



An investigation of factors affecting the comparative general level of management for farm operators on the Jocko Valley Division of the Flathead Irrigation Project as measured by indexed alfalfa yields by John George Zurenko

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Agricultural Economics

Montana State University

© Copyright by John George Zurenko (1967)

Abstract:

This study is a continuation of a previous study which revealed that there were measurable differences in levels of management among and within cultural and tenure groups. The criterion for measuring management was indexed alfalfa yields, The inputs which make up yield, in addition to management, are soil and weather conditions. To ensure the validity of yield as a criterion for measuring management, the effects of soil and weather conditions had to be eliminated., The influence of weather was removed through sampling from a small geographic area. Variations in soil were removed through a soil indexing procedure.

The sample for the study was taken from the Jocko Valley Division of the Flathead Indian Reservation Irrigation Project. This irrigation division was chosen for several reasons: (1) the small geographic area covered by the division; (2) there is a recent soil survey available that is essential for the soil indexing method used; (3) there is a high percentage of cropland in alfalfa; and (4) the number of Indian and non-Indian operators in this area was large enough to permit the use of the statistics necessary to make the desired comparisons.

The sample was divided by thirds into three yield groups.

It was found that there were differences in indexed alfalfa yields among (1) Indian operators in the low, medium and high yield group's, (2) non-Indian owner-operators' in the low, medium and high yield groups, (3) non-Indian renters in the low, medium and high yield groups, (4) all non-Indian operators in the low, medium and high yield groups and (5) Indian and all non-Indian operators. There should be some identifiable factors which contribute to variation in indexed alfalfa yields. This study is an attempt to identify these factors and detect any differences in their utilization among the above designated groups.

Indexed alfalfa yields were found to vary directly with the amount of fertilizer applied per application, amount of fertilizer applied over the life of the stand and the number of years the tract has been farmed by the present operator. Indexed yields were found to vary inversely with percentage bloom at time of cutting. Broadcasting as opposed to drilling alfalfa seed, and the application of fertilizer resulted in higher indexed alfalfa yields. Tracts on which the stand was cut twice per season had higher indexed alfalfa yields than those with one cutting. The groups with significantly different levels of management differed in their utilization of one or more of these factors.

AN INVESTIGATION OF FACTORS AFFECTING THE COMPARATIVE GENERAL
LEVEL OF MANAGEMENT FOR FARM OPERATORS ON THE JOCKO VALLEY
DIVISION OF THE FLATHEAD IRRIGATION PROJECT AS MEASURED
BY INDEXED ALFALFA YIELDS

by

John George Zurenko

A thesis submitted to the Graduate Faculty in partial
fulfillment of the requirements for the degree

of

MASTER OF SCIENCE

in

Agricultural Economics

Approved:

Clarence W Jensen

Head, Major Department

Clarence W Jensen

Chairman, Examining Committee

Louis R Smith
Dean, Graduate Division

Montana State University
Bozeman, Montana

August, 1967

ACKNOWLEDGMENTS

The author wishes to express his sincere thanks to the staff of the Department of Agricultural Economics and Rural Sociology for the opportunities and incentives to learning provided during his course of graduate study. A very special and heartfelt thanks is extended to Dr. C. W. Jensen and Dr. Layton S. Thompson for their interest, guidance and patience.

Thanks is given Dr. Lloyd H. Rixe, Dr. R. J. McConnen, Dr. C. R. Harston, Professor W. J. Ewasiuk and Professor J. W. Van Winkle for their critical review of this thesis.

Gratitude is extended to the Bureau of Indian Affairs, whose cooperation made available data essential to this study.

A debt of gratitude is owed Jeanne Gillie and Judie DeBock who throughout the ordeal imposed upon them by the author were kind, courteous and patient.

Any errors or omissions in this study are the responsibility of the author.

TABLE OF CONTENTS

	<u>Page</u>
VITA.	i
ACKNOWLEDGMENTS	ii
TABLE OF CONTENTS	iii
LIST OF TABLES.	v
ABSTRACT.	ix
GLOSSARY OF TERMS	x
 CHAPTER I. INTRODUCTION.	 1
The General Problem Setting.	1
The Problem Situation.	2
The Research Problem	3
The Hypothesis.	4
 CHAPTER II. SAMPLING PROCEDURE	 5
Type of Sample Unit Desired.	5
Size of Sample Unit.	6
Age of Stand.	7
Source of Data	7
Indexed Yield of Tract	8
Sample Size.	11
 CHAPTER III. IDENTIFICATION OF FACTORS SIGNIFICANTLY INFLUENCING YIELDS.	 14
Quantitative Continuous Data	14
The Linear Regression Model	14
Statistical Analysis.	16
Quantitative Discrete and Qualitative Data	20
The Model for Analysis of Variance	20
Statistical Analysis.	21
 CHAPTER IV. STATISTICAL TESTS FOR DIFFERENCES IN FACTOR UTILIZATION AMONG MANAGEMENT LEVEL GROUPS.	 28
Description of Tests Used for each Type of Data.	28
Quantitative Continuous Data.	28
Quantitative Discrete and Qualitative Data.	29
Tests for Differences in Factor Utilization Among Indian Operators in the Low, Medium & High Yield Groups.	30
Quantitative Continuous Data	30
Quantitative Discrete and Qualitative Data.	32

TABLE OF CONTENTS
(Cont.)

	<u>Page</u>
Tests for Differences in Factor Utilization Among Non-Indian Owner-Operators in the Low, Medium and High Yield Groups.	32
Quantitative Continuous Data.	32
Quantitative Discrete and Qualitative Data.	32
Tests for Differences in Factor Utilization Among Non-Indian Renters in the Low, Medium and High Yield Groups.	36
Quantitative Continuous Data.	36
Quantitative Discrete and Qualitative Data.	37
Tests for Differences in Factor Utilization Among All Non-Indian Operators in the Low, Medium and High Yield Groups.	38
Quantitative Continuous Data.	38
Quantitative Discrete and Qualitative Data.	38
Tests for Differences in Factor Utilization Among All Non-Indian and Indian Operators.	38
Quantitative Continuous Data.	38
Quantitative Discrete and Qualitative Data.	41
CHAPTER V. SUMMARY AND CONCLUSIONS.	44
APPENDICES.	50
LITERATURE CITED.	69

LIST OF TABLES

<u>Number</u>		<u>Page</u>
I	SOIL TYPES AND INDEXING OF THE SOILS IN THE JOCKO VALLEY DIVISION OF THE FLATHEAD IRRIGATION PROJECT.	9
II	OPERATOR CLASSIFICATION, ACTUAL YIELD, SOIL PRODUCTIVITY INDEX AND INDEXED YIELD OF EACH TRACT IN SAMPLE.	12
III	SAMPLE SIZE ARRANGED BY CULTURAL AND TENURE GROUP .	13
IV	QUANTITATIVE CONTINUOUS DATA. F TEST OF THE HYPOTHESIS THAT FACTOR VARIATION DOES NOT CONTRIBUTE TO VARIATION IN INDEXED ALFALFA YIELDS.	17
V	QUANTITATIVE DISCRETE AND QUALITATIVE DATA. F TEST OF THE HYPOTHESIS OF NO DIFFERENCES AMONG TREATMENT MEANS.	23
VI	QUANTITATIVE CONTINUOUS DATA. F TEST OF THE HYPOTHESIS OF NO DIFFERENCES IN THE MEAN LEVEL OF FACTOR UTILIZATION AMONG INDIAN OPERATORS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS.	30
VII	DUNCAN'S TEST FOR LOCATION OF SIGNIFICANT DIFFERENCES IN MEAN LEVEL OF FACTOR UTILIZATION AMONG INDIAN OPERATORS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS.	31
VIII	QUANTITATIVE DISCRETE AND QUALITATIVE DATA. TESTS OF THE HYPOTHESIS THAT THE RATIO OF NUMBERS OF OPERATORS IN EACH FACTOR CATEGORY IS THE SAME FOR INDIAN OPERATORS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS.	33
IX	QUANTITATIVE CONTINUOUS DATA. F TEST OF THE HYPOTHESIS OF NO DIFFERENCES IN THE MEAN LEVEL OF FACTOR UTILIZATION AMONG NON-INDIAN OWNER-OPERATORS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS.	34
X	DUNCAN'S TEST FOR LOCATION OF SIGNIFICANT DIFFERENCES IN MEAN LEVEL OF FACTOR UTILIZATION AMONG NON-INDIAN OWNER-OPERATORS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS.	34

LIST OF TABLES
(Cont.)

Number		<u>Page</u>
XI	QUANTITATIVE DISCRETE AND QUALITATIVE DATA. TESTS OF THE HYPOTHESIS THAT THE RATIO OF NUMBERS OF OPERATORS IN EACH FACTOR CATEGORY IS THE SAME FOR NON-INDIAN OPERATORS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS.	35
XII	QUANTITATIVE CONTINUOUS DATA. F TEST OF THE HYPOTHESIS OF NO DIFFERENCES IN THE MEAN LEVEL OF FACTOR UTILIZATION AMONG NON-INDIAN RENTERS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS.	36
XIII	QUANTITATIVE DISCRETE AND QUALITATIVE DATA. TESTS OF THE HYPOTHESIS THAT THE RATIO OF NUMBERS OF OPERATORS IN EACH FACTOR CATEGORY IS THE SAME FOR NON-INDIAN RENTERS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS	37
XIV	QUANTITATIVE CONTINUOUS DATA. F TEST OF THE HYPOTHESIS OF NO DIFFERENCES IN THE MEAN LEVEL OF FACTOR UTILIZATION AMONG ALL NON-INDIAN OPERATORS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS.	39
XV	DUNCAN'S TEST FOR LOCATION OF SIGNIFICANT DIFFERENCES IN MEAN LEVEL OF FACTOR UTILIZATION AMONG ALL NON-INDIAN OPERATORS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS.	39
XVI	QUANTITATIVE DISCRETE AND QUALITATIVE DATA. TESTS OF THE HYPOTHESIS THAT THE RATIO OF NUMBERS OF OPERATORS IN EACH FACTOR CATEGORY IS THE SAME FOR ALL NON-INDIAN OPERATORS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS.	40
XVII	QUANTITATIVE CONTINUOUS DATA. F TEST OF THE HYPOTHESIS OF NO DIFFERENCES IN THE MEAN LEVEL OF FACTOR UTILIZATION AMONG ALL NON-INDIAN AND INDIAN OPERATORS.	41
XVIII	QUANTITATIVE DISCRETE AND QUALITATIVE DATA. TESTS OF THE HYPOTHESIS THAT THE RATIO OF NUMBERS OF OPERATORS IN EACH FACTOR CATEGORY IS THE SAME FOR INDIAN AND ALL NON-INDIAN OPERATORS.	42

LIST OF TABLES
(Cont.)

<u>Number</u>		<u>Page</u>
XIX	SUMMARY OF FACTORS SHOWING DIFFERENT RATES OF UTILIZATION AMONG THE MANAGEMENT LEVEL GROUPS. . . .	43

ABSTRACT

This study is a continuation of a previous study which revealed that there were measurable differences in levels of management among and within cultural and tenure groups. The criterion for measuring management was indexed alfalfa yields. The inputs which make up yield, in addition to management, are soil and weather conditions. To ensure the validity of yield as a criterion for measuring management, the effects of soil and weather conditions had to be eliminated. The influence of weather was removed through sampling from a small geographic area. Variations in soil were removed through a soil indexing procedure.

The sample for the study was taken from the Jocko Valley Division of the Flathead Indian Reservation Irrigation Project. This irrigation division was chosen for several reasons: (1) the small geographic area covered by the division; (2) there is a recent soil survey available that is essential for the soil indexing method used; (3) there is a high percentage of cropland in alfalfa; and (4) the number of Indian and non-Indian operators in this area was large enough to permit the use of the statistics necessary to make the desired comparisons.

