

SOIL, FERTILIZER, AND MANAGEMENT
RELATIONSHIPS AFFECTING ECONOMIC
CHOICES OF CORN SILAGE AND ALFALFA
ON DAIRY FARMS

Thesis for the Degree of M. S.
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ABSTRACT

SOIL, FERTILIZER, AND MANAGEMENT RELATIONSHIPS AFFECTING ECONOMIC CHOICES OF CORN SILAGE AND ALFALFA ON DAIRY FARMS

By

Gerald D. Schwab

The purpose of this study was to determine the most economical forage ration for a 120-cow Holstein dairy herd. Within each of three soil management groups considered, management and fertilizer inputs were varied. In this manner, the effect on costs of the various management and fertilizer combinations could be shown.

The partial budgeting procedure was used to evaluate each of the problem settings. Input data was gained almost entirely from Michigan State University sources. The alfalfa yields and associated fertilization requirements were based on research and field data reported in a Michigan State University extension bulletin. The average dairy herd milk production level was assumed to be approximately 13,000 pounds of 3.5% butterfat adjusted milk. The associated rations were built and based on standard feeding references for feedstuff values and for

production and maintenance requirements. The milk production per cow was assumed equivalent regardless of forage ration fed provided that the ration was nutritionally balanced. This was based on consultation with and research completed by the Michigan State University Dairy Department. Once the crop yield levels and total feedstuff requirements were established, total crop acreage requirements were determined. The value and annual charge on this land was based on judgement values by professional agricultural economists. The production, harvesting, and storage costs were based almost entirely on research results at Michigan State University.

Two levels of management were compared for each crop and fertilization level within each soil management group. In all instances the superior level of management resulted in a lower per unit production cost than did the good level of management. A specific description of these management practices and associated yields is presented in the Appendices.

Before proceeding with the corn-alfalfa inter-enterprise comparisons, it was necessary to ascertain the most economical fertilization level on each crop. This problem was limited to determination of the alfalfa fertilization as the best available expected corn yield data listed only one yield and fertilization level. Three

levels of potassium fertilization were analyzed on the alfalfa crop with the phosphorus being maintained at a sufficient "bank" level so as not to be the limiting input. For each soil management group the medium level of potassium fertilization (100# K_2O /acre) provided the lowest production cost per unit of alfalfa produced.

It should be mentioned that the dairy herds were assumed homogeneous and prices constant. In this manner the gross revenue from each herd in the separate soil management groups was equivalent. The optimal production method then becomes that which provides the lowest cost for the required feedstuffs.

On the highly productive land, soil management group I (SMG I), the all corn silage forage ration grown with superior management provided the lowest cost ration. However, the cost differential between the all corn silage and the 75% corn silage and 25% haylage was quite small. With a slight variation in cost and yield figures used in the budget, this cost advantage could be reversed.

On the productive land, soil management group II, the all corn silage ration grown with superior management was also the lowest cost ration. The array of production, harvesting and storage costs in SMG II is quite similar to that in SMG I. As with SMG I, the cost differential between the two lowest cost rations was quite small with this cost

situation capable of being reversed if the yields were slightly altered.

With the moderately productive land, soil management group III, the 50% corn silage, 50% alfalfa ration grown with superior management became the lowest cost ration. The cost and yield relationships in this soil management group are quite different from the previous two groups. The inclusion of alfalfa in the crop rotation is not only economically advantageous but may in fact be agronomically dictated due to the inherent soil conditions and topography.

In soil management group III at least 4.8 tons of 90% dry matter alfalfa per 100 bushels corn grain are necessary to make production of alfalfa economical. However, in soil management groups I and II, approximately 5.2 tons of 90% dry matter alfalfa per 100 bushels corn grain was necessary before alfalfa was competitive in the crop rotation.

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A grateful thank you is offered to Dr. L. L. Boger for the provision of a graduate research assistantship received by the author during the course of study. Also a sincere thank you to my parents and relatives for their continued concern and encouragement.

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CHAPTER I

INTRODUCTION

Dairy products have constituted Michigan's largest single agricultural enterprise in terms of cash receipts. In 1967, dairy products accounted for 27.8% of Michigan's cash receipts from farm marketings.¹ The structure of this dairying sector is changing. The total number of milk cows is decreasing with a concurrent increase in dairy cows per farm and an increase in pounds of milk per cow annually. During the period 1961 to 1967 the number of milk cows on Michigan farms decreased from 639,000 to 495,000 while the average milk production per cow increased from 8,290 to 9,480 pounds per year.² The dairy enterprise is becoming more specialized and capital intensive. Obtaining and keeping reliable labor has been and will continue to be a problem on dairy farms. New technology

¹United States Department of Agriculture, Farm Income State Estimates, 1949-1967, FIS 211 Supplement (Washington, D.C.: Economic Research Service, August, 1968), p. 96.

²Michigan Department of Agriculture, Michigan Agricultural Statistics (Lansing, Michigan: July, 1968), p. 29.

in feeding, handling, and milking systems has reduced the amount of labor required per cow. At the same time the volume of milk output per farm must be increased to justify capital investment in these newer technologies. The result has been fewer but much larger and more highly specialized dairy farms.

Because of the increasing input costs and relatively constant milk prices, the dairy farmer is caught in the familiar cost-price squeeze. As the farmer presently has little influence on prices received, attempts must be made to reduce costs. The forage input in dairying accounts for 25 to 30% of total milk production costs.³ These forage costs can be reduced by increasing both the quantity and quality of these crops produced per acre. Combining new technology, good cultural practices and wise management can greatly aid in attaining these objectives. Corn silage has benefited from the development of minimum tillage, narrow row spacing, higher plant population, increased fertilizer rates, chemical weed control and improved harvesting and storage systems plus the use of feed grade urea to provide a relatively cheap protein source. The quantity and quality of alfalfa production

³C. R. Hoglund, "Minimizing Cost of Forage in Tomorrow's Dairy Ration (paper presented at the 1968 joint meeting of the American Dairy Science Association and American Grassland Council Symposium, Columbus, Ohio, June, 1968).

has been increased by new varieties, improved seeding practices, chemical weed control, increased fertilizer rates, more frequent harvesting scheduled and improved harvesting and storage methods.

Of the crop production cultural practices aforementioned, the concern of this thesis is with the fertilizer aspect and the overall management of production, harvesting, and storage processes. Higher crop yields offer a good opportunity for reducing per unit production costs. One of the highest returning and most profitable investments to be made by a farmer lies with lime and fertilizer expenditures. June 1968 farm cost index figures show that fertilizer was the only listed input category which had not risen in price since 1957-59.⁴ Similar figures for other time periods give evidence that fertilizer is one of the better buys.

Fertilizer has been applied at much higher levels on row crops as compared to that applied on other grass and legume acreages. It has been stated that three million tons of fertilizer are used on the entire forage acreage in the United States compared to eight million

⁴United States Department of Agriculture, Agricultural Prices (Washington, D.C.: Crop Reporting Board, Statistical Reporting Service, July 30, 1968).

tons of fertilizer on a much smaller corn acreage.⁵ It is estimated that 1 1/2 billion acres of hay and pasture lands are fertilizer responsive. Only 3% of this acreage gets fertilized and this land receives an average of 10-12 pounds per acre while corn receives an average of 175 pounds per acre.

In Michigan in 1964 it was reported that 93% of the corn acreage received some fertilizer while only 12% of the hay and cropland pasture (not including permanent pasture) received fertilizer.⁶ The average poundage of fertilizer elements applied per acre of corn was 101 whereas the average on the hay and cropland pasture was only 6 pounds of fertilizer elements per acre.

Most farmers are aware of the profitability of some fertilizer application. However very little specific information is known of the fertilizer production response surface for the varying soil and climatic conditions. Only limited information is available on marginal

⁵W. K. Griffith, "Improving Forage Yields by Lime, Fertilizer and Management (paper presented at the American Forage and Grassland Council meetings entitled "Forages of the Future," January, 1968).

⁶Richard D. Duvick, Trends in the Use of Major Fertilizer Nutrients on Michigan Cropland and Pasture, Agricultural Economics Report #88, December, 1967 (East Lansing, Michigan: Michigan State University, Department of Agricultural Economics), pp. 5-8.

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transformation rates, that is, the additional crop yield per additional fertilizer unit. Information is also limited on substitution coefficients, that is, the economic not biologic substitution rate for nutrients producing the same yield. This type of information is needed for more exact recommendations on the economically optimum use of fertilizer given the set of production resources.

Research and Development of Production Response Models

Hypotheses have been proposed and models constructed with regard to crop yield response as a function of mineral nutrients. Such a relationship is depicted as $Y = f(X)$ where Y is the crop yield and X is the plant nutrient input. Agronomists and economists have used empirical data in an attempt to develop a production surface given the mineral inputs, soil and climatic situations. Some of the earliest work in this area was by Von Liebig who proposed the "Law of the Minimum" stating that crop yields increase in direct proportion to additions of the nutrient which is limiting plant growth. Mitscherlich related growth to the supply of the plant nutrients as follows $dY/dX = (A - Y)C$ where Y and X are crop yield and quantity of plant nutrients, respectively. "A" is the maximum possible yield and C is a proportionality constant which depends on the nature of the growth

factor. It is noted that Mitscherlich recognized that plant growth, as a function of nutrient inputs, is logarithmic and generally follows a pattern of diminishing increases.⁷

W. J. Spillman stated this growth relationship as $Y = M(1 - R^X)$ where M is the maximum yield possible and R is a constant. It has been shown that Mitscherlich's and Spillman's equations reduce to

$$Y = A(1 - 10^{-CX})$$

$$\log (A - Y) = \log A - 0.301(x)$$

where 0.301 replaces the constant C when yields are expressed on a relative basis of $A = 100$.⁸

O. W. Wilcox proposed that the yield of a crop is inversely proportional to its nitrogen content. This relationship depicted as $Y = K/n$ where K is a constant representing the maximum amount of N that can be absorbed in one season by an annual crop growing on an acre of land and n is the percent N in the crop.⁹

Bray's Nutrient Mobility Concept states that "as the mobility of a nutrient in the soil decreased, the

⁷Samuel L. Tisdale and Werner L. Nelson, Soil Fertility and Fertilizers (New York: The Macmillan Company, 1966), p. 23.

⁸Ibid.

⁹Ibid., p. 27.

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amount of that nutrient needed in the soil to produce a maximum yield (the soil nutrient requirement) increased from a variable net value, determined principally by the magnitude of the yield and the optimum percentage composition of the crop, to an amount whose value tends to be a constant." This concept is expressed as

$$\log (A - Y) = \log A - C_1 b - Cx$$

where C_1 is a constant representing the efficiency of b for yields in which b represents the amount of an immobile but available form of nutrient as P or K as measured by soil test. C represents the efficiency factor for x which is the added fertilizer form of nutrient b .¹⁰

The Cobb-Douglas production function has also been used in an attempt to explain and predict production responses. It is of the form

$$Y = aX_1^{b_1}X_2^{b_2} \dots X_n^{b_n}$$

where Y is the predicted production, a is a constant--the production without any variable inputs, X_i are the variable inputs and b_i are the elasticity of output with respect to the X_i . This function is one of the easiest curvilinear functions to fit via use of logarithms. Marginal value products, iso-product contours, and high profit points of production can easily be determined on the line of least

¹⁰Ibid., p. 29.

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cost combination given the inputs, prices and production coefficients. However it has the disadvantage of not being able to fit actual production data in Stage II when the summation of the b_i 's is less than one which is the usual case showing the effect of the law of diminishing returns. This shortcoming along with others has shown the Cobb-Douglas function to not be the ultimate in prediction of production response.

Heady of Iowa State has done a great amount of research in the field of production economics. His methods have involved sophisticated statistical and mathematical models in an attempt to construct a model capable of predicting yields given a set of inputs. Results of one such attempt using yield time-series data were published in 1967.¹¹ One objective of this project was to estimate annual production functions for various crops and locations and compare these with the average production functions estimated from several years of data. Also desired was an estimate of the generalized production function to include weather, soil nutrients, locations, and soils so as to incorporate these variables into the production

¹¹John T. Pesek, Jr., Earl O. Heady, and Eduardo Venezian, Fertilizer Production Functions in Relation to Weather, Location, Soil and Crop Variables, Research Bulletin 554 (Ames, Iowa: Iowa State University, August, 1967).

function with the intention of improving decision making as related to fertilizer applications under variable weather conditions. Analysis of variance showed weather to be responsible for at least 50% of the crop yield variance. Phosphorus and potassium were the only soil nutrients applied. The selected algebraic production function was a quadratic equation of the form

$$C = b_0 + b_1P + b_2K + b_3P^2 + b_4K^2 + b_5PK$$

with C being the crop yield. The b_1 and b_2 refer to linear terms for P and K respectively, and b_3 and b_4 refer to square roots of these same two nutrient quantities. The b_5 term refers to the interaction coefficient PK. Coefficients for the various crops and locations were determined. The coefficients of determination were in many instances relatively high being greater than 0.90 with all of the regression coefficients for corn being significant at the 0.01 level of probability.

In the mid-1950's a joint project between the Departments of Agricultural Economics and Soil Science of Michigan State University was initiated in an attempt to derive fertilizer input-crop output relationships. Theses by W. F. Sundquist and J. L. Knetsch under the direction of Dr. G. L. Johnson were written on this empirical data. Continuous functional analysis of the Carter-Halter type

production function was used to analyze the data.¹² This function is of the form

$$Y = aX_1^{b_1}C_1^{x_1}X_2^{b_2}C_2^{x_2}$$

and can show all three stages of production. Partial derivatives and simultaneous equations were used to derive the economically optimum production points. The empirical field tests were subjected to many uncontrolled variables--among these was a drought which seriously affected yields. The result was that the coefficients of multiple determination were all generally quite low. No economic yield response was achieved for P and K applications and only moderate N applications were occasionally justified depending on the crop grown. Thus even though the economic benefits of some fertilizer have been substantiated in the field by farmers, it can not be said that this project solved the subject problem of determining a production

¹²For a more detailed explanation and analysis of the referenced data, see W. B. Sundquist, "An Economic Analysis of Some Controlled Fertilizer Input-Output Experiments in Michigan" (unpublished Ph.D. thesis, Michigan State University, 1957); Jack L. Knetch, "Methodological Procedures and Applications for Incorporating Economic Consideration into Fertilizer Recommendations" (unpublished M. S. thesis, Michigan State University, 1956); and Bernard R. Hoffnar and Glenn L. Johnson, Summary and Evaluation of the Cooperative Agronomic-Economic Experimentation at Michigan State University--1955-63, Research Bulletin 11 (East Lansing, Michigan: Michigan State University, Agricultural Experiment Station, 1966).

surface and the most economical point of production on this surface.

Cropping Trends in Michigan

The general cropping trend in Michigan is towards more acres for corn silage but fewer acres for corn grain, alfalfa, and alfalfa-mixtures. (See Table 1.) These acreages, particularly for corn grain, have been modified by implementation of Federal Crop acreage control and grain price support programs.

Concurrent with these acreage changes has been an increase in the average yields per acre for corn grain and silage whereas the alfalfa yields have remained relatively constant. As corn silage acreages and yields have been increased, the tonnage of corn silage being fed by dairy-men has been increasing. (See Table 2.) Also as the percent of dairy farms feeding corn silage has increased, the tonnage of corn silage fed per animal and per farm has increased. Further, the quantity of haylage being fed and to be fed in the future is increasing. These developments have greatly increased the mechanization of both the harvesting and feeding operations.

TABLE 1

MICHIGAN CROPPING TRENDS

Year	Corn Grain		Corn Silage		Alfalfa and Alfalfa Mixtures	
	Acres (000)	Yield Bu/Ac	Acres (000)	Yield T/Ac	Acres (000)	Yield T/Ac
1955	1639	47.0	290	8.3	1412	2.0
1956	1649	51.0	273	8.6	1356	2.0
1957	1452	50.0	295	8.0	1302	2.0
1958	1452	56.0	321	8.8	1341	2.0
1959	1724	57.0	276	9.9	1287	2.0
1960	1672	54.0	362	8.8	1248	2.0
1961	1455	66.0	322	11.5	1273	2.0
1962	1382	63.0	372	10.5	1311	2.0
1963	1493	64.0	379	10.5	1390	2.2
1964	1543	60.0	364	10.7	1376	2.0
1965	1481	61.0	404	9.0	1335	2.2
1966	1407	67.0	372	10.5	1282	2.2
1967	1407	65.0	368	10.5	1218	2.2
1968	1323	74.0	390	11.0		

Source: Michigan Department of Agriculture, Michigan Agricultural Statistics (Lansing, Michigan: July, 1962 and July, 1968).

TABLE 2

PRESENT AND FUTURE PLANS FOR FEEDING
AND STORAGE PRACTICES

Item	Stanchion Barn Systems Year 1965	Stanchion Barn Systems Future	Loose-Housing Systems Year 1965	Loose-Housing Systems Future
Number of Farms	71	59	78	74 ^a
Percent:				
Feed corn silage	91	93	96	98
Feed haylage	40	57	57	73
Feed hay	96	93	91	85
Feed high moisture corn	5	23	12	34
Build more silos		44		46

^aTwelve of the stanchion barn operators and four of the loose-housing operations expected to discontinue the dairy enterprise.

Source: C. R. Hoglund, Changes in Forage Production and Handling on Southern Michigan Dairy Farms, Agricultural Economics Report #78 (East Lansing, Michigan: Michigan State University, Department of Agricultural Economics, April, 1967).

Orientation of the Problem

This study will be principally concerned with the economic evaluation of yield response levels of corn and alfalfa subjected to varied fertilizer applications and management levels for three separate soil management areas in Southern Michigan. To minimize harvest and storage losses, it is assumed that the alfalfa crop will be harvested at dry matter percentages ranging from 35 to 60 but adjusted to a 50% dry matter yield. Corn silage is assumed to average 32% dry matter (DM). The optimum range in dry matter for yield and feeding value would be between 30 and 40% DM.

The various methods of harvesting alfalfa have little effect on milk production if the forage is harvested under similar conditions of growth and climate.¹³ The choice of harvesting alfalfa as low-moisture silage was made for reasons other than a possible differential in milk production.

The choice of corn silage versus alfalfa does not appear to hinge on the differential milk production rate between these two forages. Experimental evidence indicates that milk production can be maintained at the same level

¹³Donald Hillman, John T. Huber, and William J. Thomas, Balanced Rations for Dairy Cattle, D-190 (East Lansing, Michigan: Michigan State University, Dairy Department).

over a wide range of forages varying from all hay to 100% of the forage dry matter fed as silage providing the silage is of high quality and requiring grass silage to be low in moisture (40-65% moisture) which encourages high dry matter intake.¹⁴ Michigan State studies show that cows fed only corn silage as the total forage input produced as well as those fed variable quantities of hay.¹⁵ Similar studies at other locations have also shown this same phenomena. It is important that the various forage rations be properly supplemented with grain, protein, minerals, and vitamins.

The selection of a forage crop or crops to grow depends on which provides the most economical feeding ration. Inherent in this decision must be the consideration of crop yields, costs of production, nutrient composition of each crop, price relationships of the crops and the supplements which must be purchased for each to provide a balanced ration. Further, this cropping decision will be modified by soil erosion control requirements, climatological considerations and personal preferences.

¹⁴C. R. Hoglund, "Economic Production of Meat and Milk with Forages" (paper presented at the Grassland Proceedings meeting, Hershey, Pennsylvania, August, 1962).

¹⁵L. D. Brown, J. W. Thomas and R. S. Emery, "Effect of Feeding Various Levels of Corn Silage and Hay with High Levels of Grain," Journal of Dairy Science, Vol. 48 (1965), 816.

Purpose and Objectives

There is not complete agreement among the feeding experts, agronomists and agricultural economists as to what constitutes the most nutritious feeding ration and the most economical feed in terms of an input-output analysis. It shall be the purpose of this study to determine, given a set of soil and cost conditions subject to variable fertilizer applications, the forage or combination of forages which provide the most economical feed for a predetermined sized dairy herd.

