A STUDY OF RISK AND UNCERTAINTY IN NORTH CENTRAL KANSAS

by

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CHAPTER I

INTRODUCTION

In this day and age agriculture is becoming a very uncertain and risky business. With the variability of prices and rising cost of agricultural products in the past several years, farming has become a very unpredictable business. During the 1960's the degree of uncertainty and risk was fairly stable; government programs varied little throughout the 60's, prices of products and farm inputs stayed fairly constant and were not too susceptible to major price increases or price decreases and rapid movements in prices were very unusual. Thus, farmers began to develop a feel for the amount of risk and uncertainty involved in the different farming enterprises. But in todays fast moving economy with a large amount of economic and political uncertainty, it makes it very difficult for farmers to run on past track records and still be a successful businessman. Management strategies and decision-making must be given a considerable amount of time and thought before making any major farm decisions as to what cropping enterprise to use and whether to incorporate livestock into the operation. Risk and uncertainty influence decisions concerning which crops to grow, what livestock to raise and how to combine crops and livestock on a farm.

Management has been defined by Don Bostwick as deciding

carefully on the desired ends and then selecting, from all possible actions those most appropriate to these ends, with due thought to limitations imposed by present and future events.[1]

Risk and uncertainty have been defined by Frank Knight. Risk refers to the probability distribution of outcomes that can be measured by some statistical means. Uncertainty, on the other hand, is unmeasurable by any statistical analysis. It is subjective, a function of the attitude or opinions of the individual or group.[2]

Management has a role in determining the amount of risk and uncertainty one is subjected to. Through proper management strategies one can reduce the amount of risk and uncertainty that one is exposed to. One learns through experience, to adopt strategies to reduce risk and uncertainty.

Review of Literature

There has been some work done on the management of risk and uncertainty. Most of the work has been theoretical in nature with very few studies of an applied nature to back up the theoretical hypothesis. In reviewing the literature, two articles were found that did an excellent job of defining

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[1]Don Bostwick, Management Strategies for Variable Wheat Yields in Montana, Montana Agr. Exp. Sta., Bulletin 585, Montana State College, June 1964, p. 3.

[2]Mahmud Tunku Yahya and Richard M. Adams, Some Measures of Price, Yield, and Revenue Variability for Wyoming Crops and Cropping Systems, Agr. Exp. Sta., Research Journal 115, University of Wyoming, Laramie, Wyoming, September 1977, p. 1.

some theoretical ways to reduce risk.

The first article "Risk Management in Agriculture" by Dr. Michael Boehlje and Larry Trede, both from Iowa State University, gives some major sources of risk in agriculture and then some management strategies for handling this risk.

It is very important that a farmer be able to identify the different sources of risk before being able to choose the appropriate risk management strategies. Boehlje and Trede have identified several major factors that have contributed to the increased risk in agriculture. These factors are: (1) price risk, which includes the fluctuations of farm products and inputs. There has been a dramatic amount of fluctuation in prices since the early 1970's, thus making it very difficult for the farmer. (2) Governmental policy and regulations like export controls, Environmental Protection Agency regulations, and changing government programs such as price supports and target pricing, have all made an increasing amount of uncertainty for farmers. (3) Business and legal risk has become a part of the picture in farming, with OSHA regulations and the handling of more dangerous chemicals leaving the farmer very open to lawsuits. (4) Management discontinuity risk which is basically a loss of management due to death or disability. (5) Production risk, which is a very big factor involving weather conditions, disease, and possibly threat of insects. And (6) technological and obsolescence risk, which can prove to be very costly to farmers due to large investment costs in machinery and production methods.

Boehlje and Trede have outlined a few ideas to help reduce the risk in farm management. The first thing they said is that one must realize in an environment of risk and uncertainty, making management decisions should involve a systematic analysis of risk involved in a particular activity and the ability of the manager to handle that amount of risk. It is important that an assessment be made of the farmer's willingness to take on risk and his ability to manage under the pressure of risk and uncertainty. There are some farmers that are willing to assume risks, where other farmers try to avoid or eliminate all possible risks. The amount of risk a farmer is willing and capable of handling is essential to develop a risk management strategy.[3]

After determining the amount of risk a farmer can handle, strategies to reduce the risk can be applied. Boehlje and Trede have classified strategies to reduce risk into three categories. Marketing strategies which are used to minimize price risk through such practices as; hedging, spreading sales, contract sales, and input forward pricing. Financial strategies are then used to reduce financial risk by maintaining adequate liquidity and proper loaning of money. The last of these three, production strategies, is probably the most relevant to this paper. Production strategies involve the selecting of more stable enterprises. To minimize risk one selects those

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[3]Michael D. Boehlje and Larry D. Trede, Risk Management in Agriculture, Journal of American Society of Farm Managers and Rural Appraisers, April 1977, p. 21.

enterprises that tend to have a stable or low variability in income. In addition, diversification in farm activities can be attempted so that net farm income will be more stable. For example, a negative correlation of income means that if the income from one enterprise is poor, then the income from some other enterprise will probably be good and offset the poor income from the first enterprise. A positive correlation in income indicates that the income from two enterprises may tend to move together. Diversification is more successful in reducing variability of income if income from enterprises have a negative correlation and not a positive correlation, because the positive correlated enterprises do not offset each other. The last part of the production strategy is flexibility. If the farmer is flexible he then has the ability to adapt to the changing economic conditions by production adjustment.

The second article "Guidelines for Farm Decision-Making in a Period of Uncertainty" by John E. Kadlec, Professor of Agricultural Economics at Purdue University, has set up several guidelines for farm decision making to avoid some of the uncertainties and risks involved in a period when the economic situation is unpredictable and large fluctuations in farm product prices can occur.

Guideline #1 - Reassess your goals especially those of risk and profit.

The farmer should list his goals and their importance, then decide what level of risk is acceptable and develop a personal feel for the amount of risk he feels he can handle.

Guideline #2 - Study the economic and physical environment and place odds on the likelihood of various outcomes during the next five years.

The farmer must make judgements as to the probabilities of higher farm prices, inflation, changing weather conditions, for example, whether it be a dry cycle in the weather pattern or a wet cycle, and other business environment factors involved, such as increased input costs and possible shortages of farm inputs.

Guideline #3 - Evaluate the consequences of alternative product price, yield and cost possibilities before making major decisions.