The sample was divided by thirds into three yield groups. It was found that there were differences in indexed alfalfa yields among (1) Indian operators in the low, medium and high yield groups, (2) non-Indian owner-operators in the low, medium and high yield groups, (3) non-Indian renters in the low, medium and high yield groups, (4) all non-Indian operators in the low, medium and high yield groups and (5) Indian and all non-Indian operators. There should be some identifiable factors which contribute to variation in indexed alfalfa yields. This study is an attempt to identify these factors and detect any differences in their utilization among the above designated groups.

Indexed alfalfa yields were found to vary directly with the amount of fertilizer applied per application, amount of fertilizer applied over the life of the stand and the number of years the tract has been farmed by the present operator. Indexed yields were found to vary inversely with percentage bloom at time of cutting. Broadcasting as opposed to drilling alfalfa seed, and the application of fertilizer resulted in higher indexed alfalfa yields. Tracts on which the stand was cut twice per season had higher indexed alfalfa yields than those with one cutting. The groups with significantly different levels of management differed in their utilization of one or more of these factors.

A GLOSSARY OF TERMS

To establish a common frame of reference for the study, the following terms are defined:

1. A factor is defined to be one of the elements that either directly or indirectly contributes to variations in yields.
2. The codings I, nIoo, nIr, and all nI refer to Indian operators, non-Indian owner-operators, non-Indian renters and all non-Indian operators respectively.
3. The codings IL, IM, and IH refer to Indian operators in the low, medium and high yield groups respectively.
4. The codings nIooL, nIooM, and nIooH refer to non-Indian operators in the low, medium and high yield groups respectively.
5. The codings nIrL, nIrM, and nIrH refer to non-Indian renters in the low, medium and high yield groups respectively.
6. The codings all nIL, all nIM, and all nIH refer to all non-Indian operators in the low, medium and high yield groups respectively.
7. Quantitative continuous data are composed of observations which lend themselves to numerical measurement and for which all values are observable on a continuous scale.
8. Quantitative discrete data are composed of observations which lend themselves to numerical measurement and for which the possible values are not observable on a continuous scale.
9. Qualitative data are composed of observations belonging to one of several, non-numerical mutually exclusive categories.

INTRODUCTION

The General Problem Setting

Land, labor, capital, and management are generally recognized as the four factors of production. In farm budget analysis the usual practice is to treat land, labor and capital as variable factors and the level of management as a constant factor.

Not all would agree that the level of management should be treated as a constant. A recent Montana study was conducted to ascertain the existence or non-existence of measurable differences in levels of management between farm operators. 1/

That study defined management as,

"not only the ability to combine inputs, but also the ability to obtain and control inputs. The ability to obtain and control inputs reflects not only the wealth, income and credit position of the individual operator, but also the constraints which may be imposed on him by his education, his culture, and the area in which he lives." 2/

Thus, in accordance with the above definition, management may be influenced by both learning and institutions. Since management is influenced by both institutions and learning, there is reason to believe that variations in the general level of

1/ Carl Edmund Olsen, "A Method of Measuring the Comparative General Level of Management for Farm Operators on the Jocko Valley Division of the Flathead Irrigation Project." Unpublished Master's Thesis, Department of Agricultural Economics and Rural Sociology, Montana State University, 1963, pp. 3-4.

2/ Ibid.

management may exist within as well as between various cultural and tenure groups.

Olsen's study was conducted under the assumption that significant differences in levels of management existed among and within cultural and tenure groups. The criterion for measuring the level of management was indexed alfalfa yields. Based on this criterion, he found that there were differences in levels of management within groups designated as Indian operators, non-Indian owner-operators, non-Indian renters and all non-Indian operators. It was also found that all non-Indian operators had a level of management higher than Indian operators.

The Problem Situation

If there are variations in indexed alfalfa yields among and within cultural and tenure groups, then there should be some identifiable factors contributing to these variations. Groups with different levels of management should have dissimilar utilization of some of these factors.

Since emphasis is on levels of management among and within cultural and tenure groups there is a need to have these factors identified in order to determine the responsibility of management. That is, if a factor is utilized in a particular manner by a group, could the operators in this group have

increased indexed yields by varying their use of this factor. Or were circumstances or the nature of the factor such that method and rate of utilization were beyond the control of the operator. If the latter is true, then significant differences in indexed yields among and within cultural and tenure groups may not be truly indicative of differences in levels of management among these groups.

The Research Problem

The purpose of this study is to identify those factors causing variations in indexed alfalfa yields relative to the role they play as indices of the general level of management of farm operators in the designated groups.

A factor which has a direct influence on yields should differ in its utilization among groups with significant differences in levels of management measured in these same yields. Thus the research problem resolves itself into two parts. The first is the identification of factors causing variations in indexed alfalfa yields. The second is a check to determine whether the management level groups, measured in indexed alfalfa yields, actually differed in their utilization of these factors.

The Hypothesis

This study proceeds under two general hypothesis:

1. Factors having a significant influence on indexed alfalfa yields can be identified.
2. Those level of management groups differing in their utilization of these factors can be identified.

CHAPTER II

Sampling Procedure

This study is an extension of the previous study by Olsen. The operators composing that sample were interviewed in order to collect the data from which the factors suspected of causing variations in indexed yields could be examined. A condensation of the sampling procedure follows. A somewhat more detailed exposition may be found in the initial study. ^{3/} That study was the initial phase of the project. This study encompasses the second and final phase.

Type of Sample Unit Desired

In order for alfalfa yields to function as instruments for measuring levels of management, an area meeting certain specific conditions had to be chosen. The area chosen was the Jocko Valley Division of the Flathead Indian Reservation Project. The conditions which are found in the Jocko Valley and which meet the requirements of the study are outlined as follows:

1. The cultural and tenure groups studied (Indian owner-operators, non-Indian owner-operators and non-Indian renters) are actively engaged in farming in numbers sufficient to allow sampling for statistical purposes.

^{3/} Olsen, Ibid., pp. 6-18.

2. To ensure that only the influence of the management input was being measured, it was necessary that the following be removed:
 - (a) Soil variations. This was done by indexing yields. To index yields a soil indexing method is needed, which in turn requires a soil survey. The United States Department of Agriculture had performed a soil survey in the Jocko Valley in 1929 and revised it in the late 1950's.
 - (b) Weather variations. It was assumed that by confining the study to a small area the effect of weather variations on yields would be held to a minimum. The Jocko Valley encompasses a small geographic area.
3. Since management levels were measured by comparing indexed yields, a crop of major importance was required. In the Jocko Valley alfalfa accounts for 35 percent of all major cropland. It was assumed that indexed alfalfa yields would demonstrate the range of management levels present.
4. To calculate indexed yields it is necessary to have complete crop reports. These were available in the Jocko Valley Division.

Size of Sample Unit

A size limitation was imposed on both the maximum and minimum acreage of irrigated land that an operator could farm to be included in the sample. Size may be a function of management. But the level of management may also be a function of size, that is, a large unit may force the operator to reduce the intensity and variety of management practices. Olsen assumed that an operator could not handle over 320 irrigated acres and still do an adequate job of farming. It was also

felt that an operator with an irrigated acreage that is too small may tend to overlook the full potential of this resource and not devote to it the management effort warranted, particularly if this tract is only a part of the total operation. Consequently 60 irrigated acres were set for the minimum acreage an operator must farm in order to be included in the sample.

Age of Stand

The sample is composed of alfalfa stands with two or more years of maturity. There are two reasons for eliminating stands with less than two years of maturity. Some stands are seeded with a nurse crop. If the hay crop is harvested the yield will be reduced due to the nutrients removed from the soil by the nurse crop. Secondly, a first year alfalfa crop seeded without a nurse crop usually yields less than succeeding crops.

No restrictions were placed on the maximum age a stand could attain. Although it is recognized that the yield of an alfalfa stand will generally decrease after a period of years, this is a reflection of management level.

Source of Data

The data for this study, exclusive of that used in indexing yields, came from two sources. Raw yield data were obtained from the 1963 crop reports of the Flathead Irrigation Project

on the Flathead Indian Reservation. Data to be used in determining which factors caused variations in indexed alfalfa yields were obtained from interviews with the individual operators. A reproduction of the questionnaire used is shown in Appendix A.

Indexed Yield of Tract

The derivation of indexed yields occurs in a three step process. These steps are outlined as follows:

1. Index Value of Soil. The first item required in order to index yields is an indexed value of a particular soil type. In the early 1940's the Agronomy Department, Montana Agricultural Experiment Station in cooperation with the Soil Survey Division of the Bureau of Plant Industry indexed the Jocko Valley Division of the Flathead Indian Reservation Irrigation Project using a technique developed by R. E. Storie, ^{4/} of California. The data for the study were obtained from the Plant and Soil Science Department of Montana State University. ^{5/} The soil types and soil indexing of the soils in the Jocko Valley Division of the Flathead Indian Reservation Irrigation Project are shown in Table I. In determining the index value of a particular soil, six factors are considered. The first three are referred to in Table I as factors A, B, and C. "Factor A" refers to the character of the physical profile, "Factor B" the surface texture, and

^{4/} R. Earl Storie, Revision of the Soil-Rating Chart, California Agricultural Experiment Station, Berkeley, California, December, 1959.

^{5/} Taken from unpublished soil report, Department of Plant and Soil Science, Montana State University, Bozeman, Montana.

TABLE I. SOIL TYPES AND INDEXING OF THE SOILS IN THE JOCKO DIVISION OF THE FLATHEAD IRRIGATION PROJECT. *

Soil Type	Factor A	Factor B	Factor C	Freedom from Alkali and Poor Drainage	Irrigability & Erosiveness	Fertility	Index Value of Soil	
	%	%	%	%	%	%	%	
Millville Loam	95	100	95	100	95	95	90	
Moist Fine Sandy Loam, Fine Texture Phase	90	100	92	100	95	90	82	1
Millville Gravelly Loam	85	80	90	100	90	90	61	6
Trenton Very Fine Sandy Loam	95	100	80	95	95	90	76	1
Trenton Stony Loam	90	80	87	100	90	85	63	
Flathead Fine Sandy Loam	90	100	85	100	80	90	76	
Trenton Gravelly Loam	85	80	87	100	90	85	56	
Corvallis Silty Clay Loam, Brown Phase	60	95	87	100	85	90	50	
Flathead Fine Sand	50	70	70	100	60	80	24	
Hyrum Gravelly Loam, Terrace Phase	65	80	90	100	95	85	47	
Hyrum Gravelly Loam	60	80	90	100	95	85	43	
Hyrum Stony Loam	60	70	87	100	85	90	36	
Corvallis Silty Clay Loam	60	90	70	100	60	80	38	
Corvallis Silty Clay Loam, Gravelly Phase	60	80	65	100	66	70	31	
Lonepine Very Fine Sandy Loam, Steep Phase	90	100	55	100	30	80	49	
Post Clay Loam	60	70	90	100	90	90	38	

*Source: Unpublished data from Plant and Soil Department, Montana State University.

"Factor C" the slope. The three remaining factors are self-descriptive. Values are assigned to the six factors in terms of an ideal soil. This method allows a particular soil type to be rated against an ideal soil and consequently no direct comparison of soil types is involved. Equation 1 is used to calculate the index value of a soil.

Equation 1 6/

$$\text{Index Value of Soil} = \text{Factor A} \times \text{Factor B} \\ \times \text{Factor C} \times \text{Fertility} \\ \times \text{Irrigability and} \\ \text{Erosiveness} \times \text{Freedom} \\ \text{from Alkali and Poor} \\ \text{Drainage.}$$

2. Productivity Index of Tract. A tract of land may contain several different soil types. Thus an index value for a particular tract is needed. This value is referred to as the productivity index of the tract. It is a weighted productivity index composed of the indexed value of each type of soil within the tract multiplied by the number of acres of that soil type and divided by the total number of acres in the tract. Equation 2 is used to calculate the productivity index of a tract.

Equation 2 7/

$$\text{Productivity Index of Tract} = \text{Index Value of} \\ \frac{\text{Soil} \times \text{Acres of Soil Type}}{\text{Total Acres in Tract}}$$

3. Indexed Yield of Tract. The productivity index of a tract compares its producing ability with

6/ Storie, op. cit.