Three separate soil management groups will be considered. Within each management group, an 120-cow dairy herd plus replacement stock will be subjected to analysis. This herd size is felt to be of sufficient size to justify investment in silage harvesting and storage equipment. In addition, this herd size may quite possibly be a common-sized dairy unit in future years. It is desired that the best of the evaluated forage alternatives and associated practices will be revealed for each given situation.

Procedure

With the objective declared, a physical setting was needed in which to make the study. Three soil management groups were determined and are as described and pictured in Chapter II. Identical dairy herds of

120 homogeneous cows plus replacements were assumed to exist on separate farms in each of the three soil management groups. An adjusted 305-day milking period was assumed to produce approximately 13,150 pounds of 3.5% fat-corrected milk from each 1300 pound cow. Ration requirements were calculated for the dairy herd. This calculation was based on maintenance and production requirements as given by Morrison in Feeds and Feeding. Various ration combinations were calculated and are as given in Appendix B, Tables B20, B21, and B22.

Birth and survival rates of new-born calves was assumed to be 90%. A binomial distribution approximation was assumed for the sex of the new-born calves. The heifer replacement stock was assumed to decrease in each year a uniform 5% of the total potential young stock. Now that the total feedstuff requirements were calculated, it was necessary to determine probable crop yield levels for the various soil management groups in order to calculate required crop acreages.

The alfalfa yields herein are based on experimental work completed by Tesar of the Crop Science Department, Michigan State. Yields were determined for various cutting treatments and fertilizer levels. These empirical results were then incorporated into this thesis. By examining the yield differential between cutting treatments, a management

factor of 25% was assumed to exist. This means that the corn grain and alfalfa yields are 25% greater than with good management. The average alfalfa yields do not show a complete 25% yield increase as the oat silage and establishment year alfalfa yields were not assumed to differ between the good and superior levels of management. A more complete account of this management factor and the accompanying yield for the different management and fertilizer levels is given in Appendix A and B.

Corn and oat yields for the three soil management groups are adjusted from those given in Extension Bulletin E-550. Yield adjustments and calculated fertilizer requirements were completed after consultation with Robertson and Shickluna of the Soil Science Department, Michigan State. Specific yield figures and determinants of such are given in Appendix B, Tables B1-B19.

After the yield levels were determined and feed-stuff requirements calculated, it was necessary for cost accounting purposes to determine cropland acreages and the machinery and equipment complement necessary to grow these crops. For comparative purposes, it was decided that the required crop acres in each soil management group would be calculated for a forage ration of 50% alfalfa haylage-- 50% corn silage and would be determined for production levels under superior management and medium fertilization.

Thus for each farm organization at this management and fertilization level, the total crop acreage assumed would be just sufficient to grow all grain and roughage requirements. Then for other rations and production levels, adjustments would be made via buying or selling of the grain with all the forage being produced on the farm.

Now that the input procedure has been schematized, a method of analysis is needed for determination of the best alternative. To analyze the situation herein, the partial budgeting procedure was used. A description of this process and other analytic methods is contained in Chapter III.

CHAPTER II

TECHNICAL AGRICULTURAL PRACTICES AND THE PROBLEM SETTING

Developments in Crop Production Applicable to Southern Michigan Dairy Farms

Technological inventions and innovations have greatly changed--almost revolutionized--the agricultural production sector within the past two decades. Corn hybrids have been developed to the extent that there are now several varieties particularly adapted for specific areas. These hybrids are higher yielding than those evident in the past. Lime and fertilizer use has increased and continues to be a profitable investment. Nitrogen fertilizer production industries have instituted new manufacturing processes resulting in a relatively inexpensive, high returning crop input.

Cultural practices have also changed. A minimum of conventional tillage or minimum tillage itself may now be advocated depending upon soil conditions. Plant population per acre has increased via higher density of plants within the row and by way of narrower rows. Some continuous row cropping is practiced in areas of the state in which soil

erosion is not a serious problem. Chemical weed and insect control measures are now used with various degrees of effectiveness. Harvesting practices have developed from hand picking and mechanical corn pickers to picker-shellors, picker-grinders and forage choppers.

Various practices are available to increase alfalfa yields. New Flemish type varieties have been tested and found to be higher yielding than those used in the past. Selection techniques have resulted in varieties possessing wilt-resistance, rapid recovery following cutting, and winter-hardiness. Alfalfa cultural practices have also changed. Recommendations for establishment of the alfalfa seeding vary among authorities but range from spring seeding with oats to spring and fall establishment with no companion crop. Cutting the alfalfa at late bud stage is recommended for higher total digestible nutrient and protein levels. This earlier and more frequent cutting schedule encourages the harvesting of the forage as silage in order to avoid the climatic wetness of late May-early-June evident in Southern Michigan. More information is now available regarding pH requirements and fertilizer response than was so ten years ago. The result has been that liming and fertilizing of alfalfa are now practiced on a more scientific basis. Chemical insect control has been developed for many alfalfa pests and will be especially important in the control of the alfalfa weevil.

In addition to these developments in the growing and harvesting of the crop have been advancements in the storage and feeding of these crops. Methods of preservation have been developed whereby a higher quality product can now be preserved for feeding. Silage blowers have been improved to provide for faster filling of the tower silos. This aids in the reduction of air contamination. Improvements in silos range from the gas tight towers to the more conventional tight concrete silos using a weighted plastic cover over the top to help insure a good seal. The use of a silage distributor increases the holding capacity of the silo and helps impede the movement of oxygen therefore improving silage preservation and reducing losses in storage. Any and all of these developments are available for use on Southern Michigan dairy farms.

Soil Groupings and Characteristics of Each

For purposes of this thesis, several soil association areas in Southern Michigan have been collected into what are termed "soil management groups." A soil management group (SMG) may be considered as a group of soils with similar physical and chemical properties, similar management requirements and similar production potentials

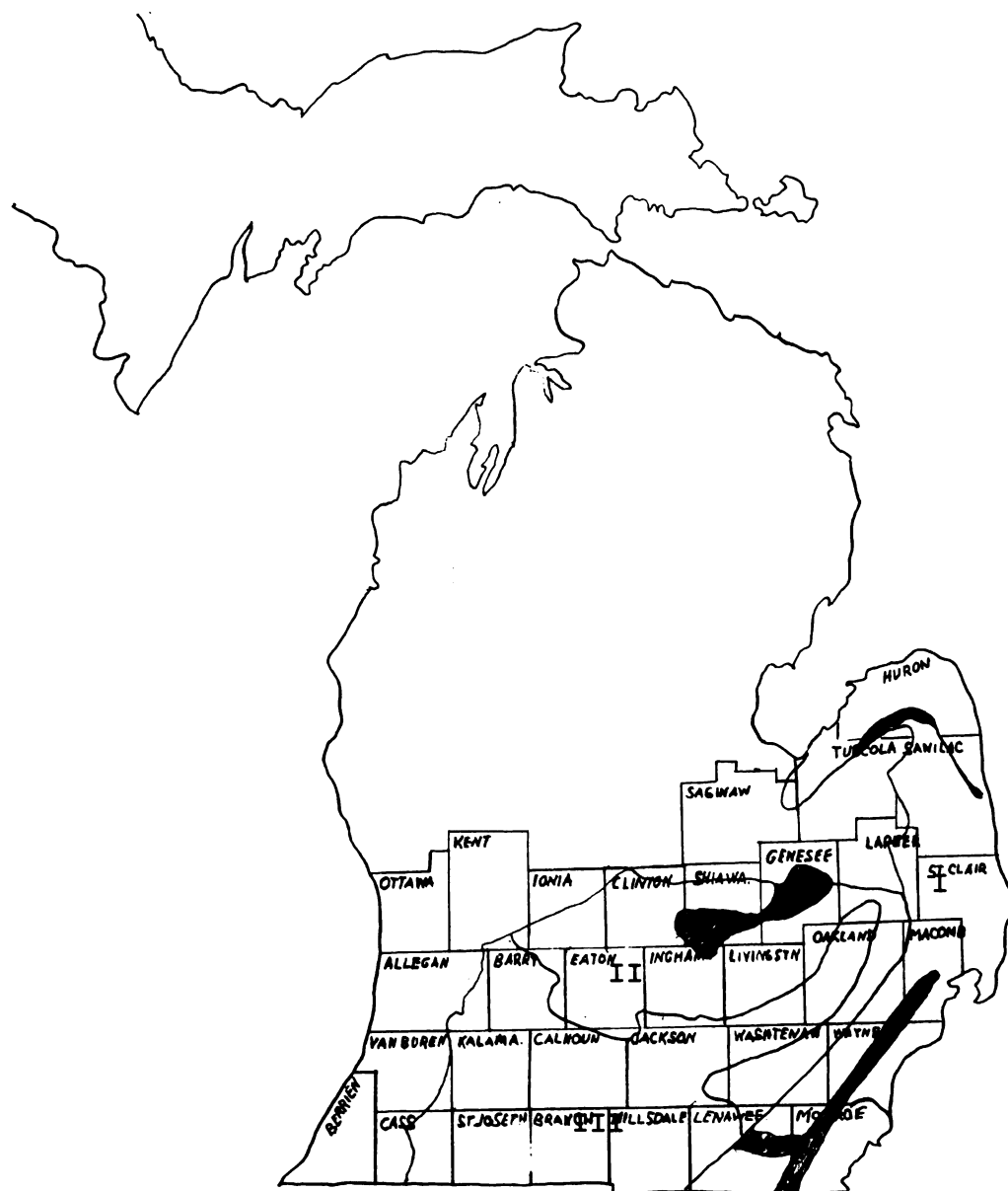
assuming the same production practices.¹ The general location of these groups is shown in Figure 1.

These soil management groups have been classified as moderately productive, productive, and highly productive. The moderately productive group includes the Fox, McHenry, Spinks, Oshtemo, Warsaw and Hillsdale soils. Generally, these soils occur on nearly level to rolling land. The soil surface texture ranges between the sandy loam and silt loam. Excepting some imperfectly drained low-lying areas, this grouping is well drained. The chief production limitations are acidity, relatively low fertility, erosion hazards on the more sloping areas, low content of organic matter and low moisture supplying capacity.²

The productive group consists of the Miami-Dodge-Conover soil association area. This area occurs in a nearly level to gently rolling landscape. This soil is predominately silt loam with some sandy loam included. The Miami and Dodge soils are well drained with the Conover being imperfectly drained. For high production levels;

¹J. C. Shickluna, "The Relationship of pH, Available Phosphorus, Potassium, and Magnesium to Soil Management Groups," Quarterly Bulletin, Vol. 45, No. 13 (East Lansing, Michigan: Michigan Agricultural Experiment Station, August, 1962), p. 136.

²University of Wisconsin, Soils of the North Central Region of the United States, North Central Regional Publication No. 76, Bulletin 544 (Madison, Wisconsin: Agricultural Experiment Station, June, 1960), p. 90.



- I Highly Productive Soil Management Group
- II Productive Soil Management Group
- III Moderately Productive Soil Management Group

FIGURE 1

LOCATION OF SOIL MANAGEMENT GROUPS

drainage, acidity, and erosion control appear to be the most limiting factors with respect to the natural conditions of the soil.³

The highly productive group consists of the Sims-Kawkawlin-Capac, the Hoytville-Nappanee-Wauseon, and the Brookston-Blount-Hoytville soil association areas. The area occupied by these soils is nearly level to undulating. The soil surface varies from a silty clay loam to a loam. These soils are poorly to imperfectly drained. This drainage problem plus the difficulty of maintaining good soil tilth are the chief production limitations.⁴

Type of Agriculture in the Three Selected Soil Management Groups

As with farms throughout the United States, Michigan's full-time commercial farmers are becoming larger and more specialized. It is projected that by 1980 Michigan's commercial farms will have an average acreage of 275 acres with an estimated capital investment of \$150,000.⁵ Relative to the year 1959 this represents

³Ibid., pp. 92-93.

⁴Ibid., p. 111.

⁵K. T. Wright, Project '80--Economic Prospects of Farmers (East Lansing, Michigan: Michigan State University, Agricultural Experiment Station and Cooperative Extension Service).

increases of 54% and 206%, respectively. Actual land under cultivation will decrease but total production levels will increase due to influence of scientific advances in the agricultural sector.

The area groupings worked with in this study will be subject to these same influences. Thus, any presentation of today's agricultural enterprise situation will be subjected to continual pressures for change. Within the farming area having moderately productive soils, livestock operations are more apparent than in the area with highly productive soils. Dairying is one of the principal enterprises in this area with corn, wheat and soybeans being the major cash crops. The area listed as productive is also typified by general farming and dairying. Corn is a more important crop acreage-wise in the moderately productive Southern Michigan area, but the yield per acre is higher in the South Central Michigan area with the Miami-Dodge-Conover soils.⁶ Much of the feed grains in both of these two areas are marketed through livestock with wheat and corn being the major cash crops.

In the highly productive area, dairying is once again a major agricultural enterprise but is generally practiced on farms with less productive and more rolling

⁶Michigan Department of Agriculture, op. cit.,
p. 11.

land. The level, highly productive and well-drained areas have cash cropping where dry field beans, wheat, corn, and sugar beets are the major cash crops.⁷ Soybeans are also quite important in Southeastern Michigan in the counties of Lenawee, Monroe, and Wayne. As the southern portion of this area is in the proximity of a large industrial area, there are many part-time farmers. These farms tend to be smaller in size with some truck-farms producing fruits and vegetables.

Forage Management for Optimum Yields
With Respect to Both Quantity
and Quality

The term management is frequently used but with a variety of meanings among users. Management is concerned with the administration of scarce resources for the fulfillment of human goals in a world characterized by risk and uncertainty. There has been a conflict as to whether management is or is not an input. For purposes of this thesis, management will be regarded as an intangible part of the production process involved in the arrangement and timely use of the factors of production. Its presence is evidenced by the results of many decisions. Management

⁷K. T. Wright and D. A. Caul, Michigan's Agriculture, Extension Bulletin 582 (East Lansing, Michigan: Cooperative Extension Service, August, 1967), pp. 16, 20, 26, and 32.

is involved in determining what is produced, the quantities produced and how it is produced, harvested and marketed.

Following are the forage practices advocated for use and assumed used in this problem structure.

A. Alfalfa

1. Variety: Use a recommended variety that is adapted to the geographic location. For a 2-4 year stand, Saranac and the Flemish varieties are recommended for Southern Michigan.⁸ For longer-lived stands, Vernal and other wilt resistant varieties are best. The high yielding Flemish varieties are assumed used with the superior management whereas the longer-lived varieties are used with the good level of management.

2. Establishment: Although there appears to be some disagreement regarding this item, the alfalfa in this problem will be assumed established in the spring with oats as a companion crop. The oats will be harvested as silage when the oat grain reaches the early to medium dough stage. Removing the companion crop early encourages a more vigorous growth of the legume.

⁸M. B. Tesar and R. L. Janes, Five to Seven Tons of Alfalfa--with Weevil Control (East Lansing, Michigan: Michigan State University, Departments of Crop Science and Entomology, January, 1969).

The land will be plowed, disked once, lime and fertilizer applied according to soil test, and the seeding done with a drill or brilliant seeder to insure good soil-seed contact. A pH of no less than 6.5 is desired. Attainment and maintenance of a high soil fertility level is necessary to insure high yields.

3. Maintenance: An establishment year plus two years of alfalfa will be assumed. In the seeding year, the oats will be harvested in the medium dough stage as oat silage. In addition, it is assumed that one cutting of alfalfa will be harvested in early September. The alfalfa will be top-dressed in the Autumn or in the Spring after the first cutting. Phosphorus and potassium fertilizer amounts will be determined according to soil test, yield desired and the economics of these items as evaluated in a benefit-cost manner. For this problem, two limestone levels and thus two pH levels will be used in each soil management group.

Spraying for the alfalfa weevil has been incorporated in the problem structure. This pest is a relatively recent occurrence but its effect can be quite serious. To simplify the comparative situations, all alfalfa in this problem has been sprayed. However in actual situations, the weevil should be sprayed only when 25-50% of the leaf tips show pest feeding damage.

4. Harvesting: A 3-cut system is recommended for Southern Michigan. The first cutting should be at late

bud to 1/10 bloom stage with the remaining cuttings at early flower to 1/10 bloom. Cutting intervals will be approximately 40 days. As long as the plant starts to bloom in each cutting, it will have stored enough food in the roots so it can be cut in the fall without injuring the stand or reducing next year's yields.⁹ Cutting the alfalfa in its early flower stage may alleviate the necessity of a weevil spray on the first cutting. By harvesting early in the flowering stage, a higher protein--lower fiber forage is made available thus encouraging higher dry matter intake and more milk produced per acre.

It is recommended that the alfalfa be harvested as haylage with a moisture content ranging 40-65%. A hay crusher or crimper should be used in conjunction with this system. Curing and harvesting losses, and labor requirements are minimized when this harvesting method is used. Also, such a method aids in better scheduling of harvest operations.

5. Storage: In accordance with some research completed at Michigan State University,¹⁰ tower concrete silos are

⁹M. B. Tesar, A New Look at Fall Cutting, File: 22.331 (East Lansing, Michigan: Michigan State University, Department of Crop Science, December, 1968).

¹⁰C. R. Hoglund, Economic Considerations in Selecting Silage Storage and Feeding Systems, Agricultural Economics Report #84 (East Lansing, Michigan: Michigan State University, Department of Agricultural Economics, September, 1967).

felt to be the best storage system alternative available for the particular sized operation being studied. Storage losses will be approximately 11% compared to 4% with the sealed storage but investment per ton storage capacity will be 50% that of the sealed storage. Storage losses will be minimized if the haylage is chopped at moisture levels not below 50% or above 65% with a theoretical 1/4-3/8 inch cut, the silo is filled quickly, a silage distributor is used, the silo has no openings or cracks in the walls and the top is capped with a plastic cover.

B. Corn

1. Variety: A corn variety should be selected according to yield, lodging resistance, maturity length, and intended use of crop. It is advisable that more than one hybrid be planted with some small differences in maturity. This spreads the harvest load over a longer period and gives greater flexibility. For corn silage, a later variety should be used relative to that for corn grain. It is desired that the variety for corn silage have a high grain yielding ability, but by using a later variety, more dry matter is produced per acre.

2. Establishment: Some soil tillage is necessary in order to attain good soil tilth. This structural condition is necessary for good soil-seed contact and for soil

erosion control. The amount of tillage required will vary with the type and condition of the soil. To simplify the comparison herein, a minimum of conventional tillage will be used on all soil management groups. With this tillage system, the soil will be plowed and disked-harrowed prior to planting then harrowed after planting. It is desired that the soil be left with a granular structure suitable for seeding but coarse enough to allow penetration of air, water, and roots.

With regard to plant population and row spacing, 20,000 seeds will be planted with an expected plant population per acre of approximately 18,000. Row width of 28 inches is assumed. However for actual on farm situations, the complete switching over to these narrower rows is not recommended until the present machinery and equipment requires replacement. The average percentage yield increase for narrow rows is approximately 6%.¹¹ Thus unless one is now using optimum production practices with the wide rows, there are less expensive ways of increasing yield.

It is recommended that the corn be planted during the first ten days of May. The early planted corn usually

¹¹S. C. Hildebrand, E. C. Rossman, and L. S. Robertson, Hybrid Selection and Cultural Practices, Extension Bulletin 436 (East Lansing, Michigan: Michigan State University, Departments of Crop Science and Soil Science, September, 1964).

yields more as it has passed the critical stage of pollination by the time of the mid-summer dry period.

Lime and potassium fertilizer will be plowed down, anhydrous ammonia will be knifed into the soil and a row fertilizer will be applied with the planter. The amounts, grades and analysis of these mineral elements will be determined by soil testing and by the prices of the various elements.

