units appearing on the A.S.C. listing sheets did fall within the required specifications, the majority of the ranches were much larger in acreage than the maximum requirement. Several individual operators within the area operated more than 50,000 acres while several company operations listed over 100,000 acres. This might further indicate that the area as a whole, tended to be largely fixed in a range forage, livestock type of operation.

Upon further investigation through actual interviews with the farmer operators, and after editing the "schedules" it was learned that some of the operators in the sample area had not listed all their acreage with the state A.S.C. office. Later, 17 units had to be dropped because 13 exceeded the maximum limit of 4,770 acres while 4 units were actually under the acreage minimum of 2,068 acres. In addition to this, 6 operators listed in the sample area could not be contacted for interview. As a result, 57 operators, of the original 63, were actually contacted; 17 from this group could not be considered in the universe, as their actual acreage (not listed at A.S.C. office) did not comply with either the maximum or minimum limits. A summary of sample data is given in Table II.

With 23 of the original 63 units not included, either from non-contact or acreages not within the specified limits, a final total of 40 units were suitable for further use in the problem.

These 40 units represent two distinct cropping areas within the state, the winter wheat area and the spring wheat area. Each area is

TABLE II. SUMMARY OF FARM OPERATORS CONTACTED FOR INTERVIEW.

WEATHER STATION	COUNTY	NUMBER OF OPERATORS				RECORDS USED
		TOTAL	SAMPLE	NO CONTACT	NUMBER INTER- VIEWED	
Livingston	Park	54	7	0	7	5
Colstrip	Rosebud	12	0	0	0	0
Hinsdale	Valley	55	32	3	29	20
Big Timber	Sweetgrass	70	7	1	6	3
Denton	Fergus	27	17	2	15	12
		218	63	6	57	40

represented by exactly half of the final number of acceptable units;
20 units each for each area.

The counties included in the winter wheat area are: Park, 5 units;
Sweetgrass, 3 units; Fergus, 12 units for a total of 20 units and the
spring wheat area is represented by Valley County with 20 units.

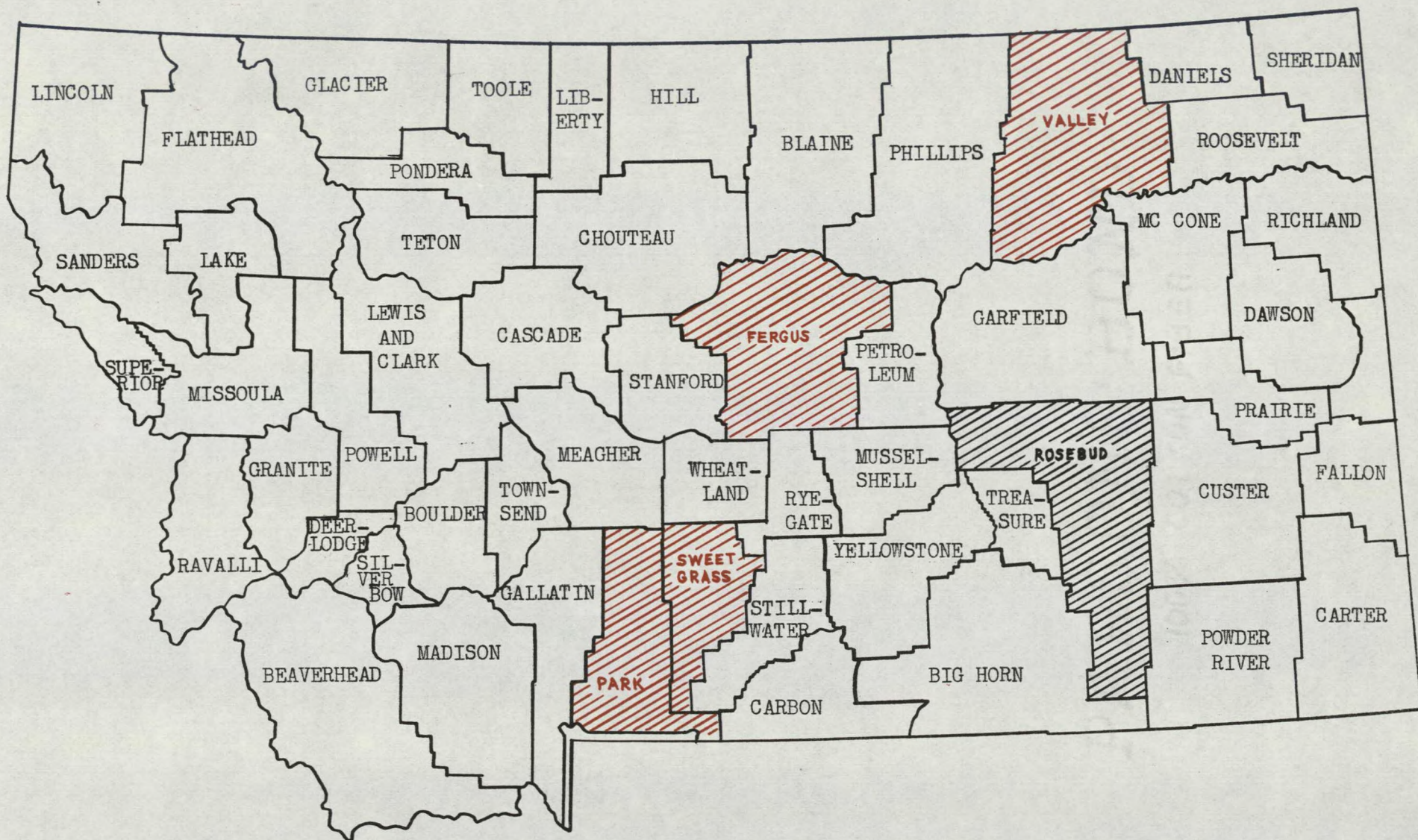


Figure 6. Counties shaded in red represent the sample area; the county shaded in black was dropped from the sample area because it did not meet the unit size specification.

PART IV

DESCRIPTION OF THE MODEL FARMS

(BUDGET)

Land Use Organization

Since two specific dryland crop areas (winter wheat and spring wheat) have been selected for study through the use of criteria established by an earlier investigation,^{1/} it is necessary to consider each area separately in its own peculiar environment. For this purpose, the budget will be used in describing a typical farm for each of the two areas in question. Because it is desirable to have as complete a description as possible of both areas, the budget will cover the major functions of the farm operation. The simplicity of the budget method lends itself well to illustrate the array of information necessary for an understanding of the areas being considered. Use of the budget here is not for the solution of a specific problem, but as a method for describing conditions as they exist within these two areas. The basic budget here provides information necessary in describing the fundamental organization of farms in each of the two areas. Since each "model" farm has a combination dryland crop, livestock operation, it is necessary at the outset to provide data needed to establish a dual enterprise organization.

The over-all size of the model unit within each of the two areas is equal to the mean acreage of the record farms in each area. Acreages in the various crops were fixed in a similar manner. The winter wheat area

^{1/} Blood, D. M. op. cit.

exceeds the spring wheat unit in the land in headquarters and waste. This may be explained by the fact that there are many foothill and river breaks in this area. All the 192 acres, classed as either farmstead or waste, does not necessarily mean that this area is completely useless. It could be presumed that many of the acres are utilized for such things as winter pasture or field edges being grazed off after the crops were harvested. Certainly this is a common practice in many areas and part of the field edges could be used very well for hay. A breakdown of total acres was accomplished by determining the actual number of acres devoted to a given use pattern in each of the given areas. Results of these calculations are found in Table III.

TABLE III. LAND USE ORGANIZATION OF MODEL FARMS, BY AREA, 1954.

LAND USE	A. WINTER WHEAT (20 FARMS)		B. SPRING WHEAT (20 FARMS)	
	ACRES	% OF TOTAL	ACRES	% OF TOTAL
Cropland	1022	32.5	1120	34.4
(Leased)	(215)	(21%)	(425)	(38%)
(Owned)	(807)	(79%)	(695)	(62%)
Hay	84	2.7	88	2.7
Pasture	1846	58.7	1967	60.0
Headquarters & waste	192	6.1	98	2.9
TOTAL	3,144	100.0	3,273	100.0

Crop Acres

Actual percentage of land devoted to specific crops was calculated from the average of the total acres devoted to that crop. Percentage of

crop land, leased and owned, was a calculated mean based on data collected in each of the two sample areas. Leased pasture or hay acres did not appear in sizable enough acreages within the two respective areas to be considered as a part of the representative model budgets.

Although a small percentage of spring wheat was seeded in the winter wheat area it was all classed as wheat because, in almost all cases, it was considered merely as a "catch" crop by the operators involved in this practice.

In the spring wheat area only two of the 20 sampled farms reported winter wheat being planted. This was largely done as an experiment on the part of the farmers involved and it was pointed out that this was not a common practice. Also peculiar to only the spring wheat area was some limited production of Durum ("Macaroni") wheat. Again all wheat acreage in the area was classed as wheat; here taken to mean spring wheat.

Acreages of barley and oats in both areas represent averages of the total acres devoted to these crops in each area. In the spring wheat area, however, 50 of the 72 acres, or 69.4% of the acres devoted to oat production was cut for hay. Later this practice will be discussed in more detail.

Also unique to the spring wheat area was the production of rye and flax. These acreages were converted to hay and wheat acreages respectively for several reasons based either on actual use of the crop or the negligible size of the operation.

- (1) The product of the average, 14 acres devoted to the production of rye was being utilized solely for a feed roughage in the livestock enterprise of the area.

- (2) The average flax acreage was only a fraction (.9 acres) of the total acres devoted to crop production.
- (3) By having all crops the same in both the winter wheat and spring wheat areas, comparison for analytical purposes would be easier between the two areas.
- (4) Cash crops in both areas would be the same facilitating more uniform practices.

Acreages devoted to pasture and hay in the model is derived from an average of the total acres in the two areas devoted to this use. Hay acreages in these areas are non-irrigated and consist of a mixture of alfalfa, native, bluejoint, brome, etc. Under ordinary conditions, these acreages provide an adequate supply of feed roughage for the livestock enterprise. In the spring wheat area, however, additional acreages of oats and other feed crops may be, and usually are, cut in varying amounts to supplement the feed base. Normally, little or no roughage feed is purchased under these conditions to support the livestock operation.

The general cropping pattern in each of the two areas follows a crop fallow type operation where two years of moisture are considered necessary to obtain satisfactory yields. With reference to Table IV, it is apparent that 50% of all the crop land is being summer fallowed; the spring wheat area again having the larger acreage under fallow.