7/ Storie, op. cit.

a tract composed entirely of an ideal soil i.e., a tract with a productivity index of 100. The indexed yield for a particular tract is found by dividing the actual yield by the productivity index of the tract. It is assumed that indexing yields in this manner eliminates the effects of soil variations. Equation 3 is used to calculate the indexed yield of a tract.

Equation 3

$$\text{Indexed Yield of Tract} = \frac{\text{Actual Yield of Tract}}{\text{Productivity Index of Tract}}$$

Sample Size

The sample for this study is composed of 53 tracts. Table II following, shows the operator classification, actual yield in tons per acre, the productivity index, and indexed yield for each tract. The sample is summarized by cultural and tenure groupings in Table III.

TABLE II. OPERATOR CLASSIFICATION, ACTUAL YIELD, SOIL PRODUCTIVITY INDEX AND INDEXED YIELD OF EACH TRACT IN SAMPLE.

Operator Classification	Actual Yield In Tons Per Acre	Soil Pro- ductivity Index	Indexed Yield In Tons Per Acre
I	0.80	61.00	1.31
nIoo	0.83	61.29	1.35
I	1.01	61.00	1.66
nIr	1.00	56.16	1.78
nIoo	1.28	70.56	1.81
I	0.83	44.73	1.85
nIoo	0.89	47.00	1.89
I	1.14	57.07	2.00
I	1.04	50.26	2.07
I	1.28	59.24	2.16
nIr	1.64	74.05	2.21
nIoo	1.75	77.54	2.26
I	1.27	55.58	2.28
nIr	1.00	43.00	2.32
nIoo	1.42	59.89	2.37
nIoo	1.87	76.18	2.45
nIoo	1.50	61.00	2.46
nIoo	1.43	55.17	2.59
nIoo	1.51	58.30	2.59
nIr	1.33	51.28	2.59
nIoo	1.20	44.15	2.72
nIoo	1.68	61.02	2.75
I	1.33	44.74	2.97
I	1.29	42.25	3.05
nIoo	1.97	63.00	3.13
nIoo	2.00	62.36	3.21
I	1.51	46.83	3.22
nIoo	1.60	49.53	3.23
nIoo	1.73	53.28	3.25
nIoo	1.43	43.00	3.32
nIoo	2.14	64.00	3.34
I	2.11	62.31	3.39
nIoo	1.50	43.00	3.49
nIoo	1.53	43.47	3.52
nIoo	2.25	63.00	3.57
I	1.74	47.46	3.67
nIr	1.61	43.00	3.74
nIoo	1.42	38.00	3.74
nIr	2.00	52.03	3.84
nIoo	2.00	49.00	4.08

TABLE II. (Cont.) OPERATOR CLASSIFICATION, ACTUAL YIELD, SOIL PRODUCTIVITY INDEX AND INDEXED YIELD OF EACH TRACT IN SAMPLE.

Operator Classification	Actual Yield In Tons Per Acre	Soil Productivity Index	Indexed Yield In Tons Per Acre
nloo	2.58	62.28	41.4
nloo	2.25	52.00	4.33
nloo	1.87	43.12	4.34
nloo	2.00	43.00	4.65
nIr	2.15	45.31	4.74
nloo	2.73	54.31	5.03
I	2.97	57.80	5.14
nloo	3.78	73.30	5.16
nIr	2.99	56.72	5.27
nloo	3.32	60.14	5.52
nloo	2.81	50.06	5.61
nloo	21.4	38.00	5.63
nloo	5.00	84.74	5.90

TABLE III. SAMPLE SIZE ARRANGED BY CULTURAL AND TENURE GROUPINGS.

Cultural Groups	Tenure Groups			Total
	I	nloo	nIr	
Indian	13			13
Non Indian		32	8	40
TOTAL	13	32	8	53

CHAPTER III

IDENTIFICATION OF FACTORS SIGNIFICANTLY INFLUENCING YIELDS

In keeping with the hypothesis, we need first to determine which factors had a significant influence on indexed alfalfa yields. This part of the analysis is performed apart from management level groups which have been set forth.

The data relating to each factor fall into three categories. These categories are "quantitative continuous," "quantitative discrete," and "qualitative." These different types of data necessitated that the statistical tests used to determine which factors significantly influenced indexed alfalfa yields vary according to the type of data under consideration.

Quantitative Continuous Data

For quantitative continuous data linear regression was used to determine whether variations in factor utilization contributed to variations in indexed alfalfa yields.

The Linear Regression Model

Let X be the independent variable signifying the factor being studied for its effect on indexed alfalfa yields and Y be the dependent variable signifying indexed alfalfa yields. In linear regression, Y values are obtained from several populations, each population being determined by a corresponding X value. It is assumed the Y populations are normal and

have a common variance. The true regression of Y on X consists of the means of these populations of Y values. The line connecting the means of the population of Y's for respective X values is called a line of means or regression line. ^{8/} When sampling from a population it is necessary to assume the form of the regression line in order to develop a computational procedure. Although the true form of the line may be non-linear, the straight line is often chosen as an approximation when it fits reasonably well over the range of X involved. The straight line is chosen because of computational ease. Because there is no reason to believe that a straight line will not fit reasonably well over the range of X for the data of this study, a straight line was assumed.

In a two variable linear regression model, an observation may be described as the sum of a population mean, an attending variable and a random component. The mathematical description of an observation is:

$$Y_i = \mu + \beta x_i + \epsilon_i$$

The parameters to be estimated are μ and β while x is an observable parameter. The ϵ 's are assumed to be from a single

^{8/} R.G.D. Steel and J. H. Torrie, Principles and Procedures of Statistics, (New York, 1960), p. 164.

population with zero mean and variance σ^2 . The variance of the ϵ 's is also a parameter to be estimated.

The hypothesis to be tested is that X (factor variation) does not contribute to variation in Y (indexed alfalfa yields). This is equivalent to testing whether β , the slope of the regression line as estimated by b , is zero. The F test at the 5 percent level of significance was used to test the null hypothesis. ^{9/}

Statistical Analysis

The results of the tests are shown in Table IV. Indexed alfalfa yields were found to vary directly with the amount of fertilizer applied per each application, amount of fertilizer applied over the life of the stand, and the number of years the tract has been farmed by the present operator and inversely with the percentage bloom at time of cutting.

It may have been noticed that in Table IV the number of observations vary among the factors. There are essentially two reasons for this. The first is that not all operators were able to provide information on seedbed preparation and seeding practices. This is because subsequent to the seeding of a stand a change of ownership had occurred. Secondly, the

^{9/} For further explanation of the statistical test used see Appendix B.

TABLE IV. QUANTITATIVE CONTINUOUS DATA. F TEST OF THE HYPOTHESIS THAT FACTOR VARIATION DOES NOT CONTRIBUTE TO VARIATION IN INDEXED ALFALFA YIELDS. a/

Independent Variable	b	Source of Variation	df	SS	MS	F b/
Age of Stand (Years)	.09915	Reduction	1	2.912	2.912	1.815
		Residual	40	64.124	1.604	
		TOTAL	41	67.036		
Depth of Seedbed Plowing (Inches)	.1505	Reduction	1	1.165	1.165	.707
		Residual	40	65.871	1.647	
		TOTAL	41	67.036		
No. of Discing Repetitions Performed in Seedbed Preparation	.2055	Reduction	1	1.538	1.538	.940
		Residual	40	65.498	1.637	
		TOTAL	41	67.036		
No. of Harrowing Repetitions Performed in Seedbed Preparation	-.06625	Reduction	1	.230	.230	.138
		Residual	40	66.806	1.670	
		TOTAL	41	67.036		
No. of Leveling Operations Performed in Seedbed Preparation	.2645	Reduction	1	1.712	1.712	1.048
		Residual	40	65.324	1.633	
		TOTAL	41	67.036		
Total No. of Operations Performed in Seedbed Preparation	.01782	Reduction	1	.0444	.0444	.0265
		Residual	40	66.992	1.675	
		TOTAL	41	67.036		
Rate of Alfalfa Seeding (lbs./acre)	.1091	Reduction	1	3.155	3.155	1.976
		Residual	40	63.881	1.597	
		TOTAL	41	67.036		
Rate of Nurse Crop Seeding (Bu./Acre)	.3828	Reduction	1	1.816	1.816	1.122
		Residual	28	45.291	1.618	
		TOTAL	29			

See footnote on following page.

TABLE IV. QUANTITATIVE CONTINUOUS DATA. F TEST OF THE HYPOTHESIS THAT FACTOR VARIATION DOES NOT CONTRIBUTE TO VARIATION IN INDEXED ALFALFA YIELDS. a/ (Cont.)

Independent Variable	b	Source of Variation	df	SS	MS	F b/
Fertilizer Per Application (lbs./Acre)	.01335	Reduction	1	9.612	9.612	8.329**
		Residual	19	21.920	1.154	
		TOTAL	20	31.532		
Fertilizer Applied Over Life of Stand (lbs./Acre)	.00117	Reduction	1	8.474	8.474	6.980*
		Residual	49	23.058	1.214	
		TOTAL	50	31.532		
Irrigation Water Application (Acre-Ft./Acre Per Crop)	-.1065	Reduction	1	.316	.316	.204
		Residual	49	75.764	1.546	
		TOTAL	50	76.080		
Irrigation Water Application (Acre-Ft./Acre Per Year)	-.02615	Reduction	1	.093	.093	.062
		Residual	49	75.177	1.490	
		TOTAL	50	76.080		
Pasture Usage (AU/M)	.11072	Reduction	1	.568	.568	.379
		Residual	51	76.457	1.499	
		TOTAL	52	77.025		
Percent Hay in Bloom At Time of Cutting	-1.812	Reduction	1	11.537	11.537	8.98 **
		Residual	51	65.488	1.284	
		TOTAL	52	77.025		
Height of Cut (Inches)	-.01111	Reduction	1	.003	.003	.002
		Residual	51	77.022	1.514	
		TOTAL	52	77.025		
Education Level of Operator	.0725	Reduction	1	2.214	2.214	1.509
		Residual	51	74.811	1.467	
		TOTAL	52	77.025		

See footnote on following page.

TABLE IV. QUANTITATIVE CONTINUOUS DATA. F TEST OF THE HYPOTHESIS THAT FACTOR VARIATION DOES NOT CONTRIBUTE TO VARIATION IN INDEXED ALFALFA YIELDS. a/ (Cont.)

Independent Variable	b	Source of Variation	df	SS	MS	F <u>b/</u>
Years Tract Farmed by Present Operator	.0401	Reduction	1	13.866	13.866	11.200 **
		Residual	51	63.159	1.238	
		TOTAL	52	77.025		
Age of Operator	.0195	Reduction	1	3.580	3.580	2.486
		Residual	51	73.445	1.440	
		TOTAL	52	77.025		

a/ Data for tests are shown in Appendix F.

b/ * significant at the five percent significance level.
 ** significant at the one percent significance level.

number of observations for such factors as rate of alfalfa seeding and rate of fertilizer application was reduced because not all operators used a nurse crop or applied fertilizer. This variation in observations among factors will also be found in tables throughout the remainder of the text.

Quantitative Discrete and Qualitative Data

For quantitative discrete and qualitative data analysis of variance was used to determine whether variations in factor utilization contributed to variation in indexed alfalfa yields.

The Model for Analysis of Variance

In analysis of variance, an observation may be described as the sum of a mean and a random element, where the mean, in turn, may be a sum of components. The mathematical description is given by:

$$X_{ij} = \mu + \tau_i + \epsilon_{ij}$$

The ϵ 's are normally and independently distributed with zero mean and a common variance σ^2 . Error mean square, designated as MSE, is an independent estimate of σ^2 , the variation among observations treated alike.

Treatment refers to a variable of the factor classification. Each factor has one or more treatments. The observations made on the treatments are the indexed alfalfa yields

on the tracts in the sample. To illustrate, method of seeding is a factor and the alternative methods of seeding--drilling and broadcasting--are treatments.