3. Maintenance: The principal concerns here are weed and insect control. Insect problems vary between years and will not be studied herein. For weed control, a herbicide (atrazine) application at planting time has been used. At 2 pounds application of atrazine per acre, oats and alfalfa may be safely planted the following year.¹² When corn is grown continuously for periods longer than two years, the last year of corn prior to the crop rotation should receive a treatment as 2 4-D in lieu of the atrazine.

In addition, one rotary hoeing and one cultivation have been incorporated in order to control between row weeds. The rotary hoe is especially beneficial if it does not rain within two weeks after the atrazine application.

¹²William F. Meggitt, Weed Control in Field Crops, Extension Bulletin 434 (East Lansing, Michigan: Michigan State University, Department of Crop Science, February, 1969).

Additional benefits as aeration and water penetration have been suggested for cultivation.

4. Harvesting: For this problem, sufficient corn silage will be harvested to provide the livestock with the needed quantities of forage. The acreage of corn silage harvested will differ between soil management groups, between rations, and between management and fertilizer levels. The crop will be harvested at an average 32% dry matter. Such a dry matter level will be reached when the grain is at the hard dent stage. At this level, maximum total digestible nutrients are obtained, and proper ensiling is insured.¹³

It is assumed that the corn grain will be harvested as ear corn with harvesting of the grain commencing when its moisture content is approximately 22%.

5. Storage: As with the alfalfa haylage, the corn silage and grain will be stored in concrete tower silos. Again much attention must be devoted to the provision of anaerobic conditions to give a good fermentation process thus insuring good silage preservation. The ear corn will be ground as it goes into storage.

¹³J. Clayton Herman and Leon E. Thompson, eds., Silage Production and Use, Pamphlet 417 (Ames, Iowa: Iowa State University, Cooperative Extension Service, February, 1968), p. 14.

Reasons for Silage Making

Silage-making, especially corn silage, has greatly increased in the past ten years. In Michigan from 1959 to 1967, corn silage acreage increased by 92,000 acres while the corn grain acreage decreased by 314,000 acres.¹⁴ An important factor in the increased production of silage crops is the substitution of year-round storage feeding for part or all of the pasture. Michigan studies show that with dairy herds of 40 or more cows it generally becomes more profitable to harvest rather than graze the forage crops.¹⁵

The most profitable crop or combination of forage crops to grow and feed to dairy and beef cattle will depend on such factors as the relative yield of the crops on a particular farm, the performance of livestock when fed various forage crops, carcass desirability, prices of vegetable protein and urea, and the scale of operations. The first and the last items are perhaps the most important in determining the individual crop or crops to grow and the form in which it pays to harvest and process it.

¹⁴Michigan Department of Agriculture, op. cit., p. 16.

¹⁵C. R. Hoglund, "The Present Contribution of Silage to America's Livestock Industry" (paper presented to the National Silo Association, Buffalo, New York, December 5, 1966).

Some specific reasons for advocating silage-making are:

1. Crops made into silage yield more total digestible nutrients (TDN) and energy per acre than when harvested by other methods. Harvesting losses are lower as compared to conventional baled hay and conventional grain harvest.
2. Silage-making mechanizes the handling of the crop from the field to the feed bunk.
3. Capital investment can replace labor investment. Also silages can be harvested over a range of moisture contents allowing a more even distribution of labor requirements.
4. Harvesting and curing losses due to the weather are minimized.
5. The possibility of using fermentation to make a feed better suited to the needs of the livestock. The nature of the fermentation is determined by moisture content, packing in the silo and the quantity and type of carbohydrates available. It is desired to get the carbohydrates converted to acetic and lactic acid for preservation purposes.¹⁶

Principles of Fertilizer Use and Application

Recommendations concerning fertilizer use must be made with an awareness of the agronomic and economic considerations. A wide range in fertilizer application can be expected in the optimal fertilizer treatment for a given crop on a given soil because of changes that occur in fertilizer and crop prices and the possibility of

¹⁶M. E. McCullough, "The Old and New of Silage," Silo News (Winter, 1967).

interaction between the fertilizer elements. The optimum application of any fertilizer nutrient occurs when the value of the marginal product from the last unit of fertilizer is equal to the additional cost of that last unit of fertilizer. Theoretically, this is a simple concept; however, the accurate estimation of marginal productivities attributed to any one input can be a difficult task. Determination of the fertilizer amounts to be applied will be discussed in Chapter III.

Major factors affecting the rate and placement of fertilizer are the crop and its rooting habits, the soil type and its fertility, and the nature of the particular fertilizer element. Early in the season, corn depends heavily on phosphorus near the roots.¹⁷ However, from the knee-high stage on, corn develops an extensive fibrous root system. It then has a great capacity for utilizing nutrients distributed through a large soil zone. On soils low in phosphorus (P) and potassium (K), it is difficult to produce top corn yields with fertilizer applied in rows only. It is necessary to build up the fertility level of the soil by broadcasting the needed amount of fertilizer. The fertilizer is then incorporated into the soil to

¹⁷Samuel L. Tisdale and Werner L. Nelson, Soil Fertility and Fertilizers (New York: The Macmillan Company, 1966), Chapters 13, 14, and 15.

encourage deep rooting of the crop. Additional starter fertilizer can be applied at planting time. The band application at planting time is important in providing a rapid start for the corn plant. This band should be placed one inch to the side and one inch below the seed. The various forms of nitrogen (N) can be applied separately with some N being applied in a mixed fertilizer with P and K. In general the nearer the time of application to peak N demand, the more efficient the N is utilized.

Alfalfa requires high levels of lime, phosphorus and potassium. It has a tap root system. Due to its being a perennial crop, the ground is not tilled annually and thus the fertilizer cannot be mechanically placed in the root zone. Topdressing of potassium and phosphorus is usually relied on. The potassium is somewhat mobile in the soil but phosphorus is not. However topdressed phosphorus for maintenance purposes is generally considered to be an efficient method of fertilizer placement. Some of this phosphorus is absorbed by the crowns of the plant as well as by very shallow roots.

It should be mentioned that for the most efficient use of the fertilizer elements, much importance should be given to the pH of the soil. Generally speaking, nitrogen, phosphorus, and potassium are most available in the pH range of 6.0 to 7.5. A pH lower than 6.0 greatly decreases

the availability of N, P, and K and increases the availability of some of the micro-elements to the point where they may become toxic. The acidity of a soil can be and should be decreased by the application of lime.

The time of fertilizer application depends on the soil, climate, nutrients, and crop. However as higher rates of fertilizer are used and soil fertility increases, the problem of application time becomes less important. There are many chemical forms in which the macro-fertilizer elements (N, P, K) can be purchased. However generally speaking, one fertilizer form is as good as another. The important consideration is cost per pound of fertilizer element.

CHAPTER III

METHODS OF STUDY

Farm Analysis Methods and Concepts

Management of any business including a farm operation requires continual decision-making. To make the best decision in a world characterized by risk and uncertainty an organizational framework is essential. Goals must be declared, problems defined with decisions and resultant actions based on the analysis and evaluation of the observations. The concern of this chapter is with the analyzation step in the decision-making process. It should be recognized that the validity and the applicability of any decision is directly related to the availability and accuracy of the input data and the conditions assumed.

Alternative Methods of Analysis

Gross Margin

By definition gross margin is the contribution of the enterprise toward covering the fixed costs and

producing a return for risk and management.¹ Gross margin equals the difference between total revenue and variable cash costs. The assumed objective is usually that of maximizing the summed gross margins for all farm enterprises on a farm. The return over all costs is determined by subtracting the fixed costs from the gross margin. Main advantages of gross margin analysis are that it is easily understood, the contribution of each enterprise in a farm organization can be easily determined, and the economic effect of changing inputs in an enterprise is clearly shown.

Linear Programming

Programming is concerned with the determination of the optimal solutions to production problems. It is essentially a mathematical technique describing what ought to be--given the objectives, constraints, and alternatives.² Objectives are usually that of maximizing net revenue or minimizing production costs. Precise specifications on input availabilities and their production

¹L. J. Connor, et al., Michigan Farm Management Handbook, Agricultural Economics Report #36 (East Lansing, Michigan: Michigan State University, Department of Agricultural Economics, October, 1967).

²William J. Baumol, Economic Theory and Operations Analysis (Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1965), Chapter 5.

coefficients are required to determine solutions to the optimization problem. Assumptions made for this programming are divisibility of enterprise levels, finiteness of activities to be considered, linear production relationships, perfect complementarity of inputs used in production of a product, constant product and resource prices, single-value production expectations for an input, and additivity of production. Matrix columns in addition to those for enterprises or products may be used to incorporate salvage and acquisition activities for the resources. Credit restraints are used to insure that a solution will be determined. Programming then is the mathematical method for the analysis and computation of optimum decisions which do not violate the limitations of the imposed side-conditions or constraints. Thus linear programming is designed to determine the most profitable farm organization with resources on hand, the crops and livestock to be produced and in what amounts, the most economical way to produce and the opportunity cost for selecting a plan other than the optimum.³

³R. Barker, Use of Linear Programming in Making Farm Management Decisions, Cornell Bulletin 993 (Ithaca, New York: 1964).

Functional Analysis

This method appears to be quite objective in its determination of input and output levels using mathematical solutions. Input-output data are usually observed under a prescribed amount of controlled environmental conditions. Statistical estimating procedures are used to determine parameters which are then assumed valid over the entire range of observations on the production surface. Production functions which best fit the data are determined. These functions may show increasing, constant, or decreasing returns to size and scale depending on the nature of the production response in the range of observations. Two of the best known production functions are the Cobb-Douglas and various forms of quadratic functions.

Once the functions are determined, marginal analysis is used to determine the optimum production level. This procedure consists of taking partial derivatives of the profit estimates with respect to each input being analyzed. Then by equating each input's marginal value product to its marginal factor cost, the optimum level of use is determined for that input. This determination is normally accomplished by setting each partial derivative of profit with respect to change of an input equal to zero and then solving the equations simultaneously. This entire procedure assumes homogeneity of inputs, unlimited capital,

constant input and output prices, and a desire to maximize profits. It requires continuous production functions in order to use the mathematical differential technique. This procedure is widely used and is valid for limited ranges of observations. However any one production function and accompanying coefficients cannot be used for general application over a wide geographic area. The major difficulties encountered in this procedure are those of specifying the correct form of the functional relationships, and acquiring a sufficient number of strategically located observations to permit reliable estimation of the parameters.⁴

Simulation

Simulation is a numerical technique for conducting experiments involving certain types of mathematical and logical models that describe the behavior of an economic system or business over extended periods of time.⁵ Essentially a model is set up to resemble a real situation and then experiments are performed on the model. This

⁴W. B. Sundquist, "An Economic Analysis of Some Controlled Fertilizer Input-Output Experiments in Michigan" (unpublished Ph.D. thesis, Michigan State University, 1957), p. 24.

⁵Thomas N. Naylor, et al., Computer Simulation Techniques (New York: John Wiley & Sons, Inc., 1968), p. 3.

model should include most of the important aspects of the system, however it should not be so complex as to be impossible to manipulate. The simulation model is sufficiently flexible to handle non-linearities, discontinuities, time-lags, irreversibilities, probabilities, interactions, qualitative factors, and can optimize a subroutine or block within the total model. In addition, simulation has the advantage of allowing several benefit and cost dimensions to be simultaneously considered but not maximized.

Simulation remains in the developmental stage with respect to its application in agriculture. Models are being built for use in developing economies. With regard to the individual farm, developmental work on SIMFARM is continuing at Michigan State University. SIMFARM I, currently being used as a teaching device, uses probability theory to simulate risk and uncertainty in dealing with resource acquisition, crop and livestock production levels, and product prices. Interrelationships of the variables are provided as are off-farm investment possibilities. Simulation models have been used in analyzing alternative methods of forage production, harvesting, and utilization; for analyzing beef feeding operations, and for dairy farms.

Comparative Analysis

Comparative analysis is that method in which standards of farm management are developed by observing individual farms or groups of farms.⁶ The determined standards of production are usually averages over arbitrary classes of farms. Although this method remains in use at the grass-roots level, it is not considered sufficiently rigorous for use in research work. Main reasons for its rejection are that average measures do not aid in determining optimal solutions to production problems and it compares what has been done rather than what can or should be accomplished in the future.

Budgeting

Budgeting is a systematic and orderly approach to planning. Farm budgeting uses the farm budget which is a physical and financial plan for the operation of the farm for some period of time.⁷ Basically there are two types of budgeting--total or complete and partial. Complete farm budgeting is used when organizing an entire farm

⁶Warren H. Vincent and Larry J. Connor, An Orientation for Future Farm Planning and Information Systems, Agricultural Economic Misc. 1968-5 (East Lansing, Michigan: Michigan State University, Department of Agricultural Economics), p. 1.

⁷Emery N. Castle and Manning H. Becker, Farm Business Management (New York: The Macmillan Company, 1967), p. 117.

business. It would compare the profitability of the various organizational alternatives. Partial farm budgeting is used to evaluate particular projected changes. Partial budgeting compares only those returns and costs of the alternatives which are different between the operations. Budgeting is a conceptually simple procedure. Essentially it compares via organized arithmetic the costs, returns, and profits for the various alternatives being considered.

Advantages of the budgeting procedure are that it is forward-looking, is applicable to individual farms and is readily understood. Shortcomings of budgeting are that it does not explicitly incorporate economic theory principles, it assumes single-value expectations for prices and technical relationships, and there is a limit to the number of enterprises and restrictions which can be feasibly considered.⁸

Method of Study

Partial budgeting has been chosen for this analysis. This procedure is applicable when the proposed change will not affect the entire farm organization. This thesis problem assumes the continuance of the dairy operation for each situation. Its concern is with various dairy forage rations and methods of producing these feedstuffs. Thus

⁸Vincent, op. cit., p. 3.

the problem is to identify and estimate those costs and returns which change among the various alternatives. It is assumed that the gross returns from the milk enterprise are constant. In this manner the problem becomes that of determining the minimum cost method of securing the dairy ration.

In a partial budgeting exercise, it is necessary to first establish the goals, and then estimate the effect of an organizational change on the costs and returns of the present system. Thus it is necessary to determine enterprise resource requirements, establish product and resource prices, estimate receipts and costs, compare net incomes between alternatives and then determine that alternative which provides the highest net income. The partial budgeting schematic is:

- A. $\text{Additional Receipts} + \text{reduced costs} = \text{total credits or additional income due to change in production method};$
- B. $\text{Additional costs} + \text{reduced receipts} = \text{total debits or loss in income due to change in production method}; \text{ and}$
- C. $\text{Total credits} - \text{total debits} = \text{change in net income}.$

Assuming that the objective is to maximize the increase in net income, then the alternative chosen would be that one which results in the largest increase in this measure.

The partial budgeting procedure is one that is commonly used by farm managers. The type and amount of

information required, and the linearity assumption are the same as in linear programming. However for most micro-economic on-farm situations, the budgeting process would be much cheaper than with linear programming. Programming makes possible the consideration of a larger number of alternatives than is feasible with budgeting. Thus with budgeting, it is possible that some important alternatives may be overlooked. Another criticism of budgeting is that it fails to explicitly incorporate economic principles into the analysis. However, implicitly budgeting does take into account, for example, the marginality concept, the substitution ratio, and the opportunity cost principle. Production processes will not be changed if added cost is greater than added returns. A factor of production will be substituted for another as long as its cost is less than that of the first input--assuming equal production. If a manager discovers that more money can be made via an alternative enterprise or production process, it is probable that a change will be instituted--assuming that profit maximization is a desired goal. Thus it is seen that the budgeting procedure does in fact incorporate many of the basic economic principles. It is felt that budgeting has been and will continue to be utilized by farm managers. It is a practical concept well based in economic theory.

Problem Structure and Assumptions

To reiterate, the problem is to determine the most economical method of securing feedstuffs for a 120-cow dairy herd plus replacements. All forage is to be grown but grain may be grown, purchased or sold depending on the situation. The problem setting is in three locations previously described in Chapter II.

In an economic analysis, there are several assumptions--some implicit and some explicit. The following is an enumeration of the structural and economic assumptions incorporated in this analysis.

1. Homogeneous dairy cows with regard to physical size, milk production, feed consumption and conversion efficiency, and reproduction.
2. No milk yield differential with change in forage ration provided ration is adequate and balanced.
3. Soils within a soil management group are homogeneous with regard to production and management considerations.
4. Production relationships are linear.
5. Crop and livestock production practices used provide the highest economic yield. These practices are based on agronomic considerations.
6. The production levels used for crops and livestock are 5-year averages.
7. Corn silage and alfalfa haylage provide more energy per acre than any other harvested form of corn and alfalfa.
8. Dry-lot feeding of dairy herd makes the most efficient use of forage acres.

9. All prices and price relationships are constant for period of study. (Land charge is 7% of market value which was assumed to be \$600, 450, and 300 for soil management groups I, II, and III respectively.)
10. Straight-line depreciation used on all investment items.
11. Capital and credit are sufficient for 120-cow dairy herd.
12. Machinery custom hire is assumed available at prices given.
13. Labor quality is homogeneous.
14. All labor required is available at \$2/hour.
15. The crop rotation is corn-corn-corn-oats-alfalfa-alfalfa for the 50% corn silage ration. With the 75% corn silage ration, the corn acreage will necessarily be increased requiring more years of continuous corn. The oats-alfalfa will continue on a three year program. It should be noted that the alfalfa program could be lengthened to three or four years. Assuming that the alfalfa yield relationships would remain linear over this longer production period, the cost per unit of alfalfa produced would decrease. Although such a system was not analyzed in this problem, it is believed that such an arrangement would decrease the farm net revenue due to lessening of the corn acreage.

CHAPTER IV

ANALYSIS OF THE DATA

Production and cost figures for each of the three soil management groups are presented in this chapter. Three different dairy forage rations were analyzed. These rations varied according to type and amount of forage fed. The type of forage varies between corn silage and alfalfa haylage and within the haylage category are two forage quality levels. The three forage rations fed were as follows:

50% of forage energy from corn silage--50% of forage energy from alfalfa haylage--a 1:1 ration¹

75% of forage energy from corn silage--25% of forage energy from alfalfa haylage--a 3:1 ration

100% of forage energy from corn silage--a 1:0 ration.

The rations calculated are presented in Appendix B, Tables B20, B21, and B22. A summation of the total and per unit feedstuff requirements for each ration is presented in Table 3.

¹Estimated net energy (ENE) measured in therms was used in lieu of total digestible nutrients (TDN). From a conversation with Dr. Hillman of the MSU Dairy Department, ENE was felt to be a more accurate measure of the forage value.

TABLE 3

ANNUAL FORAGE AND GRAIN REQUIREMENTS PER COW AND TOTAL FOR 120 COWS
AND REPLACEMENTS, THREE FORAGE RATIIONS,
AND TWO LEVELS OF MANAGEMENT

Ration	Corn Silage		Alfalfa Haylage		Corn Grain ^b	
	Per Cow (Tons 32% DM)	Total (Tons 32% DM)	Per Cow (Tons 90% DM) ^a	Total (Tons 90% DM) ^a	Per Cow (Bushels Ear Corn)	Total (Bushels Ear Corn)
50% Corn Silage						
Good Mgt.	8.92	1,070	5.18	622	79.4	9,524
Superior Mgt.	8.74	1,049	5.08	610	73.0	8,765
75% Corn Silage						
Good Mgt.	13.38	1,606	3.62	435	77.2	9,263
Superior Mgt.	13.12	1,574	3.55	426	73.0	8,765
100% Corn Silage						
Good Mgt.	22.95	2,754	--	--	73.0	8,765
Superior Mgt.	22.95	2,754	--	--	73.0	8,765

^aConverted to hay equivalent basis.

^bTo include addition of 1% (1 lb/100 lbs grain) of trace mineralized salt.