The farmer needs to also consider the consequences of lower farm prices, lower yields and more severe weather conditions than those predicted. Consideration of these problems can protect the farmer from a completely unexpected situation which could damage his financial position.

Guideline #4 - Be aware of the increased risk resulting from higher capital and other costs and widely fluctuating prices.

The farmer has to realize the increasing need for capital and investments is making him very vulnerable to a financial upset, especially with the possibility of declining prices or crop failure.

Guideline #5 - Take steps to keep risk at levels in line with goals and capital position.

The farmer may have other goals besides risk aversion, such as increased income or larger investments. There are generally trade-offs between these different goals, meaning that a farmer is willing to take more risk to increase income or investment or reduce some of his risk and take a cut in income.

But it is possible to accomplish both risk aversion and these others goals if the farmer approaches the goals at a reasonable pace.

Guideline #6 - Most farmers should give operating considerations first priority and investment second priority.

The farmers must remember they are producers of agricultural products first and investors second. Their capital should be used in production and then if managed properly a farmer can invest in the needed land, buildings, and machinery.

Guidleline #7 - Purchase needed buildings, machinery, and other inputs as soon as possible without over extending the business financially.

The farmer should have a desire to expand and invest, but he must follow price changes very closely and when he feels right, should purchase only those inputs needed for that expansion. It does not appear that investing in more farm inputs than needed at the present, to hedge against inflation, is of any great benefit.

Guideline #8 - Carefully reconsider the production system - the situation has changed.

The farmer needs to consider trends of investing capital for labor. The trend had been that of substituting capital for labor in crop and livestock production, but the rapid increases in prices of labor saving equipment and high interest rates have made the use of labor more attractive. The shift to labor saving capital has thus slowed down, but also the farmer must keep in mind that they can not afford to let the high price of capital items restrict their volume. A farmer must carefully compare the costs of capital and the cost of

labor. It is possible that the substitution of labor for capital may cost him more due to restrictions in expansion of his operations.

Guideline #9 - Continue to give much attention to decisions about time and place of marketing and purchasing.

The farmer will have to become aware of the different marketing strategies such as hedging, contract sales, and contract buying of farm inputs. Then he will have to be more willing to use these strategies to help control some of the risk of the widely fluctuating agricultural product prices.

Guideline #10 - Think more broadly about alternatives.

The farmer will need to become more open to new ideas in management and think more broadly about the possible alternatives that are available to him.

In concluding Kadlec said, the future can not be predicted with certainty. Therefore, the manager can not always be right as he looks back on decisions made earlier. However, a manager can analyze the consequences of a decision for different kinds of future situations which have a reasonable chance of occurring. Then he will be in a position to take actions which have good odds of taking him toward his goals, and avoid actions which have significant odds of taking him in the opposite direction.[4]

In the article "Socioeconomic Aspects of Risk and

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[4]John E. Kadlec, Guidelines For Farm Decision-Making in a Period of Uncertainty, Journal of American Society of Farm Managers and Rural Appraisers, April 1977, p. 18.

Uncertainty in Agriculture" Rainer Schickele talks of risk and the inefficient use of resources. The presence of risk causes less - than - full utilization of resources and less - than - optimum combination of production factors. Its human aspects are characterized by an exaggerated urge for security, and the corollary feeling of insecruity produces frustation. Thus, the risk of a future failure or loss of money dampens short-run and long-run expenditures and investments. The fear of possible additional risk then tends to cause the farmer to be inefficient in his use of land, labor and capital. For this reason it is then very important that the farmer know what risk exists within his operation and how to cope with this risk.

Objectives of Study

Risk and uncertainty have long been recognized as a major concern in agriculture. However, considerable work needs to be done at the farm level investigating risk and management techniques which can be used to reduce risk.

This is a broad field with much work being done in the area of risk management. There have been numerous studies done across the country, over the years, on ideas and possible ways to reduce the risks and uncertainty in farming through proper management. But there have only been a handful of studies at the empirical level investigating the success of proposed risk reducing strategies. In this study empirical results are studied to analyze the hypothesis that have been suggested in earlier studies.

The primary objectives of this study are:

