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RISK DIMENSIONS OF CROPPING SYSTEMS IN THE FAMILY FARM SETTING OF HEILONGJIANG PROVINCE, CHINA

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled RISK DIMENSIONS OF CROPPING SYSTEMS IN THE FAMILY FARM SETTING OF HEILONGJIANG PROVINCE, CHINA submitted by Guangzhi Liu in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Agricultural Economics.

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Dedication

To my loving wife, Shukun Guan, my daughter Jia, and my son Henry. Without your patience and understanding, this journey would never have been possible nor successful.

Abstract

The objectives of this research were to document interrelationships existing between the family farm concept and the state farm system and to develop a methodology to analyze risk situations with respect to crop enterprise selections.

Compared to Canada, China is a big agricultural country with huge population. Chinese agriculture is non-mechanized and labour-intensive. The state farm is one of two farming systems in China (the other is the countryside which is made up of peasants). The state farm system cultivates only 3 per cent of total farming land in China, however it is much more mechanized than the countryside. Since the economic reforms were carried out in 1980, a new concept, the family farm, was born on the state farm system. The interrelations that exist between the family farm and the state farm system is very complicated, just like an orange. The state farm represents the skin of the orange and each family farm is just like one piece of the orange. The state farm totally controls its family farms, thus family farmers do not have too much right to do what they like to do.

A model for selecting crop enterprise combinations which minimize the risk of defaulting on fixed cash commitments was developed. The model draws on a review of literature and is based upon the well known notion that high return is associated with high risk and non-systematic risk can be diversified away. The practical and computationally simple model requires the calculation of risk and return ratios from means, variance and covariance of individual crop enterprises.

Due to a lack of data extensive empirical testing of the model was not possible, however two case farms, from two different locations (State Farm 852 and Tieli State Farm) were developed. These cases were based upon historic crop yield data obtained from the state farms and from answers to questionnaires provided by family farm members during interviews.

This paper should be considered as a preliminary study on risk dimension of cropping system in the family farm setting of Heilongjiang province, P.R. China. Further work needs to be done in gathering reliable data on family farm operations and the study should be enlarged to investigate the scale of family farms, the effect of government policies, and the risk of farming other than cultivating crops.

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1 INTRODUCTION

1.1 Problem Identification and Background

Since 1980 China has been undergoing economic reform placing considerable economic decision making into the hands of individuals including family farms. Along with freedom in economic decision making this has increased the risk exposure of individuals. These events make it necessary to study the family farm concept and the changing exposure to risk.

1.2 Objectives

The objectives of this research were to:

1. document the interrelationships that exist between the family farm concept and the state farm system. Special attention will be paid to the services provided by the state farm and the contractual obligations that exist as a result.

2. develop a methodology for analyzing risk situations in crop enterprise selection.

3. develop, as far as possible within data limitations, a yield and price series for the major crops grown within the family farm system.

4. determine, as far as possible within data limitations, the degree of correlation between the revenues of various crops and the potential for risk reduction through diversification.

5 determine the extent to which family farms bear risk.

Before the economic reforms, the risk facing farmers was quite small, because farmers were employee of state farm and earned salaries plus bonus (benefit) rather than sharing in yearly profits as did the peasants who lived in the countryside. Salaries were fixed and only the bonus was associated with farming performance. After the reforms, risk to family farmers became significant. As a result risk management has become increasingly important.

Therefore, another purpose of this work was to find out the extent of risks to family farmers and further to look for ways to solve the risk reduction problem.

The major problems faced by family farms in China is how to get the optimum crop combination and how to minimize the various risks in order to maximize its profits. The purpose of this work is, ultimately, to provide useful information to assist Chinese family farmer managers to make better risk management decisions.

1.3 Organization of the Thesis

This chapter, Chapter One, is an introduction of the thesis. It identifies the problems facing Chinese family farmers and then describes the background and objectives of the thesis.

Chapter Two talks about the family farm in the Chinese setting, and includes two parts. The first part gives some background information about the differences between the commune and state farm systems, and about the state farm in Heilongjiang and on-going economic reforms. The second part describes the concept of the family farm, the requirements to establish a mechanized family farm, the management roles and functions of the family farm, and the quota system.

Chapter Three consists of two parts. The first part describes the theory of risk management, and reviews previous work done on this field. The second part develops the methodology and models to be used in this study.

Chapter Four is a case study of two state farms: State Farm 852 and Tieli State Farm, in which risk reduction strategies are examined. The thesis concludes with Chapter Five in which results are discussed and conclusions drawn.

2 THE FAMILY FARM IN THE CHINESE SETTING

2.1 The Chinese Agricultural Setting

China is a country with a long history, large population and vast land. The area of her state land is 9.6 million square kilometers, covering 6.5 % of total area of the earth. The total rural population in 1983 was 846,947,000, which was 82.1% of the total population. Chinese agriculture consists of two parts: the countryside or communes, and the state farm system. Table 2-1 shows some facts about Chinese agriculture (The Great Achievements of Chinese Agriculture, 1984).

Table 2-1. Comparison of Countryside and State Farm (1983)

	COUNTRYSIDE		STATE FARM		TOTAL	
	Number	%	Number	%	Number	%
Population (in 1000)	835,360	98.63	11,587	1.37	846,947	100
Labour Force (in 1000)	346,898	98.57	5,018	1.43	351,916	100
Farming Land (million mu[1])	2,160	97.02	66	2.98	2,226	100
Output* (billion yuan[2])	288	97.51	7	2.49	295	100

* Output stands for the total value of agricultural output

2.1.1 The Countryside (communes)

The countryside in China is organized into communes made up of production brigades and production teams. The production brigade coordinates the work of the production teams and runs a large number and variety of small industrial enterprises, the principal objective of which is to support agriculture. The basic accounting and production unit is the production team. This is responsible for planning output and for the use of funds in agreement with the commune's broad plan. The commune, whose leadership is elected by its members the peasants, acts as the basic

1 One *mu* = 0.164737 acre (or one *mu* = one fifteenth of hectare)

2 One *yuan* = 0.2181 Canadian dollar

unit of government in the countryside. It coordinates the work of the production brigades, runs major projects that require large inputs of capital and labour and provides a variety of services used by both the production brigades and teams. It provides education, health, welfare, culture, and a range of other similar services.

In 1983, there were 56,331 communes in China. The size is far from uniform. Some consist of no more than a few thousand members cultivating a few hundred hectares. There are also those working at least 8,000 hectares and having a membership of 100,000 people. Additional details about communes, production brigades and production teams are summarized in Table 2-2 (The Great Achievements of Chinese Agriculture, 1984).

Table 2-2. Organization of Countryside in China (1983)

	COMMUNE	PRODUCTION BRIGADE	PRODUCTION TEAM
Total Number	56,331	550,484	4,575,000
Average Population	14,830	1,114	142
Average Labour Force	6,158	462	59
Average Number of Households	3,288	24	31

2.1.2 The State Farm System

Under the state farm system, employees are paid a wage as opposed to receiving their income from profits as in the case of communes.

The state farm system was established mainly to reclaim[3] previously unused land. The development of the state farm system had military defense, army demobilization and economic development dimensions. Land reclamation focused on the border provinces of the northeast, northwest, far west and along the coast. Most of state farms were situated on waste or uninhabitable land subject to drought or water logging; on difficult alkaline or acid soils; and in

3 The term "reclaim" in the thesis means to put previously unused land into production as opposed to the more traditional implication of putting back into production after degradation.

areas regularly hit by sand and wind storms. The earliest group of state farms was set up by army soldiers in 1947-1949 in Heilongjiang province. A climax of land reclamation and farm establishment was reached in 1956-1958. At that time, thousands of veterans and school graduates came from all over the country and settled in the marginal and inhospitable region of the border provinces like Heilongjiang. State farms at first had the characteristic of an army organization, but now they are only agricultural production enterprises (Yang, 1984).

There are 2,070 state farms across the country. These farms cover 27 million hectares of land, 4.1 million hectares of which are cultivated. Four major reclamation areas, in Heilongjiang, Xinjiang, Guangdong and Yunnan provinces, contain 431 state farms covering 2.9 million hectares of cultivated land and 0.34 million hectares of rubber production area. The largest reclamation area is in Heilongjiang province, where there are 84 state farms occupying 1.78 million hectares of cultivated land and employing 400,000 farm workers and 3,300 million yuan of fixed capital (Selected Works ..., 1985).

Most Chinese peasants still depend on simple, non-mechanized farming implements and follow a labour intensive form of agriculture. State farm workers, on the other hand, employ a large amount of farm machinery following a capital intensive form of agricultural production.

In 1983, on average, there were 8.9 tractors, 2.8 combines and 2.7 heavy duty trucks per 10,000 mu of farming land on the state farms. These figures are 56.1%, 1300% and 42.1% respectively higher than those in the countryside.

2.1.3 The State Farms in Heilongjiang

On Table 2-1, it was shown that state farms occupy only about 3 per cent of total farming land in China. The state farms in Heilongjiang own 50 per cent of total farming land under the control of state farms in the country. The Heilongjiang General Bureau of State Farms is responsible for 97 state farms covering an area of 90 million mu. Of this, 32 million mu are farm land, accounting for one quarter of the total in Heilongjiang province. During the last 30 years, 23 per cent of total grain products and 40 per cent of commercial farm output in Heilongjiang were produced by the state farms (Yang, 1984).

Most of the state farms in Heilongjiang are located in the central and northern parts of the province, in a region between 44.10 and 50.20 degrees north latitude and 123.40 and 134.40 degrees east longitude. It is one of the coldest regions in China. The lowest temperature reached is minus 44 degrees Celsius in the winter. The frost free season ranges from 112 days in the northern part of the province to 149 days in the south. This is ideal for growing wheat, barley and potatoes. Soybeans and corn can also be grown in most parts, except in the far north. The annual rain fall averages 450 mm in the west and 600 mm in the east. Approximately 60-70 per cent of the rain fall is concentrated during the summer months of June, July, and August. While this rainfall distribution is ideal for growth of corn and soybeans, it creates difficulties for harvesting spring wheat and barley (Yang, 1984).

2.1.4 The Economic Reforms

Economic reforms were initiated ten years ago. In the rural areas, the over-rigid commune system of the past has given way to a contract responsibility system, mostly on a household basis. This system, where farmers are responsible for their production, stimulated the initiative of farmers and increased agricultural production.

The economic structure has also changed. The countryside is becoming industrialized. Today village and township enterprises account for 51.4 percent of the total rural value of output.

The old tightly controlled, centrally managed economy left no room for initiative on individual enterprises and neglected the market realities of supply and demand. Today "the state regulates the market and the market guides enterprises," as Communist Party General Secretary Zhao Ziyang has put it. State-run enterprises have more freedom in buying raw materials, producing according to market demand, and retaining a portion of their profits for investment for other uses. Previously they were required to turn all profit in to the state.

State-run enterprises are no longer mere appendages of central administrative departments, but are commodity producers with independent decision-making powers. The old over-egalitarian distribution system, under which workers who did poorly were paid the same as those who did well, has been discarded, and remuneration according to work has been implemented. The "iron rice bowl" of lifetime tenure for cadre and permanent employment for workers has also changed. Cadre who do not perform can be demoted, transferred or dismissed. More and more workers are employed on a contract basis.