For the production of both corn and alfalfa, two levels of management were studied. Production practices used in each management level are presented in Appendix A. Fertilizer recommendations for corn grain and corn silage differed because of the greater nutrient removal from the soil with corn silage. These fertilizer and lime recommendations were also varied among soil management groups (SMG) and management levels. These recommendations were based on judgment values of present soil nutrient test values² and on crop nutrient requirements as listed in EB-550, Fertilizer Recommendations for Michigan Vegetables and Field Crops. The natural soil fertility and fertilizer applications for corn on each SMG are presented in Appendix B, Table B2.

The alfalfa crop was also studied under two management levels over the three different soil management groups. Lime and fertilizer applied were varied with management levels and with the different soils. Within each soil management group, three potassium fertilization levels were studied with the most profitable level used for the inter-enterprise comparison with corn silage. The fertilizer applied and resultant yields were based on experimental plot work by Dr. Tesar, Crop Science

²From conversation with Dr. J. C. Shickluna, Soil Science Department, Michigan State University.

Department, Michigan State University. The cost of lime was averaged over the three year period that oats and alfalfa were grown. It should be noted that with all the soil management groups, the medium level of fertilization was found to be the most profitable. The cost and returns of the medium level of fertilization were then used for the inter-enterprise comparison with corn silage. The actual input-output figures for these various alfalfa production combinations are shown in Appendix B, Tables B12-B19.

The machinery complement is listed in Appendix B, Table B24. This machinery line was assumed adequate for all production operations except harvesting where custom corn picking and some forage harvesting were provided. The fixed costs for machinery were divided between corn and alfalfa on the basis of use and are as shown in this same table. Machinery ownership costs, machinery and man hours required per acre, machinery capacity and cost of machines per hour of use were based on Michigan State publications.

The grain and soybean oil meal prices used herein were weighted average Michigan prices over the five year period--1963-1967. The fertilizers and lime charges were average Michigan prices for the year 1966. As the fertilizer price index has been quite constant, these prices quite well represent the current fertilizer prices. The

charge for labor was arbitrarily set at \$2.00 per hour. The prices used in calculating costs of grain and fertilizer are given in Appendix B, Tables B25 and B26.

Highly Productive Cropland (SMG I)

The soil series included in this management group are Sims, Kawkawlin, Capac, Hoytville, Nappanee and Wauseon. Their general location is in northeastern Michigan, the "thumb," and down along the eastern border of Michigan. Counties included are Huron, Sanilac, St. Clair, Macomb, Wayne, Monroe, and Lenawee.

The calculated cropland requirement for a 50% corn silage forage ration grown under superior management is 230 acres. The forage acreage requirements for the various rations and levels of management are shown in Table 4. The difference between the 230 acres and that required to produce forage crops would be used for corn grain.

The average yield figures under the two management levels are as follows.

	<u>Good Mgt.</u>	<u>Superior Mgt.</u>
Alfalfa--medium fertiliza- tion (Tons 90% DM)	4.6	5.3
Corn Grain (bushels)	104.	130.
Corn Silage (Tons 32% DM)	18.9	21.7

The net calculated costs of feed for the various rations and management levels are presented in Table 5. The production components and further breakdown of these

TABLE 4

ACRES OF FORAGE REQUIRED FOR THREE FORAGE ALTERNATIVES
AND TWO LEVELS OF MANAGEMENT

Management Levels		Percent Forage Nutrients From Corn Silage				100
		50		75		Corn Silage
Corn	Alfalfa	Alfalfa Haylage	Corn Silage	Total	Alfalfa Haylage	Corn Silage
Superior	Superior	114	48	162	80	73
Good	Superior	114	57	171	80	85
Superior	Good	135	48	183	94	73
Good	Good	135	57	192	94	85
						153
						165
						167
						179
						146

TABLE 5

SUMMARIZATION OF TOTAL COST OF FEED FOR 120-COW OPERATION,
THREE FORAGE ALTERNATIVES, AND TWO LEVELS OF MANAGEMENT

Level of Management		Percent Forage Nutrients From Corn Silage		
Corn	Alfalfa	50	75	100
Superior	Superior	\$29,278.57	\$29,121.52	\$28,704.87
Good	Superior	32,420.12	32,882.34	33,582.89
Superior	Good	32,311.35	31,218.35	28,704.87
Good	Good	34,874.49	34,263.50	33,582.89

costs are presented in Appendix B, Tables B1, B3, B4, B5, B12, B14, and B15.

To briefly interpret these tables, the best alternative method of production is the one which minimizes the cost of the ration. As gross output is assumed constant, the lowest cost production alternative results in highest net return. Costs and net returns are directly affected by the management level practiced. A particular level of management can be applied on any combination of crops. It is advisable to apply managerial talents to that crop enterprise which is most responsive to the environmental growth conditions.

On this soil management group, the actual net production costs were lowest for the 100% corn silage forage ration grown under superior management; that is, growing continuous corn. These annual costs were only slightly higher--\$416--for the 75% corn silage ration but \$1,574 higher for the 50% corn silage ration. (See Table 5.) These costs were calculated by taking the total production harvesting and storage costs plus or minus the respective grain buying or selling activities plus the cost of protein supplement. However it should be noted that an overall farm production decision must be based on more than a partial analysis of separate enterprises, resources, or production possibilities. With this

consideration for crop production and ration selection, one than takes into account the labor distribution and machinery bottlenecks requiring for example some custom hire of forage harvesting. These considerations all entail a cost to the farm operator. When growing only one crop such as corn, there are associated advantages and disadvantages. Some advantages of continuous corn are:³

1. Costs and risks of establishing seedings are eliminated.
2. Most weeds are more easily controlled in corn than on other crops.
3. There is more flexibility in planning and adjusting the cropping program.
4. The soil fertility program can be more efficiently fitted to the crop being grown.
5. The crop can be fitted to the soil best suited for it.
6. Low-income crops can be eliminated.

Disadvantages of continuous corn in addition to labor and machinery distribution are:

1. Soil erosion will be more serious unless land is carefully selected and control measures are used where needed.
2. The problem of soil structure maintenance is not fully resolved and may become unfavorable on some soils.

³E. R. Duncan and F. W. Schaller, "Continuous Corn," Plant Food Review, Vol. 8, No. 4 (Winter, 1962).

3. It may include greater risks. Capital inputs may be greater and there is an increased need for skilled management.
4. Special herbicides may be needed for some weed problems.
5. Some crop diseases may become more serious or difficult to control.
6. Crop and soil insect control will require more attention and increased costs.

Corn silage provides the cheapest source of equivalent dry matter pounds. Its protein content is lower than that of alfalfa but can be substantially increased by adding urea (42% nitrogen) at the rate of 10 pounds urea per 2000 pounds corn silage. This increases the crude protein by approximately 1.4 percentage points. The digestible protein percentage is then approximately 2.7%. Assuming no nitrogen losses during ensiling, this addition of urea plus extra soybean oil meal in the grain ration increases the protein level of the corn silage ration so that it competes with alfalfa haylage in meeting the nutritional requirements for milk, maintenance and growth.

Given a lower level of management on both crops, the order arrangement of cost figures is the same as for the superior management. However the cost differential of approximately \$680 between the 75% and 100% corn silage rations is much wider than it is with the higher level of management. It would appear that at the lower levels of management, the adverse production effect on corn is less

than that for alfalfa. This management level and even lower levels are probably quite representative of the average management practiced. This factor may partially explain why corn silage is more predominant in the dairy ration.

With a change in the combination of management levels assumed for corn and alfalfa, a different ration becomes the least costly. For example, with good management assumed for corn and superior management for alfalfa, the 100% corn silage ration was the most expensive. There was little difference in costs between the 50% and 75% corn silage rations. When superior management was assumed for corn and good management for alfalfa, the 100% corn silage ration was \$2,500 to \$3,600 lower in costs than the rations including alfalfa. In essence, these figures relate that the crop to be grown is that one in which a particular affinity or adeptness is shown in its production. It is suggested that some farmers appear to have better managerial capability in growing a particular crop. This skill is usually directly related to the production and management practices employed as tempered by ones subjective preferences. Thus it appears that if a dairyman is better at producing corn than alfalfa or vice versa, a substantial portion of the forage ration should be provided by that crop. Given the linear production

relationships within each soil management group, this advice holds true over all the soil management groups. It seems evident for this situation that for alfalfa to be competitive with corn, similar levels of technology and management must be practiced on both crops. It should be recognized that all areas and soils are not capable of supporting continuous row crops. The reasons for this are varied but in such instances, the cropping alternatives are usually limited to some type of crop rotation. In particular, this limitation will be noted for soil management group III (SMG III).

TABLE 6

SUMMATION OF TOTAL FEED COSTS FOR FORAGE RATION OF
50% CORN SILAGE--50% ALFALFA HAYLAGE^a

Item	Good Management	Superior Management
Alfalfa Haylage	\$12,702.41	\$11,945.16
Corn Silage	7,273.23	6,148.37
Corn Grain	3,630.34	6,577.05
Total production costs	<u>23,605.98</u>	<u>24,670.58</u>
Hauling the grain--3¢/bu	3952 bu	8765 bu
Grinding the grain--15¢/cwt	1,000.02	918.82
Storage Costs ^b		
Alfalfa Haylage 1 30' X 60' concrete silo	1,047.19	1,047.19
Corn Silage 1 30' X 60' concrete silo	1,047.19	1,047.19
Ground Ear Corn 1 20' X 60' concrete silo	533.60	533.60
Oats 213 bu @ 68¢/bu	144.84	144.84
Soybean Oil Meal 58.32 cwt @ \$5.41/cwt	315.51	315.51
Urea--\$4/cwt	107.73 cwt	104.16 cwt
	430.92	416.64
	<u>\$28,243.81</u>	<u>\$29,357.32</u>
Buy additional corn @ \$1.19/bu	5572 bu	Sell excess grain, \$1.05 75 bu
Net cost of ration for 120-cow herd and replacements	<u>\$34,874.49</u>	<u>\$29,278.57</u>

^aComparison shows production for two levels of management.

^bSilo cost adjusted from C. R. Hoglund, Economic Considerations in Selecting Silage Storage and Feeding Systems, Agricultural Economics Report #84 (East Lansing, Michigan: Michigan State University, Department of Agricultural Economics, September, 1967).

TABLE 7

SUMMATION OF TOTAL FEED COSTS FOR FORAGE RATION OF
75% CORN SILAGE--25% ALFALFA HAYLAGE^a

Item	Good Management	Superior Management
Alfalfa Haylage	\$ 8,939.61	\$ 8,556.57
Corn Silage	10,713.23	9,462.42
Corn Grain	4,749.97	7,219.23
	<u>24,402.81</u>	<u>25,238.22</u>
Total production costs		
Hauling the grain--3¢/bu	5304 bu	8765 bu
Grinding the grain--15¢/cwt	972.62	918.82
Storage Costs		
Alfalfa Haylage 1 24' X 70' concrete silo	793.73	793.73
Corn Silage 2 24' X 70' concrete silo	1,587.46	1,587.46
Ground Ear Corn 1 20' X 60' concrete silo	533.60	533.60
Oats 213 bu @ 68¢/bu	144.84	144.84
Soybean Oil Meal 120.72 cwt @ \$5.41/cwt	653.10	438.86
Urea--\$4/cwt	160.65 cwt	158.41 cwt
	<u>642.60</u>	<u>633.64</u>
	<u>\$29,889.88</u>	<u>\$30,552.12</u>
Buy additional corn @ \$1.19/bu	3959 bu	Sell excess grain, \$1.05 1245 bu
Net cost of ration for 120-cow herd and replacements	<u>\$34,601.09</u>	<u>\$29,244.87</u>

^aComparison shows production for two levels of management.

TABLE 8

SUMMATION OF TOTAL FEED COSTS FOR FORAGE RATION OF 100% CORN SILAGE^a

Item	Good Management	Superior Management
Corn Silage	\$18,712.78	\$16,758.38
Corn Grain	7,648.98	9,616.65
	<u>26,361.76</u>	<u>26,375.03</u>
Total production costs		
Hauling the grain--3¢/bu	8736 bu	8765 bu
Grinding the grain--15¢/cwt	918.82	918.82
Storage Costs		
Corn Silage 3 26' X 70' concrete silo	2,791.38	2,791.38
Ground Ear Corn 1 20' X 60' concrete silo	533.60	533.60
Oats 213 bu @ 68¢/bu	144.84	144.84
Soybean Oil Meal 264.72 cwt @ \$5.41/cwt	1,432.14	1,432.14
Urea--\$4/cwt	275.94 cwt	275.59 cwt
	<u>1,103.76</u>	<u>1,102.36</u>
	<u>\$33,548.38</u>	<u>\$33,561.12</u>
Buy additional corn @ \$1.19/bu	29 bu	Sell excess corn, \$1.05 4625 bu
	<u>34.51</u>	
Net cost of ration for 120-cow herd and replacements	\$33,582.89	\$28,704.87

^aComparison shows production for two levels of management.

TABLE 9

SUMMATION OF TOTAL FEED COSTS FOR FORAGE RATION OF
50% CORN SILAGE--50% ALFALFA HAYLAGE^a

Item	Superior Management on Corn	Superior Management on Alfalfa	Good Management on Alfalfa	Good Management on Corn
Alfalfa Haylage	\$12,702.41			\$11,945.16
Corn Silage	6,148.37			7,273.23
Corn Grain	4,749.42			5,409.67
	<u>23,600.20</u>			<u>24,628.06</u>
Total production costs				
Hauling the grain--3¢/bu	6110 bu	183.30	6136 bu	184.08
Grinding the grain--15¢/cwt		960.22		960.22
Storage Costs				
Alfalfa Haylage 1 30' X 60' concrete silo	1,047.19			1,047.19
Corn Silage 1 30' X 60' concrete silo	1,047.19			1,047.19
Ground Ear Corn 1 20' X 60' concrete silo	533.60			533.60
Oats 213 bu @ 68¢/bu	144.84			144.84
Soybean Oil Meal 58.32 cwt @ \$5.41/cwt	315.51			315.51
Urea--\$4/cwt	104.16 cwt	416.64	107.73 cwt	430.92
		<u>\$28,248.69</u>		<u>\$29,291.61</u>
Buy additional grain @ \$1.19/bu	3414 bu	4,062.66	2629 bu	3,128.51
Net cost of ration for 120-cow herd and replacements		\$32,311.35		\$32,420.12

^aComparison shows production of corn and alfalfa for two management combinations.

TABLE 10

SUMMATION OF TOTAL FEED COSTS FOR FORAGE RATION OF
75% CORN SILAGE--25% ALFALFA HAYLAGE^a

Item	Superior Management on Corn Good Management on Alfalfa	Superior Management on Alfalfa Good Management on Corn
Alfalfa Haylage	\$ 8,939.61	\$ 8,556.57
Corn Silage	9,462.42	10,713.23
Corn Grain	6,000.81	5,936.19
	<u>24,402.84</u>	<u>25,205.99</u>
Total production costs		
Hauling the grain--3¢/bu	8190 bu	6760 bu
Grinding the grain--15¢/cwt		
Storage Costs		
Alfalfa Haylage 1 24' X 70' concrete silo	793.73	793.73
Corn Silage 2 24' X 70' concrete silo	1,587.46	1,587.46
Ground Ear Corn 1 20' X 60' concrete silo	533.60	533.60
Oats 213 bu @ 68¢/bu	144.84	144.84
Soybean Oil Meal 120.72 cwt @ \$5.41/cwt	653.10	81.12 cwt
Urea--\$4/cwt	158.41 cwt	160.66 cwt
	<u>633.64</u>	<u>642.64</u>
	<u>\$29,941.38</u>	<u>\$30,496.39</u>
Buy additional corn @ \$1.19/bu	1073 bu	2005 bu
Net cost of ration for 120-cow herd and replacements		
	<u>\$31,218.25</u>	<u>\$32,882.34</u>

^aComparison shows production of corn and alfalfa for two management combinations.

Productive Cropland (SMG II)

The soil series included in this management group are Miami, Dodge, and Conover. Their general location is south-central Michigan in the counties of Ingham, Ionia, Shiawassie, Eaton, Clinton, and Livingston.

The calculated cropland requirement for a 50% corn silage forage ration grown under superior management was 257 acres. The forage acreage requirements under the various rations and levels of management are shown in Table 11. In each instance the remainder of acreage was used for corn grain.

The average yield figures under the two management levels are as follows.

	<u>Good Mgt.</u>	<u>Superior Mgt.</u>
Alfalfa--medium fertiliza-		
tion (Tons 90% DM)	4.2	4.8
Corn Grain (bushels)	92.	115.
Corn Silage (Tons 32% DM)	16.7	19.2

The net calculated costs of feed for the various rations and management levels are given in Table 12. The production components and further breakdown of these costs are presented in Appendix B, Tables B1, B6, B7, B8, B12, B16, and B17.

An evaluation of the ration cost summary tables for soil management group II reveals that the 100% corn silage forage produced under superior management had the

TABLE 11

ACRES OF FORAGE REQUIRED FOR THREE FORAGE ALTERNATIVES
AND TWO LEVELS OF MANAGEMENT

Management Levels		Percent Forage Nutrients From Corn Silage				100
		50		75		Corn Silage
Corn	Alfalfa	Alfalfa Haylage	Corn Silage	Total	Alfalfa Haylage	Corn Silage
Superior	Superior	126	55	181	88	82
Good	Superior	126	64	190	88	96
Superior	Good	150	55	205	105	82
Good	Good	150	64	214	105	96
						170
						184
						187
						201
						165

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TABLE 12

SUMMARIZATION OF TOTAL COST OF FEED FOR 120-COW OPERATION,
THREE FORAGE ALTERNATIVES, AND TWO LEVELS OF MANAGEMENT

Level of Management		Percent Forage Nutrients From Corn Silage		
		50	75	100
Corn	Alfalfa			
Superior	Superior	\$29,346.39	\$29,000.65	\$28,496.65
Good	Superior	32,116.11	32,442.79	32,876.45
Superior	Good	32,217.42	31,076.05	28,496.65
Good	Good	34,428.02	34,258.18	32,876.45

lowest net cost of the rations considered. This was the same solution as in soil management group I. Similar to the previous situation, the cost differential between the 100% and 75% corn silage ration was only \$500. This represents a small percent of the total and under slightly altered production or cost figures the cost advantage could be reversed. Assuming no machinery and labor bottlenecks, the factor which encourages some growth of alfalfa is that this crop enables the storage capacity to be more fully utilized.

At the lower level of management, the all corn silage forage ration remains the least costly. As was the situation in soil management group I, the cost advantage of the 100% corn silage ration is increased when lower management levels are used. It appears that the crop with the cost advantage under the highest level of management increases this advantage under the lower levels of management. This suggests that for a crop such as alfalfa to be competitive with a crop as corn and both crops grown on the expensive productive land, at least as high a technology and management level must be applied on the alfalfa as on the corn crop.

With the various management combinations on corn and alfalfa, the decision as to which is to predominate in the forage ration again seems to be related to the one which a farmer is best at producing. When the technology

and management is favorably biased towards a particular crop, it is that crop which should be grown. However it is best to evaluate all forages under the same high level of management. Production is then limited only by biological and environmental conditions rather than by a low level of management.

Inter-regional comparison indicates that under the assumed production and cost conditions soil management groups I and II are quite competitive for milk production. With the cost figures presented herein, soil management group II appears to be a generally lower cost production area relative to soil management group I. However the cost differential is quite a small percent of the overall costs and could be reversed by slight alteration in land prices or production relationships. There is nothing absolute about the land prices or yield and cost relationships used in this thesis. Land prices used herein are based on judgment values with the annual charge for taxes and interest being 7% of this land value. The actual dollar figures used are presented in Appendix B. It can be seen that the land charges are a substantial proportion of total annual production costs. By varying either the basic land value or the usage charge, this cost relationship could be altered. In conclusion, it can only be said that these two areas are quite competitive for production of forages and milk.