1. To provide empirical evidence of the risks involved in agricultural production.

2. To investigate relationships between risk and farm characteristics.

3. To identify management strategies which reduce risk.

4. To compare actual county data on average wheat yields to the average yields of individual farms within the county.

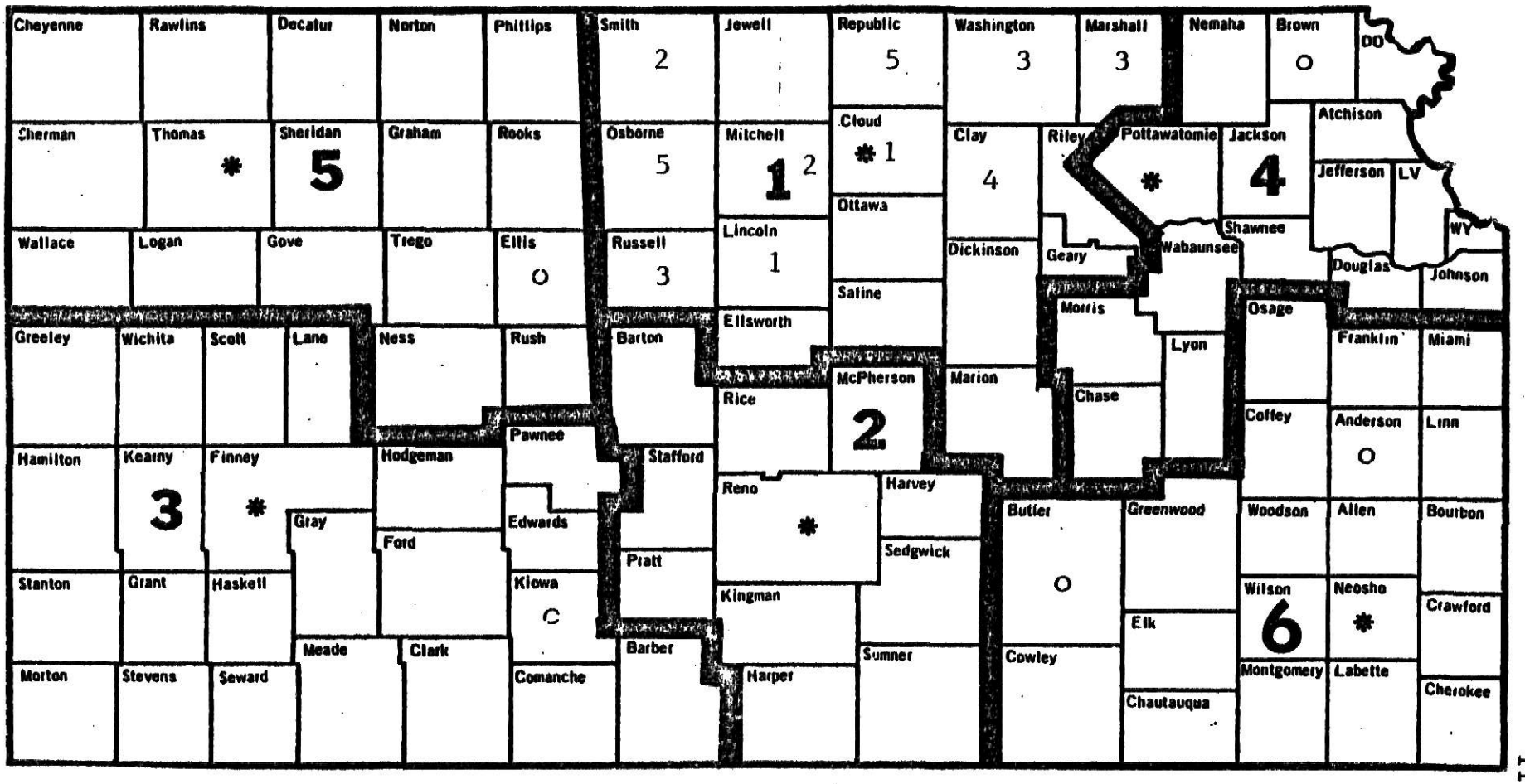
Study Region

There are six associations in the Kansas Farm Management Association which cover the state of Kansas. The farms included in this study are located in North Central Kansas in Association #1 of the Kansas Farm Management Association. The farms in Association #1 were chosen due to the availability of data. The location of Association #1 in Kansas can be seen on the Kansas Association map on the following page. (Figure 1).

The major reasons for choosing this particular area are: (1) Association #1 is one of the oldest associations in Kansas, (2) Association #1 has a larger membership than do several of the newer associations thus making data more available, and (3) the area of North Central Kansas covers more types of farming giving a broader view of Kansas farms, thus making the results of the study more applicable to the entire state.

Figure 1

Kansas Farm Management Associations and a list of farms studied



Data Collection

The major part of the needed data for this study was obtained from the Kansas Farm Management Association. Data were collected over a 16 year period from 1962-1977. The last 5 years of the collected data were taken from the Whole-Farm and Enterprise Data Bank and Retrieval System which the Kansas Farm Management Association has stored at the Kansas State University Computer Center. It was felt that 5 years of data were not sufficient for such a study and that a risk management study required a longer period due to the large amount of variability in yields and prices that have existed in farming in the United States over the past 4 to 5 years. So 11 years of data, from 1962-1977, were taken from Farm Management record-keeping worksheets that the Kansas Association used before going to the retrieval data bank at the Kansas State Computer Center. This longer period of 16 years gives a better view of risk and uncertainty over the years in farm prices, incomes, and technology. It also tempered some of the unusual variability that had existed in the past few years of farming.

A sample of 29 farms were used from various parts of Association #1. Only 29 farms were used because they were the only farms from the association that had a full 16 years of data available. Of these 29 farms, only a few had complete 16 years data for beef and swine. Most of the farms had some type of livestock over the 16 year period, but most had beef part of the time and the same applied to swine. Six of the 29

farms were without any swine and 3 were without beef for the full 16 years. It appeared that some of the farms had a tendency to move in or out of beef or swine in 1971 to 1973. Association #1 had 513 members the last year of the study, 1977, making it one of the largest associations in Kansas; and also giving a much better region for data collection.

The 29 farms were located in 10 of the 18 counties in Association #1. These 10 counties are scattered throughout the association and can be seen on the Kansas Farm Management Association map by the number located in each county, the number being the farms used from each of the respective counties. (Figure 1). Table 1-1 shows a list of the counties in Association #1 and the number of farms used from each county, with the number of members in each county in 1977.

Table 1-1

Counties in Association #1, With Number of Farms in Each County and Number of Farms Used

County	Number of Farms in 1977 That Belong to Association	Number of Farms Used in Study
Marshall	22	3
Washington	43	3
Republic	40	5
Jewell	37	0
Smith	37	2
Osborne	29	5
Mitchell	45	2
Cloud	26	1
Clay	29	4
Riley	20	0
Russell	16	3
Lincoln	21	1
Ottawa	24	0
Dickinson	27	0
Geary	13	0
Marion	46	0
Saline	16	0
Ellsworth	22	0
TOTAL	513	29

Chapter II

AFFECTS ON FARM INCOME

The farmer depends on net farm income to pay consumption expenses, increase savings, and reinvest into the farm business for growth. Reinvesting into the farm business and growing is a very vital part of todays agriculture, but in order for growth to take place the farmer has to be willing to take on some risk.[5] So it is very important that the farmer know where these risks lie and ways to manage the risks involved.

There is risk and uncertainty involved in every aspect of todays farming. This risk is related with the most important factor in farming, net income. Net farm income is the sum of all the enterprise incomes within a farm operation, and the stability of each enterprise directly affects the stability of net income on the farm. When the total farm operation consists of one enterprise and the net income from that enterprise is unstable, then the net farm income will be unstable, thus exposing that farm operation to risk. In a farm operation with several different enterprises, one unstable enterprise has a smaller affect on the total net farm income variability.

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[5]Arlo W. Biere, Net Farm Income Instability in the Great Plains, Symposium on Agricultural Policy, Kansas City, Missouri. Feb. 1977, p. 51.

In this part of the study, empirical results are used to identify management strategies of using different enterprise mixes in a farm operation. Special attention is focused on how the incomes from each enterprise affect the total net farm income and how each enterprise affects the variability of net farm income as a measure of risk and uncertainty.

The characteristics that make up any farming operation affect the net farm income. These characteristics include the number of acres a farmer has in his operation, the total income he received from his livestock operations, his total cropping income, the total capital managed in his operation, and the gross income from the operation.