In analysis of variance the null hypothesis is that there are no real differences among treatment means. When the null hypothesis is true, the treatment mean square, designated as MST, is also an independent estimate of σ^2 . Thus both MST and MSE are independent estimates of σ^2 when the null hypothesis is true. F is defined as MST divided by MSE, and if significantly large, the null hypothesis is true. 10/

Statistical Analysis

Some of the factors in this section need explanation. The rotation period refers to the period of time which has elapsed between the plowing up of the old stand and the reseeding of the new one. The practice of irrigating in the Fall was the only response to the inquiry regarding the use of any special practices in handling the stand after the last cutting. The amount of water used for Fall irrigation is not included in the irrigation water used per year figures in Table IV. This was done for two reasons. First, it was felt

10/ For further explanation of statistical test used see Appendix C.

to be more practical to study the effects of the amount of water applied during the growth period for the first and second cuttings. Secondly, it was felt that if the extra amount of water applied on stands irrigated in the Fall had any significant effects on indexed alfalfa yields it would be indicated when tests were made for the effects of Fall irrigation. Renovation practices consisted of either harrowing or disking in the Spring.

The results of the tests are shown in Table V. The evidence indicates that mean indexed alfalfa yields are higher on tracts using broadcasting as a method of seeding, on tracts where fertilizer was applied, and on tracts with two cuttings per year as opposed to one cutting.

In addition to the two factors mentioned above, the type of seed used also influenced indexed alfalfa yields. The F test, however does not specify which means differ. Therefore Duncan's test is used to determine which differences among these treatment means were significant.

The procedure for Duncan's new multiple range test is to tabulate the treatment means by ranking them from lowest to highest. The differences between means are tested for significance by comparing them with the appropriate least significant range. Differences are declared significant if they exceed

TABLE V. QUANTITATIVE DISCRETE AND QUALITATIVE DATA. F TEST OF THE HYPOTHESIS OF NO DIFFERENCES AMONG TREATMENT MEANS. a/

Factor Classification	Treatments	Source of Variation	df	SS	MS	F <u>b/</u>
Rotation Period	1 year	Treatment	2	3.86	1.93	1.18
	3 years	Error	38	62.29	1.64	
	2 years					
		TOTAL	40	66.15		
Time of Plowing Prior to Seeding	Spring	Treatment	1	3.68	3.68	2.33
	Fall	Error	40	63.36	1.58	
		TOTAL	41	67.04		
Nurse Crop Usage	Not Used	Treatment	1	0.43	0.43	.26
	Used	Error	40	66.61	1.67	
		TOTAL	41	67.04		
Grass Seed Alfalfa Seeding Mixture	Not Used	Treatment	1	2.19	2.19	1.35
	Used	Error	40	64.85	1.62	
		TOTAL	41	67.04		
Type of Seed Plants	Ladac	Treatment	7	33.70	4.81	4.91*
	Ladac-Ranger	Error	34	33.34	.98	
	Common					
	Ranger	TOTAL	41	67.04		
	919					
Method of Seeding	Grimm					
	Grimm-919					
	919-Vernal					
	Drilled	Treatment	1	6.42	6.42	4.22*
	Broadcast	Error	40	60.62	1.52	
		TOTAL	41	67.04		
Fertilizer Application	Not Applied	Treatment	1	6.98	6.98	5.08*
	Applied	Error	51	70.05	1.35	
		TOTAL	52	77.03		

See footnotes on following page.

TABLE V. QUANTITATIVE DISCRETE AND QUALITATIVE DATA. F TEST OF THE HYPOTHESIS OF NO DIFFERENCES AMONG TREATMENT MEANS. a/ (Cont.)

Factor						
Classification	Treatments	Variation	df	SS	MS	F <u>b/</u>
Manure Application	Not Applied	Treatment	1	1.73	1.73	1.17
	Applied	Error	51	75.30	1.48	
		TOTAL	52	77.03		
Fall Irrigation	Performed	Treatment	1	.32	.32	.21
	Not Performed	Error	51	76.71	1.50	
		TOTAL	52	77.03		
Renovation	Performed	Treatment	1	3.85	3.85	2.69
	Not Performed	Error	51	73.18	1.43	
		TOTAL	52	77.03		
Winter Use of Stand	Carried Live-stock	Treatment	1	1.82	1.82	1.24
	Free of Live-stock	Error	51	75.21	1.47	
		TOTAL	52	77.03		
Type of Irrigation System Used	Flood	Treatment	1	.08	.08	.05
	Sprinkler	Error	50	76.22	1.52	
		TOTAL	51	76.30		
Cuttings Per Year	One	Treatment	1	11.61	11.61	9.07**
	Two	Error	51	65.42	1.28	
		TOTAL	52	77.03		

a/ Data for tests are shown in Appendix G.

b/ * significant at the five percent significance level.

** significant at the one percent significance level.

the least significant range. 11/ The method of comparison is to compare the differences between the largest and the smallest, the largest and second smallest and so on down until a non-significant comparison is reached. If there is a significant difference between the largest and smallest then comparisons are made between the second largest and smallest, second largest and second smallest and so on down until a non-significant comparison is reached. The process is repeated until all differences have been tested. The number of comparisons it is necessary to make is reduced by the fact that the difference between two means contained in a subset with a non-significant range cannot be declared significant.

The results of the Duncan test for the type of seed planted are shown below. The evidence indicates that the means of the Ladac and Ladac-Ranger treatments are significantly different than the 919-Vernal treatment.

Ranked Treatment Means		Treatment Means Compared	Difference	LSR
Ladac	1.45	919-Vernal - Ladac	3.82*	2.67
Ladac-Ranger	1.81	919-Vernal - Ladac-Ran.	3.46*	3.25
Common	2.46	Grimm-919 - Ladac	2.81	3.21
Ranger	2.99			
919	3.29			
Grimm	3.69			
Grimm-919	4.24			
919-Vernal	5.27			

11/ For further explanation of statistical tests used see Appendix D.

Analysis of variance has indicated that indexed alfalfa yields tend to be higher on fertilized tracts. Analysis of the effects of different types of fertilizer is not feasible in this study. This is because different types of fertilizer have been used on the same tracts, both in the same year and over time. In addition, varying amounts of the different types of fertilizer have been applied in any given year and over a span of years. In short, an analysis of the effects of various types of fertilizer on indexed alfalfa yields would require some form of controlled experimentation.

CHAPTER IV

STATISTICAL TESTS FOR DIFFERENCES IN FACTOR UTILIZATION AMONG MANAGE-LEVEL GROUPS

Olsen 12/ has shown, using mean indexed alfalfa yields as the criterion, that differences in level of management existed among and within cultural and tenure groups. His sample was divided into three groups (low, medium and high) by level of indexed alfalfa yield. Within each indexed yield grouping there were Indian operators, non-Indian owner-operators and non-Indian renters. Significant differences in mean indexed alfalfa yields were found among the following groups:

1. Indian operators in the low, medium and high yield groups.
2. Non-Indian owner-operators in the low, medium and high yield groups.
3. Non-Indian renters in the low, medium and high yield groups.
4. All non-Indian operators in the low, medium and high yield groups.

It was also found that there were significant differences in mean indexed alfalfa yields between Indian operators and all non-Indian operators. Because indexed alfalfa yields were the criterion for discerning differences in level of management among these groups, factors which affect these yields should differ in their utilization among these groups.

12/ Olsen, op. cit., pp. 25 ff.

Factors affecting indexed alfalfa yields were identified in the preceding chapter. The type of test used to determine if these factors vary in their utilization among the above groups depends on whether the data under consideration are "quantitative continuous," "quantitative discrete," or "qualitative."

Description of Tests Used for Each Type of Data

Quantitative Continuous Data

Analysis of variance is used when the data are quantitative and continuous. In tests involving these data, the above management level groups are the treatments and the observations on the treatments are the level of factor utilization employed by operators in the respective groups. The null hypothesis to be tested is that there is no difference in the mean level of factor utilization among the management level groups on which the test is being made.

If the F value for treatments is not significant, the evidence is against rejecting the null hypothesis and specific treatment comparisons should not usually be made. Exceptions occur for comparisons planned before the data have been examined. Since it was planned that comparisons of the mean level of factor utilization among the designated management level groups be made, Duncan's new multiple-range test was used to

determine which differences among the treatment means were significant. This procedure may be used regardless of the significance of F.

Quantitative Discrete and Qualitative Data

To test for differences in factor utilization among the designated level of management groups when the data are quantitative discrete or qualitative, contingency tables were used. In these tables there are two variables of classification--treatment and factor. The treatments are the management level groups on which the tests for differences in factor utilization are being made. The factor classification is composed of several mutually exclusive categories into which an observation may fall. To illustrate, the factor classified as "method of seeding" has two mutually exclusive categories into which an observation may fall--those operators drilling and those broadcasting seed.

The hypothesis to be tested is the hypothesis of independence which implies that the number of operators in each factor category is not significantly different for the management groups on which the test is being made. 13/

13/ For further explanation of statistical tests used see Appendix E.

Tests for Differences in Factor Utilization
Among Indian Operators in the Low, Medium
and High Yield Groups

Quantitative Continuous Data

The results of the tests are tabulated in Table VI and VII. The evidence indicates that the mean number of years the tracts were farmed by Indian operators in the high yield group was significantly greater than that of Indian operators in the low yield group (42.00 vs. 9.86) and that the mean number of years the tracts were farmed by Indian operators in the medium yield, group was also greater than that of Indian operators' in the low yield group (31.00 vs. 9.86)..

TABLE VI. QUANTITATIVE CONTINUOUS DATA. F TEST OF THE HYPOTHESIS OF NO DIFFERENCES IN THE MEAN LEVEL OF FACTOR UTILIZATION AMONG INDIAN OPERATORS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS. a/

Factor	Treatments	Source of Variation	df	SS	MS	F <u>b/</u>
% in Bloom at Time of Cutting	IM	Treatment	2	.30	.15	1.36
	IH	Error	10	1.06	.11	
	IL	Total	12	1.36		
Years Tract Farmed by Operator	IL	Treatment	2	1,806.37	903.18	10.79**
	IM	Error	10	836.86	83.68	
	IH	Total	12	2,643.23		

a/ Data for tests are shown in Appendices H and I.

b/ ** significant at the 5 percent level of significance.

TABLE VII. DUNCAN'S TEST FOR LOCATION OF SIGNIFICANT DIFFERENCES IN MEAN LEVEL OF FACTOR UTILIZATION AMONG INDIAN OPERATORS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS. a/

Factor	Ranked Treatments	Mean Level of Factor Utilization	Treatment Means Compared	Difference ^{b/}	LSR
% in Bloom at Time of Cutting	IM	34	IM-IL	32	45
	IH	66			
	IL	66			
Years Tract Farmed by Operator	IL	9.86	IL-IH	32.14*	21.44
	IM	31.00	IL-IM	21.14*	11.82
	IH	42.00	IM-IH	11.00	11.82

a/ Data for tests are shown in Appendices H and I.

b/ * significant at the 5 percent level of significance.

It has probably been noticed that although the regression analysis of the previous chapter provided evidence that indexed alfalfa yields varied directly with the amount of fertilizer applied, this factor has not been tested for difference in utilization among Indian operators in the low, medium, and high yield groups. The purpose of the tests in this chapter is to determine whether differences in factor utilization occurred among the various management level groups. Only 38 percent of the operators in the sample applied fertilizer. Therefore any tests involving amounts of fertilizer applied would include only a small proportion of each group and not be representative of differences in factor utilization among complete groups.

Quantitative Discrete and Qualitative Data

The results of tests involving these data are summarized in Table VIII. The evidence indicates that there are no differences in utilization of these factors among Indian operators in the low, medium and high yield groups. The factor "type of seed planted" is not included in these tests for the same reason as that for fertilizer application above. That is, the varieties among which significant differences were found include only a small part of the sample--approximately 8 percent.

Tests for Differences in Factor Utilization Among Non-Indian Owner-Operators in the Low, Medium and High Yield Groups

Quantitative Continuous Data

The results of these tests are tabulated in Tables IX and X. The Duncan test indicates that there is a significant difference in the mean number of years the tract has been farmed by the operator between non-Indian owner-operators in the low, medium and high yield groups.