The national economy, after 10 years of reform, is undergoing a profound transformation, from a closed, rigid system to one that is more open and flexible. The dramatic changes that have taken place in the last decade have resulted in strong economic growth, steady improvement of people's livelihood, and increases in foreign trade and international economic relationships. However, certain problems, including inflation and corruption, have cropped up. The noted economist Gao Shangquan analyzed the urgent problems which must be solved before reform can be deepened (Gao, 1989).

A serious current problem is that of rising prices. Because the old state-set prices on all products did not reflect either the costs of production or market realities, price reform was badly needed. This required a gradual approach, to avoid economic and social chaos, and in the last several years a dual pricing system has been in effect.

State-run enterprises, for instance, can buy certain quotas of production materials such as steel, coal and timber at low, state-set prices. The materials are also available at higher, market-set prices. Competition among state enterprises which need additional raw materials and the growing number of collective and individual enterprises, particularly in the rural area, has driven up the market prices of raw materials. Heavy demand has led to a certain amount of corruption. Sometimes officials with influence over allocations have accepted bribes. Companies which existed only on paper and engaged in commodity speculation through various channels have made fortunes. Therefore, changes in the pricing system, which will be decisive in China's attempts to reform the economic structure, is currently one of the most sensitive and difficult problems to be solved (Qian, 1988).

Consumers, of course, have suffered from price rises. The partial decontrol of commodity prices, while benefiting producers, has made it hard for many families to make ends meet. When the inflation rate outstrips bank interest rates, like in 1988 when the inflation rate reached 16%, people were spending instead of saving. This has driven prices even higher and affected the amount of money available for investment.

To establish a true socialist commodity economy combining national planning with a market system is an extremely complex process. The change from the older, rigid structure to the new one involves transformations in economic behavior, management methods and in people's thinking. Currently, elements of the old and new structures co-exist. In order to clear the way for deeper reform, inflation, corruption and other problems must be curbed. Therefore the next few years are planned as a period of consolidation and adjustment, of cooling down an overheated economic expansion and tightening up financial management. This does not, however, represent any change in China's commitment to the reform process or in the policy of opening to the outside world. If anything, economic, cultural and other exchanges with foreign countries will expand.

It should be stressed that reform is still the sole motive force of China's economic development. The Chinese people well know that reform is the only way to upgrade the economy and promote the national welfare.

2.2 The Family Farm Concept in China

2.2.1 Family Farm

The family farm, under the leadership of the state farm, is a relatively independent economic entity based on the family, or household as the basic production and operation unit. Family farmers can operate their farm independently and must be responsible for the profit and loss. But they must fulfil their contracted quota. At present, the family farm is not considered to be a "legal person".

The state farm retains ownership of the land. The family farmers operate under a rental contract with the state farm through which they sell their produce to government at fixed prices. The state farm may also extend credit to the family farm for the purchase of machinery and other inputs.

There are three types of family farms: the single household family farm, the multiple household family farm, and the cooperative farm. Single family farms account for the greatest number. The labour force consists of 2 to 4 persons per farm, usually the father, the mother and their children. These farms may either own their machinery and equipment, or they may acquire services through custom work.

Multiple family farms account for a smaller number of the total. These farms usually have one family as the base and absorb the labour and capital from other families. The base farmer also performs the larger share of managerial functions because of his particular skills. These farms, which have similarities to partnerships, operate with more capital, labour and machinery and with higher levels of technology. This group of family farms is becoming more important.

Cooperative farms account for only a very small proportion of family farms. These farms consist of several bachelors who have pooled their resources.

2.2.2 The Requirements for Forming a Mechanized Family Farm

Family farms are classified into two categories; household with machinery and household without machinery. For an individual household to become a family farm with machinery, certain management and technical capabilities are required.

MANAGEMENT CAPABILITIES - At least one of the family members must have a good and correct attitude towards socialism. He or she must know how to manage and operate the farm production, must be healthy and industrious.

TECHNICAL CAPABILITIES - At least one of the family members must be a skilful mechanic or technician with a valid driver's license.[4] This may be the same person in the family who also has management capability.

Families which want to apply to become a mechanized family farm must have a desire to provide machinery services, through custom work, to family farms without machinery and be trusted by the community.

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4 In China only very small number of population have driver's licenses.

Those satisfying the above conditions are eligible to apply to become a family farm with machinery. After the application is discussed by the community, and then confirmed by the production brigade or team, and finally approved by the state farm, the certificate is issued. With the certificate, the family farm can contract the land and operate farming. The land, owned by the government, can only be contracted for a maximum of 15 years, at which time it may be renewed. The family farm must deliver a set amount of production at a set price for use of the land. This quota contract is established from the last three years' average production and must be renewed every three years.

2.2.3 Management Roles and Functions of the Family Farm

The various operational and managerial systems for the internal affairs of family farms must be established. Those are the systems of production management, machinery management, economic accounting and profit distribution (reinvestment of surplus and savings).

2.2.3.1 Production Management

Because the land is the most basic production resource the family farm must increase its utility and productivity by improving soil fertility and production conditions. The following regulations apply to the use of land.

1. The ownership of the land belongs to the state farm. The family farm can obtain only the right to use the land for the fixed years through the contract with the state farm. They cannot transfer, lease or mortgage the right to any other units or individuals outside of the state farm.

2. The family farm must protect, from destruction, the roads, bridges, shelter belts, forest strips, and water facilities on the land.

3. The family farm must make full use of the contracted land, it cannot misuse the land or use it for purposes other than the cultivation of crops.

4. Intensive, rather than extensive, farming practices must be followed. The family farm must follow the crop rotation system established by the state farm and use cultural practices which raise the soil fertility. It must return the stocks or stems of the crop into the field to increase or at least maintain organic materials in the soil. It must apply the recommended level of fertilizer, and is not allowed to transfer or resell the fertilizers provided by the state farm.

The family farm must use sound tillage practices approved by the state farm. It must also adopt the technology established by the state farm. They have the right to apply additional technology, beyond that specified by the state farm

The production and operation activities of family farm must be realized by good planning management. At present, the production brigade of the state farm assists the family farm in planning and supervises the carrying out of the plans.

2.2.3.2 Machinery Management

The management of family farm assets must be strengthened. Assets, such as farming machinery, production buildings, livestock, and etc., whether rented or owned, belong to the entire family farm not to the individual members. Each member of the family farm must understand his responsibility for the assets. Maintenance and storage of the assets must be adequate to avoid loss and waste and to ensure full use.

The farm machinery contracted from the state farm is not allowed to be recontracted to, or resold to, other persons without the permission from the state farm. The overhaul fund for farm machinery must be submitted to the state farm to do the regular overhaul. An accounting is done every three years. The surplus of the overhaul fund, with interest, is returned to the family farm. Deficiencies must be paid by the family farm. Depreciation must be calculated to correctly establish production cost and to facilitate replacement.

Family farms with contracted machinery must submit contracted rent to the state farm. This is done by deducting the cost from the products sold. When the contract period has expired, the machinery must be overhauled before returning it to the production team for recontracting or transfer. The previous contracting family farm has the priority to get the new contract of those machines. If the family farm wants to purchase the machine before the contract period has expired, it has the priority to get a good price. If the family farm has paid all its contracted rent two years ahead, the used machinery belongs to it.

Family farmers are encouraged to purchase machinery in order to improve the level of mechanization and facilitate replacement. Machinery, which was originally transferred from the state farm, may be disposed of by the family farm if its salvage value is zero. This must be confirmed by the state farm.

If the family farm is short of funds to purchase new machinery, the state farm, at its discretion, will provide 30 to 50 per cent of the purchase price with a low interest loan. The repayment length, at most, is not over three years.

2.2.3.3 Accounting and Financial Control

Family farms are required, by the state farm, to maintain an accounting system. This is required to ensure that family farm spending is done according to the plan and that cost saving is realized for the purpose of increasing profit. Therefore each family farm provides a part-time bookkeeper who works under the supervision of the production brigade accountant. This assists the family farm manager to perform the bookkeeping and accounting functions and in distributing profit. The cash inflow and outflow, and the cash management of the family farm, is under control of the production brigade cashier.

The accounting system required by the state farm must be understandable by the family farm manager and feasible to maintain. The accounting system includes the following:

1. Total operating income includes revenue from agriculture, forestry, fishery and miscellaneous revenue such as from rural industry, labour income and interest from savings.
2. Total operating expense includes all production costs incurred in the process of operating the family farm. It also includes machinery repair and overhaul, depreciation, contract rent, employee wages, interest expenses and various welfare and taxes paid to the state farm as stated in the contract.

3. Net operating profit or surplus available for distribution is the difference between total operating income and total operating expense.

To ensure accuracy, bookkeeper must record all the economic activities of the family farm in the general accounts in a timely and correct manner. Entries must be made daily. In addition there must be monthly accounting, periodic analysis and a final accounting at the end of year. Family farms should give their bookkeeper an adequate allowance for the farm work missed while doing the bookkeeping.

2.2.3.4 Profit Distribution

Before the net operating profit of the family farms is distributed, family farm should first pay for the machinery transferred from the state farm, then set aside the self-funding part of the production expenses for next year according to the regulation of the state farm. After that, the profit distribution per family farm laborer can be calculated.

If the profit distribution per laborer is over 1,200 yuan, the surplus part must be set aside as a reserve fund in the progressive manner as shown in Table 2-3.

Table 2-3. Method of Calculating Reserve Fund

Amount of surplus (in yuan)	per cent set aside
from 1201 to 1600	40
from 1601 to 2000	45
from 2001 to 2500	50
from 2501 to 3000	55
over 3000	60

The accountant from the production brigade is in charge of depositing the reserve fund but the savings account book is returned to family farm for storage. The reserve fund, under the supervision of the production brigade, is used to develop the productive capacity of the family farm and to balance the loss and gains from year to year. The reserve fund belongs to the family farm and the production brigade cannot use it to balance the reserve fund among family farms, and cannot divert it to the use of other family farms.

The balance of the net operating profit remaining after satisfying the reserve fund requirements is used for distribution to the individual laborers. Family farms are encouraged to follow the rule of "distribution according to work" and combat the egalitarianism. At the same time, there should be no sex discrimination with regard to work and wages. The compensation allowance for sick, injured, maternity leave and home leave for family members to visit parents is determined by the democratic discussion of the family farm.

If the actual distributed profit of the family farm is less than 600 yuan per laborer, the reserve fund can be used to compensate for the shortage (i.e. up to 600 yuan). If the reserve fund is depleted, family farmers cannot get compensation.

If the family farm has a loss, i.e: a negative net operating profit, each member must bear his share of the loss which will be deducted from next year's profit distribution. The rule for a share of the loss is that the more you work, the less is your share of the loss; the less you work, the more is your share of the loss; the sick and those on maternity leave do not share the loss; those absent without reason bear an even greater share of the loss.

2.2.4 The Quota System

After the agricultural economic reform in 1982, family farms were established under the farm production responsibility system and quota system. The so-called farm production responsibility system means that each individual family farm is responsible for its own farm production. Responsibility for production was shifted to households and individuals and away from collective production teams. These initiatives and incentives stimulated family farm laborer to work harder.