Table IV is set up to give a complete outline of the land use organization and disposition of the crops for the two areas, including yields, total production, how the crop was used and price, it provides data for estimating the crop contributions to gross income for each model unit.

Yields for the various similar crops vary between the two areas. With the exception of oats, yields range higher in the representative winter wheat area as would be expected where the moisture level tends to be higher. Yields used for the various crops are adjusted yields where an attempt has been made to integrate the year 1954 with the respective five year period (1948-1952).^{2/} Average annual crop yields of the representative counties were collected from the Montana Agricultural Statistics for the years 1948 through 1952 and the year 1954. An average yield was calculated for the year 1954 with data obtained from the farmer interviews. Now to derive the adjusted yield used in Table IV, the average county (area) yields for 1954 were divided into the average farm yield for 1954. The factor obtained from this calculation was then multiplied times the average county (area) yields for each of the years 1948 through 1952. These results were then added, the sum of which, when divided by 5 (for 5 year period) provided the desired adjusted yield.^{3/} Since yield figures were not available in the Montana Agricultural Statistics for oat hay, the yield used for it in Table IV is an average or mean yield of the farmers using it as a roughage feed in the spring wheat area. Actually 14 of the 20 operators in the area carried on this practice to supplement their roughage feed base.

^{2/} This was the base period used for obtaining precipitation data in the selection of the sample area.

^{3/}
$$\frac{\bar{Y}_{\text{farm}}(54)}{Y_{\text{co}}(54)} \left(\frac{Y_{\text{co}}(5 \text{ yr})}{5} \right)$$
 Where $\bar{Y}_{54 \text{ farm}}$ = average farm yield for 1954 as reported in farmer interviews in the representative areas $Y_{\text{co}}(54)$ = average yield for year 1954 as reported in the Montana Agricultural Statistics.

TABLE IV. LAND USE AND CROP DISPOSITION, BY AREA, 1954.

A. WINTER WHEAT AREA:

CROP	ACRES	BU			DISPOSITION (BU)			PRICED/	\$ TOTAL
		YIELD ^a /	PRODN.	RENT	FEED ^b /	SEED ^c /	SOLD		
Wheat	372	20.4	7,589	490	0	465	6,634	2.05	13,599.70
Barley	123	32.2	3,961		215	154	3,592	1.04	3,735.68
Oats	16	40.0	640		142	20	478	.67	320.26
TOTAL CROP	511								
Fallow	511								
Pasture	1,846	15.6 A.U.							
Hay	84	.75	63 T.		63 T.				
Hdq. & waste	192								
TOTAL	3,144								17,655.64

B. SPRING WHEAT AREA:

Wheat	424	12.8	5,427	606	0	530	4,291	2.12	9,096.92
Barley	64	27.6	1,766		225	80	1,461	.98	1,431.78
Oats	22	44.8	986		150	90	746	.67	499.82
Oat Hay	50	.98	49		49				
TOTAL CROP	560								
Fallow	560								
Pasture	1,967	15.6 A.U.							
Hay	88	.45	40		40				
Hdq. & waste	98								
TOTAL	3,273								11,028.52

^a/Adjusted yield period 1948-1952. Oat hay yield is for an average of 14 actual reported schedule yields.

^b/Feed @ an average rate conforming to Morrison's feeding standard, plus 25 Bushel Barley for chickens.

^c/Seed @ rate, 1 bushel, 1 peck/acre.

^d/Wheat Price based on - 1954 Crop Wheat Price Support Program, 1954 CCC Grain Price Support Bul. 1., Supplement 2, July 13, 1954. Barley Price based on - 1954 Crop Barley Price Support Program, 1954 CCC Grain Price Support Bul. 1., Sup. 1., March 24, 1954. Oat Price Based on Prices Paid & Prices Received by Montana Farmers & Ranchers 1952-54, Supplement to Bulletin 492-503.

Rent is paid on a share crop basis with the landlord receiving 1/3 of the wheat crop harvested from the leased cropland (see p.60 for acres of leased land). This rental agreement is based on the practice most commonly followed in each of the two sample areas.

The amount of feed grain fed on the farm is a calculated amount, based on Morrison's Feeding Standards, which is nutritionally adequate for the size and class of livestock fed on these model farms for the period of time indicated. All the hay and roughage grown on the units is consumed at the ranch. In some cases additional roughage feed is purchased to provide a sufficient amount.

The amount of grain (wheat, barley and oats) retained on the ranch for seed is calculated at the rate of a bushel and a peck to the acre. According to farmer interviews, this was the most common rate at which the various crops were seeded.

The quantity of grain sold as indicated in Table IV is the difference between the total production and what was used, for rent, seed, or feed on the ranch. Prices for the various grains vary between the two areas. A higher price is paid for wheat in the spring wheat area than in the winter wheat with a differential of .07 cents per bushel. More is paid for barley in the winter wheat area than in the spring wheat area with a 6 cent per bushel spread. Prices received for oats are the same in both areas.

Prices paid for both wheat and barley are based on the price support program.^{4/} The oat price is based on a calculated preliminary price for the 1954 crop.^{5/}

Livestock Organization

Table V outlines the general livestock organization in both the winter and spring wheat areas. The general outline covers one season's operation beginning in the spring of 1954 and progressing through the spring of 1955. Although some sheep were raised on a few units in both areas, they were usually a small farm flock type enterprise and did not contribute measurably to the operation. Two operators in the spring wheat area and one operator in the winter wheat area did indicate, however, that they planned to increase their sheep numbers. Because sheep were of negligible importance on units of this size in both areas, they were converted to cattle animal units at a rate of five mature sheep per one cow animal unit. The average percentage of sheep sold and carried over during the year's operation was transferred into the management and disposition of the cow herd.

With reference to Table V it is possible to appraise the organization of the livestock herd in both areas. Again an effort has been made to

^{4/} Wheat prices based on: 1954-Crop Wheat Price Support Program; 1954 C.C.C. Grain Price Support Bulletin 1, Supplement 2, Wheat 721 (Wheat 54) -3 U.S.D.A. CSS of C.C.C. July 13, 1954. Barley Prices based on: 1954-Crop Barley Price Support Program. 1954 C.C.C. Grain Price Support Bulletin 1, Supplement 1, Barley 721 (Barley 54) -1 U.S.D.A., CSS of C.C.C. March 24, 1954.

^{5/} Oat Prices based on: Prices Paid and Prices Received by Montana Farmers and Ranchers 1952-1954. Supplement to Bulletins 492 and 503 November 1955. M.S.C. Agricultural Experiment Station, Bozeman, Montana, p. 11.

TABLE V. THE ORGANIZATION AND DISPOSITION OF LIVESTOCK, BY AREA, 1954, 1

A. WINTER WHEAT AREA:

CLASS	SPRING 1954	NO. b/ BORN	NO. a/ RAISED	BOUGHT				DIED	USED	NO. b/ WT.	SOLD c/ WT. PRICE		CASH	C/O 1/1/55	SPRING 1955
				NO.	WT.	PRICE	COST								
Cows	101			0				1		10	1000	10.50	\$1050.	90	100
Milk cow	2			0										2	2
Calves		93	86	0				7		74	400	18.80	5564.80	12	
RPL Heifer	11			0					1	0				10	12
Bull	4			1	750	350	350			1	1550	10.75	166.63	3	4
Sow	1			0						1	220	20.00	44.	0	1
Pig		9	8	0				1	2	4	180	19.50	140.40	1	
Chicken	25		20	0				5		20		1.ea	20.	0	20
Chicks			60	75				15	25					20	
Horses	2													2	2
TOTAL														6985.83	

B. SPRING WHEAT AREA:

Cow	104							2		14	1000	10.50	1470.	88	102
Milk cow	2									0				2	2
Calves		100	90					10		72	425	18.80	5752.80	18	0
RPL Heifer	16								2	0				0	18
Bull	4			1	800	400	400			1	1550	10.75	166.63	3	4
Sow	1									1	210	20.00	42.	0	1
Pig		8	8					1	2	4	175	19.50	136.48	1	0
Chicken	25							5		20		1.ea	20.	0	10
Chicks			60	75				15	20	15		1.ea	15.	10	
Horses	4													4	4
TOTAL														7602.91	

a/ 85% Calf Crop.

b/ Cull Cattle at a rate of 10% in the Winter Wheat Area, 13% in the Spring Wheat Area.

c/ Prices: Cattle from Market News, Livestock Division, U.S.D.A., Agricultural Marketing Service, October 1954, Washington, 25, D.C. Hogs, same publication and date used for cattle. Chicken prices used from schedules, average dressed chickens.

keep the basic organization between the two model farms as typical of each area as possible for ease in utilizing the data of the two areas. The spring wheat area carries a larger inventory of total cattle numbers than does the winter wheat area. This tends to give a little more emphasis to the livestock enterprise in this area. The total number of livestock in the spring wheat unit numbers 126 while the model unit representing the winter wheat area carries a total of 118 cattle.

Some basic assumptions were made concerning the management practices carried on in each area. It was assumed that an 85% calf crop was realized from both organizations. What with the usual precautions in "handling" herds of this size, this is neither an excessively high percentage nor does it reflect slovenly management. The percentage of the calf crop was figured, not by the number of calves branded in the spring, but by the number of calves raised:

$$\text{Calf crop} = \frac{\text{Calves weaned}}{\text{cows bred} - \text{cows sold after breeding.}}$$

Data obtained from farmer interviews tend to substantiate the 85% figure.

The number of mature cows (culls and dries) culled from the two herds varies. The herd representing the winter wheat area is culled the least at a rate of 10%.

In the spring wheat area, the representative herd is culled at a heavier rate with 13% being removed. Here again these figures tend to be substantiated by data gathered from farmer interviews. This situation may well exist in these areas too, when consideration is made of the representative area location. The winter wheat area just east of the Rocky Mountains, lays in a foot-hill area which provides much natural

protection. The spring wheat area, on the other hand, lays on an open plain where prolonged extremes of winter weather are not uncommon. Cow animals could be expected to age much faster under these more severe conditions where a ten-year-old cow might be much older physically than a ten-year-old cow raised under less severe conditions. Too, with this heavier culling rate it is possible that farmers don't expect as much of their older cows in this area. Also heavier sales of more mature animals, whether "culls or dries", tend to increase the gross returns which provides for a more stable net income.

Replacement animals for the breeding herd are supplied solely from young female stock retained on the farm in both areas. These young animals are carried as replacement heifers in Table V until January 1, 1955. After this date they are transferred into the main breeding herd and carried as cows. Similarly heifer calves to be retained as replacement heifers are carried to January 1, 1955 as calves and then are transferred into the replacement group. Replacement bulls are purchased in both areas. The price paid for replacement bulls is based on average figures paid by the operators in each of the two areas.