There are ways to reduce the variability in net farm income, thus giving the farmer a more stable net farm income and taking much of the uncertainty out of his production decisions for the future. This part of the study investigates the affect of these farm characteristics on net farm income. Finding ways of increasing the average net farm income over the years of the farm operation could make the variability of net farm income easier to bear.

Correlations

The Pearson Correlation was used to investigate the relationship between farm characteristics and net farm income. Means for the variables were calculated for each of the 29 farms. Then the relationships between these means were investigated over the 29 farms.

Total Acres

There has been some speculation that the larger the farm operation in total acres the greater the average net farm income, thus making the uncertainty easier to handle at a higher level of net farm income. A casual observation of the individual farms did not show that the more acres or the less acres a farm had the higher the average net income thus not confirming the above hypothesis. However the correlation coefficient indicated that the larger the acreage of a farm the greater the net farm income. A positive correlation was shown between the total farm acres and the average net farm income with a correlation coefficient of +.6007 and a very strong significance level of .001, meaning that in general as the average acres of a farm increased so did the average net farm income. (Table II-1). The correlation coefficient measures the association of strength of the linear relationship between two variables. The closer to one or a negative one the more significant is the relationship and the closer to zero the less significant. The level of significance tells us the statistical signigicance of the relationship between the two variables. The smaller the number the more significant or the greater the importance of the relationship of these variables.

This positive relationship between farm size and net farm income does not always mean that the higher level incomes make the uncertainty easier to handle. There are other problems which may grow as the farm gets larger. Their uncertainty may be increased due to possible disease, drought, and possibly

hail or insect damage. These potential problems caused by more acres in production may increase the uncertainty of income in the future.

Beef and Swine Incomes

Beef and swine incomes and their affects on net farm incomes are being looked at because most of the farms in the area of this study produce either beef or swine. To see what affect each has on net farm income, the average gross beef income and the average gross swine income were correlated to net income. On the individual farm basis there was no significant correlation that indicates beef income to have more of an affect on net farm income than swine income or the other way around. But when the 29 farms were studied, evidence was shown that each of these two livestock enterprises had a positive correlation on net income.

The average gross beef income had a correlation coefficient of +.0406 to net farm income with a significance level of .420. The correlation coefficient between average gross swine income and net farm income was +.7141 with a significance level of .001. (Table II-1). The correlation coefficient for average gross beef income was positive but not very significant, meaning that the average net farm income is not very dependent on beef income. This low coefficient was possibly due to the large variability in beef prices and cyclical movements. On the other hand average swine income had a strong positive correlation on net farm income and showed a very positive response to

increases of incomes, thus giving a higher net farm income which could allow a farmer to more easily accept a higher variability of net income.

Capital Managed

In order to relate the overall size of the farm to the total net farm income, the total capital managed was correlated to the net farm income. It was felt that the capital managed was a good indicator of the farm size. There was a very significant relation found between the farm size and net farm income. The positive coefficient of +.6315 and the significance level of .000 showed that as the size of the farm grew there was a definite increase in the net farm income. (Table II-1).

Net/Gross Income Ratio

Net income to gross income ratio can be used as a measure of efficiency on the farm. The larger the ratio the more efficient the farm is, an example would be a ratio of ¼ changing to a ratio of ½ which would indicate an increase in net income per dollar of gross income. When the net/gross income ratio was correlated to the mean net farm income, a coefficient of .4041 and significance level of .015 was found. There was a positive correlation, but the level of significance was not within the .010 level so no real strong relationship was present. Thus net farm income was not highly responsive to this measure of efficiency. A possible reason for this weak relationship is that of management. The net/gross income ratio may

be more responsive to management and not necessarily dependent on the level of net farm income, meaning that the net farm income does not have to be larger to get a large efficiency ratio. The farmer may be managing the operation very efficiently and net a large proportion of every dollar of gross income.

Summary

It is very evident that there exists a definite set of relationships between net farm income and other farm characteristics, and that in most cases, the increasing size or income of the farm characteristic used in this study have a positive affect on net farm income. The net farm income is very important in a farming operation and by increasing this net farm income it is easier to handle the uncertainties of decision making for the future.

Table II-1

Relationships Between Different Farm Characteristics on Net Farm Income Found By Using the Pearson Correlation

Farm Characteristics	Net Farm Income Correlation Coefficient	Significance Level
Average Total Farm Acres	.6007	.001
Average Gross Income	.8196	.001
Average Gross Beef Income	.0406	.420
Average Gross Swine Income	.7141	.001
Average Total Gross Livestock Income	.7082	.000
Average Capital Managed (Farm Size)	.6315	.000
Ratio Net/Gross Income	.4041	.015

Chapter III

VARIABILITY IN INCOMES

It is very important to realize that as a farmer expands into new enterprises his total net farm income becomes less dependent on just one farm enterprise and more dependent on several different farm enterprises. Net farm income begins to increase as these different enterprises increase or become larger as in the case of total acres farmed or size of farm operation. But this is not to say that the net farm income or the income from livestock or crops becomes less variable. Variability in income causes much of the risk in agriculture. If variability of income is reduced without reducing average net income, the risk is reduced.

For this reason, the relationship between variability of net farm income and other farm characteristics was investigated. The standard deviation of net farm income was found and used as a measure of variability. Then the means of each of the characteristics were correlated to the standard deviation of net farm income to look at the relationship between each characteristic and the variability of net farm income.

Impacts on Variability of Net Farm Income

As gross beef income was correlated to the standard deviation of net farm income a coefficient of +.4259 with a

significance level of .013 was found. Gross swine income was then correlated to standard deviation of net farm income with a coefficient of +.6840 with a significance level of .000. To look at the total picture, total gross livestock income was correlated to standard deviation of net farm income, the correlation coefficient was +.7737 with a significance level of .000.

It was found that the averages of swine income and total livestock income had a highly significant affect on the standard deviation of net farm income, thus as average income from swine and the total livestock income increased so did the variability of the net farm income. The affect of average gross beef income was also significant, but not nearly as important. (Table III-1).