Before the reform, each farm household received a small piece of land from its production team to grow vegetables for its own consumption. The size of plot depended upon family size. After the reform, the family farms retained the vegetable plot, and furthermore received two other kinds of land from the production team -- grain ration land and responsibility land.

The first kind of land, called the grain ration land, was given to the farm household on which to grow its staple food, usually wheat and corn, for the year's consumption. The size of the grain plot was also dependent on the size of a family[5].

Both the vegetable plots and grain ration land are quota- free, and the farmers only pay a small, but fixed, amount of agricultural tax per mu. This is similar to the cash rent for land in Canada.

The other kind of land, called the responsibility land, is allocated to family farms for production beyond what is needed for private consumption. The amount of the land available to an individual family farm is determined by how many laborers it has. Family farms pay not only the fixed agricultural tax for the responsibility land, the same as for the other two plots, but must fulfil the quota.

This quota system is compulsory, and differs from cash rent or crop share of the land in Canada in that the Chinese farmers have to sell their large amount of grain (quota) to the government at an arbitrary low price. The contracted quota amount is pre-set by the provincial or state government. The local government, such as the production team and state farm, is responsible for making sure the quota is fulfilled, for collecting the agricultural tax and carrying on the thoughts and new ideas from the provincial government.

Generally, the farmers do not like the quota, but they must fulfil it none the less. The surplus grain, after its quota is satisfied, can be sold on the free market (called the black market before the economic reforms) at high and competitive prices. This free market approaches the model of pure competition.

5 The staple food for Chinese is grain such as wheat and corn, which differs from that of the meat-consuming Westerners.

If an individual farmer is unable to fulfil his quota, he has to buy the unfulfilled amount of grain at a high price from the free market, and then sell it to the government at the low, fixed price.

This chapter has discussed the family farm in the Chinese setting. In summary, the on-going economic reforms have significantly increased the exposure to risk for Chinese family farmers and thus it is necessary to undertake this study. Therefore, the following chapter will deal with the basic theory and the methodology of this study.

3 THE CONCEPTUAL FRAMFWORK AND METHODOLOGY

3.1 The Conceptual Framework

3.1.1 Risk and Uncertainty

In 1921, Frank H. Knight first described two lack-of-knowledge situations: risk and uncertainty. The manager was defined as facing **risk** in a production process when he was aware of all possible outcomes that could result from the process and could attach a probability to each outcome. The manager was said to face **uncertainty** when he was unable to associate probabilities with the outcomes of the production process.

Modern decision theory has evolved beyond the basic definitions of Knight. The focal point of the departure from Knight's analysis revolves around the nature of the probabilities to be used in decision-making process.

Uncertainty can be considered as the lack of information. As the amount of information increases, uncertainty will decrease. Perfect certainty exists when the future outcome of a production process is known. When confronted with a lack of information, managers rely on their subjective evaluations to determine the selection of an action appropriate to the uncertain situation. Because decisions must be made, the subjective probabilities will be determined by the manager. Viewed in this manner, Knight's dichotomy becomes unimportant and writers in modern decision theory often use the terms **risk** and **uncertainty** interchangeably to refer to situations where complete information is lacking. All decision analysis is placed in the context of risk with subjective probabilities. (Doll and Orazem, 1984)

3.1.2 Attitudes Towards Risk

Risk or uncertainty is introduced into the theory of the producer by assuming that the entrepreneur's utility is a function of the profit that he earns from production and the associated risk or variability. Attitudes towards risk vary from one farm manager and situation to another. Usually individuals are divided into three categories -- a group who are risk averters, a group who are risk neutral and a group who prefer risk. If the entrepreneur is risk averse, under the usual assumptions, he will select an output at which expected marginal revenue exceeds expected marginal cost. A risk-neutral entrepreneur will produce at levels that equate the two, while a risk preferring individual may produce at an even higher level.

Risk preference can be described in terms of expected value and variance or standard deviation giving rise to the Expected Value/Variance or EV analysis. For a risk-averse individual, the utility of the expected value of the outcome of an uncertain situation exceeds the expected utility of the outcome; i.e., his/her utility function is strictly concave. Alternatively, risk preferring and risk neutral individuals have strictly convex and linear utility functions respectively. Hence, for a risk averter the (E,V) indifference curves have increasing slope (i.e., the tradeoff rate of E for V increases) as V (variance) increases, and for a risk preferrer the (E,V) indifference curves have increasing negative slope as V increases (Henderson and Quandt, 1980).

The above relationships are portrayed diagrammatically in Figure 3-1: (a) with risk aversion, (b) with risk indifference, and (c) with preference for risk.. In each case, three isoutility or (E,V) indifference curves, are shown for utility levels U(1) > U(2) > U(3) (Anderson, 1977).

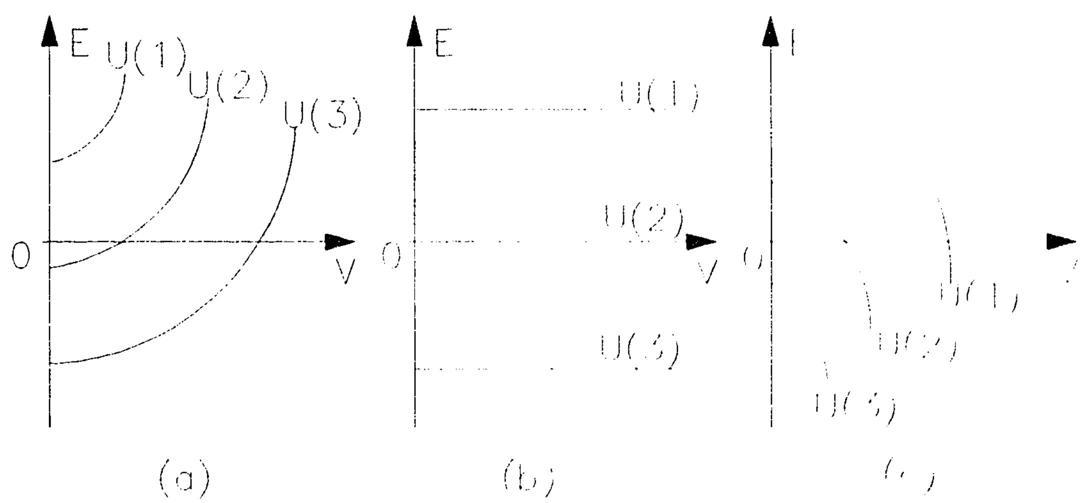

Figure 3-1. The (E,V) Indifference or Iso-utility Curves

The index of absolute risk aversion is defined as the ratio of the second and first derivatives of the utility function (Henderson and Quandt, 1980). The index is positive, negative, or zero as the individual is averse, prefers, or is neutral toward risk. Risk-averse individuals will pay a premium for insurance to convert an uncertain outcome into a certain one. The risk premium is the difference between the mean of a risky prospect (EMV) and its certainty equivalent (CE). The concept of risk premium is illustrated in Figure 3-2. The concave curve represents the utility function of a risk-averse individual.

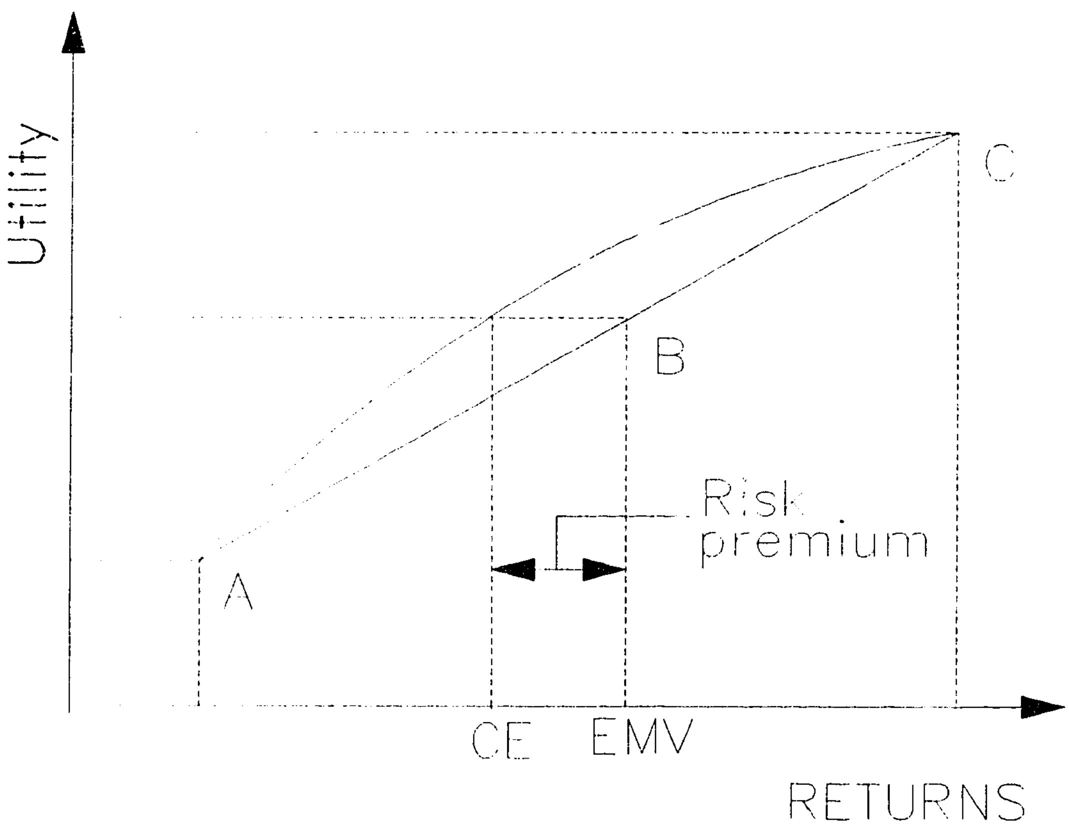

Figure 3-2. Illustration of the Concept of Risk Premium for a Risk-averse Decision Maker.

3.1.3 Classifications of Risk

Risk can be divided into the three general categories of business risk, financial risk and other risk. Business risk is defined as the risk inherent to the firm regardless of the way in which the firm is financed. There are two sources of business risk. The first is due to production variation from the biophysical environment, or variation in yield due to weather. This kind of business risk, called production risk, is one of the most severe risks facing Chinese farmers. The second source of business risk is due to variations in input and/or output prices, and is called marketing or price risk.

The second general category of risk is financial risk. Financial risk can be defined as the additional variation in net cash flows of the owner's equity resulting from fixed financial obligations associated with debt financing and cash leverage. Therefore, financial risk encompasses the risk of illiquidity (Lee, Ellis and Lacewell, 1987).

Financial risk is caused by the need to repay loans having variable interest rates from fluctuating cash flows. This category of risk is related to the firm's financial total structure and deals with the firm's ability to meet total claims. Since these risks arise from the financial claims on the farm, the greater the leverage (i.e. the ratio of debt to equity), the greater are risks in meeting obligations to lenders and lessors.

The third general category (i.e. other risk) includes, risk of changes in governmental farm policy, human risks on performances of labour and management, variations in human ability and judgment, loss from severe casualties and disasters, and risks of technological change and obsolescence. This category makes itself felt in business risk and/or financial risk.