Milk cows, swine and chickens are raised on these units mainly for home consumption. These types of enterprises do not contribute measurable to the overall operation other than providing fresh produce which would likely be unavailable otherwise. Some butcher hogs are normally sold, but when none are sold, it does not alter the farm operation.

Horses were used in both areas to aid in "handling" the herds. The model unit representing the winter wheat area keeps two saddle horses as

necessary for the operation. In the spring wheat area two saddle horses were kept with an additional work team being used for livestock feeding and other purposes.

Prices used for hogs and cattle were taken from Market News, Livestock Division, U.S.D.A. Agricultural Marketing Service, Washington 25, D. C., October 1954. Prices paid for dressed chickens represent the average prices received by the farmers in each area.

Livestock Feeding Practices

Livestock feeding practices carried on within each area reflect the type and quality of feeds available. The quantities and amounts fed to the various classes of livestock are based largely on Morrison's feeding standards. The period of time, rate, and quantity at which the various classes of livestock were fed, with reference to Table VI, conform quite closely to two earlier studies made in this Northern Great Plains region.^{6/} In the latter of the two studies the total quantity of hay fed per cow varied from a low of 943 pounds to a high of over 1400 pounds per cow in the 20-year survey. The period of time this hay was fed again varied widely from 30 days up to 130 days. For purposes of this study for the year 1954, a 60-day feeding period is used with a total of 1200 pounds of hay being fed per cow. In addition to this, 60 pounds of 20%

^{6/} Saunderson, M. H., Cattle Ranching in Montana, Montana Agricultural Experiment Station, Bulletin 341, 1937; and Gray, J. R. and Baker, C. B. Organization Costs and Returns on Cattle Ranches in the Northern Great Plains, 1930-1952, Montana Agricultural Experiment Station Bulletin in cooperation with BAE; U.S.D.A., December 1953.

TABLE VI. LIVESTOCK FEEDING PRACTICES, BY AREA, 1954.

A. WINTER WHEAT AREA:

CLASS	NO.	DAYS	HAY a/		NO.	DAYS	GRAIN b/		NO.	DAYS	CONCENTRATES c/		MASH	MASH	BARLEY
			RATE	RATE			RATE	RATE			RATE	RATE	RATE	RATE	RATE
	FED	FED	LB/DAY	TON/YR	FED	FED	LB/DAY	LB/YR	FED	FED	LB/DAY	TON/YR	LB/DAY	LB/YR	BU/YR
Cows	101	60	2020	60.6					101	60	101	3.03			
Milk cow	2	180	60	5.4	2	210	5.0	1050							
Bulls	4	180	160	14.4	4	210	8.0	1680							
RPL Heifer	11	90	275	12.4					11	60	11	.33			
Sow	1	0	0		1	365	5.0	1825	1	0					
Pigs	8	0	0		8	150	56.0	8400	8	0					
Chickens	25	0	0						25	365				100	25
Chicks	60	0	0						60	150				500	
Horses	2	120	70	4.2	2	180	4.0	720	2	0					
TOTAL POUNDS			2585				78.0	13,675			112				
TOTAL TONS			1.29	97.0				6.84				3.36			

B. SPRING WHEAT AREA:

Cows	104	60	2080	62.4					104	60	104	3.12			
Milk cow	2	180	60	5.4	2	210	5	1050							
Bulls	4	180	160	14.4	4	210	8	1680							
RPL Heifer	16	90	400	18.0					16	60	16	.48			
Sow	1	0			1	365	5	1050							
Pigs	8	0			8	150	56	8400							
Chicken	25	0							25	365				100	25
Chicks	60	0							60	150				500	
Horses	4	120	140	8.4	4	180	8	1440							
TOTAL POUNDS			2840				82	14,395			120				
TOTAL TONS			1.42	108.6				7.20				3.60			

a/ SW area is 1/2 mixed hay and 1/2 oat hay, hay includes mixed hay, less than 30% Legume (Alfalfa, Brome, Bluejoint, Native, etc.) See Recommended Nutrition Allowances for Beef Cattle. National Research Council 1950; Table 3, p. 25, Vol. IV.

b/ Grain Mixture -- 2 parts Barley, 1 part Oats.

c/ Concentrates (A) Livestock (GTA - 20% range cake) (B) Chicken (Misco feed starter-layer mash)

protein supplement are fed during the period. According to the Morrison Feeding Standards the herd bulls, milk cows and horses were considerably overfed; this characteristic is carried over in Table VI to reflect a feeding error commonly practiced by livestock men in these representative areas.

All of the feed rations outlined in Table VI are figured on percent of T.D.N. contained in each of the feeds used. Whenever one feed fell short of the minimum requirements for an animal it was supplemented with either a protein supplement or a grain mixture.

Classification of Expenses

The data contained in Table VII outline the machine operations and the number of acres included for each operation. The land use practices commonly found on the farms in both areas is a two-year rotation. Half the cropland is summer fallowed each season with the remaining portion being cropped. Summer fallowing is considered to have a two-fold purpose, to control weeds and to conserve moisture.

Total variable costs for these crop operations are included in Table VIII. Machine performance rates and costs per operation are based on tests made in Nebraska.^{7/} Per acre costs of machine operation have been corrected to meet price changes (increases) between 1948 and 1954.^{8/} The simple technique required to effect this adjustment utilized

^{7/} Miller, J., Lindsey, Q. W. and George, A. G., Cost of Operating Machinery on Nebraska Farms. University of Nebraska, Agricultural Experiment Station, Bulletin 391, December, 1948.

^{8/} The Farm Cost Situation, A.R.S., U.S.D.A., p. 2 A.R.S. 43-9 (FCS-18, March, 1955).

TABLE VII. FIELD OPERATIONS, BY AREA, 1954.

A. WINTER WHEAT AREA:

OPERATION	WHEAT	BARLEY	OATS	SUMMER FALLOW	HAY
Oneway				511	
Duckfoot				1,022	
Rodweed				511	
Seeding a/	372 Acre	123 Acre	16 Acre		
Combining	372 Acre	123 Acre	16 Acre		
Mowing					84 Acre
Raking					84 Acre
Baling					84 Acre
Hay hauling & elevating					63 Ton
Grain hauling	7,589 Bu.	3,961 Bu.	640 Bu		12,190 Bu.

B. SPRING WHEAT AREA:

Oneway				560	
Duckfoot				1,680	
Seeding b/	424	64	72		
Combining	424	64	22		
Mowing					88
Raking					88
Baling					88
Binding					50
Hay hauling & elevating					89 Ton
Grain hauling	5,427 Bu.	1,766 Bu.	986 Bu.		8,179

a/ Seeding accomplished with a press drill over summer fallow.

b/ Duckfoot pulled in combination with drill during spring seeding.

U.S.D.A. data; prices paid by farmers, United States index numbers 1935 - 39 = 100. The prices paid for farm machinery supplies and motor supplies as reported were added for 1948 and 1954 respectively, a proportion was set up with these two index prices, (1954 Ip / 1948 IIp) and multiplied times the quoted price of machine operation for 1948; e.g.:

$$1948 \text{ Ip} = 148,$$

$$1954 \text{ Ip} = 181, \text{ and}$$

$$\frac{181}{148} = 1.22 \times 1948 \text{ Cost per acre price} = \\ \text{corrected cost per acre price.}$$

The tillage practices contained in Table VIII are commonly practiced in each of the respective two areas with operations and times over, peculiar to each of the two areas, appearing in columns 1 and 4 (operations and acres).

Costs specific to the livestock operation are found in Table IX with the entire haying operation being charged against this enterprise. Machine performance rates are based on the same reference for data contained in Table VIII.^{2/} Other specific livestock costs include purchased feed, replacement bull expense and other incidental medicine and veterinary fees.

Fixed costs peculiar only to the crop operation are summarized in Table X. These are the costs which do not vary with output, hence the marginal cost curve is not affected. Because of this, the nature of

^{2/} Miller, F., Lindsey, O. W. and George, A. G. op. cit., Table 1 through 7.

adjustments in output or use of resources is unaffected since a supply response is largely determined by the marginal cost of a given process. Total annual ownership costs cause a given machine to be depreciated over the designated life span of the machine so as to allow a 10% trade-in value at the end of the period for each machine. This annual cost is calculated by multiplying percent annual depreciation times the original cost of the machine item.^{10/} Total percentage includes obsolescence and depreciation. Buildings are depreciated by the straight line method, similar to machinery, however, a resale value was not considered since it is assumed the building has little or no salvage value at the end of its service life.

Interest on the investment^{11/} in a farm machine is considered as one of the fixed costs of ownership, since the money used to buy a machine cannot be used for other purposes. The interest rate used in this budget is 5% per annum which is an amount that has been incorporated in a method used by the Production Credit Administration. Since a straight line method of depreciation is used, it is convenient to use a method for calculating interest charges that result in constant or equal yearly charge throughout the machine life. Using one-half of the first cost and the 10% trade-in value multiplied times the interest rate, it is possible to calculate equal yearly interest charges throughout the machine's life. Interest on the buildings is calculated in the same manner as the machine interest charge, but without the 10% trade-in

^{10/} Fenton, F. C., Fairbanks, G. E., op. cit., Table VII p. 18.

^{11/} Ibid., p. 22 and 23.

TABLE VIII. SPECIFIC COSTS OF CROP OPERATIONS, BY AREA, 1954.

A. WINTER WHEAT AREA:

OPERATION	MACHINE SIZE	TYPE	ACRES	ACRE ^a / PER HR	TOTAL HOURS	COST PER ACRE	TOTAL VARIABLE ^b / COSTS
Plowing	10'	oneway	511	3.6	141.9	.17	86.87
Duckfoot	12'	cultivator	1022	2.6	393.1	.15	153.30
Rod Weeder	12'		511	4.8	106.4	.11	56.21
Drilling	12'	grain press	511	3.6	141.9	.17	86.87
Combining	14'	S-P	511	4.2		1.78	909.58
Grain hauling & elevating	2 Ton 26'	truck auger	12,190 Bu			.04/Bu	487.46
Weed Spray		plane	511			1.25	638.75
Tractor hours	4-5 Pl	wheel-gas			783.3	.92/Hr	720.64
Seed clean-treat					639 Bu	.07/Bu	44.73
Labor				\$60/week	10 weeks		600.00
TOTAL							3,781.41

B. SPRING WHEAT AREA:

Plowing	10'	oneway	510	3.6	141.6	.17	86.70
Duckfoot	12'	cultivator	1020	2.6	392.3	.15	153.00
Drill-Duckfoot	12'	combination	510	3.0	17.0	.18	91.80
Combine	14'	S-P	510	4.2		1.78	907.80
Tractor Hours	4-5 Pl	wheel-gas			550.9	.92	506.82
Grain hauling & elevating	2 Ton 26'	truck auger	8179			.04/Bu	327.16
Seed clean-treat		commercial			700 Bu	.07/Bu	49.00
Labor				\$60/week	9 weeks		540.00
TOTAL							2,662.28

^a/ Machine performance rates and per acre costs are based on Miller F., Lindsey, O. W. and George, A. G. Cost of Operating Machinery on Nebraska Farms, Tables 1 through 7, University of Neb. Agricultural Experiment Station, Bulletin 391, 1948, and Choate, L. E. and Walker, S.A. Guide in Answering Questions on Farm Machinery Costs, Tables 1 through 3, University of Idaho Agricultural Experiment Station Bul. 224, Nov. 1954.