TABLE 13

SUMMATION OF TOTAL FEED COSTS FOR FORAGE RATION OF
50% CORN SILAGE--50% ALFALFA HAYLAGE^a

Item	Good Management	Superior Management
Alfalfa Haylage	\$12,615.26	\$12,068.84
Corn Silage	7,023.53	6,192.92
Corn Grain	3,528.00	6,363.77
Total production costs	<u>23,166.79</u>	<u>24,625.53</u>
Hauling the grain--3¢/bu	3956 bu	8740 bu
Grinding the grain--15¢/cwt	1,000.02	918.82
Storage Costs		
Alfalfa Haylage 1 30' X 60' concrete silo	1,047.19	1,047.19
Corn Silage 1 30' X 60' concrete silo	1,047.19	1,047.19
Ground Ear Corn 1 20' X 60' concrete silo	533.60	533.60
Oats 213 bu @ 68¢/bu	144.84	144.84
Soybean Oil Meal 58.32 cwt @ \$5.41/cwt	315.51	315.51
Urea--\$4/cwt	107.07 cwt	105.44 cwt
	<u>428.28</u>	<u>421.76</u>
	<u>\$27,802.10</u>	<u>\$29,316.64</u>
Buy additional corn @ \$1.19/bu	5568 bu	25 bu
Net cost of ration for 120-cow herd and replacements	<u>\$34,428.02</u>	<u>\$29,346.39</u>

^aComparison shows production for two levels of management.

TABLE 14

SUMMATION OF TOTAL FEED COSTS FOR FORAGE RATION OF
75% CORN SILAGE--25% ALFALFA HAYLAGE^a

Item	Good Management	Superior Management
Alfalfa Haylage	\$ 9,006.74	\$ 8,606.95
Corn Silage	10,399.06	9,194.57
Corn Grain	4,477.94	7,192.11
Total production costs	<u>23,883.74</u>	<u>24,993.63</u>
Hauling the grain--3¢/bu	5152 bu	8765 bu
Grinding the grain--15¢/cwt	972.62	918.82
Storage Costs		
Alfalfa Haylage 1 24' X 70' concrete silo	793.73	793.73
Corn Silage 1 24' X 70' concrete silo	1,587.46	1,587.46
Ground Ear Corn 1 20' X 60' concrete silo	533.60	533.60
Oats 213 bu @ 68¢/bu	144.84	144.84
Soybean Oil Meal 120.72 cwt @ \$5.41/cwt	653.10	438.86
Urea--\$4/cwt	160.61 cwt	157.19 cwt
	<u>642.44</u>	<u>628.76</u>
Buy additional corn @ \$1.19/bu	4111 bu	4111 bu
	<u>4,892.09</u>	<u>\$30,302.65</u>
Net cost of ration for 120-cow herd and replacements	\$34,258.18	\$29,000.65

^aComparison shows production for two levels of management.

TABLE 15

SUMMATION OF TOTAL FEED COSTS FOR FORAGE RATION OF
100% CORN SILAGE^a

Item	Good Management	Superior Management
Corn Silage	\$18,152.54	\$16,532.62
Corn Grain	7,186.86	9,217.60
	<u>25,339.40</u>	<u>25,750.22</u>
Total production costs		
Hauling the grain--3¢/bu	8464 bu	8765 bu
Grinding the grain--15¢/cwt	918.82	918.82
Storage Costs		
Corn Silage 3 26' X 70' concrete silo	2,791.38	2,791.38
Ground Ear Corn 1 20' X 60' concrete silo	533.60	533.60
Oats 213 bu @ 68¢/bu	144.84	144.84
Soybean Oil Meal 264.72 cwt @ \$5.41/cwt	1,432.14	1,432.14
Urea--\$4/cwt	276.04 cwt	276.05 cwt
	<u>1,104.16</u>	<u>1,104.20</u>
	<u>\$32,518.26</u>	<u>\$32,938.15</u>
Buy additional corn @ \$1.19/bu	301 bu	Sell excess corn, \$1.05 4230 bu
	358.19	4,441.50
Net cost of ration for 120-cow herd and replacements	<u>\$32,876.45</u>	<u>\$28,496.65</u>

^aComparison shows production for two levels of management.

TABLE 16

SUMMATION OF TOTAL FEED COSTS FOR FORAGE RATION OF
50% CORN SILAGE--50% ALFALFA HAYLAGE^a

Item	Superior Management on Corn Good Management on Alfalfa	Superior Management on Alfalfa Good Management on Corn
Alfalfa Haylage	\$12,615.26	\$12,068.84
Corn Silage	6,192.92	7,023.53
Corn Grain	4,542.17	5,266.80
Total production costs	<u>23,350.35</u>	<u>24,359.17</u>
Hauling the grain--3¢/bu	179.40	6164 bu
Grinding the grain--15¢/cwt	960.22	960.22
Storage Costs		
Alfalfa Haylage 1 30' X 60' concrete silo	1,047.19	1,047.19
Corn Silage 1 30' X 60' concrete silo	1,047.19	1,047.19
Ground Ear Corn 1 20' X 60' concrete silo	533.60	533.60
Oats 213 bu @ 68¢/bu	144.84	144.84
Soybean Oil Meal 58.32 cwt @ \$5.41/cwt	315.51	315.51
Urea--\$4/cwt	105.44 cwt	107.07 cwt
	421.76	428.28
Buy additional corn @ \$1.19/bu	<u>4,217.36</u>	<u>\$29,020.92</u>
Net cost of ration for 120-cow herd and replacements	\$32,217.42	3,095.19
		\$32,116.11

^aComparison shows production of corn and alfalfa for two management combinations.

TABLE 17

SUMMATION OF TOTAL FEED COSTS FOR FORAGE RATION OF
75% CORN SILAGE--25% ALFALFA HAYLAGE^a

Item	Superior Management on Corn Good Management on Alfalfa	Superior Management on Alfalfa Good Management on Corn
Alfalfa Haylage	\$ 9,006.74	\$ 8,606.95
Corn Silage	9,194.57	10,399.06
Corn Grain	5,901.81	5,709.59
Total production costs	<u>24,103.12</u>	<u>24,715.60</u>
Hauling the grain--3¢/bu	8050 bu	201.48
Grinding the grain--15¢/cwt	946.47	946.47
Storage Costs		
Alfalfa Haylage 1 24' X 70' concrete silo	793.73	793.73
Corn Silage 2 24' X 70' concrete silo	1,587.46	1,587.46
Ground Ear Corn 1 20' X 60' concrete silo	533.60	533.60
Oats 213 bu @ 68¢/bu	144.84	144.84
Soybean Oil Meal 120.72 cwt @ \$5.41/cwt	653.10	438.86
Urea--\$/cwt	157.19 cwt	160.61 cwt
	<u>628.76</u>	<u>642.44</u>
Buy additional corn @ \$1.19/bu	1213 bu	2049 bu
	<u>1,443.47</u>	<u>2,438.31</u>
Net cost of ration for 120-cow herd and replacements	\$31,076.05	\$32,442.79

^aComparison shows production of corn and alfalfa for two management combinations.

Moderately Productive Cropland (SMG III)

The soil series included in this management group are Fox, McHenry, Spinks, Oshtemo, and Warsaw. Their general location is in far south-central Michigan in the counties of Hillsdale, Branch, St. Joseph, Jackson, Kalamazoo, and Calhoun.

The calculated cropland requirement for a 50% corn silage forage ration grown under superior management is 313 acres. The forage acreage requirements under the various rations and levels of management are shown in Table 18. In each instance the remainder of acreage would be used for corn grain.

The average yield figures under the two management levels are as follows.

	<u>Good Mgt.</u>	<u>Superior Mgt.</u>
Alfalfa--medium fertiliza-		
tion (Tons 90% DM)	3.7	4.3
Corn Grain (bushels)	68.	85.
Corn Silage (Tons 32% DM)	12.4	15.4

The net calculated costs of feed for the various rations and management levels are presented in Table 19. The production components and further breakdown of these costs are presented in Appendix B, Tables B1, B9, B10, B11, B12, B18, and B19.

For soil management group III, the 50% corn silage forage ration grown with superior management was the lowest

TABLE 18

ACRES OF FORAGE REQUIRED FOR THREE FORAGE ALTERNATIVES
AND TWO LEVELS OF MANAGEMENT

Management Levels		Percent Forage Nutrients From Corn Silage				100
		50		75		Corn Silage
Corn	Alfalfa	Alfalfa Haylage	Corn Silage	Total	Alfalfa Haylage	Corn Silage
Superior	Superior	142	68	210	100	102
Good	Superior	142	87	229	100	130
Superior	Good	169	68	237	118	102
Good	Good	169	87	256	118	130
						203
						230
						220
						248
						223

TABLE 19

SUMMARIZATION OF TOTAL COST OF FEED FOR 120-COW OPERATION,
THREE FORAGE ALTERNATIVES, AND TWO LEVELS OF MANAGEMENT

Level of Management		Percent Forage Nutrients From Corn Silage		
		50	75	100
Corn	Alfalfa			
Superior	Superior	\$32,362.28	\$32,794.09	\$33,480.07
Good	Superior	35,957.54	37,306.09	39,765.18
Superior	Good	34,634.26	34,385.68	33,480.07
Good	Good	37,772.97	38,666.58	39,765.18

cost alternative. This is a shift from the lowest cost ration of the previous two soil groups. This shift in lowest cost rations reflects the consistently lower ratio of corn to alfalfa yield as compared to the other soil management groups. Corn yield in SMG III is limited because of the soil capability--especially its lack of moisture retention. This soil factor further emphasizes the effect of the mid-summer dry period. As alfalfa is much more drought-tolerant, the adverse effect on its yield is less than with corn.

When the lower level of management is applied to both crops, the cost advantage still remains with the 50% corn silage forage ration. Corn silage produces a pound of dry matter more cheaply than does alfalfa, however these dry matter pounds are not comparable due to the higher protein composition in alfalfa. For this situation, the ration's lowest net production cost was for the alfalfa crop. An additional factor for consideration is storage costs. The storage cost advantage is with that ration which most fully utilizes the storage capacity. This storage cost advantage has continually been with the program having 50% of the forage as alfalfa haylage. This storage cost factor remains one of great importance and in this particular situation gives an added advantage to the 50% corn silage forage ration.

Under the various management combinations, production emphasis should be placed on that crop towards which one is predisposed. Under the alternatives presented, this crop may be either corn or alfalfa. As has been shown, it is to the farmer's advantage that he remain flexible and not committed to any particular crop. The crop costs and returns should be objectively evaluated under the same levels of technology and management.

In general, it appears that continuous row cropping in SMG's I and II is a very real feasible alternative given the linear production assumptions over time. This advantage of continuous corn could disappear if relative production costs increase or yields decrease. In SMG III, continuous cropping does not appear economically advantageous. Also from an agronomic view, continuous row cropping may be an inappropriate choice on soil which has a rolling topography. Due to soil erosion, it is not practical from either an agronomic or economic viewpoint to continuously grow corn in soil management group III. This erosion factor would be directly related to future yield potentials which in turn affect the dollar returns and thus the economic considerations.

For an inter-regional comparison using the given yield and price relationships, SMG III is at a comparative disadvantage relative to SMG's I and II. The basic land

value is much lower in the SMG III area. However, the commercial fertilizer and lime requirement is greater than that in the other soil groups. Further, the yield response to the commercial fertilizer is lower in SMG III resulting in a higher cost per equivalent pound of forage dry matter. Thus given the assumption of constant net milk prices, the comparative advantage for dairymen is with soil management groups I and II. To allow SMG III land to produce feed-stuffs at competitive cost with SMG's I and II, given ceteris paribus requires an additional land price spread of \$75 per acre for alfalfa growth and \$150 per acre for corn grain production.

TABLE 20

SUMMATION OF TOTAL FEED COSTS FOR FORAGE RATION OF
50% CORN SILAGE--50% ALFALFA HAYLAGE^a

Item	Good Management	Superior Management
Alfalfa Haylage	\$13,283.05	\$12,789.17
Corn Silage	9,030.54	7,277.03
Corn Grain	4,103.51	7,594.14
Total production costs	<u>26,417.10</u>	<u>27,660.34</u>
Hauling the grain--3¢/bu	3876 bu	8755 bu
Grinding the grain--15¢/cwt	1,000.02	918.82
Storage Costs		
Alfalfa Haylage 1 30' X 60' concrete silo	1,047.19	1,047.19
Corn Silage 1 30' X 60' concrete silo	1,047.19	1,047.19
Ground Ear Corn 1 20' X 60' concrete silo	533.60	533.60
Oats 213 bu @ 68¢/bu	144.84	144.84
Soybean Oil Meal 58.32 cwt @ \$5.41/cwt	315.51	315.51
Urea--\$4/cwt	107.53 cwt	105.06 cwt
	<u>430.12</u>	<u>420.24</u>
Buy additional corn @ \$1.19/bu	5648 bu	10 bu
	<u>6,721.12</u>	<u>11.90</u>
Net cost of ration for 120-cow herd and replacements	\$37,772.97	\$32,362.28

^aComparison shows production for two levels of management.

TABLE 21

SUMMATION OF TOTAL FEED COSTS FOR FORAGE RATION OF
75% CORN SILAGE--25% ALFALFA HAYLAGE^a

Item	Good Management	Superior Management
Alfalfa Haylage	\$ 9,452.69	\$ 9,177.57
Corn Silage	13,393.42	10,895.70
Corn Grain	4,596.63	8,113.70
Total production costs	<u>27,442.74</u>	<u>28,186.97</u>
Hauling the grain--3¢/bu	4420 bu	8765 bu
Grinding the grain--15¢/cwt	972.62	918.82
Storage Costs		
Alfalfa Haylage 1 24' X 70' concrete silo	793.73	793.73
Corn Silage 2 24' X 70' concrete silo	1,587.46	1,587.46
Ground Ear Corn 1 20' X 60' concrete silo	533.60	533.60
Oats 213 bu @ 68¢/bu	144.84	144.84
Soybean Oil Meal 120.72 cwt @ \$5.41/cwt	653.10	438.86
Urea--\$4/cwt	160.68 cwt	81.12 cwt
	<u>642.72</u>	<u>630.36</u>
	<u>\$32,903.41</u>	<u>\$33,497.59</u>
Buy additional corn @ \$1.19/bu	4843 bu	Sell excess grain, \$1.05 670 bu
Net cost of ration for 120-cow herd and replacements	<u>\$38,666.58</u>	<u>\$32,794.09</u>

^aComparison shows production for two levels of management.

TABLE 22

SUMMATION OF TOTAL FEED COSTS FOR FORAGE RATION OF
100% CORN SILAGE^a

Item	Good Management	Superior Management
Corn Silage	\$23,253.83	\$19,370.46
Corn Grain	<u>6,256.90</u>	<u>9,771.34</u>
	29,510.73	29,141.80
Total production costs		
Hauling the grain--3¢/bu	6120 bu	8765 bu
Grinding the grain--15¢/cwt	918.82	918.82
Storage Costs		
Corn Silage 3 26' X 70' concrete silo	2,791.38	2,791.38
Ground Ear Corn 1 20' X 60' concrete silo	533.60	533.60
Oats 213 bu @ 68¢/bu	144.84	144.84
Soybean Oil Meal 264.72 cwt @ \$5.41/cwt	1,432.14	1,432.14
Urea--\$4/cwt	275.63 cwt	275.01 cwt
	<u>1,102.52</u>	<u>1,100.04</u>
	\$36,617.63	\$36,325.57
Buy additional corn at \$1.19/bu	2645 bu	Sell excess corn, \$1.05
		2710 bu
Net cost of ration for 120-cow herd and replacements	\$39,765.18	\$33,480.07

^aComparison shows production for two levels of management.

TABLE 23

SUMMATION OF TOTAL FEED COSTS FOR FORAGE RATION OF
50% CORN SILAGE--50% ALFALFA HAYLAGE^a

Item	Superior Management on Corn Good Management on Alfalfa	Superior Management on Alfalfa Good Management on Corn
Alfalfa Haylage	\$13,283.05	\$12,789.17
Corn Silage	7,277.03	9,030.54
Corn Grain	5,765.43	5,854.73
Total production costs	<u>26,325.51</u>	<u>27,674.44</u>
Hauling the grain--3¢/bu	6460 bu	5712 bu
Grinding the grain--15¢/cwt	960.22	960.22
Storage Costs		
Alfalfa Haylage 1 30' X 60' concrete silo	1,047.19	1,047.19
Corn Silage 1 30' X 60' concrete silo	1,047.19	1,047.19
Ground Ear Corn 1 20' X 60' concrete silo	533.60	533.60
Oats 213 bu @ 68¢/bu	144.84	144.84
Soybean Oil Meal 58.32 cwt @ \$5.41/cwt	315.51	315.51
Urea--\$4/cwt	105.06 cwt	107.53 cwt
Buy additional corn @ \$1.19/bu	3064 bu	3053 bu
Net cost of ration for 120-cow herd and replacements	<u>3,646.16</u>	<u>3,633.07</u>
	\$34,634.26	\$35,957.54

^aComparison shows production of corn and alfalfa for two management combinations.

TABLE 24

SUMMATION OF TOTAL FEED COSTS FOR FORAGE RATION OF
75% CORN SILAGE--25% ALFALFA HAYLAGE^a

Item	Superior Management on Corn Good Management on Alfalfa	Superior Management on Alfalfa Good Management on Corn
Alfalfa Haylage	\$ 9,452.69	\$ 9,177.57
Corn Silage	10,895.70	13,393.42
Corn Grain	6,894.56	5,764.11
Total production costs	<u>27,242.95</u>	<u>28,335.10</u>
Hauling the grain--3¢/bu	7905 bu	169.32
Grinding the grain--15¢/cwt	946.47	946.47
Storage Costs		
Alfalfa Haylage 1 24' X 70' concrete silo	793.73	793.73
Corn Silage 2 24' X 70' concrete silo	1,587.46	1,587.46
Ground Ear Corn 1 20' X 60' concrete silo	533.60	533.60
Oats 213 bu @ 68¢/bu	144.84	144.84
Soybean Oil Meal 120.72 cwt @ \$5.41/cwt	653.10	438.86
Urea--\$4/cwt	157.59 cwt	160.68 cwt
Buy additional corn @ \$1.19/bu	1358 bu	3121 bu
Net cost of ration for 120-cow herd and replacements	<u>\$32,769.66</u>	<u>\$33,592.10</u>
	\$34,385.68	\$37,306.09

^aComparison shows production of corn and alfalfa for two management combinations.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

Partial budgeting was used to evaluate three alternative forage rations produced on farms within three separate soil management groups. Three basic dairy rations with two forage quality levels in each category were compared. Based on research conducted by the Michigan State University dairy department and by other institutions, milk production per cow was assumed equal for each forage ration tested. This assumption is based on the provision that each ration is properly supplemented to provide a nutritional balance. By assuming homogeneous dairy cows in the 120-cow dairy herd and constant prices, the milk and calves produced for sale would give a constant gross return for all alternatives studied. The thesis problem then became one of determining the minimum cost ration.

Three soil management groups were delineated within the Southern Michigan area. Each group was defined to include soils having similar management requirements and production potentials. Corn and alfalfa yields were

determined as were the input requirements necessary to attain these yields. The alfalfa, corn grain and silage yields were based upon published and unpublished research, and judgment values provided by agronomists and soil scientists at Michigan State University. These yield figures do not necessarily represent the average expected yield for any particular farm or farmer. Rather these yields are average expectations given the soil management groups, fertilization and management practices as specified herein. The cost of inputs for the budgets were based upon published information and on judgment estimates from personnel in the Michigan State University Department of Agricultural Economics and upon Crop and Livestock Reporting Service prices for farm products.

Feedstuff requirements were then calculated for the three forage rations. Cropland acres were established for each soil management group. Forage acres were determined for each situation with the residual acres allocated to production of corn grain.

Production, harvesting, and storage costs were then calculated for each of the combinations of forage grown under the various fertilizer and management levels. Feed storage costs, commercial protein procurement, grain buying and selling activities were then incorporated to give the total ration cost. The feed cost summation for each soil

management group shows cost figures for ten separate alternatives. The lowest cost figure represents the most favorable alternative.