Table III-1

Standard Deviations of Farm Characteristics With Respect to Variability of Net Farm Income

Farm Characteristics	Variability of Net Farm Income	
	Correlation Coefficient	Significance Level
Average Gross Beef Income	.4259	.013
Average Gross Swine Income	.6840	.000
Average Gross Livestock Income	.7737	.000
Average Net Farm Income	.7213	.000
Average Total Acres Per Farm	.4842	.004

It was also found that the standard deviation of net income had a positive correlation with the mean net farm income, it then became evident that as the net farm income increased the variability of net income also increased. The correlation of mean net farm income and the standard deviation of net farm income produced a coefficient of +.7213 and a high significance level of .000. (Table III-1). So the higher the mean net income of a farm the less certainty there is from year to year, making the decision making process more difficult for the farmer. Thus, the higher income farming operations were subjected to more risk and less stability.

There was some significance found in the relationship between the average total acres being farmed and the standard deviation of net farm income also. A correlation coefficient of +.4842 and a significance level of .004 (Table III-1) indicates that as the acreage of the farm increased there was a tendency for the variability of net farm income to increase also. Thus the more acres a farm operation has the more risky will be the operation with respect to the farms net income.

Impacts of Beef and Swine Income

It was found that the variability of most of the farm characteristics increased as their income increased. As the mean gross beef income and the mean gross swine income increased the standard deviations of each also increased. The correlation between mean gross beef income and standard deviation of gross was .3627. The correlation between mean gross swine income and

standard deviation of that income was .9939. Both correlations were significant. Thus supporting the idea that as the farmer increases in size to increase his incomes from his enterprises he is opening himself up to more variability.

Reflections on Measuring Variability

In reviewing the results from this part of the study, it became very evident in all aspects, that as the farmer increased his incomes or size of operations, he was subjecting himself to more variability, thus increasing the risk he had to deal with. But at the same time it must be kept in mind that his net farm income was increasing and tended to offset some of this increased risk. The decision confronting the farmer then is to decide if he is willing and able to handle the increased risk so he can enjoy an increase in net farm income.

It also must be kept in mind that some of the increased variability found in these farm characteristics as their incomes increase may be due to the growth over the period of this study. The standard deviation may not accurately reflect the variability from year to year over the 16 year period. For example, a small income the first year of the study and then a gradual increase of income over the years until the last year where the income is much larger could show a relatively large standard deviation. In this case a large variability would have been found, but not due to increasing and decreasing income from year to year. Thus this measure would not be an accurate reflection of the risk of the farming enterprise.

Chapter IV

DIVERSIFICATION RATIOS

Diversification theoretically has the potential for decreasing variability of net farm income. Earl Heady, Professor of Farm Management, at Iowa State University says that diversification has limitations though. Diversification of the farm operation can only be determined by each individual farm situation and in many cases may not be the answer. When a farm operation starts to become more diversified to reduce risk, they start to sacrifice income. When diversified, income never falls as low in bad years and never gets as high in good years, thus sacrificing the possibility of capturing those higher than average incomes, but yet reducing the variability of income. Again the choice must be made by the individual farms, depending on its financial position, family responsibilities, and the ability to shoulder risk.

A diversification ratio was computed to investigate the impact diversification in farming has on net farm income and the variability of this income within these 29 farms. This diversification ratio describes the mix of crops and livestock in the farm operation. The ratio is the smaller of a) the total gross livestock income divided by the gross farm income and b) I minus the ratio calculated in a. By using the diversification ratio and taking the smaller of the two computations,

a or b, one could then use the ratio as a measure of the level of diversification. The ratio does not indicate whether the farm was diversified in livestock or crops. The ratio ranged from .00 to .50. The closer the ratio came to .50 the more diversified the farm in crops and livestock and the closer it came to .00 the less diversified, being either all crops or all livestock. The ratio was then correlated to the standard deviation of net farm income for 29 farms.

The data in this study did not have information on the gross cropping income but did have information on the gross livestock income. So it was assumed that all gross farm income that was not derived from the livestock was derived from crops.

Impact of Diversification Ratio On Net Income Variability

The relationships that were found were not nearly as significant as expected. There was a positive correlation between the mean net farm income and the diversification ratio. A correlation coefficient of .1829 and a significance level of .171 were computed, but this showed very little strength in proving that as the diversification ratio moved closer to .50 or the farm became more diversified, the average net farm income increased.

There was a negative correlation found between the variability of the net farm income and the diversification ratio, which was expected. But again no strong significance was found. A coefficient of -.1423 with a significance level of .231 showed that there was no strong relationship from which one

could draw the conclusion, that as the average farm became more diversified between livestock and crops that the variability in net farm income was reduced. The higher levels of diversification seemed to have no strong affects on net farm income.

To further look at diversification and its affects on the variability of net farm income a second ratio was developed to show the share of gross resulting from livestock. The ratio was computed by dividing the total gross livestock income by the gross farm income. It ranged from .00 to 1.0 where the closer the ratio came to 1.0 the less diversified and the more the farm operation tended toward livestock and the closer the ratio came to .00 the more the operation tended toward crops.

This ratio was then compared to the variability of net farm income. Of the 29 farms studied, the ratio ranged from .24 to .78 showing no real large amount of specialization in either livestock or crops. When correlated to the standard deviation of net farm income the ratio showed no major relationship with the variability of net farm income. A correlation coefficient of +.2098 and a significance level of .137 was computed. This indicates that no significant relationship exists between livestock and variability of net farm income. This increase in variability of net farm income might have been expected due to the seasonal and cyclical trend movements in livestock prices.

Results of Crop Diversification

Other studies investigating diversification include a Wyoming study done by Mahmud Tunku Yahya and Richard M. Adams. The study was based on data from three major areas in the state of Wyoming, using the crops of winter wheat, corn, alfalfa hay, potatoes, and barley. The study used 23 years of data from 1952 to 1974 and the data were collected on a state level for the state averages from state statistical reports. Through the use of net income correlations between crops they found that the impact of crop diversification on net farm income was to generally reduce the net income variability. They did however, point out that crop diversification may be of little use to the farmer who has few cropping alternatives to choose from. For example, if climatic or other constraints limit the farmers alternatives, crop diversification will not be too useful in risk management. But in general their results pertaining to crop diversification, serves to point out the importance of such practices in any risk management strategy.[6]

Concluding Statements

It must be kept in mind that the proxy for diversification used in this study only approximated the level of diversification

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[6]Mahmud Tunku Yahya and Richard M. Adams, Some Measures of Price, Yield, and Revenue Variability For Wyoming Crops and Cropping Systems, Agr. Exp. Sta., Research Journal 115, Uviersity of Wyoming, Laramie, Wyoming, September 1977, p. 1.

between livestock and crops, and that when measuring diversification it can be broken down into more specific levels such as types of crops like that of the Wyoming study, or types of livestock. By breaking the farm operation down into more specific levels, one might find a stronger relationship between variability of net farm income and the level of diversification. It must be kept in mind that the results of the diversification study of these 29 farms from North Central Kansas may not hold true for other farms in other areas.