^b/ Total variable cost includes fuel, oil, grease and repairs.

TABLE IX. SPECIFIC COSTS OF LIVESTOCK OPERATION, BY AREA, 1954.

A. WINTER WHEAT AREA:

ENTERPRISE	TYPE OF EXPENSE	UNIT	AMOUNT	COST ^{a/}	TOTAL VARIABLE COSTS
Chickens	Layer Mash	100 LB	500 LB	\$ 4.80	\$ 24.00
Chicks			75 EA	13.50	13.50
	Starter Mash	100 LB	100 LB	5.55	5.55
Cattle-Hogs	Feed Grinding	100 LB	13,675 LB	.15/Bu.	20.55
	Minerals (Misco)	50 LB	200 LB	4.85	19.40
	Salt	50 LB	250 LB	1.35	6.75
	Veterinary				37.80
	Medicine				50.00
Cattle	Replacement Bull			91.68	91.68
	Feed Bought				
	Hay	Ton	34	20.00	684.00
	Protein (20% range cake)	Ton	4	75.00	300.00

Hay ^{b/}	OPERATION	MACHINE SIZE TYPE	ACRES	ACRES PER HR	TOTAL HOURS	COST PER ACRE	
	Mowing	7' P.T.O.	84	2.8	30.0	.67	56.28
	Raking	7' S.D.	84	2.5	33.6	.48	40.32
	Baling	W/Motor Auto tie twine	84	2.3	36.5	2.13	178.92
	Hauling	2 Ton Truck			16 ld.	10/ld.	1.60
	& Elevating	32' Elevator					
	Tractor Hrs.	3-4 Gas wheel			100.1	.92/hr.	92.09
	Labor				\$60/wk.	2 wk.	120.00
TOTAL							1,742.44

^{a/} Costs are based on 1954 average retail costs for each area.

^{b/} Hay operation: Machine performance rates are based on Miller, F., Lindsey, O. W. and George, A. G. op. cit., Table 1 through 7.
Total variable costs include fuel, oil, grease, twine and repairs.

TABLE IX, (CONT.) SPECIFIC COSTS OF LIVESTOCK OPERATION, BY AREA, 1954.

B. SPRING WHEAT AREA:

ENTERPRISE	TYPE OF EXPENSE	UNIT	AMOUNT	COST	TOTAL VARIABLE COSTS
Chickens	Layer Mash	100 LB	500 LB	\$ 4.80	\$ 24.00
Chicks			75 EA	13.50	13.50
	Starter	100 LB	100 LB	5.55	5.55
Cattle-Hogs	Feed Grinding	100 LB	14,395 LB	.15	21.60
	Mineral (Misco)	50 LB	250 LB	4.85	24.25
	Salt	50 LB	300 LB	1.35	8.10
	Veterinary				40.00
	Medicine				45.00
Cattle	Replacement Bull			116.68	116.68
	Feed Bought				
	Hay	Ton	20	20.00	400.00
	Protein (20% range cake)	Ton	4	75.00	300.00

Hay	OPERATION	MACHINE SIZE TYPE	ACRES	ACRES PER HR	TOTAL HOURS	COST PER ACRE	
	Mowing	7' P.T.O.	88	2.8	31.4	.67	58.96
	Raking	7' S.D.	88	2.5	35.2	.43	42.24
	Baling	W/Motor Auto tie twine	88	2.3	38.2	2.13	187.44
	Hauling	2 Ton Truck			22 ld.	.10/ld.	2.20
	& Elevating	32' Elevator					
	Tractor Hrs.	10' Gas wheel			117.3	.92/hr.	107.92
	Labor	3-4			\$60/wk.	3 wk.	180.00
Oat Hay	Plowing	10' Oneway	50	3.6	14.8	.17	8.50
	Duckfoot	12' Cultivator	50	2.6	19.4	.15	7.50
	Drill-	12' Combination	50	3.0	16.6	.18	9.00
	Duckfoot						
	Binding	10' Twine	50	4.0	12.5	1.15	57.50
	Tractor Hrs.	4-5 Wheel gas			63.3	.92	58.23

TOTAL 1,718.17

TABLE X. FIXED COSTS OF CROP OPERATIONS, BY AREA, 1954.^{a/}

A. WINTER WHEAT AREA:

MACHINE	SIZE	ORIGINAL COST	MACHINE LIFE (YRS)	5% INTEREST CHARGE	\$ ANNUAL DEP.	TOTAL ANNUAL OWNERSHIP COSTS
Combine	14'	\$5,500.00	13	\$151.25	\$380.60	\$531.85
Oneway	10'	765.00	13	21.04	52.93	73.97
Duckfoot	12'	350.00	18	9.63	17.50	27.13
Rodweeder	12'	225.00	9	6.19	22.50	28.69
Drill	12'	500.00	21	13.75	21.40	35.15
Grain Auger	26'	242.00	12	6.65	18.15	24.80

BUILDINGS	TYPE	COST ^{b/}	BLDG LIFE (YRS)			
Machine Shed	Quonset	\$3500.00	33	87.50	106.06	193.56
Granaries (8 ea)	Steel	7760.00	33	144.00	235.15	379.15
						TOTAL.....\$1,294.30

B. SPRING WHEAT AREA:

MACHINE	SIZE	ORIGINAL COST	MACHINE LIFE (YRS)	5% INTEREST CHARGE	\$ ANNUAL DEP.	TOTAL ANNUAL OWNERSHIP COSTS
Combine	14'	\$5,500.00	13	\$151.25	\$380.60	\$531.85
Oneway	10'	765.00	13	21.04	52.93	73.97
Duckfoot	12'	350.00	18	9.63	17.50	27.13
Drill	12'	500.00	21	13.75	21.40	35.15
Grain Auger	26'	242.00	12	6.65	18.50	24.80

BUILDINGS	TYPE	COST	BLDG LIFE (YRS)			
Machine Shed	Quonset	\$3500.00	33	87.50	106.06	193.56
Granaries (5ea)	Steel	4850.00	33	121.25	146.96	268.21
						TOTAL.....\$1,154.67

^{a/} Data contained in Table X is based on Fenton, F. C., Fairbanks, G. E., The Cost of Using Farm Machinery, Table III through VII. Kansas State College, Experiment Station, Bulletin 74, September 1, 1954.

^{b/} Building Costs are mean averages for both areas.

value. Fixed costs were a little higher in the winter wheat area where the granary accounted for the greater fixed costs.

Costs fixed in the livestock operations for the two areas were a little higher in the spring wheat area, Table XI. This is commonly true in the respective areas where more machinery is required to provide a forage feed base and more artificial stock shelter is needed. The procedure used for deriving the annual ownership costs is the same as that used in calculating fixed costs in the crop operation.

Table XII contains nonspecific fixed costs which stem from machinery buildings and equipment which are common to both the livestock and crop enterprises. The procedure used in calculating total annual ownership costs (TFC) is the same as that used in Tables X and XI. Taxes, insurance, labor and miscellaneous costs are calculated as means obtained from data collected in each of the two respective areas. Miscellaneous expenses include such incidentals as telephone and other expenses chargeable to the whole farm.

Table XIII summarizes the specific and nonspecific expenses by area. Total expenses were over \$2,000.00 (\$2,183.01) more in the winter wheat area. Nonspecific variable expenses do not appear here, since by using this method of expense classification, it was feasible to class all variable expenses as specific. For example, tractor fuel repairs and lubricants were included when calculating variable costs which were specific to the two areas.

Table XIV, the financial summary, provides the final data necessary to figure net farm income. It is calculated by subtracting total farm

TABLE XI. FIXED COSTS OF LIVESTOCK OPERATION, BY AREA, 1954. a/

A. WINTER WHEAT AREA:

MACHINE	TYPE	ORIGINAL COST	MACHINE LIFE (YR)	5% INTEREST CHARGE	\$ ANNUAL DEP.	TOTAL ANNUAL OWNERSHIP COSTS
Mower	7' (PTO)	\$300.00	20	8.25	\$ 13.50	21.75
Rake	7' (SD)	395.00	18	10.86	19.75	30.61
Baler	Twine tie	2500.00	15	68.75	150.00	218.73
Elevator	32'	272.00	10	7.48	24.48	31.96
	Conveyor					
BUILDINGS	TYPE	COST b/	LIFE	5% INTEREST	REPAIR	
Barn	Frame	\$1750	33	43.75	45.00	53.03
Stock Shed	Frame	750	33	18.75	15.00	22.72
Hoghouse & Equip.	Frame	100	33	2.50	-----	3.03
Chicken Hs. & "	Frame	465	33	11.63	5.00	14.09
TOTAL.....						537.55

B. SPRING WHEAT AREA:

MACHINE	TYPE	ORIGINAL COST	MACHINE LIFE (YRS)	5% INTEREST CHARGE	\$ ANNUAL DEP.	TOTAL ANNUAL OWNERSHIP COSTS
Mower	7' (PTO)	\$300.00	20	8.25	13.50	21.75
Rake	7' (SD)	395.00	18	10.86	19.75	30.61
Baler	Twine tie	2500.00	15	68.75	150.00	218.75
Elevator	32'	272.00	10	7.48	24.48	31.96
	Conveyor					
Binder	10'	800.00	19	22.00	37.92	59.92
BUILDINGS & EQUIP.	TYPE	COST	LIFE	5% INTEREST	REPAIR	
Barn	Frame	\$2100	33	52.50	25.00	63.63
Stock Shed	Frame	1330	33	33.25	20.00	41.81
Stocade & Feeder	Frame	300	10	7.50	20.00	30.00
Hoghouse & Equip.	Frame	250	33	8.75	5.00	7.50
Chicken house	Frame	465	33	11.63	5.00	14.09
TOTAL.....						708.65

a/ Fenton, F. C., Fairbanks, G. E., op. cit., Tables III through VII.

b/ Building costs are mean averages for both areas.