Conclusions

The medium level of fertilization on alfalfa (see Appendix B, Table B12) was found to be the least costly per ton of 90% dry matter material. It appears that the high level of fertilization pushes the production into the latter portion of Stage II production. At the lower fertilization level, the yield response is apparently not as great as that of the medium fertilization level. Having established the least costly of the fertilization alternatives for the production of alfalfa, this fertilization and production level was used for an inter-enterprise comparison with corn silage.

Given the yield and cost relationships associated with superior management, the growing and feeding of an all corn silage forage ration was the lowest cost for soil management groups I and II, the highly productive and productive soils. The advisability of continuing this practice rests on the validity of assuming linear corn and milk production relationships over time. It should be noted that the cost differential between rations was a small percentage of the total cost. Thus if the yield

relationships were altered in favor of more alfalfa per unit corn, the lowest cost ration could switch to that favoring the production of some alfalfa. The corn silage program provides a lower cost for each pound of dry matter produced. However, corn silage dry matter is not comparable to alfalfa dry matter until the corn silage protein level is increased with commercial nitrogen and protein sources. By supplementing the corn silage with urea and feeding extra soybean oil meal, the corn silage dry matter is nutritionally comparable to that of alfalfa. This procurement of commercial protein will raise the cost of the corn silage enabling the alfalfa to become more competitive. In SMG's I and II, inclusion of an alfalfa program was not recommended until approximately 5.2 tons of alfalfa were produced per one hundred bushels of corn. This yield relationship for each soil management group and level of management is shown in the section for SMG I and SMG II, Table 25.

Dairy ration costs were quite comparable for soil management groups I and II. Their corn-alfalfa yield relationships were quite similar. For the yields and price relationships herein, SMG II is a slightly lower cost production area with both groups having a cost advantage over soil management group III. It should be noted that the cost differential between SMG's I and II is quite small.

TABLE 25

PRODUCTION YIELDS AND RELATIONSHIPS

	MGT Level		Corn Grain (bu)	Corn Silage (T 32% DM)	Alfalfa (T 90% DM)	T Alfalfa/ 100 bu Corn	T Corn Silage/ T Alfalfa	Bu Corn/ T Alfalfa	
	Corn	Alfalfa							
SMG I	SUP	SUP	130	21.70	5.3	4.1	4.1	24.5	
	Good	Good	104	18.9	4.6	4.4	4.1	22.6	
	SUP	Good	130	21.7	4.6	3.5	4.7	28.3	
	Good	SUP	104	18.9	5.3	5.1	3.6	19.6	
SMG II	SUP	SUP	115	19.2	4.8	4.2	4.0	24.0	
	Good	Good	92	16.7	4.2	4.6	4.0	21.9	
	SUP	Good	115	19.2	4.2	3.7	4.6	27.4	
	Good	SUP	92	16.7	4.8	5.2	3.5	19.2	
SMG III	SUP	SUP	85	15.4	4.3	5.1	3.6	19.8	
	Good	Good	68	12.4	3.7	5.4	3.4	18.4	
	SUP	Good	85	15.4	3.7	4.4	4.2	23.0	
	Good	SUP	68	12.4	4.3	6.3	2.9	15.8	

The cost advantage for SMG II could easily be reversed if land price relationships were to change.

On SMG III the cost and yield relationships were such that the 50% corn silage forage ration grown with superior management was the least costly. The production relationships in SMG III are quite different from the previous two groups. When approximately 4.8 tons of alfalfa are produced per 100 bushels corn, the 50% corn silage forage ration has a cost advantage over the all corn silage ration. Inclusion of an alfalfa enterprise provides for a more even distribution of labor and machinery requirements and provides fuller utilization of the storage units. In this study the problem of high labor peaks was assumed non-existent. The cost of machinery and storage were included in the problem structure. On SMG's I and II, these cost aspects did not indicate advocacy of alfalfa production until 5.2 tons of alfalfa were harvested per 100 bushels of corn grain. However on SMG III, the moderately productive soil, the growing and feeding of alfalfa is profitable at a lower alfalfa-corn ratio.

Limitations of Study and Need for Further Research

This study was limited by the lack of adequate technical production coefficients for the various soil management groups. Much agronomic research has been

conducted determining yields produced under various empirical conditions including that of variable fertilization levels. However, there is a great need for additional determination of yield levels and production potentials as affected by the many various cultural practices. It is desirable that this research be conducted on several different soil types. In attempting research of the type herein, it is evident that there is a great need for primary agronomic and economic data on forage production--for both corn silage and alfalfa.

A simulation analysis would be more realistic than the budgeting analysis used herein. Budgeting is limited by the number of variables and alternatives which can be easily handled and analyzed. In using budgeting, many simplifying assumptions are incorporated. Availability of land, labor, and credit were all assumed adequate at the levels required for the various alternatives studied. Via a simulation procedure these constraint variables (land, labor, and credit) could be brought into play. Economies and diseconomies of size could also be included. The price relationships used were assumed constant for the period of the study. For the implications of the study to be of future use, these price relationships must be valid through future periods of time. This points out the need for continued updating of present published data regarding

cost of buying, owning, and operating farm machinery and equipment. Included in this analysis should be the effect of changes in interest rates and technology.

The concept of management should be clarified. To be desired is a standardized understanding of what management is, where it enters the production processes, and its effect on the production levels.

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APPENDICES

APPENDIX A

MANAGERIAL PRACTICES

MANAGERIAL PRACTICES

Levels of Managerial Practices for AlfalfaGood Management

Maintain pH at 6.0 to 6.5.

Alfalfa is established with oats which are fertilized. Oats are harvested as oat silage at early to medium dough stage (12-13% CP, no more than 70% moisture). In seedling year, alfalfa is harvested once as haylage.

Alfalfa is harvested as haylage on a 2-cutting system--cut at 1/10-1/2 bloom. (Harvest losses no more than 10%).

Alfalfa is topdressed in Spring after first cutting or in the Autumn.

Long-lived winter hardy, wilt resistant varieties are used. Such a variety is Vernal.

Alfalfa weevil is sprayed. This treatment will also control other insects as the leafhopper.

Superior Management

Maintain pH at 6.8 to 7.0

Alfalfa is established with oats which are fertilized. Oats are harvested as oat silage at early to medium dough stage (12-13% CP, no more than 70% moisture). In seedling year, alfalfa harvested once as haylage.

Alfalfa is harvested as haylage on a 3-cutting system--cut at late bud to the early flower stage of maturity. Forage chopper is to be used so as to keep harvest losses at no more than 10% of potential harvest.

Alfalfa is topdressed in Spring after first cutting or in the Autumn.

Flemish varieties are used. These varieties possess moderate winterhardiness and are wilt resistant. Examples of such varieties are Saranac, Warrior and Glacier.

Alfalfa weevil is sprayed. This treatment will also control other insects as the leafhopper.

In essence, the main differences between the management levels as defined is with regard to the chemical

reaction (pH) of the soil, variable levels of fertilizer use, timing, and number of harvests and alfalfa varieties used.

Level of Managerial Practices for Corn

Good Management

Maintain pH at 6.0 to 6.3.

Minimum tillage practices are used but fails to be in field at most optimum time and soil moisture level to avoid soil packing.

Corn is drilled in 28-30" rows, 20,000 seeds/acre.

The one best variety with regard to soil and climatic considerations is planted.

The planter-fertilizer attachment is adjusted to place the starter-row fertilizer below the seed.

Weed control is not as effective as superior level either due to inferior seed-bed preparation or to lack of proper cultivation with respect to time of such or adjustment of cultivator.

Good insect control is provided.

Silage harvesting starts at 70% moisture and continues through to 58-60% moisture.

Superior Management

Maintain pH at 6.4 to 6.8.

Minimum tillage practices are used at proper time and moisture levels to avoid soil packing and destruction of good soil structure.

Corn is drilled in 28-30" rows, 20,000 seeds/acre with desire to approach an equidistant plant spacing.

The planter-fertilizer attachment is adjusted to place fertilizer 1" to side and 1" below corn seed.

The best varieties with regard to soil and climatic considerations are planted but planting is staggered according to plant maturity levels in order to harvest most of corn at hard-dent state.

Good weed control is provided.

Good insect control is provided.

Majority of silage is harvested at about 65% moisture to insure proper ensiling and to minimize seepage.

APPENDIX B

TABLES

TABLE B1

SUMMATION OF YIELDS AND PRODUCTION COSTS
FOR CORN SILAGE AND GRAIN

	Level of Management			
	Good	Superior	Good	Superior
	Silage		Grain	
<u>Soil Management Group I</u>				
Yields/Acre	18.9T	21.7T	104 bu	130 bu
For 1:1 ration				
Cost/unit				
Silage--32% DM	\$ 6.72	\$ 5.96		
Silage--90% DM	\$18.90	\$16.76		
Grain			91.9¢	73.8¢
For 3:1 ration				
Cost/unit				
Silage--32% DM	\$ 6.67	\$ 5.97		
Silage--90% DM	\$18.76	\$16.79		
Grain			89.6¢	72.1¢
For 1:0 ration				
Cost/unit				
Silage--32% DM	\$ 6.78	\$ 6.08		
Silage--90% DM	\$19.07	\$17.10		
Grain			87.6¢	71.8¢
<u>Soil Management Group II</u>				
Yields/Acre				
For 1:1 ration				
Cost/unit				
Silage--32% DM	\$ 6.56	\$ 5.87		
Silage--90% DM	\$18.45	\$16.51		
Grain			88.9¢	72.8¢
For 3:1 ration				
Cost/unit				
Silage--32% DM	\$ 6.47	\$ 5.85		
Silage--90% DM	\$18.20	\$16.45		
Grain			86.9¢	71.9¢
For 1:0 ration				
Cost/unit				
Silage--32% DM	\$ 6.58	\$ 5.99		
Silage--90% DM	18.51	16.85		
Grain			84.9¢	70.9¢

TABLE B1--Continued

	Level of Management			
	Good	Superior	Good	Superior
	Silage		Grain	
<u>Soil Management Group III</u>				
Yields/Acre	12.36T	15.45T	68 bu	85 bu
For 1:1 ration				
Cost/unit				
Silage--32% DM	\$ 8.40	\$ 6.93		
Silage--90% DM	\$23.62	\$19.49		
Grain			\$1.06	86.7¢
For 3:1 ration				
Cost/unit				
Silage--32% DM	\$ 8.34	\$ 6.91		
Silage--90% DM	\$23.46	\$19.43		
Grain			\$1.04	86¢
For 1:0 ration				
Cost/unit				
Silage--32% DM	\$ 8.44	\$ 7.04		
Silage--90% DM	\$23.73	\$19.80		
Grain			\$1.02	85.2¢

TABLE B2

QUANTITIES OF LIME AND FERTILIZER APPLIED TO CORN SILAGE AND GRAIN

	Corn Silage			Corn Grain		
	pH	N	P ₂ O ₅ K ₂ O	N	P ₂ O ₅ K ₂ O	
<u>Soil Management Group I</u>						
Presently Available in pounds	6.7	--	25			
Level Required	6.8	213	99	132	75	170
Fertilizer						
533 lbs 0-0-60						50
221 lbs 6-24-24		13	53			
100 lbs 18-46-0		18	46		75	
222 lbs Anhydrous		182		29		
				103		
Lime--0 Ton with Good Management 1 T/3 years with Superior Management						103
<u>Soil Management Group II</u>						
Presently Available	6.5	--	25			
Level Required	6.8	190	66	115	50	50
Fertilizer						
642 lbs 0-0-60						50
143 lbs 18-46-0		26	66		46	
200 lbs Anhydrous		164		18		
				95		
Lime--0 Ton with Good Management 1.5 T/3 years with Superior Management						

TABLE B2---Continued

		Corn Silage			Corn Grain		
		pH	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅ K ₂ O
<u>Soil Management Group III</u>							
Presently Available	5.9	--	45	120			
Level Required	6.8	155	33	578		98	25 75
Fertilizer					Fertilizer		
900 lbs 0-0-60				540	125 lbs 0-0-60		75
140 lbs 6-24-24		8	34	34	54 lbs 18-46-0	10	25
180 lbs Anhydrous		148			110 lbs Anhydrous	90	
Lime--3 T/3 years with Good Management							
4.25 T/3 years with Superior Management							

TABLE B3
TOTAL COSTS OF GROWING AND HARVESTING CORN SILAGE AND GRAIN
IN ROTATION WITH ALFALFA
(1:1 ration)

Soil Management Group I					
Cost Item	Amt/Acre	Level of Management			
		Silage		Grain	
		Good	Superior	Good	Superior
Land Charge	\$42.00				
Fertilizer and Lime		\$ 46.08	\$ 48.38	\$ 20.94	\$ 23.24
Herbicide	6.25				
Insecticide	0.50				
Plow	1.53				
Disk-harrow	0.51				
Drag-harrow	0.44				
Plant, Fertilize, and Spray	1.92				
Seed Corn	3.13				
Cultivation	1.24				
Rotary hoe	0.27				

Chopping	4.14	Pick	6.00	6.00
Hauling Silage		Ear Corn		
(40¢/T)	<u>7.56</u>			
Totals	\$57.79	\$ 61.19	\$ 26.94	\$ 29.25
	Acres	<u>48</u>	<u>38</u>	<u>68</u>
		\$2937.12	\$1023.72	\$1988.32
		<u>2773.92</u>	<u>2196.02</u>	<u>3929.72</u>
Total Variable Costs	6587.49	5711.04	3219.74	5918.04
Fixed Costs	<u>685.74</u>	<u>437.33</u>	<u>410.60</u>	<u>659.01</u>
Total Costs	\$7273.23	\$6148.37	\$3630.34	\$6577.05
Total Production	1077.3T	1041.6T	3952 bu	8840 bu
Cost/unit				
(Silage at 32% DM)	\$ 6.72	\$ 5.96	91.9¢	73.8¢
Cost/unit				
(Silage at 90% DM)	\$ 18.90	\$ 16.76		

TABLE B4

TOTAL COSTS OF GROWING AND HARVESTING CORN SILAGE AND GRAIN
IN ROTATION WITH ALFALFA
(3:1 ration)

Soil Management Group I

Cost Item	Amt/Acre	Level of Management		
		<u>Silage</u>	<u>Grain</u>	<u>Superior</u>
		<u>Good</u>	<u>Good</u>	<u>Superior</u>
Land Charge	\$42.00			
Fertilizer and Lime		\$ 46.08	\$ 20.94	\$ 23.24
Herbicide	6.25			
Insecticide	0.50			
Plow	1.53			
Disk-harrow	0.51			
Drag-harrow	0.44			
Plant, Fertilize, and Spray	1.92			
Seed Corn	3.13			
Cultivation	1.24			
Rotary hoe	0.27			
			Pick Ear Corn	6.00
				6.00

Hauling Silage (40¢/T)

Totals	<u>\$57.79</u>	<u>7.56</u>	<u>8.67</u>	<u>\$ 26.94</u>	<u>\$ 29.24</u>
	Acres	85	73	51	77
		<u>\$4559.40</u>	<u>\$4164.64</u>	<u>\$1373.94</u>	<u>\$2251.48</u>
		<u>4912.15</u>	<u>4218.67</u>	<u>2947.29</u>	<u>4449.83</u>
		<u>\$9471.55</u>	<u>\$8383.31</u>	<u>\$4321.23</u>	<u>\$6701.31</u>

Chopping acres with own equipment acres custom harvested

Total Variable Costs	<u>\$9870.61</u>	<u>327.06</u>	<u>285.66</u>		
Fixed Costs	<u>842.62</u>	<u>72.00</u>	<u>48.00</u>		
Total Production Costs	<u>\$10713.23</u>			<u>428.74</u>	<u>517.92</u>
				<u>\$4749.97</u>	<u>\$7219.23</u>

Yield/Acre

Total Production	1606.5T	18.9T	21.7T	104 bu	130 bu
				5304 bu	10010 bu

Cost/unit (Silage at 32% DM)

Cost/unit	\$ 6.67	\$ 5.97	\$ 89.6¢		72.1¢
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Cost/unit (Silage at 90% DM)

	\$ 18.76	\$ 16.79			
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TABLE B5

TOTAL COSTS OF GROWING AND HARVESTING CORN SILAGE AND GRAIN
(1:0 ration)

Soil Management Group I					
Cost Item	Amt/Acre	Level of Management			
		Silage		Grain	
		Good	Superior	Good	Superior
Land Charge	\$42.00	\$ 46.08	\$ 48.38	\$ 20.94	\$ 23.24
Fertilizer and Lime					
Herbicide	6.25				
Insecticide	0.50				
Plow	1.53				
Disk-harrow	0.51				
Drag-harrow	0.44				
Plant, Fertilize, and Spray	1.92				
Seed Corn	3.13				
Cultivation	1.24				
Rotary hoe	0.27				
				Pick Ear Corn	6.00

Hauling Silage (40¢/T)

Totals	<u>\$57.79</u>	<u>7.56</u>	<u>8.67</u>	<u>\$ 26.94</u>	<u>\$ 29.24</u>
	Acres	Acres		84	103
		\$7831.44	\$7245.35	\$2262.96	\$3011.72
		8437.34	7339.33	4854.36	5952.37

Chopping acres with own equipment (\$4.14/acre) acres custom harvested (\$12/acre)

Total Variable Costs	<u>\$17399.84</u>	<u>327.06</u>	<u>285.66</u>	<u>\$7117.32</u>	<u>\$8964.09</u>
Fixed Costs	<u>1312.94</u>	<u>804.00</u>	<u>696.00</u>	<u>531.66</u>	<u>652.56</u>
Total Production Costs	\$18712.78		\$16758.38	\$7648.98	\$9616.65

Yield/Acre

	18.9T	21.7T	104 bu	130 bu
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Total Production

	2759.4T	2755.9T	8736 bu	13390 bu
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Cost/unit

(Silage at 32% DM)

	\$ 6.78	\$ 6.08	87.6¢	71.8¢
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Cost/unit

(Silage at 90% DM)

	\$ 19.07	\$ 17.10		
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TABLE B6

TOTAL COSTS OF GROWING AND HARVESTING CORN SILAGE AND GRAIN
IN ROTATION WITH ALFALFA
(1:1 ration)

Soil Management Group II

Cost Item	Amt/Acre	Level of Management			
		<u>Good</u>	<u>Silage</u> <u>Superior</u>	<u>Good</u>	<u>Grain</u> <u>Superior</u>
Land Charge	\$33.25				
Fertilizer and Lime		\$ 39.19	\$ 42.64	\$ 17.41	\$ 20.86
Herbicide	6.25				
Insecticide	0.50				
Plow	1.53				
Disk-harrow	0.51				
Drag-harrow	0.44				
Plant, Fertilize, and Spray	1.92				
Seed Corn	3.13				
Cultivation	1.24				
Chopping		4.14	4.14	Pick Ear Corn	6.00

Rotary hoe 0.27

Hauling Silage
(40¢/T)

Totals	<u>\$49.04</u>	<u>6.69</u>	<u>7.67</u>	<u>\$ 23.41</u>	<u>\$ 26.86</u>
		Acres			
		<u>64</u>	<u>55</u>	<u>43</u>	<u>76</u>
Total Variable Costs		\$3201.28	\$2994.75	\$1006.63	\$2041.36
Fixed Costs		<u>3138.56</u>	<u>2697.20</u>	<u>2108.72</u>	<u>3727.04</u>
Total Production Costs		6339.84	5691.95	3115.35	5768.40
		<u>683.69</u>	<u>500.97</u>	<u>412.65</u>	<u>595.37</u>
		\$7023.53	\$6192.92	\$3528.00	\$6363.77
Yield/Acre		16.73T	19.17T	92 bu	115 bu
Cost/unit (Silage at 32% DM)		\$ 6.56	\$ 5.87	88.9¢	72.8¢
Cost/unit (Silage at 90% DM)		\$ 18.45	\$ 16.51		