Chapter V

VARIABILITY OF WHEAT YIELDS

Variability of wheat yield was also investigated to study risk at the farm level. Wheat is a major farming enterprise in North Central Kansas which plays an important role in the net farm income in this region. In looking at the variability of wheat yield there was a desire to see what relationship exists between variability in yield and size of the farm in acres, number of acres of wheat, and average wheat yield. There was also a desire to compare the average wheat yield and variability of yield from the individual 29 farms to the average wheat yield and variabilities with each of the respective counties, thus giving an idea of how the variabilities of a few farms compared to the average of a larger sample from each county.

Wheat Yield and Farm Size

To look at the relationship between wheat yield and farm size, the mean wheat yield for each individual farm was calculated for the 16 year period. The mean number of acres and standard deviation of yield were also calculated. It was expected that the smaller farms might have a larger average wheat yield and greater variability of yield. The larger yields would be attributed to a more efficient job of managing on the small farms. At the same time, variability of yield was

expected to be greater on smaller farms because of greater vulnerability to hail and insect damage on the smaller acreage.

After correlating the mean farm acres to the mean wheat acres, no relationship was found to show that the smaller farms had larger average yields. A coefficient of +.0800 and a significance level of .340 were computed for the relationship between total farm acres and average wheat yield. The coefficient indicates that larger farms have greater yields, but the relationship is not significant. (Table V-1).

It was felt that the number of acres in wheat production might also affect wheat yield. With a small number of acres in wheat the farmer may devote more time to wheat production, thus raising the yield. But the correlations again showed that there was no significance to support this hypothesis. (Table V-1).

Table V-1

Relationship Between Variability in Wheat Yields With Respect to Acres and Average Wheat Yields

	Average Wheat Yields		Variability of Wheat Yields	
	Correlation Coefficient	Significance Level	Correlation Coefficient	Significance Level
Average Total Farm Acres	.0800	.340	.3498	.031
Average Wheat Acres	-.0597	.379	.3918	.018
Average Wheat Yields			.0222	.454

The affect of farm size and the number of acres in wheat were also correlated to the standard deviation of wheat yield as a measure of variability. The farm size in total acres and the number of acres in wheat were both found to be significant in explaining variability of wheat yield. (Table V-1). The significance levels and coefficients for both farm size and acres of wheat showed the opposite of what had been expected. The larger the farm in total acres and the more acres in wheat production the greater was the variability in wheat yield. The greater variability on large farms may be a result of farmers spreading management too thinly. This may result in poorer management and greater variability of yield on a per acre basis. The location of the farms in the study may also account for the observation of greater variability of yield on the larger farms. There was a larger proportion of the wheat acres in the western region where wheat is the major farming enterprise, thus giving more variability.

These unexpected results contradict the results of a study done in Montana by Don Bostwick in 1964. He found that the size of a wheat farm has a large effect on variability of yields over time. An important factor in variability of yields is the combination of weather, local differences in soil type, and physical lay of the land. He feels the large acreages get an averaging out of these largely local effects which tend to reduce the variability of average yields for the larger farm. But with small acreages, there is a greater likelihood the whole farm will be damaged by bad weather or may be located in

an area of poor quality land.[7]

The results from these 29 farms, showing that as farm size increases in acres the variability of wheat yields become greater, must not be looked upon as conclusive evidence of a general relationship which always exists. Results can be different in other regions for various reasons. A large farm in one region might be a small farm in another region. The farms in this study may have more of their total acreage devoted to wheat production than farms in other regions where wheat is not such an important enterprise. Different farmers have different management abilities, which possibly accounts for part of the differences in the results also.

There was no significance in the relationship between average wheat yield and variability of wheat yield. It was expected that as the average wheat yield increased so would the variability of yield, but the study did not show this relationship. A coefficient of +.0222 and a significance level of .454 showed little relationship between average yield and variability of yield. (Table V-1). These results might be due to better management efficiency which might also explain the large average yield per acre. The resources available for wheat production may also affect this yield and its variability. A farmer with good land may tend to have a higher more constant yield than one

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[7]Don Bostwick, Management Strategies for Variable Wheat Yields in Montana, Montana Agr. Exp. Sta., Bulletin 585, Montana State College, June 1964, p. 3.

with poorer land.

Again the location of wheat acres within the association may have an impact on the variability of yield and the average wheat yield. The larger number of acreage being in western farms may tend to cause higher variability and lower average yields.

Variability in Wheat Yield at the County Level

After studying variability of wheat yield at the farm level, it was of further interest to make comparisons to variability of wheat yields on the county level. The average yields for 16 years in each of 10 counties were taken from Kansas Agriculture Reports. The mean and standard deviation were calculated for each county. Each county was then compared to the individual farms from this study that were in that county.

It was expected that the variability of yield would be less on the county level than at the individual farm level because the county figures were based on a larger number of farms in each county thus tending to even out the affects of each individual farm in the county sample. In addition the county averages were figured over a larger area than the area of just one farm, thus tending to bring the variability down because of more dispersion of possible weather damage, insect damage, and differences in land type.

After comparing the results of the counties to the individual farms, it was found that there is more variability of yields

on the individual farms. On the county level, between the 10 counties, there was a range in the standard deviation of average wheat yields of 5.6 to 8.6 bushel/acre and on the individual farm level there was a range of 6.4 to 12.2 bushel/acre (Appendix Table II). Again this small variability of yield on the county level shows the effect of averaging yields from a larger area. But at the same time the larger amount of variability of yield of these 29 farms may be representative of the differences in individual management. On the county level these management differences were averaged out, meaning that the variability of yield for individuals could partly be due to different management abilities of each of the 29 farms.

By casual observation it was found that the variability of yield on the county level increased as average acres of wheat in production in each county (Appendix Table II). Thus supporting the results found early in the study, that as individual farms increase acres of wheat in production their variability of yield also increased. But again the larger number of wheat acres tended to be in the western counties of the association, possibly accounting for this increased variability in yield as acres of wheat in the county increased.