TABLE XII. NONSPECIFIC FIXED COSTS, BY AREA, 1954.^{a/}

A. WINTER WHEAT AREA:

MACHINE	SIZE	ORIGINAL COST	MACHINE LIFE (YRS)	5% INTEREST	\$ ANNUAL DEP.	TOTAL ANNUAL OWNERSHIP COSTS
Tractor	4-5 plow	\$4000	11	110.00	\$327.20	\$437.20
Manure spreader	70 bushel	420	21	11.55	17.97	29.52
Shop Tools	-----	500	8	13.75	61.25	75.00
Trailer	4 wheel	500	16	13.75	28.15	41.90
Truck	2 ton	3000	10	82.50	270.00	352.50
Car (farm share)	50%	1250	10	34.38	112.50	146.88
BLDG. & EQUIP.	TYPE	COST ^{b/}	LIFE	REPAIR		
Tenant house	Frame	\$2500	33	\$50.00	62.50	75.75
Garage-shop	Frame	1500	33	46.90	37.50	45.00
Pump house & pressure system	Frame	1100	33	15.00	27.50	33.33
Fence (17 mi.)	4 wire	2975	15	200.00	74.38	198.33
Fuel Storage tanks	1500 gal. steel	365	33	---	9.12	11.06
Taxes						1440.00
Insurance						592.95
Labor						2729.05
Miscellaneous						75.00
						TOTAL \$6,720.47

B. SPRING WHEAT AREA:

MACHINE	SIZE	ORIGINAL COST	MACHINE LIFE (YRS)	5% INTEREST	\$ ANNUAL DEP.	TOTAL ANNUAL OWNERSHIP COSTS
Tractor	4-5 plow	\$4000	11	110.00	\$327.20	\$437.20
Manure spreader	70 bushel	420	21	11.55	17.97	29.52
Shop Tools	----	500	8	13.75	61.25	75.00
Trailer	4 wheel	500	16	13.75	28.15	41.90
Truck	2 ton	3000	10	82.50	270.00	352.50
Car (farm share)	50%	1250	10	34.38	112.50	146.88
BLDG. & EQUIP.	TYPE	COST	LIFE	REPAIR		
Bunk house	Frame	\$1600	33	\$25.00	40.00	48.48
Garage-shop	Quonset	862	33	---	21.55	26.12
Fence (20 mi)	4 wire	3500	15	200.00	8.75	233.33
Fuel tanks	1500 gal. steel	365	33	---	9.12	11.06
Taxes						1440.00
Insurance						592.00
Labor						1887.00
Miscellaneous						75.00
						TOTAL \$5652.41

^{a/}Fenton, F. C., Fairbanks, G. E., op. cit., Tables III through VII.

^{b/}Building costs are mean averages for both areas.

TABLE XIII. SUMMARY OF SPECIFIC AND NONSPECIFIC EXPENSES, BY AREA, 1954.

<u>SPECIFIC</u>	<u>A. WINTER WHEAT AREA:</u>	<u>B. SPRING WHEAT AREA:</u>
Crop		
Variable	\$3,784.41	\$2,662.28
Fixed	1,294.30	1,154.67
Livestock		
Variable	1,742.44	1,718.17
Fixed	537.57	708.65
<u>NONSPECIFIC</u>		
Fixed	6,720.47	5,652.41
TOTAL EXPENSES	\$14,079.19	\$11,896.18

TABLE XIV. FINANCIAL SUMMARY, BY AREA, 1954.

A. WINTER WHEAT AREA:

<u>RECEIPTS</u>	<u>AMOUNT</u>	<u>EXPENSE</u>	<u>AMOUNT</u>
Crop	\$ 17,655.64	Variable (Crop-Stock)	\$ 5,526.85
Livestock	6,985.83	Fixed (Crop-Stock)	1,831.87
Home Products	170.40	Nonspecific Fixed	6,720.47
TOTAL	\$24,811.87	TOTAL	\$14,079.19
		N.F.I.	10,732.68

B. SPRING WHEAT AREA:

<u>RECEIPTS</u>	<u>AMOUNT</u>	<u>EXPENSE</u>	<u>AMOUNT</u>
Crop	\$11,028.52	Variable (Crop-Stock)	\$ 4,380.45
Livestock	7,602.91	Fixed (Crop-Stock)	1,863.32
Home Products	248.05	Nonspecific Fixed	5,652.41
TOTAL	\$18,879.48	TOTAL	\$11,896.18
		N.F.I.	6,983.30

These model budgets as presented, represent the type of farms commonly found in the two areas under consideration. The next step is to use them to test production responses as they are affected to price changes.

expenses from the gross farm income. The net farm income here represents the return to the farmer and his family for management, labor and the land.

Budget Synopsis

For farms in the representative winter wheat and spring wheat areas of Montana specializing in livestock and wheat production, the basic organization is built around a dual enterprise producing system, animal product and grain (wheat-beef). Here the budget is used to describe the environmental conditions under which these farm organizations operate and attempt to tie the two enterprises together.

A farm budget may cover the whole of a farm operation or it may be drafted to deal with a specific phase of the operation. Here it is used to outline the basic farm organization for arriving at estimates of income and expenses which are specific to each enterprise and which vary directly with increases or decreases in production. These then provide a basis for estimating net farm income. The model is based on data obtained from the empirical investigations which were conducted in each of the two areas being studied on farms of specific sizes and having a dual enterprise (wheat-beef) organization.

Wheat yields used for the two areas are the adjusted figures which tend to be higher for the winter wheat area. Here an attempt was made to integrate the average yields reported by farmers for 1954 with county averages as reported in the Montana Agricultural Statistics for the five year period 1948-1952. This tended to increase the yield which

was used. The wheat was sold at a price which was government supported, however it was assumed in establishing the budget that a producer could produce all that was physically possible with no acreage restrictions.

Because of these factors, this budget represents an organization alternative which is not presently available. This was not the case three years ago, however, when it was possible to realize benefits from a price support program without acreage restrictions. Also income tax, and interest on the capital investment in land was not deducted from this figure.

All these physical and institutional factors if taken into account, would create a whole host of additional phenomena which would provide a basis for considering other problem situations which are not necessarily relevant to the problem presently being considered.

The model as presented here represents the most predominant types of wheat-livestock farms commonly found in the winter wheat and spring wheat areas. The budget described here has served as a tool for classifying expense items, both specific and nonspecific. With this expense classification, it is now possible to compare adjustments to alternative enterprise combinations. Given varied price levels for the products being produced from each of the two competing enterprises, it is hoped that certain predictions can be made pertaining to resource allocation and enterprise shift problems.

PART V

ENTERPRISE SHIFTS

Enterprise Combination and Price Variation

Enterprise combinations found on farms reflect the result of past decisions which depended on many factors -- among these, production opportunities and price relationships. Enterprise shifts require reallocations of resources common to the competing enterprises. A primary problem in maximizing net farm income on a multi-enterprise farm is to allocate such resources optimally. But at any point in time there also is a commitment of resources specific to each enterprise. These also change with a change in the allocation of common resources. In a short period of time, some of these are fixed in quantity. They create an expense also fixed in amount. Those resources which can be varied create a variable expense. In longer time periods, some resources previously fixed become variable, adding to (subtracting from) variable (fixed) specific expense. In the following analysis, two time periods are considered to illustrate the effect of time on decisions relating to enterprise combinations. Solutions are sought for price conditions which favor selected types of enterprise shifts.^{1/}

One-year Enterprise Shifts

Since some expense items (fixed and specific) will be left unchanged, they are neglected in the one-year period of enterprise adjustment.

^{1/} Baker, C. B., Break Even Prices: Wheat and Beef Cattle, unpublished paper, Department of Agricultural Economics and Rural Sociology, Montana State College, Bozeman, Montana. Calculations used in this section are based on the procedure followed in the above case study.

Although the budget method of analysis lends itself well as a descriptive or illustrative tool, it becomes progressively awkward to manipulate when comparing enterprise alternatives. Because of this situation it is substituted with a set of comparative equations which provide for a more flexible use of the budget data.

Since the system combining both crop and livestock enterprises (method used in the theoretical model) is summarized in the budget, it is convenient to make the crop production, income and expense quantities functions of the number of crop (a) acres. Similarly, livestock income and expense quantities can be made functions of the number of cows (c) in the beef herd.^{2/} With quantity, price and specific variable expense being represented by "Q", "P" and "V" respectively, the required income, net of variable expense, can be calculated. Required income here may be taken to mean a net income equivalent to what it is under the present organization before any enterprise adjustments have been made. Hence, as the different enterprise or resource combinations are substituted, the character of the alternatives to be compared can be appraised according to the effects they have on the budget.

Here again the problem deals with two specific areas (winter wheat and the spring wheat), so that it is convenient to compare both areas in a given problem situation. At the outset it is well to once again briefly summarize the present organization of each model farm with some necessary per unit costs. Table XV provides the basic land use and

^{2/} Ibid., p. 4.

TABLE XV. PRESENT LAND USE ORGANIZATION, BY AREA, 1954.

A. WINTER WHEAT AREA:

USE	RENT	OWNED	USED	TOTAL
Crop	72	439	511	511
(Summer fallow)	72	439	511	511
Hay	--	84	84	84
Pasture	--	1846	1846	1846
Hdq. and waste	--	192	192	192
TOTAL	144	3000	3144	3144

B. SPRING WHEAT AREA

USE	RENT	OWNED	USED	TOTAL
Crop	142	418	510	510
(Summer fallow)	142	418	560	560
Oat hay	---	---	50	50
Hay	---	88	88	88
Pasture	---	1967	1967	1967
Hdq. and waste	---	98	98	98
TOTAL	284	2989	3273	3273

TABLE XVI. COST, PRODUCTION AND RETURNS, BY AREA, 1954.

	A. WINTER WHEAT	B. SPRING WHEAT
a. Costs		
per acre (V_w)	\$ 7.41	\$ 4.75
" Bu.	.34	.38
" Cow (V_c)	14.45	13.60
" pound beef	.41	.36
b. Production		
Beef (Q_b) CWT/cow	3.6	3.8
Wheat (Q_w) bu/acre	20.4	12.8
c. Returns		
Beef cwt. gross	\$16.48	\$16.01
Net	12.39	12.42
Wheat gross/acre	41.82	27.14
Net	34.41	22.39

cropping operation data. This table gives the land use organization with the exact acres as they are now being cultivated. The outstanding difference between the areas is the crop acres utilized for the production of a roughage feed for the support of the livestock enterprise. In the spring wheat area, a certain portion of the crop acreage (50 acres of oats in the 1954 model unit) is utilized for this purpose; the number of crop acres utilized for this purpose varies inversely with the size of the hay crop from year to year.