Quantitative Discrete and Qualitative Data

The results of tests involving these data are summarized in Table XI. The evidence indicates that there are no differences in utilization of these factors among non-Indian

TABLE VIII. QUANTITATIVE DISCRETE AND QUALITATIVE DATA. TESTS OF THE HYPOTHESIS THAT THE RATIO OF NUMBERS OF OPERATORS IN EACH FACTOR CATEGORY IS THE SAME FOR INDIAN OPERATORS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS.

Management Level Groups	Factor Categorization		Total	χ ²
	Method of Seeding			
	Drilled	Broadcast		
IL	6	1	7	4.31
IM	2	3	5	
IH	0	1	1	
Total	8	5	13	
	Fertilizer Application			
	Applied	Not Applied		
IL	1	6	7	3.34
IM	3	2	5	
IH	0	1	1	
Total	4	9	13	
	Cuttings per Year			
	One	Two		
IL	6	1	7	4.31
IM	2	3	5	
IH	0	1	1	
Total	8	5	13	

owner-operators in the low, medium and high yield groups.

TABLE IX. QUANTITATIVE CONTINUOUS DATA. F TEST OF THE HYPOTHESIS OF NO DIFFERENCES IN THE MEAN LEVEL OF FACTOR UTILIZATION AMONG NON-INDIAN OWNER-OPERATORS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS. a/

Factor	Treatments	Source of Variation	df	SS	MS	F
% in Bloom at Time of Cutting	n100H	Treatment	2	.05	.025	1.67
	n100M	Error	29	.44	.015	
	n100L	Total	31	.49		
Years Tract Farmed by Operator	n100L	Treatment	2	787.86	393.93	2.76
	n100M	Error	29	4,135.86	142.62	
	n100H	Total	31	4,923.72		

a/ Data for tests is shown in Appendices H and I.

TABLE X. DUNCAN'S TEST FOR LOCATION OF SIGNIFICANT DIFFERENCES IN MEAN LEVEL OF FACTOR UTILIZATION AMONG NON-INDIAN OWNER-OPERATORS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS. a/

Factor	Ranked Treatments	Mean Level of Factor Utilization	Treatment Means Compared	Difference <u>b/</u>	LSR
% in Bloom at Time of Cutting	n100H	20	n100L-n100H	10	12
	n100M	15			
	n100L	10			
Years Tract Farmed by Operator	n100L	12.78	n100L-n100H	11.40*	11.18
	n100M	14.67	n100M-n100H	9.51	10.22
	n100H	24.18	n100L-n100M	1.89	10.80

a/ Data for tests are shown in Appendices H and I.

b/ * Significant at the 5 percent significance level.

TABLE XI. QUANTITATIVE DISCRETE AND QUALITATIVE DATA. TESTS OF HYPOTHESIS THAT THE RATIO OF NUMBERS OF OPERATORS IN EACH FACTOR CATEGORY IS THE SAME FOR NON-INDIAN OWNER-OPERATORS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS.

Management Level Groups	Factor Categorization		Total	2 ²
	Method of Seeding			
	Broadcast	Drilled		
nIooL	6	0	6	1.22
nIooM	7	1	8	
nIooH	9	2	11	
Total	22	3	25	
	Fertilizer Application			
	Applied	Not Applied		
nIooL	4	5	9	2.15
nIooM	4	8	12	
nIooH	7	4	11	
Total	15	17	32	
	Cuttings per Year			
	One	Two		
nIooL	2	7	9	3.11
nIooM	3	9	12	
nIooH	0	11	11	
Total	5	27	32	

owner-operators in the low, medium and high yield groups.

Tests for Differences in Factor Utilization Among
Non-Indian Renters in the Low, Medium and
High Yield Groups

Quantitative Continuous Data

The results of tests involving these data are summarized in Table XII. The tests indicate that there are no differences in utilization of these factors among non-Indian renters in the low, medium and high yield groups.

TABLE XII. QUANTITATIVE CONTINUOUS DATA. F TEST OF THE HYPOTHESIS OF NO DIFFERENCES IN THE MEAN LEVEL OF FACTOR UTILIZATION AMONG NON-INDIAN RENTERS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS. a/

Factor	Treatments	Source of Variation	df	SS	MS	F
% in Bloom at Time of Cutting	nIrH	Treatment	1	.06	.06	2.00
	nIrL	Error	6	.19	.03	
		Total	7	.25		
Years Tract Farmed by Operator	nIrH	Treatment	1	1.12	1.12	.013
	nIrL	Error	6	605.76	86.54	
		Total	7	606.88		

a/ Data for tests are shown in Appendices H and I.

Quantitative Discrete and Qualitative Data

The results of the tests involving these data are summarized in Table XIII. The evidence indicates that there are no differences in utilization of these factors among non-Indian renters in the low, medium and high yield groups.

TABLE XIII. QUANTITATIVE DISCRETE AND QUALITATIVE DATA. TESTS OF THE HYPOTHESIS THAT THE RATIO OF NUMBERS OF OPERATORS IN EACH FACTOR CATEGORY IS THE SAME FOR NON-INDIAN RENTERS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS.

Management Level Groups	Factor Categorization		Total	χ^2
	Method of Seeding			
	Drilled	Broadcast		
nIrL	1	1	2	0
nIrM	0	2	2	
Total	1	3	4	
	Fertilizer Application			
	Applied	Not Applied		
nIrL	1	3	4	0
nIrM	1	3	4	
Total	2	6	8	
	Cuttings per Year			
	One	Two		
nIrL	1	3	4	0
nIrM	0	4	4	
Total	1	7	8	

Tests for Differences in Factor Utilization
Among All Non-Indian Operators in the Low,
Medium and High Yield Groups

Quantitative Continuous Data

The results of tests involving this type of data are shown in Tables XIV and XV. The evidence indicates that the mean percentage bloom at time of cutting for all non-Indian operators was significantly lower than that of all non-Indian operators in the low yield group (13 vs. 26). Also the mean number of years the tracts were farmed by all non-indian operators in the high yield group was significantly higher than all non-Indian operators in the low yield group (24.18 vs. 12.78).

Quantitative Discrete and Qualitative Data

The results of tests involving this type of data are shown in Table XVI. The evidence indicates that there are no differences in utilization of these factors among all non-Indian operators in the low, medium and high yield groups.

Tests for Differences in Factor Utilization Among All
Non-Indian and Indian Operators

Quantitative Continuous Data

The results of these tests are shown in Table XVII. The F test indicates a real difference in the mean level of percentage bloom at time of cutting between Indian and all non-

TABLE XIV. QUANTITATIVE CONTINUOUS DATA. F TEST OF THE HYPOTHESIS OF NO DIFFERENCES IN THE MEAN LEVEL OF FACTOR UTILIZATION AMONG ALL NON-INDIAN OPERATORS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS. a/

Factor	Treatments	Source of Variation	ds-	SS	MS	F <u>b/</u>
% in Bloom at Time of Cutting	all nIH	Treatment	2	.14	.07	3.50*
	all nIM	Error	37	.76	.02	
	all nIL	Total	39	.90		
Years Tract Farmed by Operator	all nIL	Treatment	2	507.89	253.94	1.78
	all nIM	Error	37	5,275.21	143.57	
	all nIH	Total	39	5,783.10		

a/ Data for tests are shown in Appendices H and I.

b/ * significant at the 5 percent significance level.

TABLE XV. DUNCAN'S TEST FOR LOCATION OF SIGNIFICANT DIFFERENCES IN MEAN LEVEL OF FACTOR UTILIZATION AMONG ALL NON-INDIAN OPERATORS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS. a/

Factor	Ranked Treatments	Mean Level of Factor Utilization	Treatment Means Compared	Difference <u>b/</u>	LSR
% in Bloom at Time of Cutting	all nIH	26	all nIL-all nIH	13*	12
	all nIM	15	all nIM-all nIH	2	11
	all nIL	13	all nIL-all nIM	11	12
Years Tract Farmed by Operator	all nIL	12.78	all nIL-all nIH	11.40*	11.18
	all nIM	14.67	all nIM-all nIH	9.51	10.22
	all nIH	24.18	all nIL-all nIM	1.89	10.80

a/ Data for tests are shown in Appendices H and I.

b/ * significant at the 5 percent significance level.

TABLE XVI. QUANTITATIVE DISCRETE AND QUALITATIVE DATA TESTS OF THE HYPOTHESIS THAT THE RATIO OF NUMBERS OF OPERATORS IN EACH FACTOR CATEGORY IS THE SAME FOR ALL NON-INDIAN OPERATORS IN THE LOW, MEDIUM AND HIGH YIELD GROUPS.

Management Level Groups	Factor Categorization		Total	χ^2
	Method of Seeding			
	Drilled	Broadcast		
all nIL	7	1	8	.92
all nIM	7	1	8	
all nIH	19	4	14	
Total	23	6	29	
	Fertilizer Application			
	Applied	Not Applied		
all nIL	5	8	13	1.22
all nIM	4	8	12	
all nIH	8	7	15	
Total	17	23	40	
	Cuttings per Year			
	One	Two		
all nIL	3	10	13	4.25
all nIM	3	9	12	
all nIH	0	15	15	
Total	6	34	40	

Indian operators, with all non-Indian operators having the lower mean value (18 vs. 54.)

TABLE XVII. QUANTITATIVE CONTINUOUS DATA. F TEST OF THE HYPOTHESIS OF NO DIFFERENCES IN THE MEAN LEVEL OF FACTOR UTILIZATION AMONG ALL NON-INDIAN AND INDIAN OPERATORS. a/

Factor	Treatments	Source of Variation	df	SS	MS	F <u>b/</u>
% in Bloom at Time of Cutting	all nI	Treatment	1	1.25	1.25	28.41**
		Error	51	2.26	.04	
		Total	52	3.51		
Years Tract Farmed by Operator	1 all nI	Treatment	1	182.39	182.39	1.10
		Error	51	8,426.33	165.22	
		Total	52	8,608.72		

a/ Data for tests are shown in Appendix J.

b/ ** significant at the 1 percent significance level.

Quantitative Discrete and Qualitative Data

The results of these tests are shown in Table XVIII. They show that the ratio of the number of operators for one and two cuttings differs among Indian and non-Indian operators. A larger proportion of Indian operators had only one cutting than non-Indian operators.

A summary of the factors showing different rates of utilization among management level groups is presented in Table XIX.

TABLE XVIII. QUANTITATIVE DISCRETE AND QUALITATIVE DATA.
TESTS OF THE HYPOTHESIS THAT THE RATIO OF NUM-
BERS OF OPERATORS IN EACH FACTOR CATEGORY IS
THE SAME FOR INDIAN AND ALL NON-INDIAN OPER-
ATORS.

Management Level Groups	Factor Categorization		Total	χ^2 a/
	Method of Seeding			
	Drilled	Broadcast		
I	8	5	13	7.82**
all nI	4	25	29	
Total	12	30	42	
	Fertilizer Application			
	Applied	Not Applied		
I	4	9	13	0.18
all nI	17	23	40	
Total	21	32	53	
	Cuttings per Year			
	One	Two		
I	8	5	13	8.67**
all nI	6	34	40	
Total	14	39	53	

a/ ** significant at the 1 percent significance level.

TABLE XIX. SUMMARY OF FACTORS SHOWING DIFFERENT RATES OF UTILIZATION AMONG THE MANAGEMENT LEVEL GROUPS.

<u>Groups Compared</u>	<u>Factors Differing in Utilization</u>
IL and IH IL and IM	Years Tract Farmed by Operator
nIooL and nIooH	Years Tract Farmed by Operator
I and all nI	% in Bloom at Time of Cutting Method of Seeding Cuttings per Year
all nIL and all nIH	% in Bloom at Time of Cutting Years Tract Farmed by Operator

CHAPTER V

SUMMARY AND CONCLUSIONS

The following factors were found to be significantly related to indexed alfalfa yields.

