AN ABSTRACT OF THE THESIS OF

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Title: The Concept of Diversification As A Characteristic of Farm Structure

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The first reason farms diversify is generally viewed as a move towards greater economic efficiency through a more rational use of resources. The second reason for diversification, that of reducing variations in returns, may be a move away from most profitable resource utilization to insure that the long run goals of the farm manager are met.

A survey was conducted among potential users of the concept of diversification. The survey contained a total of twelve hypothetical farms from three irrigation districts in sourthern Alberta. Farmers from each of the irrigation districts and farm management specialists from Alberta and Oregon were asked to rank each of the hypothetical farms according to their perceived degree of diversification for that farm. Personal data about the respondent was also collected to determine if personal attributes of the respondent affected his/her perception of diversification.

The nonparametric Wilcoxon matched-pairs signed-ranks test was used to determine if the ranks assigned each hypothetical farm were consistent across all respondents. The test indicated that the

respondents perceived a difference in the degree of diversification for approximately fifty percent of the bi-farm comparisons. It was not possible to determine whether the respondents perceived the remaining fifty percent of the bi-farm comparisons of diversification to be the same or if they could not agree on a difference.

The survey data were analyzed by regression analysis to determine the criteria used by the respondents to differentiate the diversification ranks among farms. Personal data for the respondent and objective ranking criteria for the hypothetical farms were used as explanatory variables for the normalized diversification ranks assigned the hypothetical farms. The diversification ranks were normalized for each respondent.

It was concluded that the personal attributes tested for the farmer and farm manager respondents were not significant indicators of their perceived rankings of the hypothetical farms. Calculated diversification indices using gross return or net return as enterprise activity level indicators were highly significant in explaining the ranks assigned each hypothetical farm by both types of respondents. Diversification indicators, besides the single calculated diversification indices commonly used in the firm structure literature, were significant in explaining the ranks assigned the hypothetical farms by the farmer respondents. Indicators such as income variability, location of the farm, the amount of land irrigated, and the nonexistence of a livestock enterprise were all significant indicators of the farmer respondent's perceived levels of diversification for the hypothetical farms.

THE CONCEPT OF DIVERSIFICATION AS A CHARACTERISTIC OF FARM STRUCTURE

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CHAPTER I. INTRODUCTION

Background

The role of a farm manager or planner is to control the amount and structure of the resources over which he has control, in order to maximize his objective function subject to given constraints and varying external conditions. Farm structure describes the resulting elements or resources of a farm unit and the position of such in their external relationship to each other. The elements of farm structure include things such as size of farm, organizational form of management control and ownership, level of diversification, types of hired labor, types of enterprises, irrigation, geographic location, etc. Diversification will be discussed as an element of farm structure within this study.

Farm management literature addresses itself to understanding and describing the potential or possibly the currently accepted but not understood (at least not by professional farm management specialists) relationships between the elements of farm structure. In order to consistently analyze the elemental relationships, the farm management specialist uses techniques such as budgeting, mathematical programming, simulation, and statistical analysis to determine optimum input and output relationships for the given production functions. With the findings, the analyst then makes general statements about farm structure such as, levels of fertilizer use, farm size, and degree of diversification. The analyst will indicate that in order to meet assumed management objectives some farms may need to diversify or specialize. General analysis of the trends in agriculture also describe elements of farm structure, i.e., farms are becoming more capital intensive, larger, and more specialized.

Observations and communication about farm structure often depend on subjective evaluations. We use combinations of quantifiable measures such as, number of acres, amount of irrigated-nonirrigated crops, types of livestock, and diversification as descriptors of farm structure.

In order to communicate the concept of diversification in relation to other descriptors of farm structure, there is a need to establish a more precise concept of diversification. The concept of diversification as a descriptor of farm structure has been in common usage in farm management for some time as the adage, "Don't put all your eggs in one basket" indicates. Even so, the term diversification is seldom defined in the management literature. Quantitative measures, which will be briefly discussed later have been devised to measure diversification. However, no study has been devised, to date, to see if these measures of diversification reflect the subjective concept of diversification of those with whom the word diversification will be used as a communicative tool.

Production Theory and Diversification

Although diversification is commonly used as a descriptor of farm structure, few formal definitions for diversification exist. White and Irwin (20, p. 193) define specialization, which is often assumed to be the antonym of diversification, to be: "specializing implies restricting the scope of activities participated in". Doll and Orazem (4, p. 252) give a more specific definition of diversification. "Diversification means growing two or more products in an attempt to avoid the yield and price uncertainty of a single product."[1] Although Heady (10, p. 201) did not specifically define diversification he discussed diversification as pertaining to the role of the farm manager. One of the major management concerns for the farm manager and the farm observer is, how given resources are allocated among competing commodities or enterprises.

> "... the problem presents itself as a question of the combination of crops to be grown on the limited farm or land area and from given quantities of labor, capital, and management resources. It is also a question of what kinds and amounts of livestock products should be produced with the limited stock of resources available to the farmer. In practical terminology, it concerns the extent to which the farm should be diversified or specialized."

Heady (9) stated that there are two reasons for diversification when planning under imperfect knowledge. First the optimal degree of diversification ($MRT = P_{Y_1}/P_{Y_2}$) is largely dependent on technical

1 Doll and Orazem go on to explain that in reality agricultural prices and yields tend to move together. This limits the ability of diversification to achieve its defined purpose.

relationships (i.e., complementary) of the potential enterprises. Second diversification is used to minimize the variance of the outcome, i.e., putting a floor level on returns or in preventing the occurrence of undersirable outcomes.

Diversification and Optimum Resource Use

The decision to specialize or diversify is generally presented as that of allocating a bundle of inputs among competing production activities or enterprises. The most profitable combination of products is determined by the technical production functions for alternative enterprises and relative product prices. The types of technological relationships encountered among interdependent products in agriculture are classified as: joint, supplemental, complementary, and competitive products.

Figure 1 demonstrates representative production possibility curves for each of the product relationships. PPC(1) represents complementarity, between products A and B, over the range from A = 0 to A = a_2. PPC(2) represents supplementarity, between products A and B, over the range from A = 0 to A = a_1. Given positive prices for products A and B at least a_1 and a_2 units of A will be produced for the conditions of supplementarity and complementarity, respectively. Complimentary and supplementary relationships could lead to the production of various enterprises which would not be produced if their production were independent of the production functions of other potential products. For example, if the same amount of wheat could be obtained from the same acre of land which produced wheat

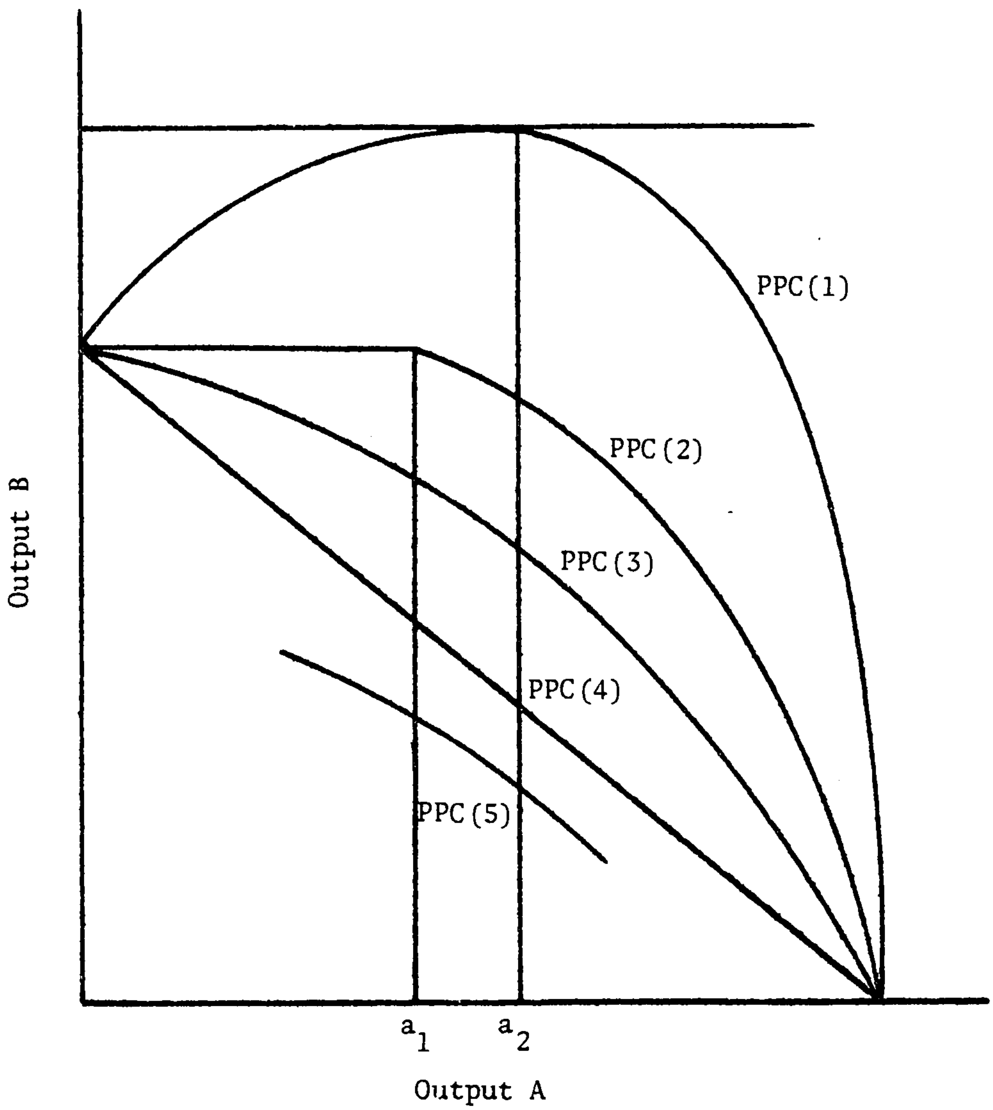

Figure 1. Production possibilities curves for five technical relationships between products A and B.

for three years and alfalfa for one year versus producing wheat for four years, then alfalfa would be produced for one year if at least variable costs for alfalfa could be recovered. Alfalfa would then not have to compete with wheat for one year out of the four. If alfalfa were considered for production on the same acre of land for two years out of the four, it would be a competitive product with wheat for the second year. Alfalfa would be supplemental to wheat for one year out of four. Complementary and supplemental product relationships all increase the tendency of a farm to diversify.

PPC(5) in Figure 1 indicates an output relationship of joint products which are competitive over a small range.[2] An example of this relationship would be a ranch which produced mutton (Output A) and wool (Output B). If the interaction of the iso revenue curve and PPC(5) were such that wool production was favored to mutton production, breeding stock would be selected to give maximum wool production. Even if wool were highly favored to mutton production, some mutton (M) has to be produced. Joint products dictate diversification of products since one product cannot be produced without at least some of the other product being produced.

PPC(4) in Figure 1 represents competitive products at a constant rate of product transformation. Given constant prices product transformation would tend to favor product specialization in output A or B. An example of products competitive at a constant rate of

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2 The range depicted by PPC(5) will vary by the type of products being considered and the time horizon involved. Given the incentive and time, research may be able to eliminate a joint product situation.

product transformation would be when a reasonably homogenous field of soil is being planted to either of two crops, e.g., wheat or barley.

PPC(3) in Figure 1 represents competitive products at an increasing rate of product transformation. If the price of both products is greater than zero and the rate of product transformation is increasing, competitive products will tend to limit product specialization. Specialization for this situation will maximize profit only when the product price ratios are extremely favorable to one product or another.

Figure 2 demonstrates the influence of fixity of resources on the production possibility curve. PPC(1) represents production possibilities for a firm where no commitment had yet been made to invest resources. If production of A were favored, specialized resources would be purchased to produce A. If efficient production of A required fixed resources, for example a milking parlor, the opportunity of switching to product B (beef cows) would be more limited than the opportunity prior to the milking parlor commitment. This is represented by an inward shift of PPC(1) to PPC(2). Fixity of resources tends to limit diversification.