Throughout the remaining discussion, the two areas vary quite widely with regard to the statistics for each area. The data, outlined in Table XVI are based on the cost price relationship as summarized from the budget.

The information contained in the preceding table is calculated as follows:

Costs

1. Per acre = $\frac{\text{TVC Crop}}{\text{Total crop acres}}$
2. Per bushel = $\frac{\text{TVC Crop}}{B_w \text{ grain } 3/}$
3. Per cow = $\frac{\text{TVC Livestock} - TL_m C 4/}{\text{No. cows}}$
4. Per lb. beef = $\frac{\text{TVC Livestock} - TL_m C 5/}{\text{Total lb. beef}}$

3/ Bushel of grain include totals for wheat oats and barley by area.

4/ $TL_m C$ refers to the total variable cost of the minor livestock enterprise including chickens and hogs which remain constant as emphasis for our enterprise shift fluctuates $TL_m C = \$58.39$ in both areas.

5/ Total lb. beef = 41150 and 46150 pounds in the winter and spring wheat units respectively.

Returns

1. Per acre (Gross) = $Q_w P_w$ ^{6/}
(Net) = Gross return - Cost
per acre
2. Per cow = CWT beef sold cow weighted
average beef
price
3. Per lb. beef (CWT/cow) = $\frac{\text{total lb. beef}}{\text{No. cows}}$
4. Weighted average $P_b = \frac{\text{TLR} - \text{TL}_m R}{\text{Total lb. beef}}$ ^{7/}

With the above data, ^{8/} it now is possible to set up an equation which will give farm income, net of variable expense and which does not include income from the minor livestock enterprise.

The present plan of operation for each area may be calculated from the general equation:

$$N_V FI - L_m = GCI - GCE_v + GL_m I - GL_m E_v$$

where $N_V FI$ = Net farm income (above variable and specific expense)

L_m = Receipt from the minor livestock enterprise net of variable expense.

GCI = Gross crop income.

GCE_v = Gross crop expense (variable and specific to crop)

$GL_m I$ = Gross livestock beef cattle income less receipts from the minor livestock enterprise.

$GL_m E_v$ = Gross livestock expense less the expense of the minor livestock.

^{6/} Q_w = bushel per acre yield; P_w = price of wheat/bu. which is 20.4 and 12.8 bu. per acre with \$2.05 and \$2.12 per bu. being received in the winter and spring wheat areas respectively.

^{7/} TLR = total livestock receipts, $TL_m R$ = total receipts of the minor livestock enterprise. It is \$204.40 and \$213.48 for the winter and spring wheat areas respectively.

^{8/} See Table XVI.

(1a) A. WINTER WHEAT AREA:

$$N_{vF_a}I$$

$$N_{vF_a}I - L_m = A_w (Q_{wP} - E_a) + c (Q_{bP} - E_c)$$

$$N_{vF_a}I - 316.41 = (17,655.64 - 3,784.41) + (6,781.43 - 1,684.05)$$

$$N_{vF_a}I - 316.41 = 13,871.23 + 5,097.38 = 18,968.61$$

(1b) B. SPRING WHEAT AREA:

$$N_{vF_b}I$$

$$N_{vF_b}I - 403.14 = (11,028.52 - 2,662.28) + (7,389.43 - 1,659.78)$$

$$N_{vR_b}I - 403.14 = 8,366.24 + 5,729.65 = 14,095.89$$

This net farm income figure for each area provides a "benchmark" from which to proceed with a one-year enterprise adjustment analysis.

Although certain types of the enterprise shifts to be considered, presently could not be completely converted in one year, it is possible, with certain assumptions, to compare the effects of these shifted acres as they affect net farm income. That is, resource shifts likely could not be matured into complete enterprise shifts within the time period now being considered.

Table XVII, below, outlines the land use organization by area when a maximum livestock minimum crop operation is desired. That is, less resources will be available for allocation and use in the crop enterprise. Data contained in this table are based on actual results obtained from farmer interviews within the two respective areas.

TABLE XVII. LAND USE ORGANIZATION--NOW AND IF SHIFTED TO BEEF CATTLE,
BY AREA, 1954.

A. WINTER WHEAT AREA:

USE	NOW	ACRES USED	SHIFT ACRES	ADJUST ACRES	ACRES USED	MODIFIED PLAN
Crop	1022	511	- 800	222	111	222
(Summer fallow)	----	511	-----	---	111	---
Hay	84	84	+ 35	119	119	119
Pasture	1846	1846	+ 765	2611	2611	2611
Hq & waste	192	192	-----	---	192	192
TOTAL	3144	3144	-----	---	3144	3144

B. SPRING WHEAT AREA:

USE	NOW	ACRES USED	SHIFT ACRES	ADJUST ACRES	ACRES USED	MODIFIED PLAN
Crop	1120	510	- 646	447	171	474
(Summer fallow)	----	560	-----	---	237	---
Hay	88	88	+ 24	112	112	112
Pasture	1967	1967	+ 622	2589	2589	2589
Hq & waste	98	98	-----	---	98	98
Oat Hay	----	50	-----	---	66	---
TOTAL	3273	3273	-----	---	3273	3273

Table XVII provides the information necessary to calculate the increased cow carrying capacity for each area. Utilizing these data, the carrying capacity for the unit representing the winter wheat area is increased from 114 to 163 cows for a net increase of 49 cows. With this increase in cow number, an increase of 35 hay acres is necessary with a 765 acre required pasture increase. The remaining 222 acres in crop may be thought to be fixed either by rent agreements or lack of stock water. As a matter of fact these are commonly found to be limiting factors.

The spring wheat area presents a little different picture, with part of the crop acreage again being utilized to support the livestock enterprise. The required acreage shift on this model unit representing the spring wheat area is able to support a 38 cow increase in the herd, for an increase to 160 cows from 122 head. Acreages required to support this herd are for hay: $88 + 24 = 112$; for oat hay: $50 + 16 = 66$; and for pasture acreages: $1967 + 622 = 2589$. Cow carrying capacity is based on the situation as it exists in the two areas, 15.6 pasture acres per cow for both areas with .71 and .70 hay acres per cow respectively in the winter and spring wheat areas. Carrying capacity for oat hay in the spring wheat area was .40 acres per cow.

To determine the minimum cattle price required to induce an operator to reallocate his resources, the general equations, (1a) and (1b) may be utilized again. This price must be high enough that, with the smaller wheat enterprise, the added cattle give a net farm income^{9/} equal at least to the original. With the current price of wheat (P_w) fixed, how high must the price of beef (P_b) go to make it economically sound^{10/} for such a shift to take place? This may be determined by the following calculation:

(2a) A. WINTER WHEAT AREA: Minimum P_b given current P_w :

$$N_v F_a I = 18,968.61 = 111 (41.82 - 7.41) + 163 (3.6 P_b - 14.45)$$

^{9/} See page 59 for the definition of net farm income.

^{10/} Maintain a net farm income which would be equal to the net income received from the original organization.

whence,

$$P_b = \frac{17,504.45}{586.80} = \$29.83$$

The approximate prices required for various classes of beef cattle would be:

Cull cows = \$18.97
Feeder calves = \$34.04
Bulls = \$19.47

(2b) B. SPRING WHEAT AREA: Minimum P_b given current P_w :

$$N_v F_b I = 14,095.89 = 171 (12.8 \cdot 2.12 - 4.75) + 160 (3.8 P_b - 13.60)$$

whence,

$$P_b = \frac{12,443.20}{608} = \$20.47$$

Cull cows = \$13.19
Feeder Calves = \$24.03
Bulls = \$13.74

These are the minimum cattle prices which would be required to cause this shift of land toward an increased livestock operation, assuming no relative price change for these classes of livestock. That is, with wheat prices fixed at \$2.05 and \$2.12 in the winter wheat area and spring wheat area respectively, the necessary price to induce a shift of resources to an increased livestock enterprise would be \$29.83 and \$20.47 per cwt., respectively. Any price for beef lower than this amount would be too small to make it economically feasible to effect such a shift.

By disregarding the obvious fact that, at the present time, a farmer who is receiving a supported wheat price is restricted in the number of acres he can plant, and assuming the supported price continues unaffected

after an acreage shift, it is possible to pursue the problem of enterprise adjustment further. For purposes of this problem, however, a resource shift in the opposite direction is necessary to test all the possible effects on an enterprise adjustment.

Limits on acreage shifts are again based on empirical data summarized from farmer interviews. Table XVIII outlines the exact disposition of acreages and use with a maximum crop minimum livestock organization before and after the shift.

Under these revised conditions it is again necessary to adjust the cow numbers on each representative model farm to stay within the established carrying capacity. In the winter wheat area with hay acreages reduced from 84 to 76 acres and pasture acreages reduced from 1846 to 1660 it is necessary to reduce the cow herd by 8 for a total of 106. In the spring wheat area it is necessary to reduce the cow herd by 18 head when hay acreages is reduced by 12 acres from 88 to 76. Oat hay is peculiar again to this area and is reduced by 8 acres from 50 to 42 acres with the pasture acres being reduced by 273 acres.

With acres devoted to the livestock enterprise lowered by these amounts, it is now possible to consider the price conditions required if such a change were to be brought about.

Given the price of beef at \$16.48 in the winter wheat area and \$16.01 in the spring wheat area, the minimum price of wheat which would still permit such a shift can be solved for from the following equations:

(3a) A. WINTER WHEAT AREA: Minimum P_w given current P_b :

$$N_v F_a I = A_w (Q_w P_w - V_a) + C (Q_b P_b - V_c)$$

whence,

$$P_w = \frac{18,716.61}{12,403} = \$1.51$$

(3b) B. SPRING WHEAT AREA:

$$N_{V_b}I = 14,095.89 = 660 (12.8 P_w - 4.75) + 104 (3.8 \cdot 16.01 - 13.60)$$

whence,

$$P_w = \frac{12,317.93}{8448} = \$1.46$$

These are the low wheat prices for each respective area which would still permit a shift into wheat production. In other words, the price of wheat could drop to this amount and the required income, net of variable expense, would still be maintained.

TABLE XVIII. LAND USE ORGANIZATION, NOW AND IF SHIFTED TO WHEAT, BY AREA, 1954.