TABLE B7

TOTAL COSTS OF GROWING AND HARVESTING CORN SILAGE AND GRAIN
IN ROTATION WITH ALFALFA
(3:1 ration)

Soil Management Group II						
Cost Item	Amt/Acre	Level of Management				
		Silage		Grain		
		Good	Superior	Good	Superior	
Land Charge	\$33.25					
Fertilizer and Lime		\$ 39.19	\$ 42.64	\$ 17.41	\$ 20.86	
Herbicide	6.25					
Insecticide	0.50					
Plow	1.53					
Disk-harrow	0.51					
Drag-harrow	0.44					
Plant, Fertilize and Spray	1.92					
Seed Corn	3.13					
Cultivation	1.24					
				Pick Ear Corn	6.00	6.00

0.27

Rotary hoe
Hauling Silage
(40¢/T)

	<u>6.69</u>	<u>7.67</u>	
	\$ 45.88	\$ 50.31	\$ 23.41
	<u>96</u>	<u>82</u>	<u>56</u>
	\$4404.48	\$4125.42	\$1310.96
	4707.84	4021.28	2746.24
			<u>87</u>
			\$ 26.86
			\$2336.82
			4266.48

Totals

Acres

Chopping
acres with own equipment
(\$4.14/acre)

	372.60	322.92	
	<u>63.60</u>	<u>42.40</u>	
	\$9548.44	\$8512.02	\$4057.20
	<u>850.62</u>	<u>682.55</u>	<u>420.74</u>
	\$10399.06	\$9194.57	\$4477.94
			\$6603.30
			<u>588.81</u>
			\$7192.11

Yield/Acre

	16.73T	19.17T	92 bu
	1606.1 T	1571.94T	5152 bu

Total Production

Cost/unit
(Silage at 32% DM)

	\$ 6.47	\$ 5.85	86.9¢
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Cost/unit
(Silage at 90% DM)

	\$ 18.20	\$ 16.45
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TABLE B8
TOTAL COSTS OF GROWING AND HARVESTING CORN SILAGE AND GRAIN
IN ROTATION WITH ALFALFA
(1:0 ration)

Soil Management Group II						
Cost Item	Amt/Acre	Level of Management				
		Silage		Grain		
		Good	Superior	Good	Superior	
Land Charge	\$33.25					
Fertilizer and Lime		\$ 39.19	\$ 42.64	\$ 17.41	\$ 20.86	
Herbicide	6.25					
Insecticide	0.50					
Plow	1.53					
Disk-harrow	0.51					
Drag-harrow	0.44					
Plant, Fertilize, and Spray	1.92					
Seed Corn	3.13					
Cultivation	1.24					
				Pick Ear Corn	6.00	6.00

Rotary hoe	0.27				
Hauling Silage (40¢/T)					
Totals	<u>\$49.04</u>	<u>6.69</u>	<u>7.67</u>	<u>\$ 23.41</u>	<u>\$ 26.86</u>
	Acres	165	144	92	113
		\$7570.20	\$7244.64	\$2153.72	\$3035.18
		8091.60	7061.76	4511.68	5541.52
Chopping					
acres with own equipment (\$4.14/acre)		372.60	322.92		
acres custom harvested (\$10.60/acre)		<u>795.00</u>	<u>699.60</u>		
Total Variable Costs		\$16829.40	\$15328.92	<u>\$6665.40</u>	<u>\$8576.70</u>
Fixed Costs		<u>1323.14</u>	<u>1203.70</u>	<u>521.46</u>	<u>640.90</u>
Total Production Costs		\$18152.54	\$16532.62	\$7186.86	\$9217.60
Yield/Acre		16.73T	19.17T	92 bu	115 bu
Total Production		2760.45T	2760.48T	8464 bu	12995 bu
Cost/unit (Silage at 32% DM)		\$ 6.58	\$ 5.99	84.9¢	70.9¢
Cost/unit (Silage at 90% DM)		\$ 18.51	\$ 16.85		

TABLE B9
TOTAL COSTS OF GROWING AND HARVESTING CORN SILAGE AND GRAIN
IN ROTATION WITH ALFALFA
(1:1 ration)

Soil Management Group III						
Cost Item	Amt/Acre	Level of Management				
		<u>Silage</u>		<u>Grain</u>		
		<u>Good</u>	<u>Superior</u>	<u>Good</u>	<u>Superior</u>	
Land Charge	\$21.00					
Fertilizer and Lime		\$ 50.00	\$ 52.87	\$ 22.07	\$ 24.94	
Herbicide	6.25					
Insecticide	0.50					
Plow	1.53					
Disk-harrow	0.51					
Drag-harrow	0.44					
Plant, Fertilize and Spray	1.92					
Seed Corn	3.13					
Cultivation	1.24					
Rotary hoe	0.27					
Chopping		4.14	4.14	Pick Ear Corn	6.00	6.00

TABLE B10
TOTAL COSTS OF GROWING AND HARVESTING CORN SILAGE AND GRAIN
IN ROTATION WITH ALFALFA
(3:1 ration)

Soil Management Group III						
Cost Item	Amt/Acre	Level of Management				
		Silage		Grain		
		Good	Superior	Good	Superior	
Land Charge	\$21.00					
Fertilizer and Lime		\$ 50.00	\$ 52.87	\$ 22.07	\$ 24.94	
Herbicide	6.25					
Insecticide	0.50					
Plow	1.53					
Disk-harrow	0.51					
Drag-harrow	0.44					
Plant, Fertilize, and Spray	1.92					
Seed Corn	3.13					
Cultivation	1.24					
Rotary hoe	0.27					
				Pick Ear Corn	6.00	6.00

Hauling Silage (40¢/T)

Totals	<u>\$36.79</u>	<u>4.94</u>	<u>6.18</u>	<u>\$ 28.07</u>	<u>\$ 30.94</u>
	Acres	<u>130</u>	<u>102</u>	<u>65</u>	<u>111</u>
		\$7142.20	\$6023.10	\$1824.55	\$3434.34
		4782.70	3752.58	2391.35	4083.69

Chopping

acres with own equipment
(\$4.14/acre)
acres custom harvested
(\$8.55/acre)

Total Variable Costs	<u>500.94</u>	<u>401.58</u>			
Fixed Costs	<u>76.95</u>	<u>42.75</u>			
Total Production Costs	\$12502.79	\$10220.01		\$4215.90	\$7518.03
	<u>890.63</u>	<u>675.69</u>		<u>380.73</u>	<u>595.67</u>
	\$13393.42	\$10895.70		\$4596.63	\$8113.70

Yield/Acre

Total Production	12.36T	15.45T	68 bu	85 bu
	1606.8T	1575.90T	4420 bu	9435 bu

Cost/unit

(Silage at 32% DM)

Cost/unit

(Silage at 90% DM)

	\$ 8.34/T	\$ 6.91/T	\$ 1.04/bu	86¢
	\$ 23.46	\$ 19.43		

TABLE B11

TOTAL COSTS OF GROWING AND HARVESTING CORN SILAGE AND GRAIN
(1:0 ration)

Soil Management Group III

Cost Item	Amt/Acre	Level of Management		
		<u>Good</u>	<u>Silage Superior</u>	<u>Grain Good Superior</u>
Land Charge	\$21.00	\$ 50.00	\$ 52.87	\$ 22.07
Fertilizer and Lime				\$ 24.94
Herbicide	6.25			
Insecticide	0.50			
Plow	1.53			
Disk-harrow	0.51			
Drag-harrow	0.44			
Plant, Fertilize, and Spray	1.92			
Seed Corn	3.13			
Cultivation	1.24			
Rotary hoe	0.27			
			Pick Ear Corn	6.00
				6.00

Hauling Silage (40¢/T)

Totals	<u>\$36.79</u>	<u>4.94</u>	<u>6.18</u>	<u>\$ 28.07</u>	<u>\$ 30.94</u>
	Acres	223	178	90	135
	\$12251.62		\$10510.90	\$2526.30	\$4176.90
	8204.17		6548.62	3311.10	4966.65

Chopping acres with own equipment (\$4.14/acre)

acres custom harvested (\$8.55/acre)	500.94	401.58			
	<u>872.00</u>	<u>692.55</u>			
Total Variable Costs	\$21828.73	\$18153.65	\$5837.40	\$9143.55	
Fixed Costs	<u>1425.10</u>	<u>1216.81</u>	<u>419.50</u>	<u>627.79</u>	
Total Production Costs	\$23253.83	\$19370.46	\$6256.90	\$9771.34	

Yield/Acre

Total Production	12.36T	15.45T	68 bu	85 bu	
	2756.3T	2750.1T	6120 bu	11475 bu	

Cost/unit

(Silage at 32% DM)	\$ 8.44	\$ 7.04	\$ 1.02	85.2¢	
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Cost/unit

(Silage at 90% DM)	\$ 23.73	\$ 19.80			
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TABLE B12

SUMMATION OF YIELDS, PRODUCTION, AND COSTS FOR ALFALFA HAY

Item	Management Level High Fertilizer		Management Level Medium Fertilizer		Management Level Low Fertilizer	
	Good	Superior	Good	Superior	Good	Superior
SMG I						
3-year avg yield Tons 90% DM	4.67	5.47	4.60	5.34	4.40	5.14
SMG II						
3-year avg yield Tons 90% DM	4.28	4.95	4.15	4.82	4.02	4.62
SMG III						
3-year avg yield Tons 90% DM	3.75	4.41	3.68	4.28	3.55	4.15
For 1:1 ration						
SMG I						
3-year costs	\$38804.99	\$36012.69	\$38107.23	\$35835.48	\$38951.13	\$36391.48
3-year yield	1863.33	1821.6	1863.0	1826.3	1861.2	1819.6
Cost/T 90% DM	\$ 20.83	\$ 19.77	\$ 20.45	\$ 19.62	\$ 20.93	\$ 20.00
SMG II						
3-year costs	\$38041.08	\$36564.57	\$37845.78	\$36206.52	\$38252.48	\$37114.02
3-year yield	1861.8	1826.6	1867.5	1822.0	1869.3	1829.5
Cost/T 90% DM	\$ 20.43	\$ 20.02	\$ 20.27	\$ 19.87	\$ 20.43	\$ 20.29

SMG III
 3-year costs \$40718.02 \$38663.52 \$39849.16 \$38367.52 \$40306.28 \$38895.15
 3-year yield 1867.5 1825.7 1865.76 1823.3 1863.75 1830.2
 Cost/T 90% DM \$ 21.80 \$ 21.18 \$ 21.36 \$ 21.04 \$ 21.63 \$ 21.25

For 3:1 ration

SMG I
 3-year costs \$27665.13 \$25824.90 \$26818.83 \$25669.72 \$27869.37 \$26113.67
 3-year yield 1302.9 1279.98 1297.2 1281.6 1306.8 1279.86
 Cost/T 90% DM \$ 21.23 \$ 20.18 \$ 20.87 \$ 20.03 \$ 21.33 \$ 20.40

SMG II
 3-year costs \$27276.00 \$26096.50 \$27020.22 \$25820.85 \$27192.84 \$26406.16
 3-year yield 1309.68 1277.1 1307.25 1272.48 1302.48 1275.12
 Cost/T 90% DM \$ 20.83 \$ 20.43 \$ 20.67 \$ 20.29 \$ 20.88 \$ 20.11

SMG III
 3-year costs \$28985.96 \$27694.53 \$28358.08 \$27532.72 \$28637.44 \$27778.85
 3-year yield 1305.0 1283.31 1302.72 1284.0 1299.3 1282.35
 Cost/T 90% DM \$ 22.21 \$ 21.58 \$ 21.77 \$ 21.44 \$ 22.04 \$ 21.66

TABLE B13
LIME AND FERTILIZER AMOUNTS WITH RESULTANT OAT AND ALFALFA YIELDS

Item	
Fertilizer on Oats	
350# 12-12-12	
(Same amount applied	
on all SMG's)	
Oat Tonnage Yield (30% DM)	
SMG I (90 bu/acre)	10T
SMG II (85 bu/acre)	9.44T
SMG III (70 bu/acre)	7.8T
First-year Alfalfa Yield	
(90% DM)	
SMG I	2.5T
SMG II	2.25T
SMG III	2.0T

(No differentiation in fertilizer and management levels was used for establishment year.)

Potassium Fertilization Level K₂O (K)

Fertilizer on Alfalfa	High			Medium			Low		
	Good Mgt	Sup Mgt	Good Mgt	Good Mgt	Sup Mgt	Good Mgt	Good Mgt	Sup Mgt	Sup Mgt
Phosphorus P ₂ O ₅ (P)	50 (22)		50 (22)		50 (22)		50 (22)		50 (22)
Fertilizer amount in pounds	50 (41.5)		100 (83)		200 (166)				
Fertilizer cost per acre	\$4.72		\$6.96		\$11.44				
Levels of Management	Good Mgt	Sup Mgt	Good Mgt	Good Mgt	Sup Mgt	Good Mgt	Good Mgt	Sup Mgt	Sup Mgt
SMG I									
Lime Applied (T)	0	1	0	1	0	1	0	1	1
Lime Cost/acre									
for 3 years	0	\$6.90	0	\$6.90	0	\$6.90	0	\$6.90	\$6.90
Alfalfa Yield									
(Tons 90% DM)	4.6	5.8	4.5	5.6	4.4	5.3	4.4	5.3	5.3
SMG II									
Lime Applied (T)	0	1.5T	0	1.5T	0	1.5T	0	1.5T	1.5T
Lime Cost/acre									
for 3 years	0	\$10.35	0	\$10.35	0	\$10.35	0	\$10.35	\$10.35
Alfalfa Yield									
(Tons 90% DM)	4.2	5.2	4.0	5.0	4.02	4.7	4.02	4.7	4.7
SMG III									
Lime Applied (T)	3.5	5.0	3.5	5.0	3.5	5.0	3.5	5.0	5.0
Lime Cost/acre									
for 3 years	\$24.15	\$34.50	\$24.15	\$34.50	\$24.15	\$34.50	\$24.15	\$34.50	\$34.50
Alfalfa Yield	3.8	4.8	3.7	4.6	3.55	4.4	3.55	4.4	4.4

TABLE B14
TOTAL COSTS OF GROWING AND HARVESTING ALFALFA HAYLAGE
(1:1 ration)

Soil Management Group I		Level of Management			
Cost Item		High Fertilizer		Medium Fertilizer	
		Good	Superior	Good	Superior
Land Charge	\$42.00				
Plowing	1.53				
Disking	0.51				
Seed Oats @ \$1.75					
per bu	5.25				
Drilling	1.76				
Alfalfa Seed @ \$37.80					
per bu	5.04				
Fertilizer on Oats	12.25				
Fertilizer Topdress	1.00				
Harvest Oat Silage	7.73				
Hauling Oat Silage	4.00				
Alfalfa in Seedling Year					
Mowing-conditioning	1.67				
Chopping	7.73				
Hauling Haylage	1.80				
Variable Costs	\$92.27				
	Acres	133	111	135	114
				141	118

Total Variable Costs	\$12271.91	\$10241.97	\$12465.45	\$10518.78	\$13010.07	\$10887.86
Fixed Costs	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>
Total 1st Year Costs	\$13442.17	\$11412.23	\$13626.71	\$11689.04	\$14180.33	\$12058.12

2nd Year Costs

Land Charge	42.00	42.00	42.00	42.00	42.00	42.00
Lime (actually applied in 1st year)	--	6.90	--	6.90	--	6.90
Fertilizer	11.44	11.44	6.96	6.96	4.72	4.72
Fertilizer Topdressing	1.00	1.00	1.00	1.00	1.00	1.00
Insecticide for Weevil	10.00	10.00	10.00	10.00	10.00	10.00
Mowing-conditioning	3.34	5.01	3.34	5.01	3.34	5.01
Chopping	15.46	23.19	15.46	23.19	15.46	23.19
Hauling Haylage	<u>3.31</u>	<u>4.18</u>	<u>3.24</u>	<u>4.03</u>	<u>3.02</u>	<u>3.82</u>
	86.55	103.72	82.00	99.09	79.54	96.64
	<u>133</u>	<u>111</u>	<u>135</u>	<u>114</u>	<u>141</u>	<u>118</u>

Acres

2nd Year Variable Costs	\$11511.15	\$11512.92	\$11070.00	\$11296.26	\$11215.14	\$11403.52
Fixed Cost	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>
Total 2nd Year Costs	\$12681.41	\$12683.18	\$12240.26	\$12466.52	\$12385.40	\$12573.78

3rd Year Cost (same as

2nd year cost minus
liming charge)

	<u>\$12681.41</u>	<u>\$11917.28</u>	<u>\$12240.26</u>	<u>\$11679.92</u>	<u>\$12385.40</u>	<u>\$11759.58</u>
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Total Production Costs
Three Years

	\$38804.99	\$36012.69	\$38107.23	\$35835.48	\$38951.13	\$36391.48
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TABLE B15
TOTAL COSTS OF GROWING AND HARVESTING ALFALFA HAYLAGE
(3:1 ration)

Soil Management Group I		Level of Management			
Cost Item		High Fertilizer		Medium Fertilizer	
		Good	Superior	Good	Superior
Land Charge	\$42.00				
Plowing	1.53				
Disking	0.51				
Seed Oats @ \$1.75 per bu	5.25				
Drilling	1.76				
Alfalfa Seed @ \$37.80 per bu	5.04				
Fertilizer on Oats	12.25				
Fertilizer Topdress	1.00				
Harvest Oat Silage	7.73				
Hauling Oat Silage	4.00				
Alfalfa in Seedling Year					
Mowing-conditioning	1.67				
Chopping	7.73				
Hauling Haylage	1.80				
Variable Costs	\$92.27				
	Acres	93	78	94	80
				99	83

Total Variable Costs	\$ 8581.11	\$ 7197.06	\$ 8673.38	\$ 7381.60	\$ 9134.73	\$ 7658.41
Fixed Costs	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>
Total 1st Year Costs	\$ 9576.35	\$ 8192.30	\$ 9668.62	\$ 8376.84	\$10129.97	\$ 8653.65

2nd Year Costs

Land Charge	42.00	42.00	42.00	42.00	42.00	42.00
Lime (actually applied in 1st year)	--	6.90	--	6.90	--	6.90
Fertilizer	11.44	11.44	6.96	6.96	4.72	4.72
Fertilizer Topdressing	1.00	1.00	1.00	1.00	1.00	1.00
Insecticide for Weevil	10.00	10.00	10.00	10.00	10.00	10.00
Mowing-conditioning	3.34	5.01	3.34	5.01	3.34	5.01
Chopping	15.46	23.19	15.46	23.19	15.46	23.19
Hauling Haylage	<u>3.31</u>	<u>4.18</u>	<u>3.24</u>	<u>4.03</u>	<u>3.02</u>	<u>3.82</u>
	86.55	103.72	82.00	99.09	79.54	96.64

Acres

2nd Year Variable Costs	\$ 8049.15	\$ 8090.16	\$ 7708.00	\$ 7927.20	\$ 7874.46	\$ 8021.12
Fixed Cost	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>
Total 2nd Year Costs	\$ 9044.39	\$ 9085.40	\$ 8703.24	\$ 8922.44	\$ 8869.70	\$ 9016.36

3rd Year Cost (same as 2nd year cost minus liming charge)

	<u>9044.39</u>	<u>8547.20</u>	<u>8703.24</u>	<u>8370.44</u>	<u>8869.70</u>	<u>8443.66</u>
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Total Production Costs Three Years

	\$27665.13	\$25824.90	\$27075.10	\$25669.72	\$27869.37	\$26113.67
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TABLE B16
TOTAL COSTS OF GROWING AND HARVESTING ALFALFA HAYLAGE
(1:1 ration)