The production possibilities curves discussed so far have assumed perfect divisibility of resources. In practise inputs are often purchased in lumpy units. For example, a field crop will only require seasonal labor while labor is available or even purchased for the entire year. Participation in off-season labor-intensive enterprises may be utilized to make both the cropping enterprise and

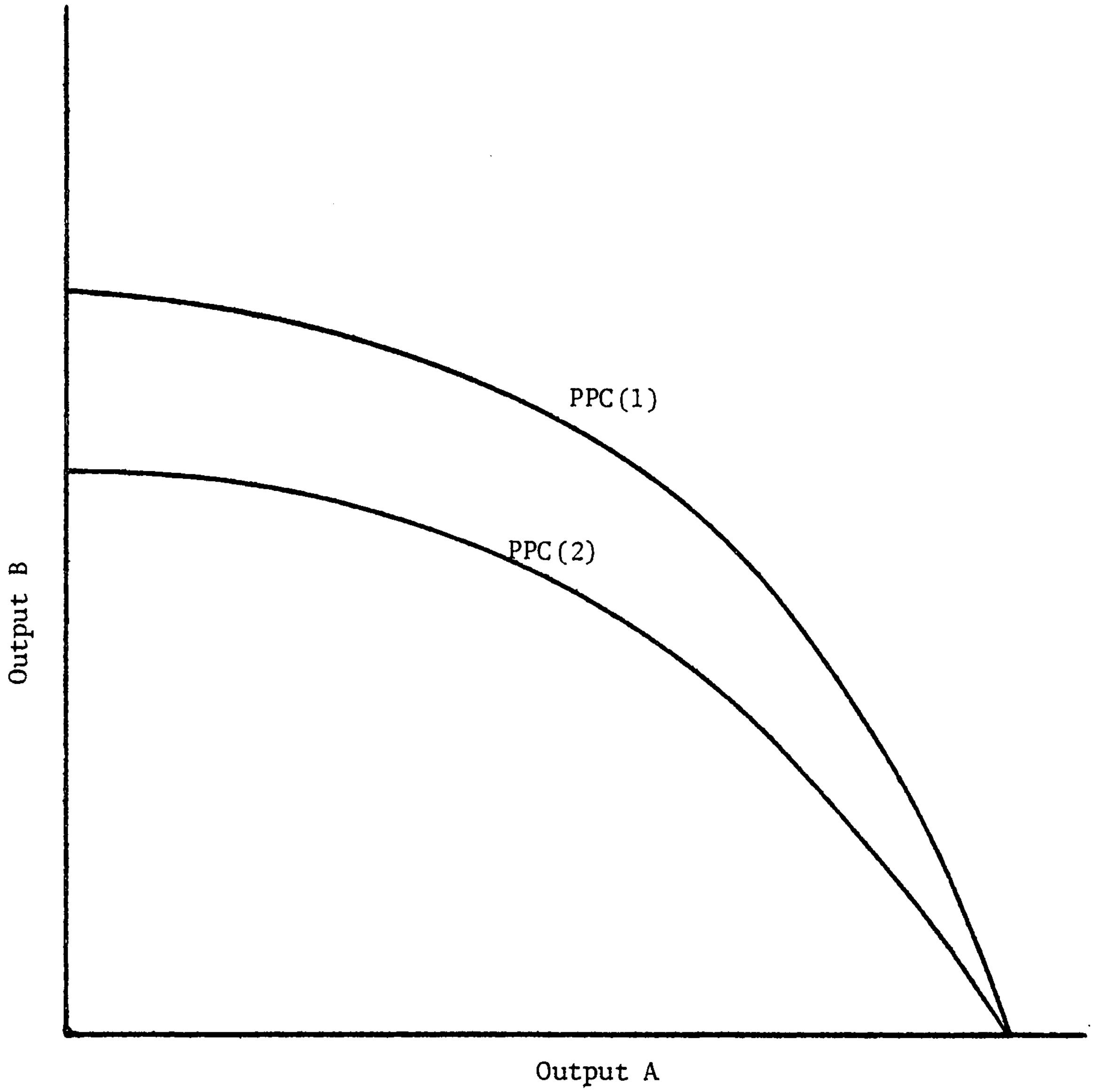

Figure 2. Production possibilities of dairy cows and beef feeders before and after commitment to fixed resources.

the off-season enterprise financially feasible. Therefore, indivisibility of non-specialized resources will tend to move a firm towards diversification.

Planning Under Imperfect Knowledge

The production functions and thus the production possibility curve in the previous section are assumed to be known with certainty. Prices are also assumed to be known with certainty. In reality, decisions are made given the decision makers subjective evaluation of the probabilities of uncertain prices, technical relationships and yields. A common measure of the degree of risk of various enterprise combinations is the variance of their combined income.

It is generally assumed that if more enterprises are included in the farm structure, variability is reduced. However, this would depend on the covariance between the enterprises in the farm structure and those to be added. If only one enterprise is considered the income variance is:

$$V' = q_1\sigma_1^2$$

where:

V' = income variance for one enterprise;

σ_1 = standard deviation of the per unit returns from prospect 1;

q_1 = proportion of enterprise 1. Since there is only one enterprise involved $q_1 = 1$.

If a second enterprise were added the income variance would be:

$$V'' = \sigma_1^2q_1^2 + \sigma_2^2q_2^2 + 2\sigma_{12}q_1q_2$$

where:

V'' = income variance for two enterprises;

σ_i = standard deviation of the per unit returns from prospect i;

σ_{12} = covariance of the per unit net returns from enterprises 1 and 2;

q_i = proportion of activity attributed to enterprise i ($q_i \geq 0$) ($\Sigma q_i = 1$).

The ability of the second enterprise to reduce variance will depend on the covariance term (or correlation coefficient) between the two enterprises and its interaction with both q's. The addition of the second enterprise does not automatically insure a decrease in income variance.

The profit maximizing objective of the decision maker is to choose from N risky prospects, a combination of enterprises that will maximize his income subject to his resource constraints, his subjective probabilities, and his risk attitude. In general, as the expected return is increased, the risk associated with that return is increased as well. No general statement can be made as to the effect on the level of diversification as a result of the decision maker maximizing his expected returns subject to a risk preference or aversion.

Measures of Diversification

Several measures of diversification have been assumed or developed in the industrial management and farm management literature.

Most of these measures can be categorized into three general types of indices. The most obvious diversification index is a count of the number of all or the major enterprises included in the firm. Another measure of diversification is the relative proportion of total activity within a firm that can be attributed to the major enterprise. Activity is defined as some measure of products or resources produced or used by the firm or industry in question. The more comprehensive measures of diversification include a weighted measure of the number of enterprises and their relative proportions of total activity within the firm or industry. The relative weight, of the major enterprises, for the third type of measure, has the most significant effect on the resulting diversification rank.

A benchmark measure of perfect diversification or specialization is seldom stated for a diversification measure when it is used. An undefined benchmark measure results in an index ranking for a particular farm that is meaningless unless it is compared to the rank of another farm. Most measures imply that specialization and diversification are antonyms. The first two types of measures assume that one enterprise is the benchmark for a perfectly specialized farm. These measures do not define perfect diversification. Any movement from specialization implies diversification. This is consistent with Doll and Orazem's definition of diversification. The third type of diversification measure also assumes perfect specialization to be one enterprise. It is demonstrated in Appendix I that all but one of the third type of the previously used diversification measures, assumes the inverse of N to be perfect diversification. N can be defined as the total number of enterprises which it is possible for a farm to participate in or the total number of enterprises participated in. There is no difference between the calculated diversification indices for either definition of N. But the benchmark value of perfect diversification is affected by the definition of N. A complete list of the three types of indices appearing in earlier studies and their properties is included in Appendix I.

Drummond (5) devised an index of diversification which falls into the third type of diversification measures. He used the diversification index to compare the degree of diversification of Brazilian farms to other elements of farm structure namely: size, asset specificity, and risk. He explored the question: "Is the firm more or less 'economically efficient' when it diversifies?" He did not reject the hypothesis that the productive efficiency of every resource is independent of the level of diversification of the firm employing the resource. The relationship between diversification and farm size is mixed and no firm conclusion can be made. Drummond also did not reject the hypothesis that asset specificity is related to diversification. He concluded that there is a significant positive relationship between diversification and the coefficient of income variation for the surveyed farms.

Pope and Prescott (13) and Pope (12) have also explored the interrelationships of diversification and elements of farm structure for a sample of California farms. They concluded that there was little evidence that particular crops lend themselves to substantially more specialization than others. There was a statistically significant positive relationship between the degree of specialization and farm size, net worth, and farmer experience. The relationship between diversification and organizational farms of management, i.e., corporate vs. partnership, was inconclusive. The location of the farm had no effect no the degree of diversification. Pope and Prescott tested their model with four diversification indices which included the three general types of diversification measures. They found there was no significant effect on their conclusions using the different measures.

Objective

The objective of this study is to evaluate the concept of diversification. Specific objectives are:

1. To check for common agreement, on relative levels of diversification, among potential users of the concept of diversification.
2. To test for common components of diversification to reflect the potential users concept of diversification.
    a. Test various activity level indicators within a common diversification index for common components of diversification.
    b. Test various types of diversification indices with a common activity level indicator for common components of diversification.
    c. Test various personal characteristics of potential users for possible subjective bias in their perceived levels of diversification.
    d. Test impersonal indicators of diversification as indicators of perceived levels of diversification.

A survey of current and potential users of the term diversification was conducted to determine the interviewees concept of diversification (Appendix II). The results of the survey will be tested with non-parametric statistics to determine if there is common agreement among the people surveyed as to the relative degrees of diversification among twelve hypothetical farms. If the concept of diversification is determined to be consistent among the interviewees, regression analysis will be used to determine personal and impersonal indicators which can be used to reflect perceived relative levels of diversification.

The remainder of this thesis is organized as follows: Chapter II includes a brief description of a survey to determine farmers' and farm management specialists' perceptions of diversification levels. Non-parametric statistics are presented to test for a homogeneous perception of diversification amongst the interviewees. A regression model is developed in Chapter III in an attempt to measure what affects farmers' and farm management specialists' perceptions of diversification. Chapter IV includes a summary, some conclusions and a note on the possible directions of future research.

CHAPTER II. DIVERSIFICATION, A COMMON CONCEPT

The Survey

A survey (see Appendix II) was initiated to explore the concept of diversification as it might be viewed by potential users of farm management communication. The survey respondents were thirty farmers from three irrigation districts in southern Alberta and eighteen professional farm management specialists from both Alberta and Oregon. The survey was designed to elicit three types of information: 1) To rank four typical (hypothetical) farms for each of the three irrigation districts. The information given for each hypothetical farm included: number of livestock, net revenue by type of crop, gross revenue by type of crop, acres by type of crop, and off-farm work. The twelve hypothetical farms were each ranked on a scale of one to ten according to the respondent's concept of diversification. Ten was a completely specialized farm. 2) The respondents were then asked to indicate which of five criteria he/she used to assign his/her perceived degree of diversification to the farms. Additional comments were welcomed. From these comments, management skill, and machine and labor intensity were added as criteria for the analysis. 3) Personal questions about the respondents were asked in order to help categorize the responses. Questions to the farmers included: age, years of experience, location, net worth of capital assets, and distribution of personal enterprises. Farm management specialists were asked only the first three personal questions.

The Survey Area

The hypothetical farms were formulated from three representative irrigation districts in southern Alberta. These hypothetical farms were used to represent various levels of diversification for a cross section of farms. The representative irrigation districts (Western, Taber, and Lethbridge Northern) were chosen from a total of thirteen irrigation districts in southern Alberta. The Western irrigation district (WID) is east of Calgary and is further north than the other irrigation districts. It encompasses the largest total land area of the three irrigation districts but has the smallest irrigated acreage. Climatic conditions in this area are adequate for grain and forage production. Almost all the acreage irrigated in this area is for harvested forage production. The Taber irrigation district (TID) is a smaller, more intensively irrigated area between Lethbridge and Medicine Hat. Its climate during the growing season is more arid than WID and requires irrigation for most crops. In 1973 irrigated cereal yields were sixty percent higher than dryland yields in the TID but only about twenty-five percent higher than in the WID (15). With intensive irrigation, specialized crops such as potatoes, sugar beets, corn, and beans can be produced in the TID. The Lethbridge Northern irrigation district (LNID) is an integrated district. It encompasses some intensive specialty crops and some extensive cropping systems. Some agroclimatic conditions for the three irrigation districts are compared in Table I.

TABLE I. REPRESENTATIVE LONG TERM AVERAGE AGRO-CLIMATIC CONDITIONS FOR THREE IRRIGATION DISTRICTS IN SOURTHERN ALBERTA.