3.1.4 Measurement of Risk

3.1.4.1 Measurement of Business Risk

Risk is the variability of expected returns and is usually measured in terms of standard deviation. A higher standard deviation denotes greater variability and risk than does a lower one. The variability in returns to assets is called "business risk".

Return to assets is the net return after salaries have been paid but before interest payments have been deducted:[6]

$$R_A = [N - S] + I \tag{3.1}$$

Where:

R_A is total dollar return to assets

N is net income

I is interest expense

S is salary earned by unpaid workers and operator.[7]

The dollar return R_A may be expressed as a percent return on assets in the following manner:

$$r_A = \frac{R_A}{A} \tag{3.2}$$

where:

r_A is percent returns on assets

A is the value of assets.

The expected value or mean is the probability distribution is a weighted average of the return to assets for the projected outcomes. Expected values are found by summing the products of each possible outcome times its probability. This process is expressed as:

$$\bar{R}_A = E(R_A) = \sum_i P_i R_{A,i} \tag{3.3}$$

where:

$\bar{R}_A$ or $E(R_A)$ is expected value of the return to assets,

P_i is the probability for each forecast i,

$R_{A,i}$ is the return to assets projected for each forecast.

6 Since net income from an accounting stand point has had interest payments deducted it is necessary to add these back in order to arrive at return to assets.

7 In unincorporated family farm operations (i.e. proprietorship) the equity holder is not usually paid a salary. As a result net income is a reward to both labour and capital invested. Therefore, dollar return to the equity holder must be adjusted as the net return after imputed salaries have been paid.

The standard deviation (σ) is a statistical measure of the amount of dispersion or variation of the projected outcomes about the expected value. Thus, it serves as a measure of the amount of risk. The standard deviation is found with the formula:

$$\sigma = \sqrt{\sum_i (P_i)(R_{A,i} - \bar{R}_A)^2} \tag{3.4}$$

The coefficient of variation (CV), is the standard deviation divided by the expected value. It provides a relative measure of an investment's degree of risk and shows the amount of risk relative to the amount of expected return (Barry and Hopkin and Baker, 1983).

3.1.4.2 Measurement of Financial Risk

The variability in asset values brought about by changing anticipations of future returns is an important component of business risk. If anticipations of farm prosperity are down, asset values in farming will be down.

The return to total assets can be separated into two portions. One portion is the earning made by the debt holders. The other portion is the earning made by the equity holder. The calculations are summarized in the following equations.

$$R_A = R_D + R_E \tag{3.5}$$

where:

R_D is the dollar return to the debt holder or interest paid by the borrowers.

R_E is the dollar return to the equity holder.

The dollar return to the debt holder may be expressed as:

$$R_D = [I] \tag{3.6}$$

where:

I is interest expense.

The dollar return R_D may be expressed as a percent return on debt, ie: interest rate, in the following manner:

$$r_D = i = \frac{R_D}{D} \tag{3.7}$$

where:

r_D is percent return on debt

D is the value of debt capital

i in the interest rate.

The dollar return to the equity holder is the net return after salaries have been paid:

$$R_E = [N - S] \tag{3.8}$$

where:

N is net income

S is salary earned by unpaid workers and operator.

The dollar return R_E may be expressed as a percent return on equity in the following manner:

$$r_E = \frac{R_E}{E} \tag{3.9}$$

where:

r_E is the return on equity

E is the value of equity capital.

Leverage is defined as the ratio of debt to equity.

$$L = \frac{D}{E} \tag{3.10}$$

where:

L is the leverage ratio.

The return to equity can then be expressed in relation to the return on assets, the cost of debt and the level of leverage.[8]

$$r_E = r_A + (r_A - r_D)L \qquad (3.11)$$

This equation is interpreted to say that the return made on equity is composed of the return on assets on the "owned" portion plus the margin of return on assets above the cost of debt on the "borrowed" portion. The cost of debt is fixed by contract. On the other hand, the return on assets is volatile. It depends upon the yield of crops and on the prices (i.e. business risk). Since the interest rate is fixed, the variability in the return on assets will all be absorbed by the equity holder. The return on equity thus becomes more volatile with increasing leverage.

Mean equity return increases as more debt capital is used relative to capital equity. Risk, as measured by standard deviation and coefficient of variation, also increases with leverage. Not only does leverage have an effect on equity returns from operations, leverage also has a volatility effect on equity as a result of asset value changes (Bauer, 1987 & 1989).

---

8 The development of Equation 3.11.

note that

$$r_A = \frac{R_A}{A} \quad , \quad r_E = \frac{R_E}{E} \quad \text{and} \quad r_D = i = \frac{R_D}{D}$$

then

$$R_A = r_A A \quad , \quad R_E = r_E E \quad , \quad R_D = r_D D$$

also

$$R_A = R_D + R_E \quad \text{and} \quad R_E = R_A - R_D$$

also

$$A = E + D \quad \text{and} \quad L = \frac{D}{E}$$

then

$$r_E E = r_A A - r_D D$$

$$r_E E = r_A(E + D) - r_D D$$

$$r_E E = r_A E + (r_A - r_D)D$$

$$r_E = r_A + (r_A - r_D)\frac{D}{E}$$

$$r_E = r_A + (r_A - r_D)L$$

3.1.5 Reducing risk through diversification

The word "portfolio" refers to a mix, or combination, of assets, enterprises, or investments. The portfolio model indicates how different combinations of investments may reduce an investor's risk more than having only a single investment. Holding combinations of investments is called diversification, with the potential for risk reduction determined by: (1) the number of investments held and (2) the covariation (or correlation) among the expected returns of the individual investments.

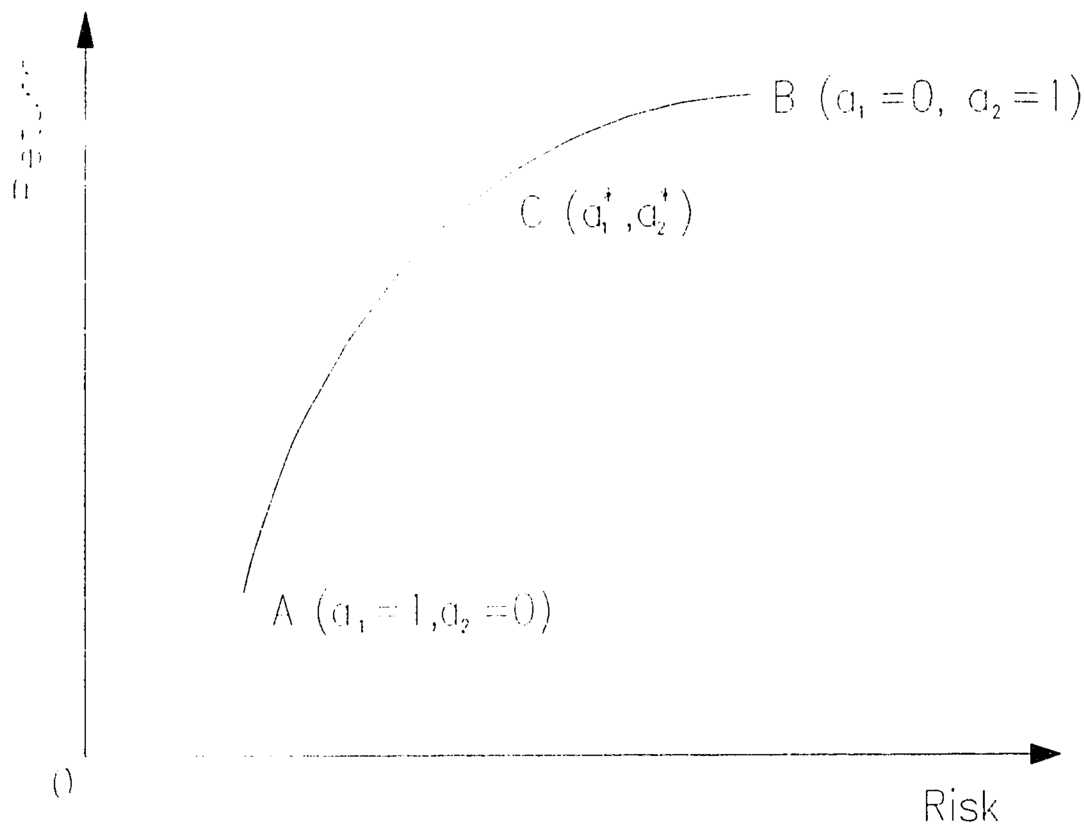

Figure 3-3. Risk, Return and Crop Diversification

For individual activities included in the farm sector portfolio, there are two type of risk. The first is non-diversifiable because it is correlated with the farm sector portfolio (systematic risk). The second component is not correlated with variations in the farm sector portfolio (nonsystematic risk). Diversification can potentially eliminate this risk.

The degree of risk is affected by the magnitude of the variances and the relationship of the covariances of income of different enterprises in combination with each other. The expected income-variance (E-V) efficient frontier was developed as a theoretical approach to portfolio selection. There are several ways or models for isolating risk efficient portfolios.

The Quadratic Programming Model

The quadratic programming - risk aversion model is theoretically appealing because it incorporates the income variances and covariances of the possible enterprise combinations and can be used to describe the (E-V) efficient frontier. Therefore, quadratic programming is an important approach to tackle risk problems. Scott and Baker (1972) studied a practical way to select an optimum farm plan under risk. They used quadratic programming to calculate the variance-efficient mean income path and associated lower income bounds and suggested a way to select an optimum farm plan under risk based on the farmer's own self-assessed income-risk preference function.

The Linear Programming Model and Minimization of Absolute Deviations

Linear programming is another approach to analyze risk. Hazell (1971) studied a linear alternative to quadratic and semi-variance programming for farm planning under uncertainty. He concluded that quadratic programming solutions for farm planning decisions are theoretically appealing but difficult to handle computationally. He reviewed the advantages of the quadratic approach and developed a linear alternative which, while retaining most of the desired features of the quadratic model, can be readily solved using conventional linear programming approaches with the parametric option. Thus a linear decision criterion using the expected return and the mean absolute income deviation has been proposed as an alternative to the expected income-variance and expected income-semivariance criteria for farm planning under gross margin uncertainty. This approach, referred to as MOTAD, had also been applied successfully to the practical problems (Brink and McCarl, 1978)

The Single-Index Portfolio Model

The single-index portfolio model is another approach for measuring risk. The single-index model provides a measure of risk for an individual activity of a multi-product firm that directly accounts for variance and covariances and closely approximates a full variance-covariance matrix. The single-index model offers a summary of risk for individual assets or enterprises that accounts for the combined effects of the asset's own variance and covariances with other assets. When used in portfolio analysis to derive risk efficient sets of decision choices, the single-index model offers a computationally efficient way to use quadratic programming that accounts for a full constraint set and for the covariance relationships among the decision choices (Collins and Barry, 1986).

Collins and Barry (1986), in a study of the farm diversification problem, set out to develop risk measures, based on single-index parameters and computationally simple methods for farm risk planning suitable for microcomputers and modern hand-held calculators. Their results indicated that the single-index solutions may closely approximate the E-V frontier derived with the full-variance-covariance matrix.