A. WINTER WHEAT AREA:

USE	ACRES NOW	ACRES USED	SHIFT ACRES	ADJUST ACRES	ACRES USED	MODIFIED PLAN
Crop	1022	511	+ 194	1216	608	608
(Summer Fallow)	-----	511	-----	-----	608	608
Hay	84	84	- 8	76	76	76
Pasture	1846	1846	- 186	1660	1660	1660
Hdq & waste	192	192	-----	192	192	192
TOTAL	3144	3144	-----	-----	3144	3144

B. SPRING WHEAT AREA:

USE	ACRES NOW	ACRES USED	SHIFT ACRES	ADJUST ACRES	ACRES USED	MODIFIED PLAN
Crop	1120	510	+ 285	1405	660	660
(Summer Fallow)	-----	560	-----	-----	703	703
Oat hay	-----	50	-----	-----	42	42
Hay	88	88	- 12	76	76	76
Pasture	1967	1967	- 273	1694	1694	1694
Hdq & waste	98	98	-----	-----	98	98
TOTAL	3273	3273	-----	-----	3273	3273

This group of "break-even prices" assumes that the acreage shifts, if made, on these two representative model units would be carried to the maximum. That is, shift acres listed in Tables XVII and XVIII indicate the maximum number of acres which are physically possible to shift. Adjusted acres in these two tables indicates a minimum of required acres. Pasture acres are fixed as such because of the topography and the like while crop acres may be suitable only for cropping because of lease arrangements or lack of stock water.

TABLE XIX. "BREAK-EVEN PRICES:" WHEAT AND BEEF, BY AREA, 1954.

DESCRIPTION OF SHIFT IN ENTERPRISE	PROBLEM NO.	REQUIRED PRICE FOR	GIVEN THE PRICE FOR
A. WINTER WHEAT AREA			
Livestock Shift	(2a)	Min. $P_b = \$29.83/\text{cwt.}$	$P_w = \$ 2.05/\text{bu.}$
Wheat Shift	(3a)	Min. $P_w = \$ 1.51/\text{bu.}$	$P_b = \$16.48/\text{cwt.}$
B. SPRING WHEAT AREA:			
Livestock Shift	(2b)	Min. $P = \$20.47/\text{cwt.}$	$P = \$ 2.12/\text{bu.}$
Wheat Shift	(3b)	Min. $P_w^b = \$ 1.46/\text{bu}$	$P_w^b = \$16.01/\text{cwt.}$

"Break-even prices" as such provide the answer to the question: are shifts of this sort economically feasible? They give minimum conditions which maintain constant net farm income after shift in enterprise.

Thirteen-Year Enterprise Shifts

Total variable costs so far considered have been only those specific costs which vary in a one-year period, as the production in that period is increased or decreased. When a longer period of time is considered,

however, certain of the other specific costs, considered fixed during one year, may become variable through depreciation, sale of equipment, replacement, etc. As this occurs, enterprise shifts become easier; that is, "the break-even price" tends to become smaller and it is possible to convert these expenses, once considered fixed, to variable expenses.

For purposes of illustrating this problem, a 13-year period has been selected to represent the longer than one-year period. This is the expected machine life, in years, for the most expensive piece of equipment in either of the two enterprises (the combine). Assuming this time period is of sufficient length to transform these fixed expenses into variable expenses, it is now possible to review each of the preceding farm plans, calculate a new series of "break-even prices" and see what effect a longer period for shifting has upon these new prices which are required to maintain a constant net farm income. Table XX summarizes the fixed expense items which would become variable over a 13-year period. The annual ownership costs here include depreciation and interest which are itemized by enterprise with a total for each enterprise and sum total for the model farm representing each area.

Table XXI summarizes the farm expenses for one year as they are affected when certain of the fixed expense items become variable over the longer 13-year period. From these expense items it is possible to calculate a new per acre cost and per cow cost for each area as was done previously. In the winter wheat area, the per acre expense of variable resources specific to crops is given by:

$$\frac{\$4,443.70}{511 \text{ acres}} = \$8.70/\text{acre};$$

TABLE XX. ADDITIONS TO VARIABLE SPECIFIC EXPENSE: BY AREA, ASSUMING A 13-YEAR ADJUSTMENT PERIOD.

ITEM	A. WINTER WHEAT AREA:			B. SPRING WHEAT AREA:		
	FIRST COST	MACHINE LIFE YR.	ANNUAL ^{a/} OWNERSHIP COSTS	FIRST COST	MACHINE LIFE YR.	ANNUAL OWNERSHIP COSTS
<u>Crop:</u>						
Combine	\$5500	13	\$531.85	\$5500	13	\$531.85
Oneway	765	13	73.95	765	13	73.97
Rod Weeder	225	9	28.69			
Grain Auger	242	12	24.80	242	12	24.80
		TOTAL	659.29		TOTAL	630.62
<u>Livestock:</u>						
Elevator	272	10	31.96	272	10	31.96
Stocade						
Feeder				300	10	57.50
		"TOTAL"	31.96		"TOTAL"	89.46
		"SUM TOTAL"	691.25 ^{b/}		"SUM TOTAL"	720.08

^{a/} Annual ownership costs include obsolescence, depreciation and a 5% interest charge.

^{b/} Sub total refers to crop and livestock costs combined.

TABLE XXI. FARM EXPENSES, BY AREA, ASSUMING A 13-YEAR ADJUSTMENT PERIOD.

EXPENSES	WINTER WHEAT AREA:		SPRING WHEAT AREA:	
	Crop	Livestock	Crop	Livestock
Variable in one year	\$3,784.41	\$1,742.44	\$2,662.28	\$1,718.17
Fixed become variable in 13 years	659.29	31.96	630.62	89.46
TOTAL-MODIFIED VARIABLE EXPENSE.	\$4,443.70	\$1,774.40	\$3,292.90	\$1,807.63

the per cow expense of variable resources specific to beef cattle, by

$$\frac{1,774.40}{114 \text{ cows}} = \$15.56/\text{cow}.$$

These per unit costs represent increases of \$8.70 - 8.19 = \$.51 per crop

acre and $\$15.56 - 14.45 = \$1.11$ per cow in the winter wheat when certain fixed (see Table XX) expense items become variable over a longer period.

In the spring wheat area per acre expense of variable resources specific to crops is given by:

$$\frac{\$3,292.90}{510 \text{ acres}} = \$6.46/\text{acre};$$

the per cow expense of variable resources specific to beef cattle, by

$$\frac{\$1,807.63}{122 \text{ cows}} = \$14.81/\text{cow}.$$

These per unit enterprise expenses represent increases of:

$$\$6.46 - 6.08 = \$.36/\text{acre}$$

and

$$\$14.81 - 13.60 = \$1.21/\text{cow}$$

when variable expenses are increased from a one year period to the longer 13-year period.

Although certain expense items become variable over a longer than one-year period, others still remain fixed. This situation occurs when the life of a machine or the period required to depreciate a building is longer than the 13-year period now being considered. These items are itemized in Table XXII.

With these increased variable expense items, it is now necessary to establish a new net farm income "bench mark." Because of the increased variable expense the new "bench mark" (NFI) is smaller than it was in the original situation.

TABLE XXII. UNAFFECTED FIXED EXPENSE ITEMS, BY AREA, ASSUMING A 13-YEAR ADJUSTMENT PERIOD.

A. WINTER WHEAT AREA:				B. SPRING WHEAT AREA		
ITEM	FIRST COST	MACHINE LIFE YR.	ANNUAL OWNERSHIP COST	FIRST COST	MACHINE LIFE YR.	ANNUAL ^{a/} OWNERSHIP COST
<u>Crop</u>						
Duckfoot	\$350	18	\$27.13	\$350	18	\$27.13
Drill	500	22	35.15	500	21	35.15
Machine shed	3500	33	193.56	350	33	193.56
Granary	7760	33	379.15	4850	33	268.21
		TOTAL	634.99		TOTAL	534.05
<u>Livestock</u>						
Mower	300	20	21.75	300	20	21.75
Rake	395	18	30.61	395	18	30.61
Baler	2500	15	218.75	2500	15	218.75
Binder	----	--	-----	800	19	59.92
Barn	1750	33	141.78	2100	33	141.13
Stock shed	750	33	56.47	1330	33	95.06
Hq. Hs. & equip.	100	33	5.53	250	33	21.25
Chicken hs.	465	33	30.72	465	33	30.72
		"TOTAL"	505.61		"TOTAL"	619.19
		"SUM TOTAL"	1140.60		"SUM TOTAL"	1143.24

^{a/} Annual ownership costs include obsolescence, depreciation and a 5% interest charge.

Under the present plan, when a 13-year period is considered, and given current prices for wheat (P_w) and beef (P_b), the new net farm income may be calculated again from the general equation:

$$N_{v_a} F_a I - L_m = A_w (Q_w P_w - V_a) + C (Q_b P_b - V_c).$$

(5a) A. WINTER WHEAT AREA: Present plan given current P_b and P_w :

$$N_{v_a} F_a I - 316.41 = (17,655.64 - 4,443.70) + (6,781.43 - 1,774.40)$$

$$N_{v_a} F_a I = 18,218.97$$

(5b) B. SPRING WHEAT AREA: Present plan, given current P_b and P_w .

$$N_{vF_b}I - 403.14 = (11,028.52 - 3,292.90) + (7,389.43 - 1,807.63)$$

$$N_{vF_b}I = 13,317.42$$

From these net farm income figures (less the contributions from minor livestock), a whole new series of desired "break-even prices" may be calculated, each of which will give a minimum or maximum price condition for an enterprise shift over the 13-year period. Table XVII, page 61, provides the necessary data required to calculate a "break-even price" for beef (at current price of wheat) or wheat (at current price of beef), for a maximum livestock-minimum crop operation.

To maintain the required net farm income, it is necessary to utilize acres in such a way that the income net of variable expenses will remain constant. With the shift acres utilized for an increased livestock herd, how low could the price of beef (P_b) go and still permit this type of shift?

(6a) A. WINTER WHEAT AREA: Minimum P_b given current P_w :

$$N_{vF_a}I = 18,218.97 = 111 (41.82 - 8.70) + 163 (3.6 P_b - 15.56)$$

$$P_b = \frac{17,078.93}{586.80} = \$29.10$$

Cull cows = \$18.54
Feeder Calves = \$33.19
Bulls = \$18.97

(6b) B. SPRING WHEAT AREA: Minimum P_b given current P_w :

$$N_v F_b I = 13,317.42 = 171 (12.8 \cdot 212 - 6.46) + 160 (3.8 P_b - 14.81)$$

$$P_b = \frac{12,150.74}{608} = \$19.98$$

Cull cows = \$13.10
Feeder Calves = \$23.46
Bulls = \$13.42

The prices for the various classes of beef must increase to at least these amounts then before the crop shiftable acres would be used in beef cattle production.

The "break-even prices" solved for so far, deal only with an enterprise shift in which resources (acres) are reallocated to accommodate an increased livestock (beef) operation.