	LIND[1]	WID[1]	TID[1]
Growing season (day)[2]	120	110	127
Mean growing season temperature[3] (centigrade)	15.02	13.90	16.00
Total heat units[4]	2150	2050	2240
Annual rainfall (inches)	16.69	13.73	14.69
Growing season rainfall (inches)	8.49	9.03	7.31

1 LNID - Lethbridge Northern irrigation district (Lethbridge)

WID - Western irrigation district (Strathmore)

TID - Taber irrigation district (Taber)

2 Average frost free period

3 Mean daily temperature - May through August

4 Corn heat units

Nonparametric Analysis

The first question of concern was: are each of the respondents' rankings of the twelve hypothetical farms consistent with the rankings of each of the other respondents? In order to analyze this question nonparametric analysis was used. A nonparametric test was chosen because of the limiting assumption of parametric analysis. Parametric analysis dictates that the data must at least be in an interval scale with identical distributions for each observation.[3]

The only criterion given to the respondents was to rank the hypothetical farms on a scale between zero and ten. Each respondent was free to formulate his own interscale. The respondents could have ranked the farms according to different criteria and also weighted these criteria differently. It is impossible to give an exact measure of farm diversification and the individual farm rankings can not be assumed to be on an interval scale.

The nonparametric Wilcoxon matched-pairs signed-ranks test (16 p. 75) was used to analyze the question. The Wilcoxon test utilizes information about the relative magnitude as well as the direction of the differences within a pair of observations. In order to utilize these data the researcher must be able to tell which member of a pair is "greater than" which, i.e., tell the sign of the difference between any pair, and rank the differences in order of absolute size. This test is only two-dimensional, i.e.,

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3 The numbers on an interval scale can be ranked in relation to each other and the distances from each other are known.

it will only compare a series of matched pairs. The ability to compare matched observations is important in that the relative ranks between farms for each respondent can be compared. A nonparametric test designed to measure several dimensions, such as the Kendall coefficient of concordance ((16) p. 229), would rank the scores for each farm as a group without regard to the relationships of each of the respondent's scores.

The differences in the diversification rank, for each respondent, between all combinations of the twelve hypothetical farms taken two at a time are analyzed. This results in a total of sixty-six tests or bi-farm comparisons with thirty observations each for the farmer respondents, and eighteen observations for the farm management specialists.

The null hypothesis to be tested is as follows: The rank assigned by the interviewees to each of the pair of farms being considered does not differ. The alternative hypothesis: The rank assigned by the interviewees to each of the pair of farms being considered does differ. A measure of the variation of the differences between the rankings assigned each pair of hypothetical farms by the respondents, has a two-tailed probability of occurring under the hypothesis. See Appendix III for calculation of the Wilcoxon matched-pairs signed-ranks test statistic.

The null hypothesis might not be rejected for either of two reasons. First, there could be a consensus among respondents that there is no difference in the degree of diversification between the farms. When the Wilcoxon test encounters zero differences, it ignores that observation. The calculated test statistic is affected by the number of differences and their relative magnitudes. No differences and small differences in the diversification ranks increase the likelihood of not rejecting the null hypothesis. Second, disagreement among the respondents will cause large fluctuations in sign and relative magnitudes of the differences. This also could result in the hypothesis not being rejected. It is difficult to tell for most comparisons if failure to reject the hypothesis is a result of a consensus among the interviewees that there is no difference between diversification levels of two farms or whether there is no consensus among the interviewees.

Results

The farmer respondent and the management specialist respondent samples were considered separately. Significance levels for each of the tests are given in Table III for farmer respondents and in Table II for farm management specialists. The null hypothesis that the two farms being compared were considered equally diversified by the respondents was rejected, at a significance level of .90, for twenty-six of the sixty-six bi-farm comparisons for the farm management specialist respondents and for forty of the sixty-six bi-farm comparisons for the farmer respondents. Lowering the significance level to .50 results in a rejection of the null hypothesis for an additional seventeen of the sixty-six comparisons for the farm management specialists and five of the sixty-six comparisons for the farmer respondents.

At a statistical level of significance of .90 the hypothesis was not rejected for forty of the comparisons for the farm management specialist respondents and twenty-six of the comparisons for the farmer respondents. The test statistic is a function of both the number of recorded differences and their relative variations. The interaction of these two elements, for the majority of comparisons, would be difficult to sort out without some sort of statistical test. Casual observation of the individual comparisons indicates a consensus of zero differences in rank and a non-consensus of rank among the respondents for a few polar cases. A consensus of zero differences would result in the indicated difference in

TABLE II. SIGNIFICANCE LEVELS FOR THE WILCOXON MATCHED-PAIRS SIGNED-RANKS TEST. FARM MANAGEMENT SPECIALIST RESPONDENTS.

	T1	T2	T3	T4	L1	L2	L3	L4	W1	W2	W3	W4
T1												
T2	*											
T3	*	**										
T4		**										
L1		#	**	**								
L2			#		*							
L3	**	***		#	**							
L4		**	#			#						
W1	**		**	**		**	***	**				
W2		*		#	**		#		**			
W3		**	#	#	***	#			***	#		
W4		**	#	#	***	#		#	***	#	#	

\# Comparison significant at X = .50

* Comparison significant at X = .90

** Comparison significant at X = .95

*** Comparison significant at X = .99

T1 hypothetical farm number 1 in the Taber Irrigation District

L1 hypothetical farm number 1 in the Lethbridge Northern Irrigation District

W1 hypothetical farm number 1 in the Western Irrigation District

TABLE III. SIGNIFICANCE LEVELS FOR THE WILCOXON MATCHED-PAIRS SIGNED-RANKS TEST. FARMER RESPONDENTS.

	T1	T2	T3	T4	L1	L2	L3	L4	W1	W2	W3	W4
T1												
T2	#											
T3												
T4			**									
L1	***	***	***									
L2		*			**							
L3	*			**	***	**						
L4	***	**	***	***		**	***					
W1	***	***	***	***		***	***	#				
W2	*	*		***	***	***		***	***			
W3	#	#	#		**			***	***			
W4	*	*	**				***	*	***	***	*	

Comparison significant at X = .50

* Comparison significant at X = .90

** Comparison significant at X = .95

*** Comparison significant at X = .99

T1 hypothetical farm number 1 in the Taber Irrigation District

L1 hypothetical farm number 1 in the Lethbridge Northern Irrigation District

W1 hypothetical farm number 1 in the Western Irrigation District the ranking of two farms to be zero or very small differences which fluctuate around zero for the respondents. A non-consensus of differences in rank would result in large and small fluctuations about zero for the differences in the respondents' ranking of the two farms. It can be stated that there is a consensus among respondents as to their perceived levels of diversification between farms for at least forty percent of the bi-farm comparisons for professional farm management specialists and for at least sixty-one percent of the bi-farm comparisons for farmer respondents at a significance level of .90.

Implications of Previous Research

In the past researchers have assumed a common concept of diversification. Three general types of diversification measures were outlined in Chapter I. The general types of diversification measures include number of enterprises, a proportion of the enterprises or a weighted combination of the two measures. These have been used as common diversification indicators in the past. Given the results of the survey, there are probably some subjective criteria used in evaluating diversification levels that are not common among all the survey respondents, and caution should be used in presenting a universal measurement of diversification.

Pope etal (13) and Drummond (5) have defended chosen measures of diversification by comparing desirable characteristics or behavior of the function in order to aid in user convenience. The nonparametric results of this study suggest that more research needs to be done on the essential components of a diversification measure before the components are combined into a neat and usable package. If an index is not meaningful to potential users other characteristics of the function become less important.

Pope etal (13) and Drummond (5) have defended assumed components of a diversification index by comparing indices composed of different components in their ability as explanatory variables of other measures of farm structure. This practise does not validate the ability of various diversification measures to indicate levels of diversification;

especially if these same measures of diversification and farm structure are being used to test for the correlation between diversification and other elements of farm structure.

CHAPTER III - COMPONENTS OF DIVERSIFICATION

Chapter II outlined the survey that was conducted and the general types of information that were collected. Personal attributes of each respondent and his farm are recorded in the survey. These personal data, along with possible hypothetical indicators of diversification, are used as explanatory variables to predict each transformed rank assigned, by the respondent, to the hypothetical farms. The purpose of this chapter is to identify, through regression analysis, factors affecting the respondents' perceived concept of diversification.

Dependent Variable

Observations on the dependent variables, used for the regression analysis, are the individual ranks assigned each hypothetical farm by the survey respondents. It was indicated in Chapter II that the individual diversification ranks cannot be assumed to be in an interval scale, which is necessary for a parametric type of analysis such as regression. The only ranking criterion given the respondents was the two end points of the scale on which they were to rank the hypothetical farms. The hypothetical farms were each ranked on a scale of zero to ten where ten was to be a completely specialized farm.

A Likert scale is used to convert the ranks assigned to the hypothetical farms by each respondent into an interval scale (3, p. 10). Each individual observation is standardized by the formula:

$$Z_{si} = \frac{(X_{si} - \bar{X}_s)}{SD_s} \quad [4]$$

where: X_{si} is the ith individual rank assigned a hypothetical farm by the sth individual respondent; $\bar{X}_s$ is the average rank assigned all twelve hypothetical farms by the sth individual respondent; and SD_s is the standard deviation of ranks assigned by the sth individual respondent over the twelve hypothetical farms.

4 The standardization of the individual responses will result $\Sigma Z^2_{is} = 1.0$ which will make the various Zis comparable among respondents.

Explanatory Variables

The explanatory variables, used in the analysis to explain the respondents perceived levels of diversification for the hypothetical farms, are divided into three general categories.

Calculated Diversification Indices

The calculated diversification indices refer to the three general types of calculated indices which are briefly introduced in Chapter I. The types of indices include: a count of the number of enterprises or number of major enterprises, the proportion of total activity for the major enterprises, and a weighted combination of proportion and number of enterprises. Four specific indices are used in the study to represent the three general types of indices. Detailed information for each index is given in Appendix 1. The indices used are as follows:

Type 1 index, the count:

(Count)

D = number of enterprises reported by the hypothetical farms

where: D is the calculated diversification index.

The minimum value for D is one since at least one enterprise would be needed for a firm to exist. The maximum value is the total number of enterprises feasible in that particular region. It is anticipated that the respondents perceived level of specialization will increase as the index value increases.

Type 2 index, the proportion:

(Specialization Ratio)

$D = (P_i)$ max

where: (P_i) max is the proportion of activity level attributed to the enterprise which accounts for the highest activity level within the firm; D is the calculated diversification index.

The minimum value for D is the inverse of the total number of enterprises feasible in that region. The maximum value is one. The respondent's perceived level of specialization is expected to increase as the index value increases.

Type 3 index, the weighted combination:

(Drummond)

$$D = \sum_{j=1}^{n} \frac{P_j}{W^{j-1}}$$

where: n is the number of enterprises reported for the farm; P_j is the proportion of total activity attributed to the jth enterprise; W is an arbitrary weighting constant; D is the calculated diversification index.

The minimum value of D is 1/n and the maximum value of one occurs when only one enterprise is reported. The index D is assumed to be positively correlated with the assigned diversification ranks for the hypothetical farms.

(Entropy)

$$D = \sum_{i=1}^{n} P_i \log \frac{1}{P_i}$$

where: P_i is the proportion of the total activity of the firm attributed to the ith enterprise; n is the total number of enterprises; D is the calculated diversification index; log is arbitrarily set to the base e.

The minimum value of D is zero when only one enterprise exists. The maximum value is log n (see Appendix 1). The entropy index is expected to be negatively correlated with the diversification ranks assigned to the hypothetical farms.

Activity measures can be a measure of output or a measure of resources utilized by the farm. Net returns and gross returns for each enterprise are considered as measures of output, and acres employed for each enterprise is considered as a representative measure of resource use.

Hypothetical Farm Characteristics

These explanatory variables are measures of characteristics which are specific to the hypothetical farms. It is hypothesized that some of these characteristics are factors that the survey respondents considered in ranking the levels of diversification for the hypothetical farms.

Location - The irrigation district of the hypothetical farms is described in Chapter II. Typical or norm enterprise combinations vary between irrigation districts. If the respondents view locality of the hypothetical farm as an important component of the concept of diversification, then possibly they consider movements away from the norm enterprise combination for that locale as a change in their perceived level of diversification. It is expected that farms will be evaluated individually and that locality will have no influence on the respondents perceived level of diversification.

Crops-Only - It is sometimes suggested that a diversified system must have a combination of livestock and crops in order to fully utilize fixed resources and broaden the marketing opportunities of the farm. All the hypothetical farms produce some crops for sale. A crops-only variable is included in the analysis to differentiate those hypothetical farms which produce only crops from those farms which produce livestock and crops. The exclusion of livestock enterprises will limit the scope of the enterprises participated in. It is expected that the variable crops only will be negatively correlated with the degree of diversification.

Intensive Crops - Specialization is sometimes considered to be a measure of the fixity of productive resources. The existence of intensive crops is used as a resource fixity indicator. The crops included in the intensive crops category are the forage and row crops. The existence of intensive crops in a farm structure is expected to increase the respondents perceived level of specialization.