The Two-parameter Model

Turvey and Driver (1987) constructed a two-parameter model in terms of the expected gross revenues of individual farm activities and their contribution to the variance of the expected gross revenue of a farm sector portfolio. Their Farm Sector Capital Asset Pricing Model (FSCAPM) was developed to examine systematic agricultural risks. Beta coefficients can be used to assist farm managers in making portfolio decision. Their results reveal that for many agricultural commodities and crop mixes the amount of systematic risk is high. Moreover, for the majority of commodities and crop mixes examined, they concluded that farmers are being under-compensated for the level of systematic risk they are accepting. It is suggested that off-farm investment might be a feasible approach to reducing systematic risk within agriculture. This is because portfolio holdings of non-farm assets are uncorrelated with the farm sector portfolio.

Summary of Various Models

Brown (1987) reviewed various risk efficiency criteria in a study of crop rotations in

Saskatchewan. He concluded that if production and marketing risks associated with various rotations are considered, there is close correspondence between rotations that are selected via stochastic dominance and actual producer behavior with respect to fallow use in crop rotations.

Just (1975) studied risk response models and their use in agricultural policy evaluation. His paper was particularly concerned with estimating risk response at the aggregate level so that policies which affect risk can be adequately evaluated. He also reviewed the state of the art for two existing approaches in risk response estimation, i.e. the normative or programming approach and positive or econometric approach.

McSweeny, Kenyon and Kramer (1987) studied various measures of uncertainty in a risk programming problem. They found that when using historical gross returns per acre, the optimal solution values are sensitive to the choice of detrending technique. They also pointed out that until additional approaches more accurately reflect subjective probability distributions elicited directly from farmers, researchers should estimate variance-covariance structures (for risk-programming studies) using methods most consistent with conceptual models of how farmers form expectations. On this basis, using Young's criteria, the mean- squared forecast error method is more appropriate than the more commonly used procedures based only on realized market data and selected detrending methods.

Kaliel (1982) developed a matrix of correlation coefficients for the area of South Central Alberta in support of a budgeting process. The "risk budgeting" decision tool was designed to employ a farm manager's subjective estimates of prices and yields for enterprises.

3.2 The Methodology

The portfolio model will be the main tool to conduct this research project. The portfolio model shows how different combinations of enterprises or investments may reduce an owner's or investor's risk more than holding only a single enterprise or investment.

As discussed in chapter two, Chinese family farmers do not own land. They only can obtain the right to use the land through the contracted quota system. Therefore, the risk facing the Chinese family farmer is different from the one facing Canadian family farmer.

The Chinese farmer has a quota and fixed cash commitments for agricultural taxes, apportioned expenses[9] and living cost. His problem is to find the combination of crops that satisfy his objective. We will take his objective to be minimize the probability of not meeting the FCC (fixed cash commitment), or, the probability of default.

We will consider two crops to demonstrate the methodological issues: crop 1 and crop 2. The expected gross revenue for one unit of land devoted to crop 1 can be calculated by following formulae.

$$E(GR)_1 = Q_1\mu_{1p} + (\mu_{1y} - Q_1)\mu_{1m} \tag{3.12}$$

$$E(GR)_1 = Q_1\mu_{1p} + \mu_{1y}\mu_{1m} - Q_1\mu_{1m} \tag{3.13}$$

$$E(GR)_1 = \mu_{1y}\mu_{1m} - Q_1(\mu_{1m} - \mu_{1p}) \tag{3.14}$$

where:

$E(GR)_1$ is the mean gross revenue for crop 1

Q_1 is the contracted quota per unit of land for crop 1

μ_{1p} is the mean quota price of crop 1

μ_{1m} is the mean market price of crop 1

μ_{1y} is the mean yield of crop 1.

Equation 3.12 indicates that gross revenue consists of two parts: the revenue from quota sale and the revenue from free market sale. The second part of revenue can be negative if total yield is less than total quota.

9 apportioned expenses are similar to a tax farmers must pay for the overhead cost imposed by the production team, production brigade and state farm.

Equation 3.14 indicates that the first part is total gross revenue if all grain is sold on the free market. The second part is the rent for the use of the state land, this is real "quota".[10]

When the contracted quota is equal to zero, or when the quota price and market prices are equal, Equations 3.12, 3.13 and 3.14 become:

$$E(GR)_1 = \mu_{1y}\mu_{1m} \tag{3.15}$$

Since the quota amount is fixed, the standard deviation of it is zero. Under the assumption of stochastic independence[11] among crop yield, quota price and market prices, variances are additive and the standard deviation for the gross revenue of crop 1 is given by:

$$\begin{aligned} S(GR)_1 &= \sqrt{[(0+Q_1^2)(\sigma_{1p}^2+\mu_{1p}^2)-Q_1^2\mu_{1p}^2]+\{[\sigma_{1y}^2+(\mu_{1y}-Q_1)^2](\sigma_{1m}^2+\mu_{1m}^2)-(\mu_{1y}-Q_1)^2\mu_{1m}^2\}} \\ &= \sqrt{(Q_1\sigma_{1p})^2+(\sigma_{1y}\sigma_{1m})^2+(\sigma_{1y}\mu_{1m})^2+[(\mu_{1y}-Q_1)\sigma_{1m}]^2} \end{aligned} \tag{3.16}$$

where:

$S(GR)_1$ is the standard deviation of gross revenue of crop 1

σ_{1p} is the standard deviation of quota price of crop 1

σ_{1y} is the standard deviation of yield of crop 1

σ_{1m} is the standard deviation of market price of crop 1.

When the contracted quota of crop 1 is equal to zero, or when the quota price and market prices are equal, Equation 3.14 becomes:

$$\begin{aligned} S(GR)_1 &= \sqrt{(\sigma_{1y}\sigma_{1m})^2+(\sigma_{1y}\mu_{1m})^2+(\mu_{1y}\sigma_{1m})^2} \\ &= \sqrt{(\sigma_{1y}^2+\mu_{1y}^2)(\sigma_{1m}^2+\mu_{1m}^2)-\mu_{1y}^2\mu_{1m}^2} \end{aligned} \tag{3.17}$$

This equation is identical to the equation used by Bauer (1987).

10 The so-called quota is a fixed amount of grain that the Chinese farmer has to sell to the government at an arbitrarily low price as a charge for using the state land. The surplus grain after fulfilling the quota can be sold at the free market. If there is a shortage of grain for quota, the farmer has to buy the unfulfilled amount of grain from the free market.

11 The assumption of stochastic independence implies that there is a zero correlation among the variances. In reality, local markets may be correlated to local conditions (eg. weather).

The variable costs are defined as those which would disappear if the particular crop activity were not engaged in. Gross margin (GM) is the return an activity gives above the variable costs. Hence, it is the difference between gross revenue (GR) and the total variable cost. Since assuming variance associated with variable costs is zero, the standard deviation of gross margin S(GM) is identical to the standard deviation of gross revenue S(GR). Therefore, the expected gross margin and standard deviation for crop 1 are given by:

$$\begin{aligned} E(GM)_1 &= E(GR)_1 - V_1 \\ &= \mu_{1y}\mu_{1m} - Q_1(\mu_{1m} - \mu_{1p}) - V_1 \\ &= (\mu_{1y}\mu_{1m} - V_1) - Q_1(\mu_{1m} - \mu_{1p}) \end{aligned} \tag{3.18}$$

where:

$E(GM)_1$ is the expected gross margin of crop 1

V_1 is the variable cost per unit of land associated with crop 1

$$S(GM)_1 = S(GR)_1 \tag{3.19}$$

where:

$S(GM)_1$ is the standard deviation of crop 1.

Using the same reasoning as with crop 1, the expected gross revenue for one unit of land devoted to crop 2 is given by:

$$E(GR)_2 = \mu_{2y}\mu_{2m} - Q_2(\mu_{2m} - \mu_{2p}) \tag{3.20}$$

where:

$E(GR)_2$ is the mean gross revenue for crop 2

Q_2 is the contracted quota per unit of land for crop 2

μ_{2p} is the mean quota price of crop 2

μ_{2m} is the mean market price of crop 2

μ_{2m} is the mean yield of crop 2.

The standard deviation for the gross revenue of crop 2 is given by:

$$S(GR)_2 = \sqrt{(Q_2\sigma_{2p})^2 + (\sigma_{2y}\sigma_{2m})^2 + (\sigma_{2y}\mu_{2m})^2 + [(\mu_{2y} - Q_2)\sigma_{2m}]^2} \qquad (3.21)$$

where:

$S(GR)_2$ is the standard deviation of gross revenue for crop 2

σ_{2p} is the standard deviation of quota price of crop 2

σ_{2y} is the standard deviation of yield of crop 2

σ_{2m} is the standard deviation of market price of crop 2

The expected gross margin and standard deviation for crop 2 are given by:

$$\begin{aligned} E(GM)_2 &= E(GR)_2 - V_2 \\ &= \mu_{2y}\mu_{2m} - Q_2(\mu_{2m} - \mu_{2p}) - V_2 \qquad (3.22) \\ &= (\mu_{2y}\mu_{2m} - V_2) - Q_2(\mu_{2m} - \mu_{2p}) \end{aligned}$$

where:

$E(GM)_2$ is the expected gross margin of crop 2

V_2 is the variable cost per unit of land associated with crop 2

$$S(GM)_2 = S(GR)_2 \qquad (3.23)$$

where:

$S(GM)_2$ is the standard deviation of crop 2.

The expected total gross margin $E(GMT)$ of a combination of crop 1 and crop 2 is given by:

$$\begin{aligned} E(GMT) = {} & a_1(\mu_{1y}\mu_{1m} - V_1) - A_1Q_1(\mu_{1m} - \mu_{1p}) \\ & + a_2(\mu_{2y}\mu_{2m} - V_2) - A_2Q_2(\mu_{2m} - \mu_{2p}) \qquad (3.24) \end{aligned}$$

where:

a_1 is the percentage of area of crop 1 to be seeded

A_1 is the percentage of quota area of crop 1

a_2 is the percentage of area of crop 2 to be seeded

A_2 is the percentage of quota area of crop 2

The standard deviation of total gross margin $S(GMT)$ of a combination of crop 1 and crop 2 is given by:

$$S(GMT) = \sqrt{a_1^2 S(GM)_1^2 + 2\rho a_1 a_2 S(GM)_1 S(GM)_2 + a_2^2 S(GM)_2^2} \qquad (3.25)$$

where:

ρ is the correlation coefficient between the gross margins of crop 1 and crop 2.

The chance of default on the fixed cash commitment can be determined by calculating the number of standard deviation units the actual gross margin can be below (or above) the expected gross margin in a particular year and still cover the fixed cash commitment. The number of standard deviation units can be calculated as:

$$Z = \frac{FCC - E(GMT)}{S(GMT)} \qquad (3.26)$$

where:

Z is the standard normal deviate.