1. Fertilized tracts had higher yields than non-fertilized tracts.
2. Yields varied directly with the amount of fertilizer applied--both per application and over time.
3. Yields were higher on tracts which were seeded by broadcasting than on those using drilling as a method of seeding.
4. Yields varied directly with the number of years the tract was farmed by the operator.
5. Yields were higher on tracts with two cuttings per year than on those with one cutting per year.
6. Yields varied inversely with the percentage bloom at the time of cutting.
7. Tracts seeding a Vernal-919 combination had higher yields than those seeding Ladac and a Ladac-Ranger combination.

Before attempting any conclusions regarding the responsibility of management, a few remarks regarding capital are in order. Fifty three percent of the operators indicated the cash available to them was limited. These same operators indicated that if more cash were available they would apply fertilizer, or if they were already applying it, increase the amount. Their eagerness to apply fertilizer on a cash basis seems to indicate that they feel the additional returns realized will exceed the additional costs incurred.

Only four of the operators admitted to credit limitations. If the capital is available, why then, is it not used to purchase and apply fertilizer. One reason may be that the amount by which additional returns exceed additional costs may be small enough to be exceeded by the interest charge on borrowed capital. Another reason may be a reluctance on the part of the operator to go into debt.

In 1963 the operators in the sample applied an average of 146.19 pounds of fertilizer per acre. The cost of fertilizer based on prices quoted by dealers, is estimated at \$5.93. The cost of capital, based on an interest rate of 6 percent, is estimated at \$.36 per acre ($.06 \times 5.93$), bringing the cost of fertilizer per acre to \$6.29. The cost of applying fertilizer is estimated at \$1.00 per acre and is based on the rate for custom work in Montana. ^{14/} This brings the cost of purchasing and applying fertilizer to \$7.29 per acre.

In this study, the average indexed alfalfa yields on fertilized tracts exceeded those on non-fertilized tracts by seven-tenths of a ton per acre. Based on these estimates, the returns

^{14/} Tietema, S. J., Rates for Custom Work in Montana, Cooperative Extension Service, Montana State University, Circular 242, 1965, p. 3.

per acre from fertilizer application would have to exceed \$7.29 per acre, the cost of purchase and application. That is, seven-tenths of a ton of alfalfa would need to return \$7.29 and one ton would need to return \$10.41 ($\$7.29 \div .7 = \10.41). In 1963, the average value of hay in the area was \$19.65 per ton.^{15/} It would thus seem, based on the above estimates, that returns from fertilizer application would exceed costs of purchase and application. Consequently there is some reason to believe that the operators in this area are reluctant to go into debt. Reluctance to use borrowed capital when it may be done profitably is a reflection on managerial ability.

It was found that a significantly large proportion of Indian operators, whose mean indexed alfalfa yields were lower than those of all non-Indian operators, used drilling as a method of seeding than all non-Indian operators. In general, costs, methods and equipment are the same for both methods of seeding. Therefore the choice of the method of seeding seems to be a managerial decision of choosing between two seeding methods relatively equal in all respects except the yields which result.

^{15/} Montana Agricultural Statistics, Montana Department of Agriculture in cooperation with USDA Statistical Reporting Service, Helena, Montana, Vol. X, p. 61.

Indian, non-Indian owner-operators and all non-Indian operators in the low yield groups were found to have farmed their tracts for a shorter period of time than those in the corresponding high yield groups. Two considerations are involved here. On the one hand the length of tenure may be due to the managerial ability of the operator while on the other hand knowledge acquired over a long period on the same tract of land may be a factor responsible for increases in yields. In either case there seems to be a difference in managerial abilities among operators coincident with length of tenure.

More Indian than non-Indian operators cut only once per year. This factor is more than likely an indicator of poor management rather than a practice which in itself results in higher yields per cutting. This is borne out to some extent by the fact that only 21 percent of those operators cutting once fertilized as opposed to 49 percent of those cutting twice. There is, however, a reservation to be considered.

The indexed alfalfa yield criterion for measuring level of management does not consider costs and returns. One could possibly obtain higher yields and not higher profits by harvesting the second crop. An alternative, such as grazing the second crop, could conceivably result in net returns greater than those achieved through harvesting. The approach established in the initial phase of this project assumes that if there is a

reasonably good second crop, profits will be maximized by harvesting it. A good alfalfa crop that is not harvested implies poor management. If the second crop is not harvested the assumption is that poor management practices have resulted in a hay crop not really worth harvesting and only in this case is alternative use made of the stand.

Indian operators were found to cut at a later stage of bloom than non-Indian operators. All non-Indian operators in the low yield group cut at a later date of bloom than those in the high yield group. This is another factor which is probably an indicator of poor management rather than a practice which in itself results in higher yields. Although it is generally accepted that the nutrient value of alfalfa is greater when cut at an early stage of bloom, there is no evidence that this practice increases yields. Of the 34 operators cutting at 10 percent bloom, 19, or 56 percent applied fertilizer. Of the 19 operators cutting at more than 10 percent bloom, only 2, or 11 percent applied fertilizer. Thus there is some indication that percentage bloom at time of cutting is an indicator of management rather than a factor which has direct influence on yields.

In conclusion, it appears that an operator in this area could increase his yields and his profits by using broadcasting as a method of seeding and applying fertilizer. There seems to

be nothing beyond his control to keep him from implementing these practices. Therefore, it would seem that there is some difference in level of management among the operators in this study. With respect to differences in utilization among the management level groups in the study only method of seeding differed in utilization and only between Indian and all non-Indian operators. The other factors found to be significantly related to indexed alfalfa yields (years tract farmed by operator, percentage bloom at time of cutting and number of cutting per year) seem to be indicators of management level rather than practices which in themselves result in increased yields.

APPENDICES

APPENDIX A

Questionnaire Used in Study

CONFIDENTIAL

Montana Agricultural Experiment Station
Department of Agricultural Econ.
Bozeman, Montana

Date _____

Enumerator _____

LEVEL OF MANAGEMENT STUDY: M.S.-1165

I. TRACT AND FARM IDENTIFICATION

1. Tract No. _____ 2. Legal Description _____
3. Total acres in farm _____
 - a. Acres irrigated _____ b. Acres dry _____
 - c. Acres Alfalfa hay _____ d. Acres all other crops _____
4. Kind of livestock _____, _____, _____
 - a. No. of cows _____ d. Ewes _____
 - b. Young Stock _____ e. Other animals _____
 - c. Dairy cows _____

II GENERAL INFORMATION

1. Operator's name _____ Age _____
 - a. Where were you born? _____ city _____ farm _____
 - b. Education level _____
 - c. Do you keep farm records? _____
 - d. Kind _____
2. Number in family _____
3. Ages of wife _____, daughters _____, sons _____
4. Hired labor _____ (months)
5. Is this tract owned? _____ or rented? _____
6. If rented, length of lease? _____

7. How long have you farmed this tract?_____
- a. Do you sell or feed your alfalfa hay?_____
- b. If sold, to whom is it sold?_____
- c. Delivered, or at the farm?_____

III. MANAGEMENT PRACTICES

A. Previous Use of This Tract:

1. What was the crop rotation prior to seeding this tract to alfalfa?_____
2. What was the immediately preceding crop?_____
3. When was this tract last in alfalfa?_____
4. When was this stand of alfalfa seeded?_____

B. Seedbed Preparation:

1. Was the land plowed before seeding?_____
- How deep?_____ How long before seeding?_____
2. Number of times worked_____
3. Types of operations_____
- _____
- _____
- _____

C. Planting Practices:

1. Variety of seed used?_____
2. Had seed been checked for germination and purity?_____
- a. Do you remember the % germination_____
- % purity_____
3. Was seed drilled in?_____
- a. Type of equipment used?_____,_____,_____

4. If broadcast, what equipment was used?_____
5. Rate of seeding_____ (lbs./A.)
6. Depth of seeding_____
7. Time of year sowed, Spring_____ or Fall_____
8. Was a nurse crop used?
 - a. If so, what was it?_____
 - b. Rate of nurse crop seeding_____ (lb. or bu/a)
 - c. Was nurse crop harvested?_____ cut for hay?_____
At what stage of growth?_____
 - d. Yield of nurse crop_____ (bu. or tons)
9. Was the nurse crop irrigated up?_____
 - a. Number of irrigations for nurse crop_____
 - b. Amount of irrigation water applied on nurse crop_____

D. Irrigation Practices:

1. Is the irrigation water supply adequate?_____
2. If you have shortages, when do they occur?_____
3. What type of irrigation system is used on this tract?_____
4. Irrigations per year on this tract.
Average year_____, (1961)_____ (1963)_____
5. Amount of water each irrigation,
Average year_____, (1961)_____ (1963)_____
6. Total water applied,
Average year_____, (1961)_____ (1963)_____

7. How do you decide when to irrigate alfalfa?_____
8. Has the amount of irrigation water applied on this tract varied with the age of stand?_____
- month of year?_____
- amount of rainfall?_____

E. Fertilizer Practices:

1. When, if any, was fertilizer first put on this stand?_____
- a. Kind_____ b. Amount_____
2. How often has this stand been fertilized since it was established?_____
- a. Kind_____ b. Amount_____
3. How was fertilizer applied?_____
4. Was fertilizer applied in 1961?_____ 1963?_____
- a. Kinds_____
- b. Amounts_____
- c. Methods of application_____
- d. Time of application_____
5. Have you applied manure to this tract of alfalfa?
- a. If so, how applied?_____
- b. How often?_____ At what time of year?_____
- quantity_____
- c. Have you applied minor elements?_____
- d. Identify each_____
- e. Quantity of each_____

f. Time of application_____

g. Method of application_____

F. Harvesting Practices:

1. How do you decide when to cut hay?_____

2. Your own equipment or custom cut?_____

3. Equipment used (types & sizes)_____

4. How close to the ground do you cut?_____

a. How long in the swath?_____

b. How long in the windrow?_____

c. Number of times usually turned?_____

5. If hay is baled, how many days from cutting to
baling?_____

6. How soon after baling are bales removed from the
field?_____

7. How soon after removing the hay crop is hay again
irrigated?_____

How heavily is it irrigated?_____

8. How many cuttings per year on this tract?
average year_____, (1961)_____(1963)

9. At what time of year does last cutting take place?

10. Any special practices in handling the stand after the last cutting of hay?_____

G. Stand Management Practices:

1. Was this stand renovated in any way?_____

Explain_____

2. Was this stand ever clipped for weed or other control?_____

a. How was it done? (kind of equip., etc.)_____

b. When?_____

c. How many times?_____

d. At what stage of growth?_____

e. Were clippings removed?_____

f. If so, how?_____

3. Has this stand been pastured?_____

a. At what times?_____

b. How heavily was it stocked?_____ (AU/A)

c. How long were stock left on?_____

4. Have you had any problems with disease, weeds, rodents, or insects?_____

a. Explain, giving the type of treatment, amount and year_____

H. Credit Use:

1. Is cash or credit limited for purchase of haying equipment, labor for haying, fertilizers, seed, etc.? _____
2. If more cash or credit were available, how much more would you have used on this tract? _____

3. If you use credit, where is it obtained? _____

APPENDIX B

CALCULATING FORMULAS FOR REGRESSION ANALYSIS

Let X_i = Observations on the independent variable.

Y_i = Observations on the dependent variable.