Percent of Non-Irrigated Crop - The proportion of irrigated crop, within a farm structure, affects the opportunity of the farm firm to alter the proportion of enterprises without extra transition costs. It is also used as an indicator of fixity of resources. The variable, percent of non-irrigated crop, is expected to be negatively correlated with the diversification index assigned by the respondent.

Risk - It is generally assumed that more diversified farms have a lower risk coefficient than less diversified farms.[5] The measures of diversification outlined in Appendix I do not include a risk parameter. It is possible that relative levels of risk as perceived by potential users of the concept of diversification are an integral part of diversification indicators and are not the result of diversification as previously perceived by index users. The measure of risk used in this analysis is the coefficient of income variation (CV). The following formula is used to calculate the coefficient of income variation:

$$CV = \frac{(SD)_{income}}{\text{average income}}$$

where: CV is the coefficient of income variation; (SD) is the standard deviation of income for a given period of time; average income is the average income for the same time period.

Income is measured as detrended gross income over the thirteen-year period from 1961 to 1973. Gross income is used because estimates of production costs for each enterprise considered are not available over the thirteen years. The Canadian consumer price index (CPI) in 1961 was sixty-six percent of the index in 1973. In order to correct for inflation, returns were detrended each year by the CPI and the

5 Other factors may also cause farms to diversify beyond the point of maximizing expected returns. For example, farms may diversify into additional enterprises which will hold open opportunities for potential large gains in particular enterprises.

variations of returns over this modified trend are used to indicate risk.

The traditional coefficient of variation is calculated by dividing the standard deviation of returns for a given time period by the average returns for the same period. If returns are fairly consistent with an expected inflation trend and the trend did occur, the coefficient of variation could still indicate a high variation in income as demonstrated in Figure 3. The returns were detrended because a return, as viewed by the farm planner, could be expected to increase and if it did so consistently, this would not be considered a high variability of returns series. It is assumed that the farm planners' anticipated price trends are coincident with the consumer price index. Figure 4 demonstrates the anticipated effect on the coefficient of variation. If this assumption is correct, the coefficient of income variation will be negatively correlated with the respondents' perceived concept of diversification.

Respondent Characteristics

The survey included a series of personal questions pertaining to the respondent and to the farmer respondent's own farm. These questions were included to ascertain whether a respondent's own personal situation influences his concept of an impersonal farms' degree of diversification. It is anticipated that diversification is an objective concept which is not influenced by the personal characteristics of the viewer.

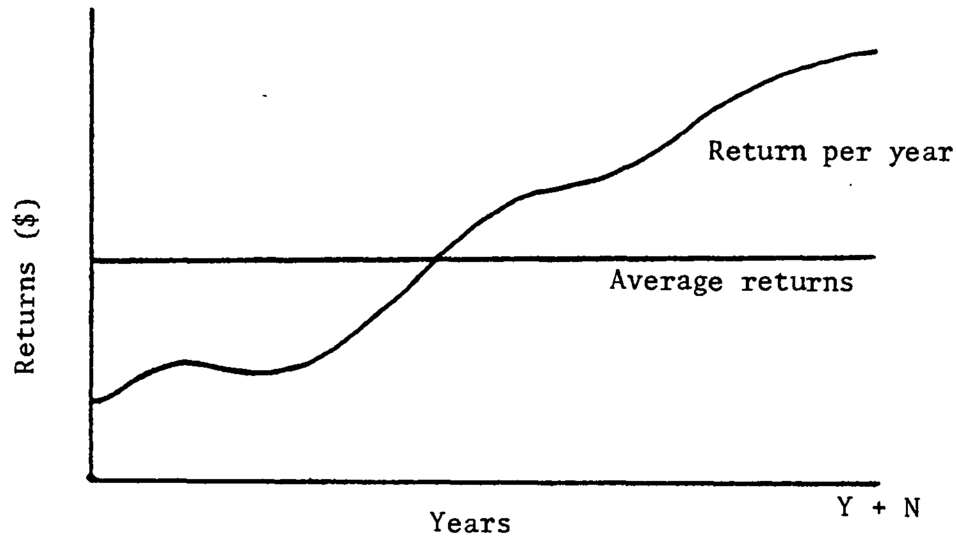

Figure 3. Example of income trend from average income during an inflationary period.

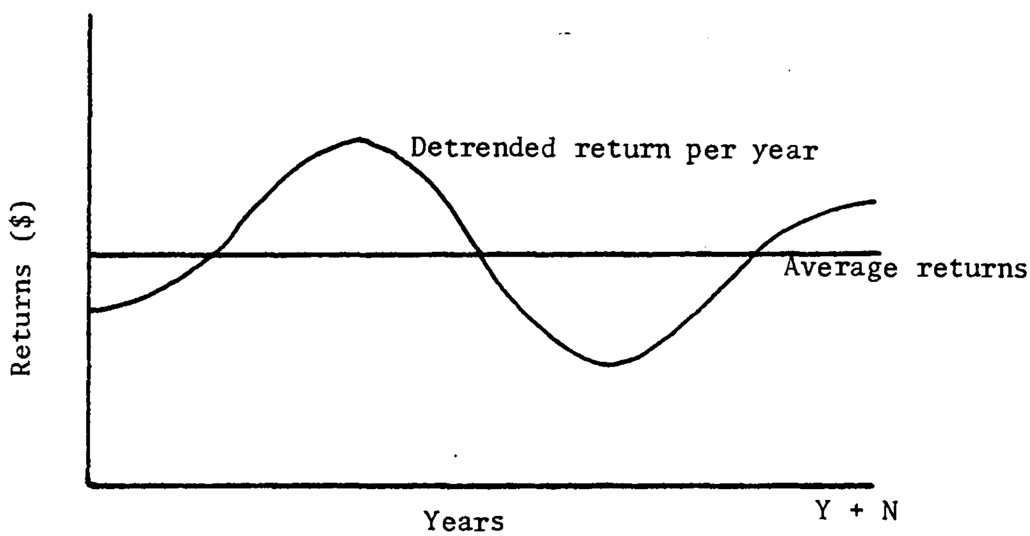

Figure 4. Example of detrended income trend from average income during an inflationary period.

Personal information in the survey included the respondent's age and location. It is noted in Chapter I that previous studies have found that the years of experience of a farm operator and the degree of specialization of his farm are significantly positively related. The variable, age of the respondent, was included in the analysis to detect differences in the perceived ranks by the respondent due to his own experience. It is expected that the age of the respondent will not affect his perceived concept of diversification.

The farm management specialist respondents are equally divided between Alberta and Oregon. The farm operator respondents are equally divided between irrigation districts. A variable to indicate location is included in the model to distinguish any difference in perceived levels of diversification for those more closely associated with the locale of the hypothetical farms. It is anticipated that the location of the respondent will not affect his/her concept of diversification ranks.

Different variables for the farmer respondents' personal farm which reflect the variables being tested as diversification indicators for the hypothetical farms, are included in the model. The wealth position of the hypothetical farm is not included as a variable. It is assumed that the farmer respondents' own personal farm characteristics do not affect their perceived concept of diversification. Variables for the farmer respondents' personal farms are as follows:

Respondent Net Worth - Much of the current discussion involving diversification measures involves the interaction of diversification and farm size (6) (20) (5). Four general categories of the respondents' net worth are included in the model. It is hypothesized that net worth combined with the age of the respondent can be used as an indicator of the respondents' farm size, e.g., a young farmer with low net worth would not necessarily indicate a small farm while an older farmer with low net worth probably would indicate a smaller farm, since an older farmer would probably carry less debt.

Respondents' Off-Farm Work - One of the hypothetical farms included off-farm work as one of its enterprises. Reaction during the survey to that particular enterprise ranged from the respondent ranking the farm as a highly specialized or diversified farm to the respondent refusing to rank the farm because it was a "hobby farm." A variable for steady, seasonal, or no off-farm work for the respondent is included in the analysis to determine if the respondent's type of farm work influenced his perceived diversification rankings.

Respondent Has Only Crops - The existence of crops only in the respondent's farm structure is included in the analysis as a test for the respondent's subjective bias in reflecting his farm situation into his perceived levels of diversification.

Respondent Has an Intensive Crop - Intensive crops refer to row crops and forage crops. This also is a test for the respondent's subjective bias in reflecting his farm situation into his perceived levels of diversification.

Diversification Index for Respondent's Farm - A measure of diversification for the respondent's farm was calculated with a Herfindahl index based on gross returns as an activity level. The Herfindahl index is a weighted combination of number of enterprises and their proportions of total activity levels. Information for the calculation of the respondent's farm was based on information from a previous farm structure survey of the farmer respondent in 1973 (17).

Empirical Results

Farm Management Specialist Respondents

The results of the farm management specialists' responses will be discussed in two stages:

1. Three activity indicators, within a given diversification index, will be tested for their significance in explaining the respondents' concept of diversification.
2. The three general types of diversification indices, with one type of activity measure, will be tested for their significance in explaining the respondents' concept of diversification.

Chapter I briefly introduced three general types of diversification indices used in the literature to describe or indicate relative levels of diversification. Several of these general types of diversification measures utilize activity levels of the various enterprises within the firm. Initially, a regression equation was used to test the applicability of three activity measures as indicators of the respondents' perceived levels of diversification. Two activity indicators are a measure of output (net return and gross return for each enterprise) and one activity indicator is a measure of resource use (acres employed for each enterprise).

It is hypothesized that the three activity indicators are equivalent in explaing the survey respondents' perceived levels of diversification. The alternate hypothesis is that the activity indicators are not equivalent in explaining diversification levels and/or needs to be used simultaneously to explain diversification.

The regression equation used to test possible activity indicators of diversification, as perceived by the farm manager respondents, is as follows:

$$DEX = a_0 + a_1 D(I) + a_2 L + a_3 A + a_4 T(k) + a_5 C + a_6 I + a_7 R + a_8 P + \text{error}$$

where: DEX is the transformed index ranks assigned to each hypothetical farm by the respondents;

D(I) is the Drummond method of measuring diversification over I = 1, 2, 3 ways of measuring activity levels for each enterprise;

L is a binary variable indicating the location of the respondent (L = 1 for Alberta);

A is the age of the respondent;

T(k) is a variable indicating the location of the hypothetical farm, k = 1, 2 where 1 indicates the Western Irrigation District and 2 indicates the Lethbridge Northern Irrigation District;

C is a binary variable indicating that the hypothetical farm structure consists only of cropping enterprises (C = 1 if farm has crops only);

I indicates an intensive type crop, which includes row or forage crops, is included in the farm structure (binary variable; I = 1 if farm has intensive crops);

R is a risk variable indicating the variability of detrended gross returns for a thirteen-year period;

P is the percent of land used for dry crop production;

a_i are regression coefficients.

Four variants of the above regression model are analyzed. First, all three indicators of activity levels are included in the analysis. The purpose of this analysis is to determine if several activity measures need to be considered simultaneously as indicators of diversification. The regression equation is then analyzed as each of the activity indicators is considered separately. The sign of the regression coefficients for the calculated Drummond diversification indices indicate a positive relation between the index and the level of specialization. This is consistent with the theoretical construct of the Drummond index.

The results of the four analyses are presented in Table IV. When all three measures of activity levels are considered simultaneously (regression 4), the estimated intercept and coefficient for the Drummond index of diversification with gross returns as an activity level is statistically different from zero at the five percent level of significance. The inclusion of 'crops only' as an indicator of diversification is significant at twenty percent.

When net return and acreage measures of activity are dropped from the analysis, the gross return indicator of activity and the intercept term remain highly significant. The coefficient for 'crops only' is statistically significant at the ten percent level of significance. If net returns is used as an indicator of activity, R^2 does not change appreciably from gross income as an activity indicator but more variables are utilized to indicate the respondents'

TABLE IV. REGRESSION COEFFICIENTS (COEF.) AND F SIGNIFICANCE VALUES (F VALUE)* OF VARIOUS ACTIVITY INDICATORS FOR DRUMMOND DIVERSIFICATION INDEX - FARM MANAGEMENT SPECIALISTS**

	Activity Indicators							
	Gross Returns		Net Returns		Acres		All	
	Coef.	F Value	Coef.	F Value	Coef.	F Value	Coef.	F Value
Reg. No.	1		2		3		4	
Int.	-3.48	.00	-3.39	.00	-1.68	.12	-3.46	.01
D(1)	4.22	.00	N/I		N/I		4.97	.03
D(2)	N/I		4.12	.00	N/I		- .92	.71
D(3)	N/I		N/I		1.04	.19	.09	.92
L	.06	.61	.06	.64	.67	.62	.07	.61
A	- .31	.64	- .03	.62	- .03	.71	- .30	.65
T(1)	.44	.31	.85	.04	.83	.09	.35	.47
T(2)	.17	.67	.69	.07	.55	.19	.61	.89
C	.40	.06	.61	.01	.30	.19	.34	.20
I	- .02	.92	- .14	.56	- .18	.56	.05	.99
R	.04	.98	- .72	.68	3.29	.05	.37	.84
P	- .23	.54	-1.05	.00	.55	.19	- .05	.93
R^2	.22		.20		.12		.22	
n = 216								

N/I Variables not included in the regression

* .01 and less - highly significant
.10 and less - significant

** See page 41 and 42 for description of variables.

perception of diversification. The coefficients for the calculated index of diversification for net return and for the proportion of dry cropland are significantly different from zero at .01 percent. One coefficient for the location of the hypothetical farm is significant at the ten percent level of significance.