From the equations 3.12 to 3.26, we know that a_1 is the only decision variable ($a_2 = 1 - a_1$) as shown in Figure 3-4. Since it is desired to minimize the Z value, equations 3.12 to 3.25 can be substituted into Equation 3.26. The best combination is obtained by taking first derivative of equation 3.26 with respect to a_1, and solving for a_1. This combination, which minimizes the probability of defaulting on the fixed cash commitment is given by: (for more details see Appendix I)

$$a_1 = \frac{k - \rho j}{\frac{j}{k} + k - \rho - \rho j} \qquad a_2 = \frac{\frac{j}{k} - \rho}{\frac{j}{k} + k - \rho - \rho j} \qquad (3.27)$$

where:

ρ is the correlation coefficient between the gross margins of crop 1 and crop 2.

$$k = \frac{S(GM)_2}{S(GM)_1} = \frac{S(GR)_2}{S(GR)_1} \tag{3.28}$$

$$j = \frac{\mu_{2y}\mu_{2m} - V_2 - FCC - A_1Q_1(\mu_{1m} - \mu_{1p}) - A_2Q_2(\mu_{2m} - \mu_{2p})}{\mu_{1y}\mu_{1m} - V_1 - FCC - A_1Q_1(\mu_{1m} - \mu_{1p}) - A_2Q_2(\mu_{2m} - \mu_{2p})} \tag{3.29}$$

In above equations 3.27, 3.28 and 3.29, α_1 and α_2 are the risk minimizing combination of crop 1 and crop 2. The parameter k is the ratio of risk and j is the ratio of return between crop 1 and crop 2. Therefore, the frontier of returns and its risk of two crop combination is shown in Figure 3-4.

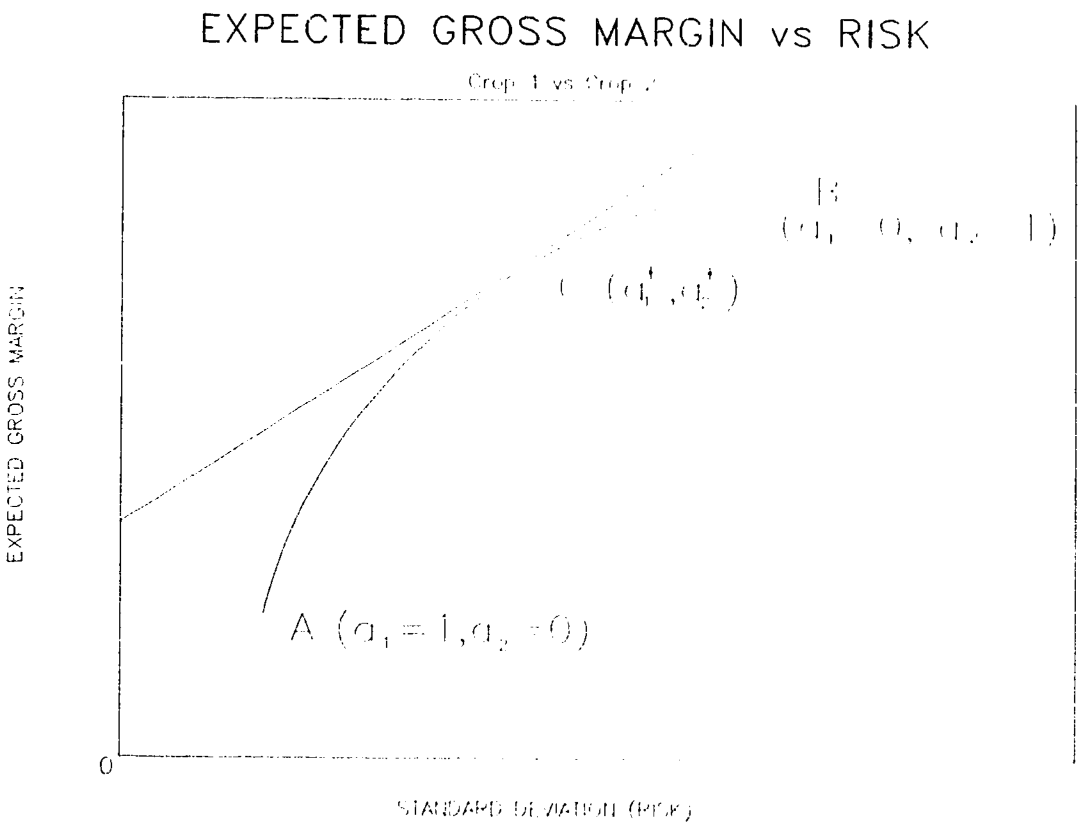

Figure 3-4. The Frontier of Returns and Its Risk

When the contracted quota is equal to zero, or when the quota price and market prices are equal, Equations 3.27 and 3.28 remain same, Equation 3.29, however, becomes:

$$J = \frac{\mu_{2y}\mu_{2m} - V_2 - FCC}{\mu_{1y}\mu_{1m} - V_1 - FCC} \qquad (3.30)$$

Next the case example will be used to illustrate the methodology. A typical non-mechanized Chinese family farm only get 30 mu of responsibility land from the government is assumed. This illustrative example was developed from survey data and observations in Heilongjiang province. The contracted quotas for use of the land are summarized in Table 3-1.

Table 3-1. Contracted Quotas for a Typical Farm

	quota/mu (jin[12])	area (mu)	total quota (jin)
wheat	270.00	15	4050
soyabean	190.00	15	2850

At the start of the year the farmer must decide how much of each crop to produce. It is given the quota requirement as shown in Table 3-1. The manager of this typical family farm estimates of his lowest, his highest and his most likely yields and market prices and quota prices for each of two crops[13], which are summarized in Table 3-2.

12 One *jin* = 0.5 kilogram

13 Variability of the quota price is due to the grading of grain and water content of grain and government polices.

Table 3-2. Estimate Yields and Prices of Two Crops

	Wheat	Soyabean
YIELDS (jin/mu)		
lowest	260	165
most likely	300	200
highest	340	235
QUOTA PRICE (yuan/jin)		
lowest	0.20	0.32
most likely	0.22	0.35
highest	0.25	0.40
MARKET PRICE (yuan/jin)		
lowest	0.25	0.40
most likely	0.32	0.50
highest	0.40	0.60

The mean or expected value of the triangular distribution for yield and price estimates is given by (Bauer, 1987):

$$\mu = \frac{a + m + b}{3} \qquad (3.31)$$

where:

- μ is the mean or expected value
- a is the lowest possible value
- m is the most likely possible value
- b is the highest possible value.

The variance of the triangular distribution is given by:

$$\sigma^2 = \frac{(b - a)^2 - (m - a)(b - m)}{18} \qquad (3.32)$$

Where:

σ^2 is the variance of estimates

The standard deviation (σ) is given by the square root of the variance (σ^2).

The standard deviation and expected gross revenue about the typical family farm is shown in Table 3-3.[14]

Table 3-3. Standard Deviation and Expected Gross Revenue

	WHEAT	SOYABEAN
yield estimates: (jin/mu)		
expected yield	300.00	200.00
standard deviation	16.33	14.29
quota price estimates:(yuan/jin)		
expected yield	0.20	0.36
standard deviation	0.01	0.02
market price estimates:(yuan/jin)		
expected price	0.32	0.50
standard deviation	0.03	0.04
EXPECTED GROSS REVENUE	70.00	72.77
STANDARD DEVIATION	6.06	7.83

The manager also estimates the variable costs shown in Table 3-4.

14 The crop enterprise analysis program on Lotus 123 spreadsheet, which originally created by Bauer (1987), has been adopted in this study.

Table 3-4. Variable Cost Estimates, E(GM) and S(GM)

	wheat	soyabean
VARIABLE COST (yuan/mu)		
seed	10.00	6.50
fertilizer	9.00	8.00
pesticides	0.50	0.50
custom work	10.00	15.00
miscellaneous	2.00	2.00
TOTAL VARIABLE COST	31.50	32.00
EXPECTED GROSS MARGIN	38.50	40.77
STANDARD DEVIATION	6.06	7.83

In the case farm, there are five options, shown in Table 3-5, available for the manager to consider.

Table 3-5. Comparison of Five Options of Crop Combination

	Option I	Option II	Option III	Option IV	Option V
Crop Combination:(mu)					
wheat	0	7.5	15	22.5	30
soyabean	30	22.5	15	7.5	0
Expected Gross Margin	1226	1208	1189	1170	1152
Standard Deviation	235	210	191	182	182
Z Value	-4.06972	-4.45972	-4.78847	-4.94854	-4.85235
Prob. Of Not Meeting FCC					
Level A amount	960	956	953	949	945
default probability	0.000	0.000	0.000	0.000	0.000
Level B amount	1230	1226	1223	1219	1215
default probability	0.000	0.000	0.000	0.000	0.000
Level C amount	1830	1826	1823	1819	1815
default probability	0.065	0.054	0.050	0.049	0.061

Table 3-5 indicates that Option 4 is the best choice with the probability of not meeting fixed cash commitment 4.9% in level C. For detail information, see Appendix II.

If we use the mathematical equation approach to tackle this problem, we just substitute all known variables into equations 3.27, 3.28 and 3.29 and we get:

$l = 1.0850822$

$k = 1.2937483$

$\rho = 0.692$

$a_1 = 0.7872455$

Therefore, the risk minimizing combination is that wheat accounts for 78.72% and soyabean accounts for 21.28% of land to be seeded. The expected gross margin vs risk of two crops are shown in Figure 3-5 and Figure 3-6. Furthermore, the Trial and Error was adopted and proved that the results are correct.