To calculate b , the sample regression coefficient, the following formula was used:

$$b = \frac{\sum x_i y_i}{\sum x_i^2}$$

$$\text{where } \sum x_i y_i = \sum X_i Y_i - \frac{\sum X_i \sum Y_i}{n}$$

$$\text{and } \sum x_i^2 = \sum X_i^2 - \frac{(\sum X_i)^2}{n}$$

The formula for F , the test used to test the null hypothesis, $H_0: \beta = 0$, for sample size n is given by

$$F(1, n-2) = \frac{MSR}{MSE} = \frac{SSR}{SSE/n-2}$$

Where $SSR = b \sum x_i y_i$ and $SSE = \sum y_i^2 - SSR$

APPENDIX C

CALCULATING FORMULAS FOR ANALYSIS OF VARIANCE

Let X_{ij} denote the j th observation on the i th treatment, $i = 1, 2, \dots, t$ and $j = 1, 2, \dots, r_i$, where t is the number of treatments and r_i is the number of replicates on the i th treatment.

$$\text{Total SS} = \sum_{i,j} X_{ij}^2 - C \text{ where } C = \frac{(\sum_{i,j} X_{ij})^2}{\sum_i r_i}$$

$$\text{Treatment SS (SST)} = \frac{\sum_j X_{1j}}{r_1} + \frac{\sum_j X_{2j}}{r_2} + \dots + \frac{\sum_j X_{tj}}{r_t}$$

$$\text{Error SS (SSE)} = \text{Total SS} - \text{Treatment SS}$$

$$F(t-1, \sum_{i=1}^t r_i - t) = \frac{SST/t-1}{SSE/\sum_{i=1}^t r_i - t} = \frac{MST}{MSE}$$

APPENDIX D

CALCULATING FORMULAS FOR DUNCAN'S NEW MULTIPLE RANGE TEST

Let SSR = significant studentized range which is a tabulated value for the error degrees of freedom of the sample.

Let LSR = least significant difference.

$$LSR = SSR \times \sqrt{MSE} \times \sqrt{.5 \left(\frac{1}{r_i} - \frac{1}{r_j} \right)}$$

where r_i and r_j are the number of observations in the two means being compared.

APPENDIX E

CALCULATING FORMULAS FOR THE CHI-SQUARE TEST FOR INDEPENDENCE USING CONTINGENCY TABLES

Let Chi-square = χ^2

In testing the hypothesis of independence, the calculating formulas for χ^2 depend on the dimension of the contingency table. The number of observations in the ij th cell is denoted by n_{ij} . Let n_i represent the totals in the i th row, $n_{.j}$ the totals in the j th column and $n_{..}$ the grand total. The degrees of freedom is given by $(r-1)(c-1)$.

If the table is 2×2 , the calculating formula is given by:

$$\chi^2 = \frac{(n_{11}n_{22} - n_{12}n_{21})^2}{n_{1.}n_{2.}n_{.1}n_{.2}}$$

with one degree of freedom

If the table is $r \times 2$, the calculating formula is

$$\chi^2 = \frac{\sum_i (n_{ij}^2/n_{i.}) - n_{.j}^2/n_{..}}{n_{.1}n_{.2}/n_{..}}$$

with $r-1$ degrees of freedom.

APPENDIX TABLE F. INDEXED YIELDS (Y) AND QUANTITATIVE CONTINUOUS VARIABLES (X_i).

Yield Group	Operator Classification	Indexed Yields	Age of Stand (Years)	Depth of Seeding (Inches)	Discing Repetitions	Harrowing Repetitions	Leveling Repetitions	Total No. of Operations performed in Seeding Preparation	Rate of Alfalfa Seeding (Lbs./A.)	Rate of Nurse Crop Seeding (Lbs./A.)	Fertilizer Application (Lbs./A.)	Fertilizer Applied Over Life of Stand (Lb./A.)	Irrigation Water (Acres Ft./A.) Per Crop	Irrigation Water (Acres Ft./A.) Per Year	Pasture Usage		Height of Cut (Inches)	Educational Level of Operator	Years Farmed by Operator	Age of Operator	
															Animals Per Acre	% in Bloom at Time of Cutting					
LOW	I	1.31	8	6	2	2	0	4	12				2.26	4.52	.81	.75	2	8	15	61	
	nloo	1.35	9	7	1	1	1	3	10	1.00	70	170	1.63	4.89	2.19	.10	4	8	3	71	
	I	1.66	6	6	2	2	0	4	12				.76	1.52	.44	.75	2	8	15	61	
	nlr	1.78	4	6	2	1	1	4	10				2.38	4.76	.52	.50	2	8	2	37	
	nloo	1.81	4	4.5	0	0	0	2	10	2.00			.69	1.60	3.80	.10	2	10	4	59	
	I	1.85	4	6	1	1	1	3	8	1.00			1.31	1.31	.40	.50	2	5	4	57	
	nloo	1.89											1.52	3.04	.82	.10	2	14	4	48	
	I	2.00											1.02	2.04	.52	.50	2	12	9	53	
	I	2.07	6	6	3	2	2	1	6	10	1.88			1.07	2.14	.47	1.00	2	12	6	44
	nlr	2.16	6	7.5	2	2	0	4	4	8	1.67	200	200	.56	1.12	.78	.10	2	10	14	40
	nloo	2.21											.72	2.16	2.28	.50	2	8	7	60	
	I	2.26											.69	1.37	.67	.10	3	8	5	61	
MEDIUM	I	2.28	6	6	3	2	1	7	10	1.88			.83	1.66	3.50	1.00	2	12	6	44	
	nlr	2.32	5	3	2	3	2	7	12	1.67			1.13	2.26	.64	.50	2	6	7	32	
	nloo	2.37	2	6	2	2	2	6	12				.69	1.14	.42	.10	2	8	10	76	
	nloo	2.45											.69	1.38	1.20	.10	2	8	30	69	
	nloo	2.46	5	6	1	0	1	2	10	1.04			.53	1.59	3.00	.10	1	5	34	80	
	nloo	2.59	5	10	3	1	2	6	10	1.88	115	445	.52	.96	.72	.75	2	12	10	42	
	nloo	2.59	7	4	3	2	2	7	10	1.88	120	360	1.00	3.00	.66	.33	2	9	15	48	
	nlr	2.59											.74	1.52	.86	.10	2	8	30	69	
	nloo	2.72	3	5	2	1	1	4	10	2.08			4.67	9.34	2.55	.25	3	12	5	31	
	nloo	2.75	12	7	1	1	1	3	10				.36	.76	.60	.25	2	12	20	46	
	I	2.97	4	6	2	0	1	3	10	2.34	100	200	1.02	2.04	1.35	.75	2	9	13	40	
	I	3.05	8	6	3	4	2	9	12	2.08	180	1260	1.36	2.72	1.25	.10	3	8	27	60	
HIGH	nloo	3.13	4	6	2	1	3	6	10	1.56			.29	.87	1.62	.10	2	12	14	40	
	nloo	3.21											.48	.96	1.20	.10	2	9	8	64	
	I	3.22	6	4	0	1	1	2	10	3.13			.35	.70	1.24	.10	3.5	6	46	64	
	nloo	3.23	14	7	1	1	1	3	10				1.03	2.06	.60	.25	2	12	20	46	
	nloo	3.25											1.22	2.44	.82	.10	2	14	4	48	
	nloo	3.32	10	6	0	3	1	4	10	.94			.69	1.37	1.26	.10	4	8	16	63	
	nloo	3.34	7	7	2	0	1	5	10	1.00	100	1000	2.02	4.04	1.98	.25	2	12	20	46	
	nloo	3.39	4	7	3	0	1	4	15	3.13			1.98	3.96	.82	.66	2	8	42	60	
	I	3.49	6	6	0	2	3	5	6	1.88	80	160	1.67	3.34	1.90	.10	2	9	7	45	
	nloo	3.52											1.95	3.90	.82	.10	2	14	4	48	
	nloo	3.57	4	6	4	4	0	8	12		100	200	.69	1.15	.54	.10	2	8	46	76	
	nloo	3.67	4	6	3	4	2	9	12	2.34	180	720	2.10	6.30	1.25	.10	3.5	8	27	60	
I	3.74	6	6	2	0	2	4	10	1.67			.56	1.68	.70	.10	2	8	12	68		
nloo	3.74	9	6	2	1	0	3	5		125	500			3.66	.10	2.5	10	20	70		
nlr	3.84											1.17	2.34	1.40	.33	4	12	5	43		
nlr	4.08	6	6	1	1	1	1	3	18			.89	1.78	4.00	.10	2	3	28	77		
nloo	4.14	6	6	2	1	1	4	18						2.67	.10	2	3	28	77		
nloo	4.33	10	7	2	3	1	6	8		100	400	.71	2.13	2.50	.10	3	10	8	41		
nloo	4.34	7	5.5	2	1	2	5	9	1.25	100	1100	.87	1.74	.15	.10	3	10	18	41		
nloo	4.65	15	6	2	0	2	4	10	1.67	125	1625	1.67	5.01	1.33	.10	2	8	20	68		
nloo	4.74											.81	1.62	1.39	.33	4	12	7	43		
nlr	5.03	8	6	2	0	0	1	3	12	3.13	200	1800	.69	1.60	2.31	.10	1	16	10	706	
nloo	5.14	8	7	3	0	1	4	15	3.13			.45	.90	.82	.66	2	8	42	60		
I	5.16	8	6	2	2	2	6	12	1.56			.71	1.42	.24	.10	2	8	46	76		
nloo	5.27	10	6	3	3	1	7	8	1.67	200	1800	.69	1.14	1.65	.10	2	16	11	48		
nlr	5.52	6	8.5	1	1	1	3	13	2.19	240	1200	.80	1.60	.68	.10	2	12	17	57		
nloo	5.61	4	6	2	1	0	3	12	2.08	200	200	1.12	4.48	.76	.10	2	12	23	50		
nloo	5.63	6	6	1	1	1	3	10	1.00			1.70	3.40	3.05	.10	2	10	22	76		
nloo	5.90	5	6	2	2	2	6	12				1.94	3.98	1.29	.10	2	8	46	76		
nloo		142.73	142.73	142.73	142.73	142.73	142.73	142.73	142.73	103.87	78.62	78.62	166.81	166.81	174.69	174.69	174.69	174.69	174.69	174.69	
Y		552.08	552.08	552.08	552.08	552.08	552.08	552.08	552.08	406.74	325.87	325.87	621.68	621.68	652.81	652.81	652.81	652.81	652.81	652.81	
Y ²		277.00	257.00	79.00	62.00	50.00	194.00		453.00	55.73	3035.00	14840.00	57.20	124.65	70.04	14.11	120.50	506.00	912.00	2990.00	
X ₁		2123.00	1624.00	185.00	144.00	84.00	1036.00		5149.00	115.92	492575.00	16638950.00	92.02	438.32	138.94	7.27	297.75	5252.00	24302.00	178104.00	
X ₁ ²		970.70	881.11	275.95	207.22	176.39	661.77		1568.36	197.70	12082.50	62800.50	184.12	404.14	235.99	40.14	395.26	1698.33	3351.52	10038.78	
XY																					

APPENDIX TABLE G. INDEXED YIELD DATA FOR QUANTITATIVE DISCRETE AND QUALITATIVE DATA.