When acreages are used as a measure of activity levels for the Drummond index, the index coefficient is significant only at twenty percent and R^2 decreases to .12. The regression coefficients for percent of crops on non-irrigated land, the risk variable and the locational variable for farms in Western Irrigation District are significantly different from zero to ten percent. The risk variable contains a measurement of income. It may be that income is a key concept of a diversification index. Both of the other types of activity measures are a form of income.

In summary, the Drummond index measure with gross returns as an activity indicator seems to be the most statistically significant variable of those tested in explaining the farm management specialists' concept of diversification. The correlation coefficient between gross return and net return as activity indicators for the Drummond index is .72 which indicates that the two indicators might be reasonable substitutes for each other. When net return is substituted for gross return in the analysis there is a small decrease in R^2, but more variables become significant in explaining the concept of diversification. It appears that an acreage measure of activity levels is not a significant indicator of the farm managers' concept of diversification. The hypothesis that each of the activity indicators is independently equal in explaining the respondents' concept of diversification is rejected in favor of the alternate hypothesis.

Three general types of diversification indices are outlined in Chapter I. It is hypothesized that each type of index is equivalent in explaining the farm manager respondents' concept of diversification. The alternate hypothesis is that the indices not equivalent in explaining the concept of diversification. A representative measure of each type of index is analyzed to determine its potential as an indicator of diversification levels.

The regression equation for this analysis was identical to the previous regression, except that three different types of diversification indices are used separately with one type of activity measure. The diversification measures to be used are: count diversification index (D(1)); specialization ratio diversification index (D(2)); entropy diversification index (D(3)). Activity levels are measured by gross returns.

Table V outlines the results of this analysis. The entropy index measure is a highly significant indicator of diversification levels. When the entropy or the count index is used to explain the perceived levels of diversification, the coefficient of the other explanatory variables are not significantly different from zero at the ten percent level of significance. Total R^2 drops slightly from the entropy index method of diversification measurement to count method. The sign of the regression coefficient for these two indices is negatively related to the level of specialization which

TABLE V. REGRESSION COEFFICIENTS (COEF.) AND F SIGNIFICANCE VALUES (F VALUE)* FOR VARIOUS DIVERSIFICATION MEASURES WITH GROSS RETURNS AS AN ACTIVITY INDICATOR - FARM MANAGER SPECIALISTS**

	Diversification Measures					
	Count		Specialization Ratio		Entropy	
	Coef.	F Value	Coef.	F Value	Coef.	F Value
Reg. No.	5		6		7	
Int.	2.30	.03	-2.19	.01	1.15	.15
D(1)	- .63	.00	N/I		N/I	
D(2)	N/I		2.72	.00	N/I	
D(3)	N/I		N/I		-1.40	.00
L	.07	.59	.06	.62	.66	.60
A	- .03	.70	- .03	.63	- .03	.65
T(1)	- .51	.37	.82	.05	.23	.61
T(2)	.003	.99	.35	.35	.12	.76
C	- .32	.21	.56	.01	.23	.28
I	- .09	.72	- .06	.81	- .14	.55
R	- .29	.87	.76	.63	.15	.93
P	.31	.53	- .52	.13	- .19	.61
R^2	.18		.22		.22	
n = 216						

N/I Variables not included in regression

* .01 and less - highly significant
.10 and less - significant

** See page 41 and 42 for description of variables.

is consistent with the theoretical construct of these indices. The proportion of total activity of the major enterprise is a highly significant indicator of diversification. When this method is used, two other diversification measures become significant at the ten percent level of significance. The sign for this coefficient is also consistent with the theoretical construct of the specialization ratio index.

In summary, it appears that when a count of the number of enterprises or a weighted combination of number of enterprises and their proportions are used as indicators of diversification, each of these indicators individually are significant explanatory variables. The specialization ratio (the proportion of total activity of the major enterprises(s)) is not as comprehensive as the other indicators since two other explanatory variables become significant when the specialization ratio is used as a diversification index. The hypothesis, that each type of diversification index is equivalent in explaining the concept of diversification, is rejected in favor of the alternate hypothesis.

Farmer Respondents

The survey included a series of personal questions pertaining to the farmer respondent's own farm. These questions were included to ascertain whether a respondent's own personal situation influences his concept of an impersonal farm's degree of diversification. From these personal questions, additional variables were added to the model to test the hypothesis.

The hypothesis is that the farmers' concept of the relative levels of diversification is unaffected by the characteristics of their personal farms. The alternate hypothesis is that the farmer respondents' concept of diversification is affected by their own personal situation.

A second hypothesis is that the calculated diversification index is the only significant indicator of the respondents' perceived levels of diversification. The second alternate hypothesis is that other impersonal indicators are significant in explaining the assigned diversification ranks.

The regression equation used for this part of the analysis is as follows:

$$DEX = a_0 + a_1D + a_2L(I) + a_3A + a_4T(k) + a_5C + a_6I + a_7R + a_8P + a_9FD + a_{10}FC + a_{11}FI + a_{12}J(I) + a_{13}V(I) + \text{error}$$

where: DEX are transformed index ranks assigned to each hypothetical farm by the respondents;

D is the Drummond method of measuring diversification with gross returns as an activity level indicator;

L(I) is a variable indicating the location of the farmer respondent;

I = 1, 2 for the Western Irrigation District and the Taber Irrigation District, respectively;

A is the age of the respondent;

T(k) is a variable indicating the location of the hypothetical farm; K = 1, 2 for Western Irrigation District and the Lethbridge Northern Irrigation District, respectively;

C is a binary variable indicating that the hypothetical farm structure consists only of cropping enterprises (C = 1 for cropping enterprises only);

I indicates an intensive crop, which includes row or forage crops, is included in the hypothetical farm structure (binary variable; T = 1 if intensive crop is present);

R is a risk variable indicating the variability of detrended gross returns for a twelve-year period;

P is the percent of land used for dry crop production on the hypothetical farm;

FD is the diversification index calculated for the respondent farms with the Herfindahl index;

FC is a binary variable indicating whether or not the respondent's farm structure consists only of cropping enterprises (FC = 1 if intensive crop exists);

FI is a binary variable indicating whether or not the respondent has an intensive type of cropping enterprise (FI = 1 if intensive crop exists);

J(I) is a variable indicating the type of off-farm work in which the respondent is involved; I = 1, 2 for steady off-farm work and seasonal off-farm work respectively;

V(I) is a variable indicating a general net worth category for the respondent's farm. I = 1, 2, 3: I = 1 for $100,000 \leq$ net worth $< 250,000$; I = 2 for $250,000 \leq$ net worth $< 500,000$; I = 3 for $500,000 \leq$ net worth;

a_i are regression coefficients.

Table VI outlines the results of the analysis. All eleven regression coefficients for personal characteristics of the farmer respondent or his farm were not statistically different from zero at the ten percent level of significance. The Drummond diversification index was significant at ninety-nine percent level of significance, but other characteristics of the hypothetical farms were also significantly different from zero.

The results of the farmer respondent analysis show some results different from those of the farm management specialists'. The type of enterprises within the farm structure and the locale of the farm have a significant effect on the perceived levels of diversification by the farmer respondents. The coefficients for cropping enterprises only, the proportion of dryland to total cropland, and the existence of intensive type crops were all statistically different from zero at ninety-eight percent level of significance. Income

TABLE VI. REGRESSION COEFFICIENTS AND F SIGNIFICANCE VALUES* FOR DRUMMOND DIVERSIFICATION INDEX WITH GROSS RETURNS AS AN ACTIVITY INDICATOR - FARMER RESPONDENTS

	Regression Coefficient	F Significance
Reg. No. = 8		
Constant	-4.34	.00
D	2.78	.00
L(1)	.09	.95
L(2)	.08	.96
A	- .01	.83
T(1)	1.29	.00
T(2)	.83	.01
C	.72	.00
I	.79	.00
R	4.04	.00
P	- .72	.02
FD	- .04	.92
FC	.03	.88
FI	.00	.99
J(1)	- .02	.94
J(2)	.001	.99
V(1)	- .05	.90
V(2)	.01	.98
V(3)	- .01	.93
R^2 = .16		
n = 360		

* .01 and less - highly significant

.10 and less - significant

** See pages 48, 49, and 50 for description of variables.

varability and location of the hypothetical farm were also statistically significant at ninety-nine percent.

In summary, the hypothesis that personal characteristics of the respondents do not affect their perceived levels of diversification is not rejected even at extremely low levels of significance. The hypothesis that each of the impersonal indicators of diversification are not significant in describing the respondent's perceived levels of diversification is rejected at a very high level of significance for each indicator.

Given the results of the farmer respondent analysis all of the impersonal indicators of diversification are significant diversification indicators. This probably indicates that farmers view moves away from the local typical farm structure (locality of the hypothetical farm) as a move in the level of diversification/specialization. The sign on the regression coefficient indicates that fixity of resources is directly related to the perceived levels of diversification. Types of enterprises and fixity of productive resources (crops-only and percent non-irrigated cropland) are also inherent diversification indicators. These latter two indicators can also be viewed as possible measures of the farm structures departure from the norm enterprise structure.[6] A measure of risk (income variability) is also a significant indicator of diversification. The sign on the coefficient indicates that more specialization farms have a higher coefficient of income variability.

6 A possible norm enterprise structure indicator is the Ogive index which is introduced in Appendix I.

The signs of the regression coefficients for the characteristics of the hypothetical farms are as expected except for the sign of the location variables. The coefficients for the location variables were expected to be insignificant, instead they are significant and indicate that generally the WID farms were ranked as the most specialized and the TID farms as the least specialized. This adds some confusion to the results as the TID is generally more intensively irrigated and the "percent non-irrigated cropland" variable indicates that irrigation tends to greater specialization.

Characteristics of the farm firm other than the calculated diversification indices were all significant in describing the farmer responses and were significant only occasionally for the farm management specialists' responses. The information included in the characteristics of the hypothetical farm (cropping enterprises only, intensive crop in farm structure, income variability, and percent of non-irrigated cropland) was not presented to the respondent other than as outlined on the survey farm. It may be that farmers are more aware of the other characteristics, while evaluating a farm structure, than the farm management specialist. For example, a management specialists' own income is often not dependent on the possible income fluctuations of a particular management strategy while a farmer's income is.

Relationship of Results to Previous Research

A count of the number of enterprises and a weighted combination of count and major proportion of enterprises are significant indicators of diversification, according to survey results. However, they are not the sole significant variable in explaining the respondent's concept of diversification. Other significant indicators varied with the regression equation. It appears that a measure of risk, a measure of fixity of resources, and a local enterprise structure norm should be included with the calculated diversification index as an indicator of levels of diversification.

Caution should be used in using an index to rank farms according to various levels of diversification when that particular diversification index may not encompass the total meaning of diversification as perceived by the receiver of the diversification analysis. Also caution should be used in evaluating the relationship of diversification/specialization with other particular characteristics of farm structure (e.g., risk and resource fixity) when those other characteristics of farm structure may be an integral part of the potential receivers' concept of diversification.

CHAPTER IV - SUMMARY AND CONCLUSIONS

Summary

The first reason farms diversify is generally viewed as a move towards greater economic efficiency through a more rational use of resources. The second reason for diversification, that of reducing variations in returns, may be a move away from most profitable resource utilization to insure that the long run goals of the farm manager are met.

A survey was conducted among potential users of the concept of diversification. The survey contains a total of twelve hypothetical farms from three irrigation districts in southern Alberta. Farmers from each of the irrigation districts and farm management specialists from Alberta and Oregon were asked to rank each of the hypothetical farms according to their perceived degree of diversification for that farm. Personal data about the respondent was also collected to determine if personal attributes of the respondent affected his/her perception of diversification.