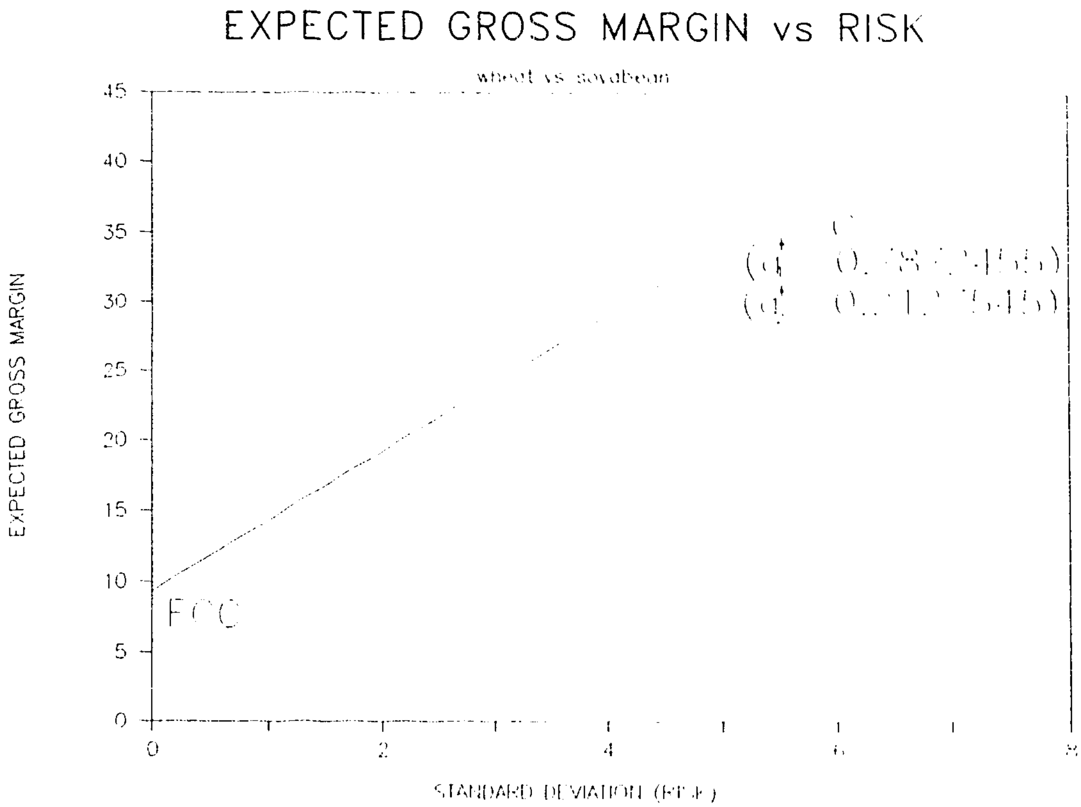

Figure 3-5. The Risk Minimizing Combination of Wheat & Soyabean

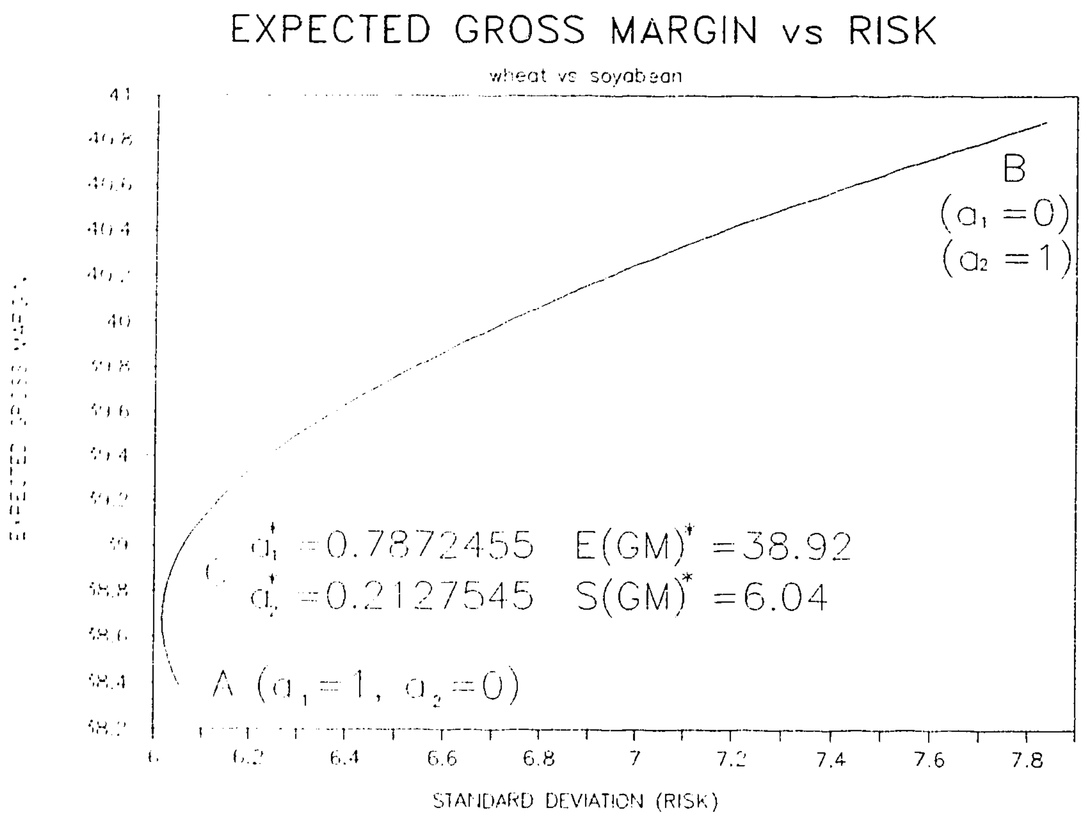

Figure 3-6. The Risk Minimizing Combination of Wheat & Soyabean (enlarged)

4 CASE FARM STUDIES

4.1 General Introduction

The project entailed library study and personal interviews with government and state farm officials to document the relationship between the family farm unit and the state farm. The nature of the quota contract, particularly how amounts are set and the methods of payment are critical to an understanding of the risk implications.

The decision environment of the individual family farm operation was examined, through personal interviews with family farms operators. This also provided input into the data series on yields and prices, particularly as to the formation of expectations.

Published data regarding historical yields and prices were sought from government agencies in Beijing and in Harbin and from the State Farm Bureau in Jiamusi. It is recognized that the price series, because of the only recent introduction of market mechanisms, are limited, but it is felt that some attention to this area, even if preliminary, must be given.

There are two data sources: State Farm 852 and Tieli State Farm. Data for these state farms were obtained from published year books and from personal interview with state farm officials and family farm managers.

4.2 State Farm 852

4.2.1 Description of the Farm

State Farm 852 is located between 46°06' -- 46°37' northern altitude and 132°18' -- 132°54' east longitude. It located in the northern part of the Wanda Mountain, in the middle part of the Yaoli River, and the eastern part of Baoqing County in The Three River Plain.

The elevation of the state farm is high in the southern part and low in the northern part. From the summit of the Wanda Mountain to the Yaoli River, the land range from hilly to plain and low plain. This flat land is suitable for large scale mechanized production.

State Farm 852 was established on June 1, 1956 as a larger geographic area. Since then, the State Farm 853 and State Farm 597 have been separated from it. At present, the State Farm 852 ranges 46 kilometers wide from east to west, 57 kilometers long from south to north, and covers 1,363 square kilometers of total land area.

In 1988, 6,351 households on State Farm 852 established 6,594 various family farms and employed 13,415 laborers. The operational scale of State Farm 852 is summarized in Table 4-1. The areas and rent of the land for family farms on State Farm 852 are shown in Table 4-2.

Table 4-1. Operational Scale of State Farm 852 (1988)

		Family farms	Households	Laborers
Family Farms With Machinery	Less than 500 mu	33	44	92
	501 - 1,000 mu	12	35	51
	1,001 - 1,500 mu	137	310	582
	1,501 - 2,000 mu	183	489	993
	Over 2,000 mu	38	156	316
	Subtotal	403	1,034	2,034
Family Farms Without Machinery	Less that 30 mu	4,211	3,298	6,361
	31 - 60 mu	1,098	990	2,343
	61 - 100 mu	271	208	813
	101 - 150 mu	99	73	399
	151-200	20	15	41
	Over 200 mu	1	1	5
	Subtotal	5,700	4,585	9,962
Other Family Farms & Misc.		491	732	1,419
TOTAL		6,594	6,351	13,415

Table 4-2. Areas and Rent of Land for Family Farms

	Family Farms	House-holds	Laborers	Land (mu)	Rent (yuan)
FF with Machinery*	403	1,034	2,034	755,446	22,156,927
FF without Machinery	5,700	4,585	9,962	272,685	8,477,635
Other Family Farms & Misc.	491	732	1,419	17,853	701,881
TOTAL	6,594	6,351	13,415	1,045,984	31,336,443

* FF stands for family farms

Table 4-1 indicates that only 6.1% (403 of 6,594) of the total family farms are mechanized family farms, 86.4% (5700 of 6594) are non-mechanized and 7.5% (491 of 6594) are other family farms which specialize in seed breeding, machinery repairs, and other services. The average land area ranged from approximately to 1500 mu for mechanized family farms to 30 mu for non-mechanized family farms.

Table 4-2 shows that mechanized family farms cultivate 72.2% (755,446 of 1,045,984) of total farming land and non-mechanized family farms cultivate 26.1% of the land. The average rent[15] per mu is approximately 30 yuan (29.33 yuan for mechanized and 31.09 yuan for non-mechanized family farms).

4.2.2 Crop Yield Data

Crop yield history data were collected from The Yearbook of State Farm 852, which was published in 1984. For the purpose of this study, only the yield data for three crops, i.e. wheat, soyabean and corn are summarized in Table 4-3.

15 The rent includes the price difference between the quota and market prices, various taxes, state farm overhead expenses and so on.

Table 4-3. Crop Yield From State Farm 852 (jin/mu)

YEAR	WHEAT	SOYABEAN	CORN
1957	132	56	133
1958	65	52	95
1959	112	119	107
1960	152	40	16
1961	109	61	122
1962	132	88	219
1963	155	58	252
1964	190	85	182
1965	224	194	349
1966	177	209	390
1967	259	183	394
1968	289	207	412
1969	244	149	252
1970	292	232	379
1971	194	197	444
1972	205	157	405
1973	134	194	344
1974	241	144	265
1975	194	261	457
1976	247	237	574
1977	337	151	289
1978	83	217	429
1979	354	139	375
1980	395	200	496
1981	110	57	101
1982	167	188	261
1983	412	207	405

The regression equation for wheat is:

$$y_1 = 120 + 6.24\,(T - 1956)$$

where:

T is year.

Predictor	Coef	Stdev	t-ratio
Constant	120.29	31.89	3.77
Wheat	6.236	1.991	3.13

Standard error of Y estimate = 80.56

R-sq = 28.2% R-sq(adj) = 25.3%

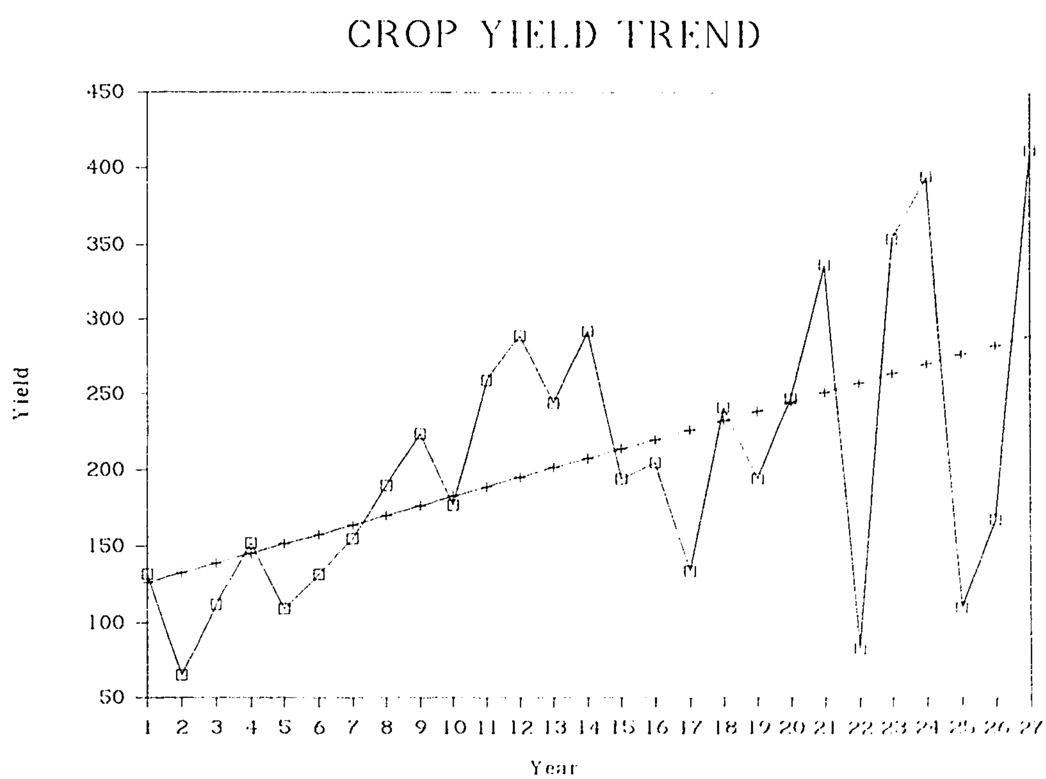

Figure 4-1. Crop Yield Trend for State Farm 852 (wheat)

The regression equation for soyabean is:

$$y_2 = 84.0 + 4.80\,(T - 1956)$$

where:

T is a year.