It is possible also to solve for the necessary "break-even prices" which would permit a shift toward an increased wheat operation. Table XVIII, page 64, provides the necessary data required to calculate "break-even prices" for this sort of shift.

Given current (P_b), what is the minimum price of wheat (P_w) that would permit this type of shift?

(7a) A. WINTER WHEAT AREA: Minimum P_w given current P_b :

$$N_v F_a I = 18,218.97 = 608 (204 P_w - 8.70) + 106 (3.6 \cdot 16.48 - 15.56)$$

$$P_w = \frac{18,868.95}{12,403.20} = \$1.52$$

(7b) B. SPRING WHEAT AREA: Minimum P_w given current P_b :

$$N_v F_b I = 13,317.42 = 660 (12.8 P_w - 6.46) + 104 (3.8 \cdot 16.01 - 14.81)$$

$$P_w = \frac{12,793.90}{8,448} = \$1.51$$

These prices are calculated with the same basic equation as was used in the previous problem with only the constants (per acre cost of wheat \$8.70 and per cow costs \$15.56) varying. Although these per unit expenses are increased, the resulting "break-even price" is changed but little. In the winter wheat area, only a one-cent increase results in the "break-even price" over the price resulting when only variable expenses were calculated. In the spring wheat area, a three-cent increase in wheat price is forthcoming when certain fixed expense items are reclassified. (See Tables XIX and XXIII for comparative purposes). These negligible increases result since the required net farm income, which permits this shift, has been reduced due to increased variable expenses.

Adjusted acres in Tables XVII and XVIII indicate the maximum number of acres which are physically possible to shift. The "break-even prices" for the adjusted acre problems are summarized in Table XXIII below:

TABLE XXIII. BREAK-EVEN PRICES: WHEAT AND BEEF, BY AREA, ASSUMING A 13-YEAR ADJUSTMENT PERIOD.

DESCRIPTION OF ENTERPRISE SHIFT		REQUIRED PRICE FOR	GIVEN THE PRICE FOR
PROBLEM NO.			
A. WINTER WHEAT AREA:			
Livestock shift	(6a)	Min $P_b = \$29.10/\text{cwt}$	$P_w = \$ 2.05/\text{bu}$
Wheat shift	(7a)	Min $P_w = \$ 1.52/\text{bu}$	$P_b = \$16.48/\text{cwt}$
B. SPRING WHEAT AREA:			
Livestock shift	(6b)	Min $P_b = \$19.98/\text{cwt}$	$P_w = \$ 2.12/\text{bu}$
Wheat shift	(7b)	Min $P_w = \$ 1.51/\text{bu}$	$P_b = \$16.01/\text{cwt}$

Assuming the 13-year transition period, where certain fixed prices become variable, it is interesting to note that the "break-even price" for beef is not greatly altered (see Table XIX, page 69). By comparing Tables XIX, page 69, and XXIII, the direct effects of the longer (13-year) period may be observed as the necessary "break-even prices" are altered. In the winter wheat and spring wheat areas, respectively, a \$29.83 and \$20.47 cwt. were the minimum prices of beef which would induce shifts into more beef during a one-year period. In the longer period, these minimum beef prices (P_b) were, respectively, \$29.10 and \$19.98, a reduction of \$.73 per cwt., and \$.49 per cwt., respectively in the winter wheat and spring wheat areas.

The "break-even prices" necessary to shift more resources into wheat production (crop acres) increased negligibly as the period of time was expanded from one to 13 years. When a one-year shift period was considered and given current beef prices in the winter wheat area, the minimum price of wheat (P_w) was \$1.51/bushel as compared to \$1.52/bushel required "break-even price" during a 13-year shift period in the same area. In the spring wheat area, this per bushel wheat price increased from \$1.46/bushel in the one-year period to \$1.51/bushel in the longer 13-year shift period.

"Break-even prices" for livestock become smaller during the longer (13-year) period when the enterprise shift is towards a larger wheat operation. (Increased crop acres.) Variations in these prices would suggest then that a livestock shift might be relatively profitable on a long-run basis rather than a short-run basis. I.e., in the longer period,

a shift might be produced by a relatively lower "break-even price."
An enterprise shift, where an increased wheat operation was desired, correspondingly could be more easily brought about during the shorter one-year period.

PART VI

CONCLUSIONS

The operator of a shift-sensitive unit faces the problem of allocating resources on the basis of internal and external environment for his particular unit. The final organization may be to produce all wheat, all cattle or some combination of resource use for both enterprises. In many cases the first two possibilities (all wheat or all livestock) may be limited because of certain environmental characteristics beyond the control of the operator. This in fact was the situation which prevented complete enterprise shifts in the two model farms representing the winter wheat and spring wheat areas in this study.

The brief attempt here has been to develop the situation facing the operator of a combination wheat-beef organization. To accomplish this, a "synthetic" budget was constructed for each of two representative units in question. One unit faced the alternatives of range beef cattle vs. winter wheat; the other, range beef cattle vs. spring wheat. The budgets used to describe farms in each of the two areas were used mainly to classify expense items.

Once expense items for each enterprise had been established for each enterprise, in a given operation, it was then possible to test the economic feasibility of shifting from one enterprise to another. This analysis was accomplished through a series of "break-even prices" to determine what price would be necessary to cause certain shifts in the allocation of resources, hence enterprise shifts.

Methodologically, this study illustrates the usefulness of the budget as a tool for classifying expenses, and the "break-even price" analysis,

in which these expenses were used, to solve for the necessary price which would permit given enterprise shifts. Also, on the basis of the assumptions made, the budget provided a means for systematically comparing the relative returns from a group of production possibilities available to each of the two representative farms.

Since a linear production opportunity curve was assumed to exist between the two competing enterprises, the results of this analysis, from a "practical" standpoint, were limited at the outset. Yet the price conditions yielded by the analysis, appear to be somewhat reasonable. It is apparent that wide price shifts would be required to bring about enterprise shifts, even on units selected because of their sensitivity to shifts in land use.

Possible future research might deal with the assumption of linearity in the production opportunity curve between two competing enterprises and in the relation of marginal cost to enterprise output. Too, a comprehensive study dealing with problems of agricultural credit in sensitive shift areas, could be a most useful research contribution.

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A P P E N D I X

Enumerator _____ Montana Agricultural Experiment Station
 Date _____ Shifts in Land Use: Dryland Units

No. _____

Name _____ Address _____
 Age _____ Year started as operator? _____ Do you live on the farm year around? _____
 Distance from (a) grain delivery point? _____ (b) livestock selling point? _____

1. Size and tenure of farm: 1954

Type	Owned	Rented	Total	Remarks (terms of lease, etc.)
Cropland				
Hay				
Pasture				

2. Land Use

A. Crop production and disposition: 1954

Use	Planted for '54	Harvested in '54	Yield /Acre	Unit	Produc- tion 1/	Disposition				Planted for '55
						rent	seed	fed	sold2/	
Cropland										
Hay										

1/ Aftermath grazing: list under production of grain (which is in bushels) in AUM's.
 2/ List grain which is stored with the grain which is listed as sold.

B. Production and use of grazing resources: 1954

Type Resource	Acres	Dates Grazed	Type and weight of stock grazed	AUM's

1. What use was made in 1954 of land planted to wheat, but not harvested? _____

C. Shifts in land use: 1950-'54

Year	Grazing to Crop Production		Crop production to Grazing	
	Acres	Av. yld. since shift	Acres	Reason for shift
1954				
1953				
1952				
1951				
1950				

2. Do you have additional grazing land physically capable of crop production? _____ acres. Why hasn't it been shifted? _____

- D. Shiftable land:

A. Livestock inventory: 1954

B. Livestock Practices Since 1950:

2/ Calf and lamb crop percentages based on offspring weaned and the number of females in the breeding herd wintered.

[illegible]

- A. Farm machinery and equipment inventory: 1954

[illegible]

1/ Indicates disposition if replaced, if year purchased 1950-'54.
2/ If machine could handle addition work, indicate amount.

A. Do you plan to buy any machinery in the near future? Item? _____
Price? _____?

B. Do you plan to sell any equipment in the near future? Item? _____
Price? _____?

B. Inventory of Real Property Other than land.

Item	Size or Capacity	Year New	Cost New	Present Cond.	Maint. Cost	Purpose & Use	Remarks <u>1/</u>
Building							
Fences		2/					
Water Supply							
Other							

1/ Indicate adequacy of facilities: if not adequate, list cost to bring up to adequacy. If more than adequate, indicate to what degree.

2/ Give age in increments of 10 years.

5. Miscellaneous expenses, 1954

Item and kind	Rate of use	Total Used	Unit Cost	Total Cost
Fuel, oil & grease				
Seed bought				
Seed treatment				
Weed spray				
Fertilizer				
Insecticides				
Misc. supplies (crop)				
Feed bought				
Livestock supplies				
Water				

[illegible]

2/ If more than one size of tractor on this farm, show which one usually used.

What recent changes have you made in your field operations? Have any of these been caused by acreage restrictions?

7. Farm labor

Family labor

1954	Operator			Wife Age			Son-Daughter Age			Son-Daughter Age			Son-Daughter Age		
	Avail. 1/	Work 2/	Kind of work	Avail. 1/	Work 2/	Kind of work	Avail. 1/	Work 2/	Kind of work	Avail. 1/	Work 2/	Kind of work	Avail. 1/	Work 2/	Kind of work
January															
February															
March															
April															
May															
June															
July															
August															
September															
October															
November															
December															

1/ Proportion of month available for full time work.)

2/ Proportion of available time worked.

These may be listed as number of days, or,
except in case of operator, as average hours
per day.

No. _____

Hired labor

Kind & number	Dates hired		Time worked	Kind of work done	Wage rate	Cost
	From	To				
Year						
Month						
Day 1/						

1/ List by type of work.

8. Custom work (include exchange) 1954

Operation	Equipment and power furnished	Crew furnished	Work done		Cost or income	
			Amount	Unit	Per unit	Total
Your farm						
For others						

9. Other expense.

Item	Cost	Item	Cost	Item	Cost
Insurance crop building liability		Truck (1) license insurance (2) license insurance (3) license insurance		Farm taxes real estate personal property	

Automobile make & model _____ miles driven 1954 _____ percent farm use _____

10. Which of the following alternatives would you solicit if you were to borrow money to finance?

Item	Farm mortgage lenders			Short term lenders				Remarks
	FLB	Ins. Co.	Other	Bank	PCA	FHA	Other	
Reseeding operation								
Purchase of livestock								
Purchase of machinery								
Fencing								
Water spreader								
Buildings								
Other								

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