The nonparametric Wilcoxon matched-pairs signed-ranks test was used to determine if the ranks assigned each hypothetical farm were consistent across all respondents. The test indicated that the respondents perceived a difference in the degree of diversification for approximately fifty percent of the bi-farm comparisons. It was not possible to determine whether the respondents perceived the remaining fifty percent of the bi-farm comparisons of diversification to be the same or if they could not agree on a difference.

The survey data were analyzed by regression analysis to determine the criteria used by the respondents to differentiate the diversification ranks among farms. Personal data for the respondents and objective ranking criteria for the hypothetical farms were used as explanatory variables for the normalized diversification ranks assigned the hypothetical farms. The diversification ranks were normalized for each respondent.

It was concluded that the personal attributes tested for the farmer and farm manager respondents were not significant indicators of their perceived rankings of the hypothetical farms. Calculated diversification indices using gross return or net return as enterprise activity level indicators were highly significant in explaining the ranks assigned each hypothetical farm by both types of respondents. Diversification indicators, besides the single calculated diversification indices commonly used in the firm structure literature, were significant in explaining the ranks assigned the hypothetical farms by the farmer respondents. Indicators such as income variability, location of the farm, the amount of land irrigated, and the nonexistence of a livestock enterprise were all significant indicators of the farmer respondent's perceived levels of diversification for the hypothetical farms.

Implications for Future Work

Traditional concepts of specialization/diversification were assumed prior to this study. Statistical results of the study and casual observation shed some doubt on several of these assumptions.

The concepts of diversification and specialization may not be the same among potential observers of farm structure. Respondents perceived a difference in diversification/specialization ranks of hypothetical farms for approximately fifty percent of the bi-farm comparisons. It is unknown whether the respondents agreed that the remaining fifty percent of the comparisons were equal in rank or if they could not agree on a relative rank for each comparison. Casual observation of the survey results suggest that both situations did occur. Comments from the respondents during the survey suggest that some of the respondents consider specialization as the most efficient or "best" combination of resources. This is not consistent with the traditional concept of specialization/diversification as antonyms.

Pope et al and Drummond used several calculated indices as measures of diversification to explore the correlation between diversification levels and relative levels of income variations for farms. Regression results for the farmer respondents indicate that the concept of risk, as measured by relative income variation, may be an integral part of their concept of diversification. If risk is considered as part of the definition of diversification, examining the relative correlation of the two indices, as separate concepts, may be incorrect.

Drummond concluded that diversification may not be independent of resource fixity. Analysis of farmer response data indicate that farmers may view the concept of resource fixity as an integral part of their concept of diversification. Regression variables which can be interpreted as measures of resource fixity (percent non-irrigated land and crops-only) indicate resource situations which may be altered over time at no additional costs as the current fixed assets are depreciated out. The length of the planning horizon which the farmers were considering, when they ranked the farms, might have a substantial effect on their conceived negative relationship between resource fixity and diversification.

It appears that diversification, as perceived by potential users, is a general concept that is difficult to apply a specific definition to. It may still be advantageous to further validate the components of the conceptual definition of diversification for potential receivers of diversification analyses.

Results of this study indicate that it is advisable to at least define ones specific intended concept of diversification before the concept is used as a means of farm structure communication.

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APPRENDICES

APPENDIX I

DIVERSIFICATION INDICES

AND

DESIRABLE PROPERTIES OF AN INDEX

Desirable Properties of an Index

1. The index must be meaningful to researchers and management specialists (14). If the index does not relay information based on consistent criteria with the receiver's concept of diversification, the information will be of little use to him and may even be misleading.
2. The index should be simple (14). In order to send out information quickly and inexpensively, the index needs to be simple. With an easily derived index, a large number of farms can be evaluated for a relatively small outlay of resources. If the index is meaningful, the conclusions drawn from a larger sample would be more reliable.
3. The index should include a measure of number of enterprises and their relative degrees of activity within the firm (5). For example, a farm structure of three equally sized enterprises may be more diversified than a structure of one major and two minor enterprises. A farm structure of three enterprises may be more diversified than a structure of one enterprise. The relative degree of activity of each enterprise within a farm can be measured as the proportion of total output or total employment of resources attributed to a given enterprise. Measures of activity in the industrial literature have included employment, gross sales, value added, and capital investment.

4. It is important that the diversification measure has a benchmark or norm with which to judge diversification (8). It should also have defined limits. If there were no norm and no limits on the diversification index, an individual index rank would be meaningless. The index would then only be meaningful for intra farm comparisons. The problem would remain though, as to what exactly was being compared. If a norm for complete diversification could be defined as N enterprises within a farm with equal levels of activity, or complete specialization as only one enterprise, then an individual index rank could be compared to a norm. If two norms existed, such as complete diversification and complete specialization, then defined limits on an index would probably be unnecessary. If only one norm was defined then some type of limits would need to be defined on the diversification measure to evaluate degrees or amounts of diversification.
5. The index should facilitate cross-sectional comparisons of farms. If the index is to be used as an indicator of diversification for regional studies or across a wide spectrum of farms, it will need to be universally applicable to all types of farms.
6. The index should be objective in that it may be derived by methods that are easily quantified and may be repeated by other competent investigators. The supportive argument for this property is essentially the same as the supportive

argument for the property of simplicity. The key difference is repeatability. In order for an index to be universally meaningful, several investigators using the same index on the same farm should get consistent results.

7. The index should be unique. Is the index number assigned to a farm structure clear to the potential index user or is it an ambiguous number? For example, does a diversification rank of .5 mean that a farm structure consists of two equally divided enterprises or does it mean that the farm structure consists of one large enterprise and several small enterprises?

Diversification Indices

TYPE 1 This type of index involves a count of the number of enterprises involved in the farm structure.

1. The Count Index (C) (5)

This index assumes that diversification is a function of the number of enterprises in which the farm participates.

$$C = N$$

The index is simple and objective. The minimum value will be 1 since a farm cannot exist without at least one enterprise. The maximum value will be the total number of enterprises which the firm could participate in. If there is no criterion as to the type of enterprises in which a farm could participate the number of enterprises participated in could be infinite.

$$1 \leq C < \infty$$

The benchmark or norm value of diversification would be perfect specialization at C = 1.

2. The Benchmark Index (BM) (7) (5)

This is a variation of the count index except that only major enterprises are considered.

$$BM = L$$

where: $\sum_{i=1}^{L} P_i$ is maximized subject to:

$$\sum_{i=1}^{L} P_i \leq B \text{ and } P_i > P_{i+1}$$

P_i is the measure of activity of the ith enterprise to total activity.

The order of P_i in calculating the index is vital. The index is still straight forward to calculate and is objective given some level of B. For example if a farm consisted of a flock of chickens (which accounts for five percent of the total farm activity, P = .05), a cereal grain enterprise (which accounts for eighty percent of the total farm activity, P = .8), and a hog farrowing enterprise (which accounts for fifteen percent of total farm activity, P = .15), and the benchmark value were set at .9 then L = 1. If the benchmark value were set at .95 then L = 2. The count index would equal three for this particular farm. The maximum value of the diversification index for the benchmark function would approach N - 1 if B were set at some level less than one. The indice's nearness to N - 1 would be determined by the arbitrary B value and the size of the smaller enterprises. The minimum value obtainable would be zero (when the proportion of activity of the smallest enterprise is greater than B).

$$0 \leq BM < 1$$

This method of measuring diversification does not have a benchmark or norm value for diversification.

TYPE 2 This type of index is a measure of the proportion of the total activity attributed to an enterprise.

1. The Specialization Ratio Index (SR) (14)

The specialization ratio is an index measure indicated by the proportion of total activity attributed to the largest enterprise in the farm.

$$SR = P^* \quad \text{where } P^* = \max \{P_1, P_2, \ldots P_N\}$$

The resulting SR index is then ranked by single product ($.95 < SR \leq 1.$), dominant product ($.7 < SR \leq .95$), and related product ($SR \leq .7$) or unrelated product ($SR \leq .7$). The division of the latter two categories is by subjective evaluation. Without the subjective evaluation for $SR \leq .7$, this index is the most simple one to evaluate. The related and unrelated product categories would probably not be consistent across all observers. The benchmark or norm index measure would be perfect specialization at SR = 1. This would also be the maximum limit, because of the restriction on the P_i, if negative P_i are not allowed. The minimum limit would approach 0 for an infinite number of equally sized enterprises.

$$0 < SR \leq 1$$

TYPE 3 This type of index is a combination of a count and the proportion of total activity of the enterprises involved in the farm structure.

1. Gort Index (G) (7)

This index assumes that diversification is a function of the number of enterprises and the proportionate size of the major enterprise.

$$G = (1-P^*)\ (N) \text{ where } P^* = \text{Max } \{P_1, P_2, \ldots P_N\}$$

The index is a simple and objective measure of diversification. The diversification measure is a linear function for which the minimum and maximum values are determined by the constraints on number of enterprises (N) and the proportion of the enterprises. Table VII demonstrates the possible diversification index values for $N > 0$ and $0 < P_i \leq 1$.

TABLE VII. INDEX VALUES FOR GORT INDEX

P^*	$1-P^*$	N	G
1	0	1	0
.99	.01	2	.02
.5	.5	2	1
.2	.8	5	4
.8	.2	5	1

G is a minimum when a farm has one enterprise which accounts for all the activity in a farm. For more than one enterprise the index approaches 0 as the proportion of the largest enterprise approaches one. The maximum level the function can attain is (N - 1) since the major enterprise cannot be smaller than 1/N. The norm or benchmark values for the function would occur at the limits of the function. Perfect specialization would be subject to the total number of enterprises considered, i.e., OG = (N - 1). There would be no upper limits to the function since the upper limit of N is unconstrained. The lower limit of the function is G = 0 and is the norm measure for perfect specialization.

$$0 \leq G < \infty$$

2. The Drummond Index (D) (5)

This function is the sum of an arbitrarily weighted series of enterprise proportions. The index is a function of the number of enterprises participated in and their proportions.

$$D = \sum_{i=1}^{N} \frac{P_i}{\omega^{i+1}} \quad ; \quad P_i > P_{i+1}$$

ω is an arbitrary weighting constant which is set at a value greater than one (2 is used in this study). The largest enterprise is weighted the most. Its contribution to the diversification index is its proportion of total activity. Succeeding enterprises contribute less to the diversification index. For example, given $\omega = 2$, the tenth largest enterprise would contribute 1/512 of its proportionate level of total activity to the diversification index. The P_i must be considered in decreasing order during the calculation of the index. The index is objective. The Drummond function will be a maximum at D = 1 with N = 1. For more than one enterprise, the index can approach one as the proportionate size of the major enterprise approaches one. The minimum value of the Drummond function is:

$$D_{min} = \sum_{i=1}^{N} \frac{1/n}{\omega^{i-1}} = \sum_{i=1}^{N} \frac{1}{n\omega^{i-1}}$$

since 1/N is the minimum value that the largest enterprise can have and still be the largest enterprise. The benchmark or norm level of diversification would be 1/N for a given level of N.

3. The Herfindahl Index (H) (1) (2)

The H measure of diversification assumes that the cumulative contribution of each enterprise to total activity needs to be considered.

$h(P_i)$, where P_i is defined to be the measure of activity of the ith enterprise to the total activity, is defined as:

$$h(P_i) = \sum_{i=1}^{N} P_i = t_i; \quad P_i > P_{i+1}$$

N - 1 is the number of enterprises that are smaller than the ith enterprise being considered. t_i is the cumulative proportion of total activity attributed to the largest N enterprise(s).