One other interesting observation, was the individual farms had a better average wheat yield over the 16 years than did the individual counties. This might say something for these 29 farms and the Farm Management Association. These farms on a farm management program that use the management program to the fullest extent may be better managers.

Chapter VI

SUMMARY AND CONCLUSIONS

Summary

This study provided empirical evidence of the risk involved in production agriculture. It also studied how this risk affects net farm income. Different farm characteristics such as total acres farmed, total gross livestock income, gross beef income, gross swine income, capital managed as a measure of size of farm operation and the ratio of net to gross income were correlated to net farm income to see what affect each might have on net farm income.

First these characteristics were correlated, using Pearson Correlation, to the average net farm income to see how each affected the net farm income. It was found that all of the characteristics except average gross beef income had a positive correlation with net farm income at a very high level of significance. This was an indication that as these different variables increased in either size or income the average net farm income increased. This does not necessarily reduce risk, but as the income increases it makes it easier to handle the uncertainties involved in future decision-making.

Variability of net farm income was investigated as one of the factors contributing to risk in farming. To measure this variability in net farm income, the standard deviation of the

average net farm income was correlated to the mean gross beef income, mean gross swine income, and mean total gross livestock income. The relationships between these variables and the variability of net farm income were all significant with the mean of gross beef income having the least significance. The variability of net farm income was also compared to the average net farm income. As the net farm income increase the variability of that income also increased. These relationships indicate that as a farmer increases in size in order to increase his income, he subjects himself to more risk as measured by variability of income.

The relationship between variability of net farm income and the total farm acres was also investigated. Variability in net farm income increased as the total number of acres farmed increased. This could be a result of management abilities being spread out to thinly because of large size and more fluctation from greater quantities of agricultural products being produced and sold.

The affect of diversification on risk was also investigated. A diversification ratio was established in order to measure diversification level of the farms. The ratio was computed as the smaller of a) the total gross livestock income divided by the gross farm income, or b) one minus the total gross livestock income divided by the gross income. This ratio indicates the degree of diversification between livestock and crops for the farm. As diversification between livestock and crops increased a smaller variability of net farm income was expected.

A negative correlation coefficient indicated what was expected, but the significance level was too low to be of any importance, thus showing diversification was not an effective type of management strategy to reduce risk.

Variability of wheat yield, and its relationship to the number of acres farmed on individual farms, was studied. It was expected that as a farm increases its acres of wheat in production the variability of wheat yield would decrease. Generally one would expect that the larger acreages would be less subjected to weather damage, disease, insect damage, and poor land types, because the larger acreages would tend to be more spread out reducing the chances of being completely wiped out by some of the above factors. However, it was found that as the acreage increased so did the variability of wheat yield per acre. This may be explained by the fact that as acreage increases the management gets spread too thinly and efficiency begins to decrease or because of locational differences among the farms. Several larger farms were located in the western part of the association where variability would tend to be greater.

Variability on the county level was investigated also, so that comparisons could be made between county and farm level. It was expected that variability on the county level would be smaller than the variability at the individual farm level. This phenomena was expected because the greater area would reduce the impacts of unfavorable weather, land type, disease, and insect damage. The results indicate that the variability

is smaller on the county level than on the individual farm level. Different management abilities are averaged out for the different farms, resources such as the lay of the land and the soil types tend to average out, and the smaller and larger farms within the county tend to average out to a more uniform sized acreage. Thus all of these tend to bring the variability of wheat down on the county level, and give a smaller range in the variability of yield per acre.

Conclusions

Many of the hypothesis tested in this study have not been tested previously. Many of the results turned out differently than expected. In some cases the results did not agree with results of similar studies. It must be kept in mind though, that these twenty-nine farms were located in a small region and may not be representative for farms in other regions. Management abilities of these farms may be different than the management level of other farms, in that their abilities may be fairly well developed for their particular farm operation.

The results of this study have many possible implications for the future, in that as the farms tend to increase in size, new more efficient types of management will have to be developed. Results indicate that as farm size and income increase, the variability of net farm income becomes greater thus increasing some aspects of risk. This may suggest that as the farms continue to grow in size the risks may become too great for a single manager to handle and thus tend to lead into more

partnerships and more corporate farming. If this happens then more individuals will be involved in an operation and the mental stress of risk will be spread out over more individuals. It is also possible that this increased risk may be considered as a diseconemy of size and eventually slow the trend toward increased farm size.

BIBLIOGRAPHY

Anderson, Kim B. and Holt, John, A User-Oriented Model for Incorporating Risk Into Short-Run Decisions, Southern Journal of Agricultural Economics, December 1977.

Biere, Arlo W., Net Farm Income Instability in the Great Plains, Farm and Food Policy Symposium, Great Plains Council, Publication No. 84, February 1977.

Boehlje, Michael D. and Trede, Larry D., Risk Management in Agriculture, Journal of American Society of Farm Managers and Rural Appraisers, April 1977.

Bostwick, Don, Management Strategies for Variable Wheat Yields in Montana, Bulletin 585, Montana Agr. Expt. Station, Montana State College, Bozeman, Montana, June 1964.

Heady, Earl O. and Jensen, Harold R., Farm Management Econimics, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1954.

Great Plains Council, Preceedings of Research Conference on Risk and Uncertainty in Agriculture, Bulletin 400, Agr. Expt. Station, North Dakota Agricultural College, Fargo, North Dakota, August 1955.

Great Plains Council, Proceeding of a Workshop on Management Strategies in Great Plains Farming, Publication No. 19, Agr. Expt. Station, University of Nebraska College of Agriculture, Lincoln, Nebraska, August 1961.

Kadlec, J. E., Guidelines for Decision-Making in a Period of Uncertainty, Agr. Econ. Department, Purdue University, West Lafayette, Indiana, January 1975.

Kansas Agriculture Report, Kansas State Board of Agriculture, Reports from 1962-1977.

Klieberstein, James B. and Scott, John T. Jr., Assessment of Risk When Contract Crops Are Included Among Other Crop Alternatives, Southern Journal of Agricultural Economics, December 1975.

Moore, C. V. and Snyder, J. Herbert, Risk and Uncertainty in Lettuce Production in Salinas Valley, California, Giannini Foundation Research Report No. 300, California Agr. Expt. Station, University of California, January 1969.