Rotation Period			Time of Plowing Prior to Seeding		Nurse Crop Usage		Grass Seed Alfalfa Seeding Mixture		Type	of		Seed		Planted		
1	2	3	Spring	Fall	Used	Not Used	Used	Not Used	Grimm	919	Grimm-919	919-Vernal	Ladac	Ranger	Ladac-Ranger	Common
Av. 2.44	Av. 3.48	Av. 3.46	Av. 3.16	Av. 4.01	Av. 3.46	Av. 3.24	Av. 3.87	Av. 3.25	Av. 3.62	Av. 3.29	Av. 4.24	Av. 5.27	Av. 1.45	Av. 2.99	Av. 1.81	Av. 2.46
1.85	1.31	1.35	1.31	1.35	1.35	1.31	2.07	1.31	1.31	1.85	3.05	5.27	2.07	2.75	1.81	2.46
2.07	1.66	1.81	1.66	2.37	1.81	1.66	2.16	1.35	1.35	2.32	4.65		2.16	3.23		
2.28	1.78	2.16	1.78	4.33	1.85	1.78	2.28	1.66	1.66	2.72	5.03		2.28			
3.57	2.32	2.37	1.85	5.16	2.07	2.37	2.37	1.78	1.78	3.13						
	2.75	2.46	2.07	5.52	2.16	2.75	2.46	1.81	2.37	3.67						
	3.05	2.59	2.16	5.63	2.28	3.23	3.57	1.85	2.59	3.74						
	3.22	2.59	2.28	5.90	2.32	3.57	3.67	2.32	2.59	5.61						
	3.23	2.72	2.32	1.81	2.46	3.74	4.33	2.59	2.97							
	3.32	2.97	2.46		2.59	4.08	4.34	2.59	3.22							
	3.34	3.13	2.59		2.59	4.14	5.03	2.72	3.32							
	3.49	3.39	2.59		2.72	4.33	5.16	2.75	3.34							
	3.67	3.74	2.72	2.97	2.97	5.90	5.27	2.97	3.39							
	4.08	3.74	2.75		3.05		5.90	3.05	3.49							
	4.14	4.34	2.97		3.13			3.13	3.57							
	5.03	4.65	3.05		3.22			3.22	3.74							
	5.27	5.14	3.13		3.32			3.23	4.08							
	5.52	5.16	3.22		3.34			3.32	4.14							
	5.61	5.61	3.23		3.39			3.34	4.33							
	5.63		3.32		3.49			3.39	4.34							
		5.90	3.34		3.67			3.49	5.14							
			3.39		3.74			3.74	5.16							
			3.57		4.65			4.08	5.63							
			3.67		5.03			4.14	5.90							
			3.74		5.14			4.65								
			3.74		5.16			5.14								
			4.14		5.27			5.52								
			4.34		5.52			5.61								
			3.65		5.61			5.63								
			5.03		5.63											
			5.14													
			5.27													
			5.61													
			4.08													

E Y1 ₂	9.77	62.81	65.82	110.66	32.07	103.87	38.86	48.61	94.12	84.93	23.04	12.73	5.27	6.51	5.98	1.81	2.46
E Y1	25.64	247.55	260.14	399.00	153.08	406.74	145.34	204.13	347.95	341.67	84.93	56.23	27.77	14.15	18.00	3.28	6.05
EE Y1 ₂	138.40			142.73		142.73		142.73		142.73							
EE Y1	533.33			552.08		552.08		552.08		552.08							

APPENDIX TABLE G. INDEXED YIELD DATA AND QUANTITATIVE DISCRETE AND QUALITATIVE DATA. (Continued)

Method of Seeding		Fertilizer Application		Manure Application		Fall Irrigation		Renovation		Winter Use of Stand		Type of Irrigation System Used		Cuttings Per Year	
Broadcast	Drilled	Applied	Not Applied	Applied	Not Applied	Performed	Not Performed	Performed	Not Performed	Carried Livestock	Free of Livestock	Flood	Sprinkle	1	2
Av. 3.63	Av. 2.74	Av. 3.71	Av. 3.00	Av. 3.57	Av. 3.15	Av. 3.23	Av. 3.40	Av. 3.02	Av. 3.56	Av. 3.09	Av. 3.45	Av. 3.26	Av. 3.34	Av. 2.51	Av. 3.56
1.35	1.31	1.35	1.31	1.35	1.31	1.31	1.81	1.35	1.31	1.35	1.31	1.31	1.81	1.31	1.35
1.81	1.66	2.16	1.66	1.66	1.78	1.35	1.89	1.66	1.78	1.66	1.78	1.35	2.26	1.66	1.78
2.16	1.78	2.26	1.78	1.89	1.81	1.66	2.07	2.00	1.81	1.85	1.81	1.66	2.37	1.85	1.81
2.32	1.85	2.59	1.81	2.16	1.85	1.78	2.21	2.07	1.85	1.89	2.16	1.78		1.89	2.00
2.37	2.07	2.59	1.85	2.26	2.00	1.85	2.28	2.16	1.89	2.00	2.26	1.85	3.32	2.07	2.21
2.46	2.28	2.97	1.89	2.59	2.07	2.00	2.37	2.21	2.37	2.07	2.28	1.89		2.16	2.26
2.59	3.05	3.05	2.00	3.05	2.21	2.16	2.97	2.26	2.45	2.21	2.32	2.00		2.28	2.32
2.59	3.13		2.07	3.21	2.28	2.26	3.05	2.28	2.59	2.45	2.37	2.07	5.27	2.46	2.37
2.72	3.67	3.21	2.21	3.25	2.32	2.32	3.13	2.32	2.72	2.46	2.59	2.21		2.59	2.45
2.75	4.33	3.32	2.28	3.32	2.37	2.45	3.21	2.46	3.22	2.59	2.97	2.21		2.97	2.59
2.97	5.03	3.49	2.32	3.34	2.45	2.46	3.25	2.59	3.25	2.59	3.05	2.28		3.22	2.59
3.22		3.57	2.37	3.49	2.46	2.59	3.32	2.59	3.32	2.72		2.32		3.49	2.72
3.23		3.67	2.45	3.52	2.59	2.59	3.52	2.75	3.39	2.75	3.13	2.45		3.52	2.75
3.32		3.74	2.46	3.67	2.59	2.59	3.57	2.97	3.49	3.22	3.21	2.46		3.74	3.05
3.34		4.33	2.59	3.74	2.72	2.72	3.67	3.05	3.52	3.23	3.32	2.59			
3.39		4.34	2.72	4.84	2.75	2.75	3.74		3.57	3.25	3.34	2.59			3.13
3.49		4.65	2.75	4.65	2.97		5.16	3.13	3.84	3.39	3.49	2.59			3.21
3.57		5.03	3.13	5.27		3.22	5.27	3.21	4.08	3.52	3.57	2.72			3.23
3.74		5.27	3.22	5.61	3.13	3.23	5.52	3.23	4.14	3.74	3.67	2.75			3.25
3.74		5.52	3.23	5.63	3.22	3.34	5.90	3.34	4.33	4.34	3.74	2.97			3.32
4.14		5.61	3.25	5.90	3.23	3.39		3.67	4.74	4.65	4.08	3.13			3.34
4.08		5.90	3.34		3.39	3.49		3.74	5.03	5.14	4.14	3.21			3.57
4.34			3.39		3.57	3.74		3.74	5.14	5.52	4.33	3.22			3.67
4.65			3.52		3.74	3.84		4.34	5.16	5.63	4.74	3.23			3.74
5.14			3.74		3.84	4.08		4.65	5.61		5.03	3.25			3.84
5.16			3.84		4.08	4.14		5.27	5.63		5.16	3.34			4.08
5.27			4.14		4.14	4.33		5.52	5.90		5.27	3.39			4.14
5.52			4.08		4.33	4.34					5.61	3.49			4.33
5.61			4.74		4.74	4.65					5.61	3.52			4.34
5.63			5.14		5.03	4.74					5.90				4.65
5.90			5.16		5.14	5.03						3.67			4.74
			5.63		5.16	5.14						3.74			5.03
					5.52	5.61						3.84			5.14
						5.63						4.08			5.16
												4.33			5.27
												4.34			5.52
												4.65			5.61
												4.74			5.63
												5.14			5.90
												5.16			
												5.52			
												5.61			
												5.63			
												5.90			
112.57	30.16	78.62	96.07	73.90	100.79	106.78	67.91	78.56	96.13	74.22	100.47	146.92	23.63	35.21	139.48
454.91	97.17	325.87	326.94	295.22	357.59	393.91	258.90	265.09	387.72	263.44	389.37	544.83	90.84	96.13	556.68
142.73		174.69		174.69		174.69		174.69		174.69		170.55		174.69	
552.08		652.81		652.81		652.81		652.81		652.81				652.81	

APPENDIX TABLE H. PERCENT IN BLOOM AT TIME OF CUTTING BY CULTURAL AND TENURE GROUP BASED ON THIRDS OF TOTAL SAMPLE.

Operator Classification Yield Group		Indian			Non-Indian Renter			Non-Indian Owner-Oper.		
		Low	Med.	High	Low	Med.	High	Low	Med.	High
Average		.66	.34	.66	.40		.22	.20	.15	.10
		.75	.75	.66	.50		.10	.10	.25	.10
		.75	.10		.50		.33	.10	.25	.10
		.50	.10		.50		.33	.10	.10	.10
		.50	.66		.10		.10	.10	.10	.10
		1.00	.10					.10	.25	.10
		.10						.10	.25	.10
		1.00						.10	.10	.10
								.75	.10	.10
								.33	.10	.10
									.10	.10
									.10	.10
X _i ²		4.60	1.71	.66	1.60		.86	1.78	1.80	1.10
X _i ²		3.63	1.03	.44	.76		.24	.74	.33	.10
X _i ²		6.97			2.44			4.68		
X _i ²		5.10			1.00			1.17		

APPENDIX TABLE I. YEARS TRACT FARMED BY OPERATOR BY CULTURAL AND TENURE GROUP BASED ON
THIRDS OF TOTAL SAMPLE

Operator Classification Yield Group	Indian			Non-Indian Renter			Non-Indian Owner-Oper.		
	Low	Med.	High	Low	Med.	High	Low	Med.	High
Average	9.86	31.00	42.00	11.50		10.75	12.78	14.67	24.18
	15	13	42	2		20	3	5	28
	15	27		7		5	4	20	28
	4	46		7		7	4	14	8
	9	42		30		11	5	8	18
	6	27					10	20	20
	14						30	4	10
	6						34	16	46
							10	20	17
							15	7	23
								4	22
								46	46
								12	
$\sum X_i^2$	69	155	42	46		43	115	176	266
$\sum X_i$	815	5,507	1,764	1,002		595	2,547	4,082	7,990
$\sum \sum X_i$	266			89			557		
$\sum \sum X_i^2$	8,086			1,597			14,619		

APPENDIX TABLE J. FACTOR USAGE BY CULTURAL GROUP.

Operator Classification	% in Bloom at Time of Cutting		Years Tract Farmed by Operator	
	I	allnI	I	allnI
Average	.54	.18	20.46	16.15
	.75	.10	15	3
	.75	.50	15	2
	.50	.10	4	4
	.50	.10	9	4
	1.00	.50	6	7
	.10	.10	14	5
	1.00	.50	6	7
	.75	.10	13	10
	.10	.10	27	30
	.10	.10	46	34
	.66	.75	42	10
	.10	.33	27	15
	.66	.10	42	30
		.25		5
		.25		20
		.10		14
		.10		8
		.25		20
		.10		4
		.10		16
		.25		20
		.10		7
		.10		4
		.10		46
		.10		12
		.10		20
		.33		5
		.10		28
		.10		28
		.10		8
		.10		18
		.10		20
		.33		7
		.10		10

APPENDIX TABLE J. FACTOR USAGE BY CULTURAL GROUP. (Cont.)

Operator Classification	% in Bloom at Time of Cutting		Years Tract Farmed by Operator	
	I	allnI	I	allnI
Average	.54	.18	20.46	16.15
		.10		46
		.10		11
		.10		17
		.10		23
		.10		22
		.10		46
Xi	6.97	7.14	266	646
Xi ²	5.10	2.17	8,086	16,216
Xi ₂	14.11		912	
Xi ²	7.27		24,302	

LITERATURE CITED

Montana State University, Department of Plant and Soil Science (unpublished data).

Montana Agricultural Statistics, Montana Department of Agriculture in cooperation with USDA Statistical Reporting Service, Helena, Montana, Vol. X, 1964.

Olsen, Carl E., "A Method of Measuring the Comparative General Level of Management for Farm Operators on the Jocko Valley Division of the Flathead Irrigation Project." Unpublished Master's Thesis, Department of Economics, Montana State University, 1963.

Steel, R.G.D. and J. H. Forrie, Principles and Procedures of Statistics, New York, N. Y., McGraw-Hill Book Company, Inc.

Storie, R. Earl, Revision of the Soil Rating Chart, California Experiment Station, Berkeley, California, December, 1959.

Tietema, S. J., Rates for Custom Work in Montana, Cooperative Extension Service, Montana State University, Circular 242, 1965.

United States Department of Interior, Bureau of Indian Affairs, Flathead Irrigation Project Crop Report, 1963 (unpublished data).



N378	Zurenko, J.G.
Z87	An investigation of
cop.2	factors affecting the
	comparative general
	level of management for farm
	operators on the Jocko Valley...
NAME AND ADDRESS	
Feb 1971	John Markesard
5-14-72	Teodoro C. Rot
1-29-73	RT. 2, Box 2
MAR 17 1973	Box 2
	N378
	Z87
	cop.2