If N were the total number of enterprises within a firm then:

$$h(P_i) = \sum_{i=1}^{N} P_i = 1. \; ; \; P_i > P_{i+1}$$

The function $h(P_i)$ is demonstrated in Figure 5. The slope of $h(P_i)$ at (N, P_i) represents the contribution of the i enterprise to a total output and is the ratio $t_i/N = P_i$. The change in total output attributed to each enterprise needs to be summed into one meaningful number. If each observation along the schedule is weighted by its proportionate contribution to the total activity, then the following sequence would result:

$$\sum_{i=1}^{N} P_i(P_i) = \Sigma (P_i)^2$$

$$H = \text{Herfindahl index} = \sum_{i=1}^{N} (P_i)^2$$

The simplicity of calculating this index and the other indices in this chapter will depend primarily on the basic assumptions of how to calculate each P_i. Once the P_i are calculated the calculation of the index is straight forward and objective. The index is a function of P_i and N. N is given for each farm being evaluated. The maximum/minimum value for the diversification measurement function

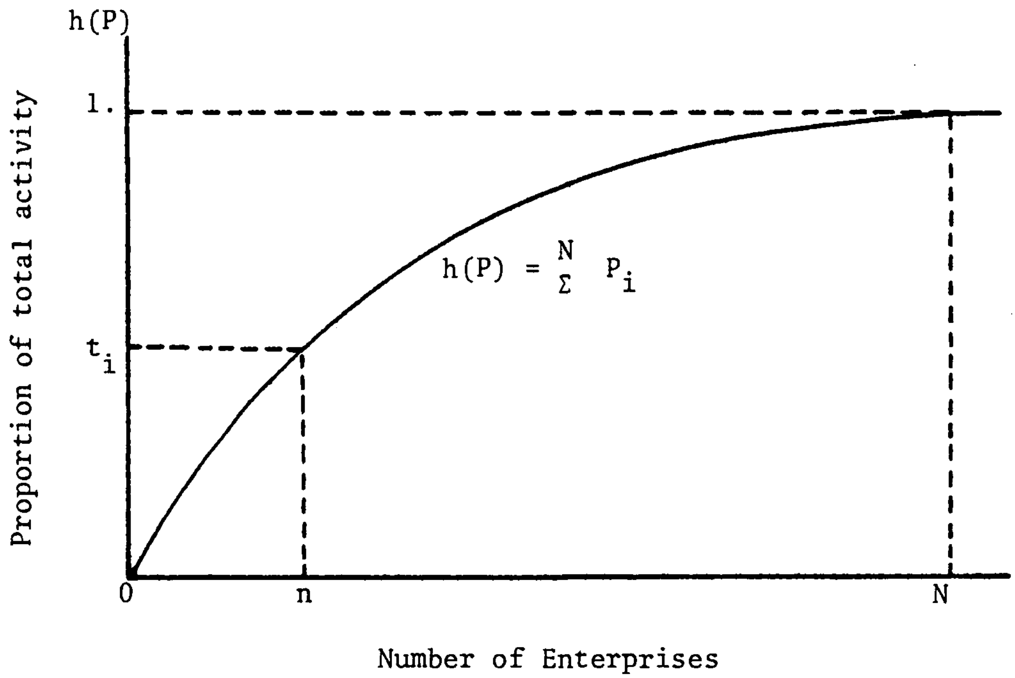

Figure 5. Theoretical Construction of the Herfindahl Index

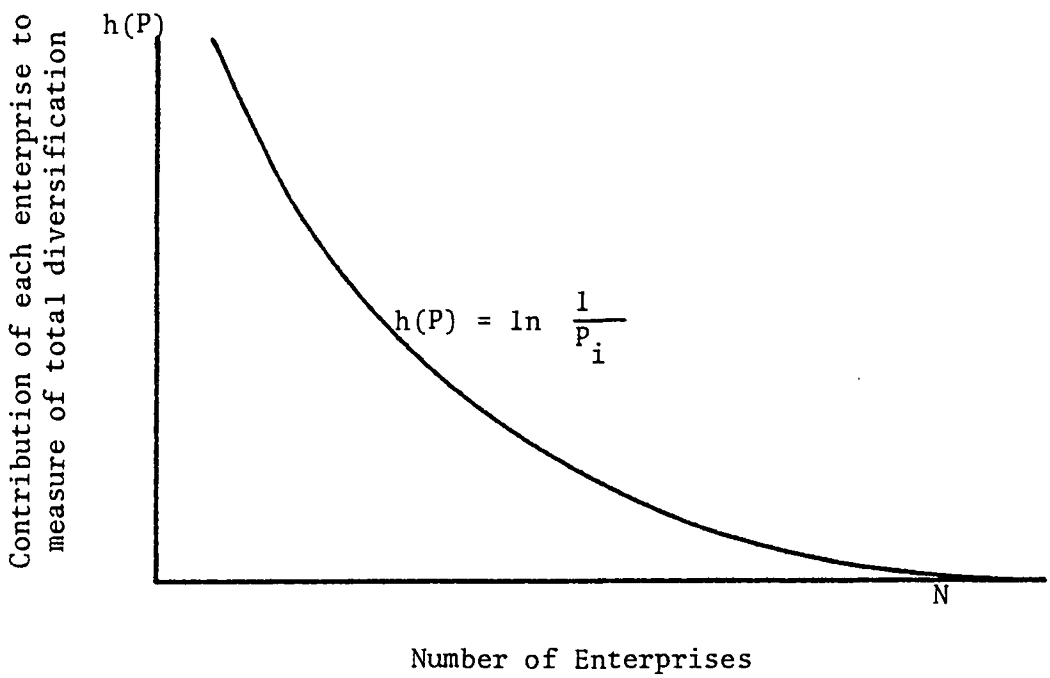

Figure 6. Theoretical Construct of the Entropy Index

for a given N would occur at the point where the slope of the function (subject to the constraint $\Sigma P_i = 1$) would be zero. The rate of change in the slope of the function at this point would determine if it were a minimum or maximum point on the function. The Lagrangian solution to the norm or benchmark measure would be as follows:

$$L = \sum^{N} (P_i)^2 - \mu` (\sum^{N} P_i - 1)$$

$$\frac{L}{P_i} = 0 = > 2 P_i - \mu = 0$$

$$= > P_i = \mu/2$$

$$= > P_i = P_{i+1} = P_{i+2} \text{ etc.}$$

$$= > P_i = 1/N \text{ since N is given.}$$

Substitute $P_i = 1/N$ into $\sum^{N} (P_i)^2$

$$= \quad H = \sum^{N} (1/N)^2 = N(1/N^2) = 1/N$$

Check second order conditions:

$$\frac{\partial \left(\frac{\partial L}{\partial P_i}\right)}{\partial P_i} = 2 > 0$$

therefore the H index is a minimum value for $P_i = 1/N$.

The H index assumes diversification to be a function of the relative weights of the enterprises and the number of enterprises. Lower index values indicate higher levels of diversification. Given the Herfindahl method of measuring diversification, D = 1/N is the norm for perfect diversification. The limits of the function H would be a minimum at $N = \infty$. By inspection the maximum would occur at N = 1.

$$1/\infty \leq H \leq 1/1 = > 0 < H \leq 1$$

4. The Entropy Index (E) (18) (8) (12)

The entropy function is a measure of the expected impact of all additional enterprises on diversification. The measure assumes that the enterprises are considered from the largest to the smallest. If no enterprises have been considered the impact on the measure of diversification of the first enterprise to be considered (which would also be the largest) would be relatively large. As additional smaller enterprises are considered their impact on the measure of diversification would be smaller. When the last enterprise was considered, there would be no more changes to the measure of diversification. $h(P) = \log(^1/P_i)$ has been arbitarily chosen as a respresentative decreasing function of the impact on diversification of each enterprise of N total enterprises being considered. The base of the logarithm is arbitrarily set at a value greater than one. (Log to the base e is used in this study.) Figure 6 is a representation of the $h(P) = \ln(1/P_i)$ function. The expected impact on diversification for one enterprise would be $P_i h(P_i)$. The expected total impact on diversification if a farm had two enterprises would be:

$$(P)\ h\ (P) + (1-P)\ h\ (1-P) = P \ln 1/P + (1-P) \ln \left(\frac{1}{1-P}\right)$$

In general, if there are N enterprises, then the expected impact on diversification would be:

$$\sum_{i=1}^{N} P_i \ln \frac{1}{P_i} => E = \text{Entropy} = \sum_{i=1}^{N} P_i \ln 1/P_i$$

Although the theoretical construct of the E index considers the N enterprises in descending order, the function is additive, and if all N enterprises are considered, the order of computation of each enterprise in the index has no effect on the resulting index value. Given the predetermined values of P_i, the computation of the E index is simple and objective. The E index is a function of both relative degrees of activity of each enterprise and their number. A Lagrangian system, similar to the one used for the Herfindahl index, can be used for Entropy index to find a norm or benchmark measure.

$$L = -\sum_{i=1}^{N} P_i \log P_i - \mu \left(\sum_{i=1}^{N} P_i - 1\right)$$

$$\frac{\partial L}{\partial P_i} = 0 => -1 - \log P_i - \mu = 0$$

$$=> P_i = (-1-\mu)$$

$$=> P_i = P_{i+1} \text{ etc.}$$

$$=> P_i = 1/N \quad \text{since N is given}$$

Substitute $P_i = 1/N$ into $-\sum_{i=1}^{N} P_i \log P_i$

$$=> E = -\sum_{i=1}^{N} 1/N \log 1/N = -N/N \log 1/N = \log N$$

Check second order conditions

$$\frac{\partial\left(\frac{\partial L}{\partial P_i}\right)}{\partial P_i} = -1/P_i < 0$$

therefore the E index is a maximum for $P_i = 1/N$.

The concept of diversification as explained by the E index is implied by the definition of Entropy. The activity level that is being monitored is identical for each enterprise. The norm for perfect diversification is $P_i = 1/N$. Limits on the entropy function occur when $N = \infty$ and when $N = 1$. The maximum limit would be $\log \infty = \infty$.

If $n = 1$ then $P_1 = 1$ since $\sum_{i=1}^{N} P_i = 1$. The minimum value of the E

index would be $\sum_{i=1}^{N} P_i \log 1/P_i = > 1 \log 1 = 0$.

$0 \leq E < \infty$

Norm type - This type of index measures movements from the local norm enterprise structure as movements in diversification/specialization.

1. The Ogive Index (OG) (19)

This index measures the relative absolute deviation of each enterprise in a farm from its norm proportion of the farm population. The number of enterprises is indirectly accounted for by summing the deviations over all N enterprises. This index assumes that deviation from the norm for a characteristically large proportion enterprise will have less effect on the index of diversification than deviations for a characteristically small enterprise. The index is as follows:

$$OG = \text{Ogive Index} = \sum_{i=1}^{N} \frac{(P_i - M_i)^2}{M_i} \quad ; \quad \sum_{i=1}^{N} M_i = 1.$$

M_i is the norm for the activity level of the ith enterprise (proportion) over all farms. A Lagrangion system is used to calculate the norm measure of diversification. M_i will be a fixed set of proportions for the farms being considered.

$$L = \sum_{i=1}^{N} \frac{(P_i - M_i)^2}{M_i} - \mu \left(\sum_{i=1}^{N} P_i - 1 \right)$$

$$\frac{\partial L}{\partial P_i} = 0 => \frac{2(P_i - M_i)}{M_i} - \mu \left(\sum_{i=1}^{N} P_i - 1 \right)$$

$$=> P_i - M_i = \left(\frac{\mu}{2}\right) M_i$$

$$=> P_i = M_i \left(1 + \frac{\mu}{2}\right)$$

$$=> \frac{P_i}{M_i} = \left(1 + \frac{\mu}{2}\right)$$

$$=> \frac{P_1}{M_1} = \cdots = \frac{P_i}{M_i} = \frac{P_{i+1}}{M_{i-1}} = \cdots = \frac{P_N}{M_N} \quad (1)$$

$$\frac{\partial L}{\partial \mu} = 0 => \sum_{i=1}^{N} P_i - 1 = 0$$

$$=> P_1 + \cdots + P_i + P_{i+1} + \cdots + P_N = 1$$

$$=> P_i = 1 - P_1 - \cdots - P_{i+1} - \cdots - P_N \quad (2)$$

from the definition of M_i

$$M_1 + \cdots + M_i + M_{i+1} + M_{i+2} + \cdots + M_N = 1$$

$$=> M_i = 1 - M_1 - \cdots - M_{i+1} - \cdots - M_N \quad (3)$$

The solution to equations (1), (2), (3) shows that: $P_i = M_i$

$P_{i+1} = M_{i+2}$

etc.

Substituting M_i for P_i for all i in OG yields:

$$OG = \sum_{i=1}^{N} \frac{(M_i - M_i)^2}{M_i}$$

$$=> OG = 0$$

Check on second order conditions:

$$\frac{\partial\left(\frac{\partial L}{\partial P_i}\right)}{\partial P_i} = 2 > 0$$

The OG index is a minimum when $M_i = P_i$. Since diversification is a measure of the amount of deviation from the norm for each enterprise, the norm or benchmark value for this index is perfect specialization at $P_i = M_i$. The limits of the OG function are at $P_i = M_i$ = > OG = 0 and there would be no limit on the maximum value.

$0 \leq OG < \infty$

APPENDIX II

THE SURVEY

SOURTHERN ALBERTA FARM STRUCTURE SURVEY

Economics Branch

Agriculture Canada

Research Station

Lethbridge Alberta

The purpose of this survey is to evaluate farmers' and farm management specialists' concepts of specialization. The personal questions will be used to categorize your perspective of a farming enterprise.