Soil Management Group II						
Cost Item		Level of Management				
		High Fertilizer Good	Superior	Medium Fertilizer Good	Superior	Low Fertilizer Good
Land Charge	\$33.25					
Plowing	1.53					
Disking	0.51					
Seed Oats @ \$1.75 per bu	5.25					
Drilling	1.76					
Alfalfa Seed @ \$37.80 per bu	5.04					
Fertilizer on Oats	12.25					
Fertilizer Topdress	1.00					
Harvest Oat Silage	7.73					
Hauling Oat Silage	3.78					
Alfalfa in Seedling Year						
Mowing-conditioning	1.67					
Chopping	7.73					
Hauling Haylage	1.62					
Variable Costs	\$83.12					
Acre		145	123	150	126	155
						132

Total Variable Costs	\$12052.40	\$10223.76	\$12468.00	\$10473.12	\$12883.60	\$10971.84
Fixed Costs	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>
Total 1st Year Costs	\$13222.66	\$11394.02	\$13638.26	\$11643.38	\$14053.86	\$12142.10
2nd Year Costs						
Land Charge	33.25	33.25	33.25	33.25	33.25	33.25
Lime (actually applied in 1st year)	--	10.35	--	10.35	--	10.35
Fertilizer	11.44	11.44	6.96	6.96	4.72	4.72
Fertilizer Topdressing	1.00	1.00	1.00	1.00	1.00	1.00
Insecticide for Weevil	10.00	10.00	10.00	10.00	10.00	10.00
Mowing-conditioning	3.34	5.01	3.34	5.01	3.34	5.01
Chopping	15.46	23.19	15.46	23.19	15.46	23.19
Hauling Haylage	<u>3.02</u>	<u>3.74</u>	<u>2.88</u>	<u>3.60</u>	<u>2.74</u>	<u>3.38</u>
	77.51	97.98	72.89	93.36	70.51	90.90
Acres	<u>145</u>	<u>123</u>	<u>150</u>	<u>126</u>	<u>155</u>	<u>132</u>
2nd Year Variable Costs	\$11238.95	\$12051.54	\$10933.50	\$11763.36	\$10929.05	\$11998.80
Fixed Costs	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>
Total 2nd Year Costs	\$12409.21	\$13221.80	\$12103.76	\$12933.62	\$12099.31	\$13169.06
3rd Year Cost (same as 2nd year cost minus liming charge)	<u>12409.21</u>	<u>11948.75</u>	<u>12103.76</u>	<u>11629.52</u>	<u>12099.31</u>	<u>13169.06</u>
Total Production Costs for Three Years	\$38041.08	\$36564.57	\$37845.78	\$36206.52	\$38252.48	\$37114.02

TABLE B17
TOTAL COSTS OF GROWING AND HARVESTING ALFALFA HAYLAGE
(3:1 ration)

Soil Management Group II						
Cost Item	Level of Management					
	High Fertilizer Good	Superior	Medium Fertilizer Good	Superior	Low Fertilizer Good	Superior
Land Charge	\$33.25					
Plowing	1.53					
Disking	0.51					
Seed Oats @ \$1.75 per bu	5.25					
Drilling	1.76					
Alfalfa Seed @ \$37.80 per bu	5.04					
Fertilizer on Oats	12.25					
Fertilizer Topdress	1.00					
Harvest Oat Silage	7.73					
Hauling Oat Silage	3.78					
Alfalfa in Seedling Year						
Mowing-conditioning	1.67					
Chopping	7.73					
Hauling Haylage	1.62					
Variable Costs	\$83.12					
Acres	102	86	105	88	108	92

Total Variable Costs	\$ 8478.24	\$ 7148.32	\$ 8727.60	\$ 7314.56	\$ 8976.96	\$ 7647.04
Fixed Costs	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>
Total 1st Year Costs	\$ 9473.48	\$ 8143.56	\$ 9722.84	\$ 8309.80	\$ 9972.20	\$ 8642.28

2nd Year Costs

Land Charge	33.25	33.25	33.25	33.25	33.25	33.25
Lime (actually applied in 1st year)	--	10.35	--	10.35	--	10.35
Fertilizer	11.44	11.44	6.96	6.96	4.72	4.72
Fertilizer Topdressing	1.00	1.00	1.00	1.00	1.00	1.00
Insecticide for Weevil	10.00	10.00	10.00	10.00	10.00	10.00
Mowing-conditioning	3.34	5.01	3.34	5.01	3.34	5.01
Chopping	15.46	23.19	15.46	23.19	15.46	23.19
Hauling Haylage	<u>3.02</u>	<u>3.74</u>	<u>2.88</u>	<u>3.60</u>	<u>2.74</u>	<u>3.38</u>
	77.51	97.98	72.89	93.36	70.51	90.90
	<u>102</u>	<u>86</u>	<u>105</u>	<u>88</u>	<u>108</u>	<u>92</u>

Acres

2nd Year Variable Costs	\$ 7906.02	\$ 8426.28	\$ 7643.45	\$ 8215.68	\$ 7615.08	\$ 8362.80
Fixed Costs	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>
Total 2nd Year Costs	\$ 8901.26	\$ 9421.52	\$ 8648.69	\$ 9210.92	\$ 8610.32	\$ 9358.04

3rd Year Cost (same as
2nd year cost minus
liming charge)

	<u>8901.26</u>	<u>8531.42</u>	<u>8648.69</u>	<u>8300.13</u>	<u>8610.32</u>	<u>8405.84</u>
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Total Production Costs
for Three Years

	\$27276.00	\$26096.50	\$27020.22	\$25820.85	\$27192.84	\$26406.16
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TABLE B18
TOTAL COSTS OF GROWING AND HARVESTING ALFALFA HAYLAGE
(1:1 ration)

Soil Management Group III						
Cost Item	Level of Management					
	High Fertilizer Good	Superior	Medium Fertilizer Good	Superior	Low Fertilizer Good	Superior
Land Charge	\$21.00					
Plowing	1.53					
Disking	0.51					
Seed Oats @ \$1.75 per bu	5.25					
Drilling	1.76					
Alfalfa Seed @ \$37.80 per bu	5.04					
Fertilizer on Oats	12.25					
Fertilizer Topdress	1.00					
Harvest Oat Silage	7.73					
Hauling Oat Silage	3.12					
Alfalfa in Seedling Year						
Mowing-conditioning	1.67					
Chopping	7.73					
Hauling Haylage	1.44					
Variable Costs	\$70.03					
	166	138	169	142	175	147
Acres						

Total Variable Costs	\$11624.98	\$ 9664.14	\$11835.07	\$ 9944.26	\$12255.25	\$10294.41
Fixed Costs	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>
Total 1st Year Costs	\$12795.24	\$10834.40	\$13005.33	\$11114.52	\$13425.51	\$11464.67
2nd Year Costs						
Land Charge	21.00	21.00	21.00	21.00	21.00	21.00
Lime (actually applied in 1st year)	24.15	34.50	24.15	34.50	24.15	34.50
Fertilizer	11.44	11.44	6.96	6.96	4.72	4.72
Fertilizer Topdressing	1.00	1.00	1.00	1.00	1.00	1.00
Insecticide for Weevil	10.00	10.00	10.00	10.00	10.00	10.00
Mowing-conditioning	3.34	5.01	3.34	5.01	3.34	5.01
Chopping	15.46	23.19	15.46	23.19	15.46	23.19
Hauling Haylage	<u>2.74</u>	<u>3.46</u>	<u>2.66</u>	<u>3.31</u>	<u>2.52</u>	<u>3.17</u>
Variable Costs	89.13	109.60	84.57	104.97	82.19	102.59
Acres	<u>166</u>	<u>138</u>	<u>169</u>	<u>142</u>	<u>175</u>	<u>147</u>
2nd Year Variable Costs	\$14795.58	\$15124.80	\$14292.33	\$14905.74	\$14383.25	\$15080.73
Fixed Costs	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>	<u>1170.26</u>
Total 2nd Year Costs	\$15965.84	\$16295.06	\$15462.59	\$16076.00	\$15553.51	\$16250.99
3rd Year Costs (same as 2nd year cost minus liming charge)	<u>11956.94</u>	<u>11534.06</u>	<u>11381.24</u>	<u>11177.00</u>	<u>11327.26</u>	<u>11179.49</u>
Total Production Costs for Three Years	\$40718.02	\$38663.52	\$39849.16	\$38367.52	\$40306.28	\$38895.15

TABLE B19
TOTAL COSTS OF GROWING AND HARVESTING ALFALFA HAYLAGE
(3:1 ration)

Soil Management Group III					
Cost Item		Level of Management			
		High Fertilizer Good	Medium Fertilizer Good	Superior Fertilizer Superior	Low Fertilizer Good Superior
Land Charge	\$21.00				
Plowing	1.53				
Disking	0.51				
Seed Oats @ \$1.75 per bu	5.25				
Drilling	1.76				
Alfalfa Seed @ \$37.80 per bu	5.04				
Fertilizer on Oats	12.25				
Fertilizer Topdress	1.00				
Harvest Oat Silage	7.73				
Hauling Oat Silage	3.12				
Alfalfa in Seedling Year					
Mowing-conditioning	1.67				
Chopping	7.73				
Hauling Haylage	1.44				
Variable Costs	\$70.03				
		116	97	118	100
					122
					103

Total Variable Costs	\$ 8123.48	\$ 6792.91	\$ 8263.54	\$ 7003.00	\$ 8543.66	\$ 7213.09
Fixed Costs	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>
Total 1st Year Costs	\$ 9118.72	\$ 7788.15	\$ 9258.79	\$ 7998.24	\$ 9538.90	\$ 8208.33
2nd Year Costs						
Land Charge	21.00	21.00	21.00	21.00	21.00	21.00
Lime (actually applied in 1st year)	24.15	34.50	24.15	34.50	24.15	34.50
Fertilizer	<u>11.44</u>	<u>11.44</u>	<u>6.96</u>	<u>6.96</u>	<u>4.72</u>	<u>4.72</u>
Fertilizer Topdressing	1.00	1.00	1.00	1.00	1.00	1.00
Insecticide for Weevil	10.00	10.00	10.00	10.00	10.00	10.00
Mowing-conditioning	3.34	5.01	3.34	5.01	3.34	5.01
Chopping	15.46	23.19	15.46	23.19	15.46	23.19
Hauling Haylage	<u>2.74</u>	<u>3.46</u>	<u>2.66</u>	<u>3.31</u>	<u>2.52</u>	<u>3.17</u>
	89.13	109.60	84.57	104.97	82.19	102.59
	<u>116</u>	<u>97</u>	<u>118</u>	<u>100</u>	<u>122</u>	<u>103</u>
2nd Year Variable Costs	\$10339.08	\$10631.20	\$ 9979.26	\$10497.00	\$10027.18	\$10566.77
Fixed Costs	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>	<u>995.24</u>
Total 2nd Year Costs	\$11334.32	\$11626.44	\$10974.50	\$11492.24	\$11022.42	\$11562.01
3rd Year Costs (same as 2nd year cost minus liming charge)	<u>8532.92</u>	<u>8279.94</u>	<u>7129.56</u>	<u>8042.24</u>	<u>8076.12</u>	<u>8008.51</u>
Total Production Costs for Three Years	\$28985.96	\$27694.53	\$28358.08	\$27532.72	\$28637.44	\$27778.85

TABLE B20
50% CORN SILAGE--50% ALFALFA FORAGE RATION (1:1) FOR 120-COW HERD PLUS REPLACEMENTS

Item	Lbs Corn Silage/Day	Total Lbs Corn Silage	Lbs Alfalfa Per Day (90% DM)	Total Lbs Alfalfa	Lbs Ear Corn/ Good Mgt	Sup Mgt	Total Lbs Ear Corn Good Mgt	Sup Mgt
120 Cows; 56 lbs milk/day; 100 days	35.72	428,640	12.48	149,760	20.75	20.00	240,000	249,000
120 Cows; 44 lbs milk/day; 100 days	33.68	404,160	11.79	141,480	16.38	15.70	196,560	188,400
120 Cows; 30 lbs milk/day; 105 days	31.38	395,388	10.97	138,222	11.29	8.57	142,254	134,820
120 Cows; Maintenance and Pregnancy; 60 days	46.05	331,560	16.09	115,848	0.86	--	6,192	--
54 Heifer Calves 90 days (This calf-starter ration also includes 6,804 lbs oats and 5,832 lbs soybean oil meal.) Ave Wt--150 lbs	--	--	--	--	1.75	1.75	8,505	8,505
48 Heifer Calves 4-8 months of age 150 days Ave Wt--400 lbs	13.1	94,320	4.6	33,120	3.75	4.00	27,000	28,800
42 Yearlings 9-23 months of age 450 days Ave Wt--800 lbs	--	--	20.50	387,450	1.06	--	20,034	--
36 First-Calf Heifers 24-25 months of age 30 days Ave Wt--1100 lbs	22.60	24,408	7.9	8,532	14.19	13.75	14,850	15,325
Totals		1,678,476		974,412			666,670	613,575
Cow-Calf unit requirements/year Forage Adjustment Factor for digestion inefficiencies and feed wastage								
With Superior Mgt	125.0%	8.74T		5.08T				73.1 bu
With Good Mgt	127.5%	8.92T		5.18T				79.4 bu

TABLE B21
75% CORN SILAGE--25% ALFALFA FORAGE RATION (3:1) FOR 120-COW HERD PLUS REPLACEMENTS

Item	Lbs Corn Silage/Day	Total Lbs Corn Silage	Lbs Alfalfa Per Day (90% DM)	Total Lbs Alfalfa	Lbs Ear Corn/ Good Mgt	Total Lbs Ear Corn		Total Lbs Good Mgt	Total SBOM	
						Sup Mgt	Ear Corn		Good Mgt	Sup Mgt
120 Cows; 56 lbs milk/day; 100 days	53.55	642,600	6.28	75,360	20.31	20.00	243,720	240,000	6,240	2,280
120 Cows; 44 lbs milk/day; 100 days	50.59	607,080	5.91	70,920	16.00	15.7	192,000	188,400	--	--
120 Cows; 30 lbs milk/day; 105 days	47.11	593,586	5.49	69,174	10.99	10.70	138,474	134,820	--	--
120 Cows; Maintenance and Pregnancy; 60 days	69.08	497,376	8.08	58,176	0.40	--	2,880	--	--	--
54 Heifer Calves 90 days (This calf-starter ration also includes 6,804 lbs oats and 5,832 lbs soybean meal.) Ave Wt--150 lbs	--	--	--	--	1.75	1.75	8,505	8,505	58.32	58.32
48 Heifer Calves 4-8 months of age 150 days Ave Wt--400 lbs	19.74	142,128	2.31	16,632	3.85	3.75	27,720	27,000	--	--
42 Yearlings 9-23 months of age 450 days Ave Wt--800 lbs	--	--	20.5	387,450	1.06	--	20,034	--	--	--
36 First-Calf Heifers 24-25 months of age 30 days Ave Wt--1100 lbs	34.01	36,731	3.97	4,288	13.95	13.75	15,066	14,850	--	--
Totals		2,519,501		682,000			648,399	613,575	12,072	8,112
Cow-Calf unit requirements/year										
Forage Adjustment Factor for digestion inefficiencies and feed wastage										
With Superior Mgt	125.0%	13.12T		3.55T						73.1 bu
With Good Mgt	127.5%	13.38T		3.62T						77.2 bu

TABLE B22
ALL CORN SILAGE FORAGE RATION (1:0) FOR 120-COW HERD PLUS REPLACEMENTS

Item	Lbs Corn Silage/Day	Total Lbs Corn Silage	SBOM/Day lbs	Total Lbs SBOM	Lbs Ear Corn/Day	Total Lbs Ear Corn
120 Cows: 56 lbs milk/day; 100 days	66.45	797,400	1.29	15,480	20.00	240,000
120 Cows: 44 lbs milk/day; 100 days	67.43	809,160	0.43	5,160	15.7	188,400
120 Cows: 30 lbs milk/day; 105 days	62.76	790,776	--	--	10.7	134,820
120 Cows: Maintenance and Pregnancy; 60 days	92.10	663,120	--	--	--	--
54 Heifer Calves 90 days (This calf-starter ration also includes 6,804 lbs oats and 5,832 soybean oil meal.) Ave Wt--150 lbs	--	--	1.20	5,832	1.75	8,505
48 Heifer Calves 4-8 months of age 150 days Ave Wt--400 lbs	26.3	189,360	--	--	3.75	27,000
42 Yearlings 9-23 months of age 450 days Ave Wt--800 lbs	58.6	1,107,540	--	--	--	--
26 First-Calf Heifers 24-25 months of age 30 days Ave Wt--1100 lbs	45.3	48,924	--	--	13.75	14,850
Totals		4,406,280		26,492		613,575
Cow-Calf unit requirements/year						
Forage Adjustment Factor for digestion inefficiencies and feed wastage						
Forage Adjustment Factor	125.0%	22.95T		220 lbs		73.1 bu

TABLE B23
DIGESTIBLE PROTEIN AND ENERGY LEVELS OF FEED INGREDIENTS

Item	Digestible Protein (%)	Estimated Net Energy (Therms/cwt)
Corn Grain	6.7	80.1
Corn Silage Without Urea	1.3	15.2
Corn Silage With Urea at .5% Rate (10 lbs Urea/Ton Silage)	2.7	15.2
Alfalfa Under Superior Management	12.8	43.5
Alfalfa Under Good Management	10.2	40.1
Soybean Oil Meal	42.0	79.6

TABLE B24
DISTRIBUTION OF FIXED COST OF MACHINERY

Annual Ownership Cost ^a		Percent of Forage Ration From Corn Silage			
Item		50		75	
		Alfalfa	Corn	Alfalfa	Corn
Tractor	\$864				
74 HP diesel		\$ 345.60	\$ 432.00	\$259.20	\$ 581.40
Plow--5-16"	190				\$ 777.60
semi-mounted		47.50	142.50	30.40	159.60
Disk--16'	148	37.00	111.00	23.68	124.32
Harrow--24'	34	--	34.00	--	34.00
Rotary Hoe					
16'	60	--	60.00	--	60.00
Cultivator					
4-row	111	--	111.00	--	111.00
Planter					
4-row	136	--	136.00	--	136.00
Grain Drill					
15' 7"	123	123.00	--	123.00	--
Mower-condi-					
tioner 7'	299	299.00	--	299.00	--
Forage					
Chopper					
2-row	388	318.16	69.84	259.96	128.04
Total Fixed Cost		\$1170.26	\$1096.34	\$995.24	\$1271.36
					388.00
					\$1844.60

^aL. J. Connor, et al., op. cit., pp. 27-30.

TABLE B25

ESTIMATED MICHIGAN PRICES^a

Year	Corn Price Received November December (\$/bu)		Oats (\$/bu)	SBOM (\$/cwt)
1963	1.00	1.03	62	5.10
1964	0.96	1.04	62	5.07
1965	0.99	0.99	66	5.13
1966	1.22	1.25	69	5.68
1967	0.92	0.97	71	5.58
5-year weighted average	1.05		68	5.41

^aUnited States Department of Agriculture, Agricultural Prices, Annual Summary (Washington, D.C.: Statistical Reporting Service, June 1964, 1965, 1966, 1967 and 1968).

TABLE B26

FERTILIZER PRICES^a

Fertilizer Grade	Average \$/Ton in Michigan	Pounds Elements per 100 lbs	Element Cost per pound (¢)
0-20-20	65.00	25.4	12.8
5-20-20	73.00	30.4	12.0
6-24-12	75.00	26.52	14.1
6-24-24	85.00	36.48	11.7
7-28-14	88.00	30.94	14.2
8-32-16	92.00	35.36	13.0
12-12-12	70.00	27.24	12.8
18-46-0	110.00	38.24	14.4
Sulfate of Ammonia	55.00	20.50	13.4
NH ₄ NO ₃	79.00	33.5	11.8
Anhydrous Ammonia	115.00	82.00	7.0
Urea	100.00	45.00	11.1
Superphosphate (20%)	45.00	8.80	25.6
Muriate of Potash (60%)	54.00	49.80	
Limestone	6.90		

^aUnited States Department of Agriculture, Agricultural Prices
(Washington, D.C.: Statistical Reporting Service, April 28, 1967).

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