Walker, Odell L. and Nelson, A. Gene, Agricultural Research and Education Related to Decision-Making Under Uncertainty: An Interpretative Review of Literature, Research Report P-747, Agr. Expt. Station, Oklahoma State University, March 1977.

Yahya, Mahmud Tunku and Adams, Richard M., Some Measures of Price, Yield and Revenue Variability for Wyoming Crops and Cropping Systems, Research Journal 115, Agr. Expt. Station, University of Wyoming, Laramie, Wyoming, September 1977.

APPENDIX

Tables of Variabilities of Wheat Yields on Individual Farms and Respective Counties

Table I

Listing of the Average Wheat Yield, Standard Deviations of Wheat Yield, Total Acres, and Wheat Acres by Farm in Each County

Counties	Average Wheat Yields (Bu./Acre)	Standard Deviation of Wheat Yields (Bu./Acre)	Total Farm Acres	Wheat Acres
Marshall				
1	31.79	6.44	357.29	129.50
2	34.27	7.61	585.56	131.00
3	38.25	8.25	603.75	116.13
Cloud				
4	37.51	10.06	617.06	284.13
Washington				
5	35.41	9.31	310.38	78.75
6	37.47	9.27	363.13	106.00
7	39.84	11.54	960.94	322.31
Republic				
8	39.99	8.15	1,148.63	342.00
9	34.05	9.38	518.00	146.13
10	37.88	10.15	954.31	245.94
11	27.62	6.63	536.13	138.06
12	35.22	10.57	753.75	245.13
Clay				
13	32.81	6.56	286.13	75.69
14	31.22	7.65	598.93	202.93

Table I (Cont.)

Counties	Average Wheat Yields (Bu./Acre)	Standard Deviation of Wheat Yields (Bu./Acre)	Total Farm Acres	Wheat Acres
Clay				
15	31.31	8.23	637.44	269.00
16	37.89	8.13	308.75	113.44
Smith				
17	35.78	12.00	578.63	155.56
18	27.18	9.69	691.31	248.19
Mitchell				
19	31.81	13.36	364.69	111.13
20	31.03	11.49	1,096.25	476.69
Osborne				
21	33.82	11.52	379.63	155.44
22	28.99	10.91	994.69	390.63
23	30.70	9.21	675.88	290.19
24	32.09	10.40	1,587.81	741.00
25	32.10	10.44	805.56	350.31
Russell				
26	19.85	8.89	346.75	94.62
27	25.15	10.84	732.88	289.94
28	30.53	12.22	1,017.50	432.38
Lincoln				
29	31.82	8.57	503.63	205.13

Table II

Average Wheat Yield and Standard Deviation of
Wheat Yield by Farm and by County

County	Farm Level		County Level		
	Average Yield	Variability	Average Yield	Variability	Average Acres Wheat
Marshall			32.55	5.689	75,600
1	31.79	6.44			
2	34.27	7.61			
3	38.25	8.25			
Cloud			31.64	7.324	121,850
4	37.51	10.06			
Washington			32.95	5.839	83,500
5	35.41	9.31			
6	37.47	9.27			
7	39.84	11.54			
Republic			32.40	7.778	91,200
8	39.99	8.15			
9	34.05	9.38			
10	37.88	10.15			
11	27.62	6.63			
12	35.22	10.57			
Clay			30.11	5.688	91,000
13	32.81	6.56			
14	31.22	7.65			
15	31.31	8.23			

Table II (Cont.)

County	Farm Level		County Level		
	Average Yield	Variability	Average Yield	Variability	Average Acres Wheat
Clay					
16	37.89	8.13			
Smith			31.34	7.958	101,600
17	35.78	12.00			
18	27.18	9.69			
Mitchell			30.20	7.923	158,900
19	31.81	13.36			
20	31.03	11.49			
Osborne			27.53	8.622	123,500
21	33.82	11.52			
22	28.99	10.91			
23	30.70	9.21			
24	32.09	10.40			
25	32.10	10.44			
Russell			24.912	8.363	134,000
26	19.85	8.89			
27	25.15	10.84			
28	30.53	12.22			
Lincoln			28.069	7.270	114,000
29	31.82	8.57			

A STUDY OF RISK AND UNCERTAINTY IN NORTH CENTRAL KANSAS

by

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ABSTRACT

The purpose of this study was to provide empirical evidence of the risk involved in production agriculture and to investigate some of the relationships between risk and farm characteristics. An attempt was then made to identify those farm characteristics which result in less risk.

Twenty-nine farms from Association #1 of the Kansas Farm Management Association were used in this study. Data including wheat yield, acres of wheat produced, net farm income, livestock income, capital managed, acres farmed, etc. were collected for a period of sixteen years. These data for each farm were used to calculate means and standard deviations for the variables over the 16-year period. Pearson Correlation coefficients were then calculated to investigate the relationship between risk and other farm characteristics.

Variability in net farm income was used as a measure of risk. Strong relationships were found between the variability in net farm income and other farm characteristics. As total farm acres, total gross livestock income, and total capital managed increased, the variability of net farm income increased. It was also found that as average net farm income increased so did the variability of that income. This indicates that, in general, as the farm gets larger the variability of net income increases.

To look at some possible management strategies to reduce risk, diversification was studied. To investigate the affects of diversification on variability of net farm income, a

diversification ratio was computed and correlated to the standard deviation of net farm income for each of the twenty-nine farms. This ratio was computed as the smaller of a) the total gross livestock income divided by the gross farm income, or b) one minus the total gross livestock income divided by the gross farm income. This ratio indicates the degree of diversification between livestock and crops for the farm. The results provide little evidence to show that as the farm becomes more diversified between livestock and crops, the variability of net farm income decreases.

Variability of wheat yield was also studied. The affect of farm size on yield variability was investigated by calculating correlations between number of acres and variability of yield. In addition, a comparison was made between variability at the farm level and the county level. It was found that the county averages had lower variability in yields than did the individual farms, probably due to the larger area over which the average was calculated. It was also found that as the farm size in acres increased, the variability of yield also increased. The result may be caused by decreased efficiency as the farm becomes larger or because of locational differences among the farms. Several larger farms were located in the western part of the association where variability would tend to be greater.

In general, this study found that as farms increase production and size of operations, they increase their variability of net income. The study also found that it is difficult to reduce risk even through the use of such management strategies as

as diversification, thus leaving it a matter of whether one is willing to bear the risk involved in the increasing pace of production agriculture.