Hypothetical enterprise structures and hypothetical returns are outlined for four different farms from each of three different irrigation districts in southern Alberta. Please rank each set of farms on a scale from one to ten according to your concepts of farm specialization. As farms become more specilized, their specialization rank will become larger, i.e., ten would be a completely specialized farm.

This survey is being conducted as part of a research project by a staff member of the Lethbridge Research Station who is on educational leave at Oregon State University. The survey is designed to provide data for one aspect of a study of farm diversification. Any information provided or opinions expressed will be kept confidential.

WESTERN IRRIGATION DISTRICT

		Farm 1	Farm 2	Farm 3	Farm 4
Irrigated Forage for Sale					
	Acres	40		400	
	GR $	6,000		30,000	
	NR $	2,000		10,000	
Dry Cereal	Acres	200	600		500
	GR$	20,000	60,000		50,000
	NR$	8,000	24,000		20,000
Dry Oilseed	Acres	100	400		100
	GR $	11,000	44,000		11,000
	NR $	4,500	18,000		4,500
Summerfallow	Acres	200	250		100
	NR $	-4,000	-5,000		-2,000
Cow-calf*	Head	100		250	25
	GR $	18,000		45,000	4,500
	NR $	4,000		10,000	1,000
	Total GR $	55,000	104,000	75,000	65,500
	Total NR $	14,500	37,000	20,000	23,500
	Total Crop-Land **	540	1,250	200	700
	Total Irrigated Crop-land**	40		200	

* includes sufficient dry pasture for six months and irrigated forage for four months, crop aftermath two months.

** land producing crops for sale.

LETHBRIDGE NORTHERN IRRIGATION DISTRICT

		Farm 1	Farm 2	Farm 3	Farm 4
Irrigated Forage for Sale					
	Acres	100		75	
	GR $	15,000		11,250	
	NR $	5,000		3,750	
Cow-calf*					
	Head	50	10		
	GR $	9,000	1,800		
	NR $	1,750	350		
Feeder**					
	Head	50		500	
	GR $	27,000		270,000	
	NR $	5,000		25,000	
Dry Cereal					
	Acres		100		50
	GR $		10,000		5,000
	NR $		4,000		2,000
Irrigated Cereal					
	Acres	25	200	50	100
	GR $	5,000	40,000	10,000	20,000
	NR $	2,500	20,000	5,000	10,000
Off-farm Work					
	Days				220
	NR $				10,000
	Total GR $	56,000	51,800	291,250	25,000
	Total NR $	14,250	24,350	33,750	22,000
	Total Dry Crop-Land ***	0	100	0	50
	Total Irrigated Crop-Land ***	125	200	125	100

* sufficient irrigated acreage available for six months, crop after math for two months, and irrigated forage for four months.

** all feed is purchased.

*** land producing crops for sale.

TABER IRRIGATION DISTRICT

		Farm 1	Farm 2	Farm 3	Farm 4
Irrigated Cereal	Acres	225	100	175	250
	GR $	45,000	20,000	35,000	50,000
	NR $	22,500	10,000	17,500	25,000
Irrigated Sugar Beets	Acres	75	75		
	GR $	33,750	33,750		
	NR $	15,000	15,000		
Irrigated Potatoes	Acres		75	150	
	GR $		41,250	82,500	
	NR $		18,750	37,500	
Summerfallow	Acres		75	75	50
	NR $		-2,625	-2,625	-1,750
Irrigated Oilseed	Acres				100
	GR $				20,000
	NR $				10,000
Green Peas	Acres	100	75		
	GR $	12,000	9,000		
	NR $	7,500	5,625		
	Total GR $	90,750	104,000	117,500	70,000
	Total NR $	45,000	46,750	52,375	33,250
	Total Irrigated Cropland	400	400	400	400

FOR BOTH MANAGEMENT SPECIALISTS AND FARMERS

Please indicate your perceived degree of specialization for the following farms. Use a scale of one to ten where ten indicates a completely specialized farm.

WESTERN IRRIGATION DISTRICT

Farm 1	Farm 2	Farm 3	Farm 4

TABER IRRIGATION DISTRICT

Farm 1	Farm 2	Farm 3	Farm 4

LETHBRIDGE NORTHERN IRRIGATION DISTRICT

Farm 1	Farm 2	Farm 3	Farm 4

NAME ______________________________

On which particular criterion or combination of criteria did you base your rank on?

Distribution of net revenue	Distribution of gross revenue	Acreage distribution between irrigated and dryland	Acreage distribution between crops	Possible income fluctions for various enterprises

Age of interviewee

11 - 20	21 - 30	31 - 40	41 - 50	51 - 60	61 - 70	71 +

<u>FOR FARM MANAGEMENT SPECIALISTS</u>

Number of years you have formally been employed as a management specialist

0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	40 +

FOR FARM OPERATORS

Irrigation district

LNID	TID	WID

Number of years you have operated a farm.

0-10	10-20	20-30	30-40	40-50	50-60	60-70	70+

ESTIMATED MARKET VALUE OF LAND, MACHINERY AND BUILDINGS
(in thousands)

$0-$100	$100- $200	$200- $300	$300- $400	$400- $500	$500- $600

$600- $700	$700- $800	$800- $900	$900 +

INDICATE AMOUNT OF CURRENT DEPT BY THE LENGTH OF THE ORIGINAL LOAN
(the amount currently owing)

0-1 yr	1-3 yrs	3-5 yrs	5-10 yrs	10-20 yrs	+ 20 yrs

INDICATE TOTAL FARM DEBT
(in thousands)

$0-$25	$25- $50	$50- $100	$100- $150	$150- $200	$200- $250	$250- $300	$300 $350	$350+

FAMILY OFF-FARM INCOME

Total annual gross

$0 - $5,000	$ 5,001- $10,000	$10,001- $15,000	$15,001- $20,000	$20,001- $25,000	$25,001+

Nature of employment

Steady	Seasonal

Total income from custom farming

0 - 1000	1001- 2000	2001- 3000	3001- 4000	4001- 5000	5001- 6000	6001- 7000	7001- 8000	8001+

Total payments for custom farming

0 - 1000	1001-2000	2001-3000	3001-4000	4001-5000	5001-6000	6001-7000	7001-8000	8001+

ENTERPRISES

Percent of gross farm income received from the following enterprises

Oilseeds and grains	Livestock	Seedcrops	Row and Vegetable Crops	Forage	Other

APPENDIX III

WILCOXON MATCHED-PAIRS

SIGNED-RANK TEST

"The Wilcoxon test is a useful test for the behavioral scientist. With behavioral data, it is not uncommon that the researcher can (a) tell which member of a pair is "greater than" which, i.e., tell the sign of the difference between any pair, and (b) rank the differences in order of absolute size. That is, he can make the judgement of "greater than" between any pair's two performances, and can also make the judgement between any two different scores arising from any two pairs. With such information, the experimenter may use the Wilcoson test." (16, p. 75).

For large samples (number of comparisons is greater than twenty-five) the sum of ranks is practically normally distributed

$$\text{Mean} = \mu_T \quad \frac{N(N + 1)}{4}$$

$$\text{Standard deviation} = \sigma_T = \sqrt{\frac{N(N + 1)\ (2N + 1)}{24}}$$

$$\text{Therefore} \quad Z = \frac{T - \mu_T}{\sigma_T} = \frac{T - \frac{N(N + 1)}{4}}{\sqrt{\frac{N(N + 1)\ (2N + 1)}{24}}}$$

Z is approximately normally distributed with zero mean and unit variance. A table of normal distribution probabilities gives the probabilities associated with the occurrence under H_0 of various values as extreme as an observed Z. N is the number of matched pairs minus the number of pairs whose difference is zero. T is either the sum of the positive ranks or the sum of the negative ranks, whichever sum is smaller.

The rank is derived from ranking all the absolute differences between pairs: give the rank of one to the smallest difference, the rank of two to the next smallest, etc. then assign a sign to the ranks by which ranks arose from negative differences and which ranks arose from positive differences. If two or more differences are the same size, the rank assigned is the average of the ranks which would have been assigned if the d's had differed slightly.

Note: N was less than twenty-five for more than half of the bi-farm comparisons. In order to make all comparisons compatible with each other the normal distribution was assumed to be valid for all cases. Siegel demonstrates that the normal approximation is a good estimate for small samples.

APPENDIX IV

ECONOMETRICS

The results of the regression analyses in Chapter III are based on ordinary least squares (OLS) estimates. The assumptions for the OLS model are as follows:

$$Y_{n1} = X_{nk} B_{k1} + \mu_{n1}$$

1. $E(\mu_{n1}) = 0_{n1}$

2. $E(\mu_{n1}\mu'_{1n}) = \sigma^2 I_n$

3. X_{nk} is a set of fixed numbers

4. $(X'_{nk}) = K, K < n$

If the above four assumptions are met the OLS estimate is considered to be BLUE (11, p. 122).

Check for violation of assumption 1.

A plot of the residuals was made for each regression analysis. There is no reason to believe that assumption 1 is violated.

Check for violation of assumption 2.

This could occur under two conditions.

Condition 1 (Heteroscedasticity)

This occurs when $E(\mu\mu') = \sigma^2 \Omega_n$ and $\Omega_n \neq I_n$

This condition often occurs in models where the structural background conditions change in cross sectional data. Structural background conditions over which the variability of the perceived diversification ranks could vary are: individual respondents, location of respondent, location of hypothetical farm and occupation of respondent. Farmer and farm management specialist respondents were considered separately so that the OLS estimates for these two groups should not be affected by heteroscedasticity. Individual respondents each ranked twelve hypothetical farms, ten farmer respondents were chosen from each irrigation district and nine farm management respondents were chosen from Alberta and nine from Oregon, four hypothetical farms were analyzed from each of the three irrigation districts. If the above variables are the only variables over which variability of the observed independent variable changes, heteroscedasticity will not be a problem.

Condition 2. (Autocorrelation)

This occurs when $E(\mu\mu') = \sigma^2 \Omega$

where: $$\Omega = \begin{pmatrix} 1 & P_1 & P_2 \\ P_1 & 1 & P_3 \\ P_2 & P_3 & 1 \end{pmatrix}$$

This condition is often caused by a lack of independence among observations. The respondents perceived diversification ranks were modified by the Likert Scale across each respondent. This should eliminate any dependence between the observations by each respondent. It is assumed that autocorrelation is not a problem.

<u>Check</u> for violation of assumption 3.

Individual observations were grouped by respondents. Durban Watson test statistics varied from 2.20 to 2.23 for the farmer respondent regressions and from 2.04 to 2.09 for the farm management specialist regressions. It is assumed that assumption 3 is not violated.

Check for violation of assumption 4 (Multicolinearity)

Perfect multicolinearity did not exist since the matrix (X'x) was inverted. A check of the variance inflation factors (VIF) is made to analyze the possible effect of partial multicolinearity on the resulting OLS estimate. Table VIII outlines the variance inflation factors from several regression equations in Chapter III. When various measures of activity levels are not considered simultaneously the variance inflation factors indicate that multicolinearity is not a problem.

TABLE VIII. VARIANCE INFLATION FACTORS FOR SEVERAL REGRESSION EQUATIONS IN CHAPTER III

Equation Number	1	4	8
Drummond index on gross returns	1.95	15.77	1.92
Drummond index on net returns	N/A	20.99	N/A
Drummond index on acres	N/A	4.74	N/A
Location of farmer respondent - WID	N/A	N/A	2.09
Location of farmer respondent - TID	N/A	N/A	2.38
Location of manager respondent - Alberta	1.05	1.05	N/A
Age	1.05	1.05	1.86
Location of hypothetical farm - WID	10.99	13.79	11.64
Location of hypothetical farm - LNID	8.79	12.03	9.11
Cropping enterprise only	3.02	4.75	3.24
Intensive crop in farm structure	4.02	6.04	4.03
Income variability	5.29	6.34	5.29
Percent of non-irrigated cropland	6.15	13.10	6.29
Diversification index - respondents farm	N/A	N/A	2.07
Cropping only - respondent's farm	N/A	N/A	1.86
Respondent has intensive crop enterprise	N/A	N/A	13.78
Respondent's off-farm work - steady	N/A	N/A	2.02
Respondent's off-farm work - seasonal	N/A	N/A	1.44
Wealth position of respondent			
- 100,000 to 250,000	N/A	N/A	1.67
- 250,000 to 500,000	N/A	N/A	2.09
- above 500,000	N/A	N/A	1.36