Predictor	Coef	Stdev	t-ratio
Constant	83.95	22.28	3.77
Soyabean	4.802	1.391	3.45

Standard error of Y estimate = 56.28

R-sq = 32.3% R-sq(adj) = 29.6%

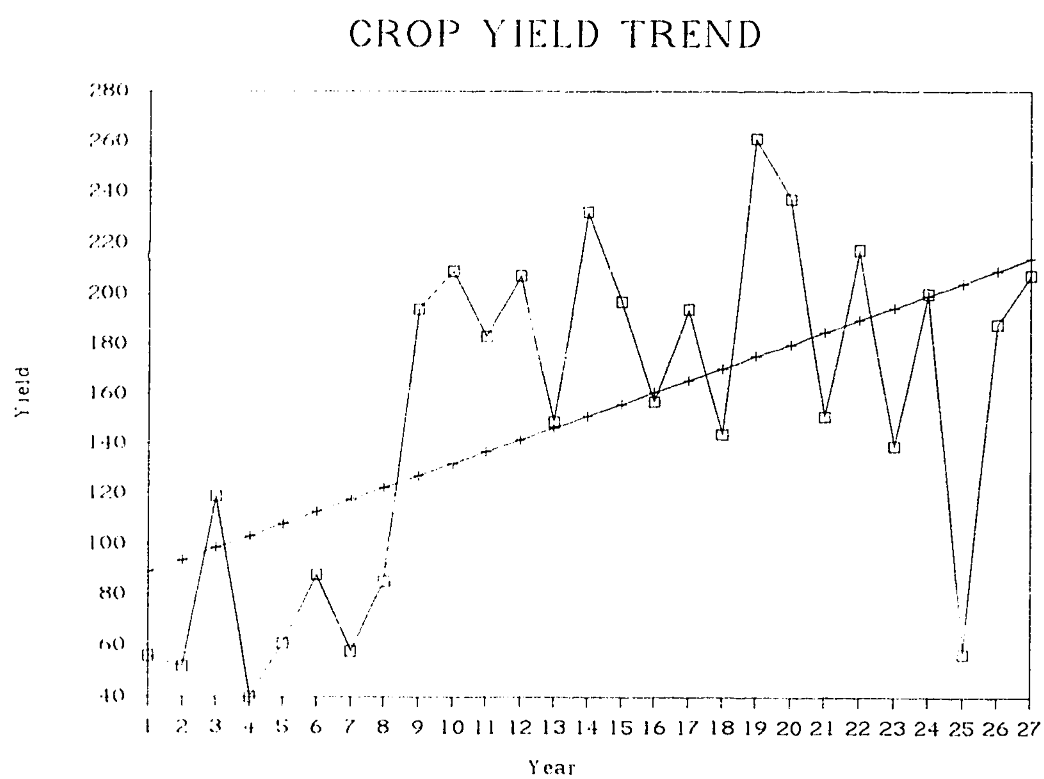

Figure 4-2. Crop Yield Trend for State Farm 852 (soyabean)

The regression equation for corn is:

$$y_3 = 157 + 10.3\,(T - 1956)$$

where:

T is a year.

Predictor	Coef	Stdev	t-ratio
Constant	157.31	47.23	3.33
Corn	10.316	2.948	3.50

Standard error of Y estimate = 119.3

R-sq = 32.9%   R-sq(adj) = 30.2%

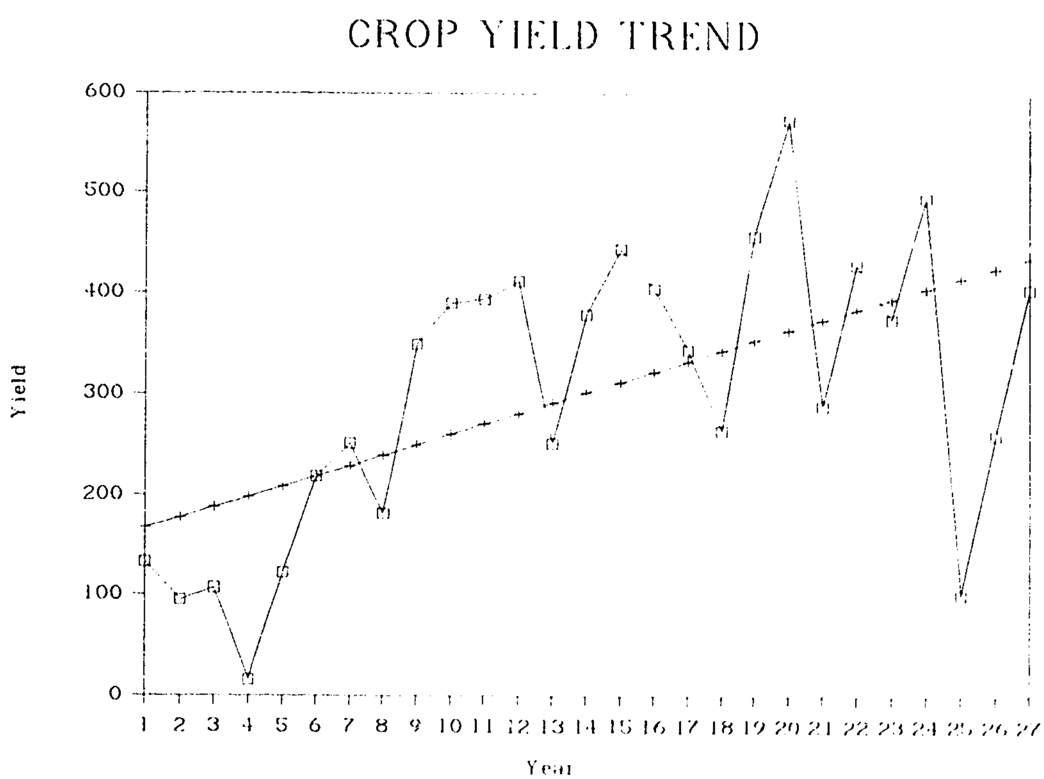

Figure 4-3. Crop Yield Trend for State Farm 852 (corn)

Table 4-4. Description of Data (852)

	N	MEAN	MEDIAN	STDEV	MIN	MAX
wheat	27	207.6	194.0	93.2	65	412
soyabean	27	151.2	157.0	67.1	40	261
corn	27	301.7	344.0	142.8	16	574

Table 4-5. Detrended Variances and Covariances of Data (852)

	wheat	soyabean	corn
wheat	6,490	4,534	9,611
soyabean	4,534	3,168	6,714
corn	9,611	6,714	14,236

Table 4-6. Detrended Correlation Matrix of Data (852)

	year	wheat	soyabean	corn
year	1.000	0.531	0.568	0.573
wheat	0.531	1.000	0.482	0.566
soyabean	0.568	0.482	1.000	0.887
corn	0.573	0.566	0.887	1.000

4.2.3 Price and Cost Data

The production costs for wheat, soyabean and corn are summarized in Table 4-7. The costs include total variable costs and total fixed (overhead) costs.

Table 4-7. Cost of Production of State Farm 852 (Yuan/mu)

YEAR	WHEAT	SOYABEAN	CORN
1957	13.50	10.70	31.06
1958	7.60	5.90	15.50
1959	11.50	12.95	9.20
1960	17.55	14.33	11.84
1961	14.09	9.62	18.48
1962	16.46	14.86	19.72
1963	17.16	14.54	18.14
1964	17.28	12.13	13.89
1965	17.67	14.29	18.03
1966	19.80	18.30	26.32
1967	21.80	20.60	29.29
1968	22.70	21.65	30.84
1969	24.50	23.20	33.35
1970	25.40	24.70	34.20
1971	24.20	23.21	32.70
1972	24.30	23.48	32.80
1973	25.78	24.97	35.45
1974	26.36	26.17	27.41
1975	26.36	28.25	30.36
1976	27.61	26.96	29.32
1977	30.84	24.35	29.57
1978	27.34	23.71	31.36
1979	27.09	25.05	32.14
1980	33.22	32.33	36.81
1981	41.44	34.23	40.29
1982	35.98	36.11	37.37
1983	38.91	41.02	40.13

The prices for wheat, soyabean and corn are summarized in Table 4-8.

Table 4-8. Price Data of State Farm 852 (cent/jian)

year	wheat	soyabean	corn
1977	14.50	15.20	8.10
1978	14.50	20.80	7.90
1979	17.80	23.30	9.60
1980	18.03	21.87	9.60
1981			
1982		32.80	
1983	18.00	32.90	9.45

From data in Table 4-7 and Table 4-8, the gross revenue for each can be calculated. In 1983, for example, the gross revenues are 74.16 yuan (412*18/100) per mu for wheat, 68.10 yuan per mu for soyabean and 38.27 yuan per mu for corn.

4.2.4 Risk Minimizing Crop combinations

The typical non-mechanized family farm on State Farm 852, as determined from Tables 4-1 and 4-2, contracted 30 mu of land. He uses the historical crop yield and cost data to predict the expected values of this year (1991). Since there is an incomplete history data set for price, he has to estimate the prices. The expected and estimated data are summarized in Table 4-9. He also estimates that agricultural taxes are 150.00 yuan and apportioned expenses are 120.00 yuan, so total overhead cost would be 270.00 yuan.

Table 4-9. The Expected and Estimated Data (852)

	wheat	soyabean	corn
Quota per mu (jin)	270	200	400
quota areas (mu)	10.00	10.00	10.00
EXPECTED YIELD(jin/mu)	338.54	252.03	518.38
STANDARD DEVIATION	93.20	67.10	142.80
quota price estimates:			
worst possible	0.20	0.30	0.12
most likely	0.22	0.35	0.16
best possible	0.25	0.40	0.20
EXPECTED QUOTA PRICE	0.22	0.35	0.16
STANDARD DEVIATION	0.01	0.02	0.02
market price estimates			
worst possible	0.25	0.40	0.20
most likely	0.32	0.46	0.25
best possible	[illegible]	0.52	0.32
EXPECTED MARKET PRICE	0.32	0.46	0.26
STANDARD DEVIATION	0.03	0.02	0.02
EXPECTED GR per mu	82.46	93.93	94.38
STANDARD DEVIATION	30.47	31.20	37.51
TOTAL VARIABLE COST	44.13	43.00	46.18
EXPECTED GM per mu	38.33	50.93	48.20
STANDARD DEVIATION	30.47	31.20	37.51

Using the Equation 3-27, the best combination (minimum risk) of three crops are obtained and summarized in Table 4-10.

Table 4-10. Risk Minimizing Crop Combinations (852)

	Wheat-Soy	Wheat-Corn	Soy-Corn	W-S-C
E(GM)-FCC-Q (j)	1.429662	[illegible]	0.934904	3 CROPS
S(GM) RATIO (k)	1.024129	1.2319310	1.202[illegible]	TRIAL
CORRELATION	0.4820	0.5660	0.887[illegible]	AND
a1	0.268238	0.4772511	1.414459	ERROR
WHEAT (%)	26.82	47.73	********	25
SOYABEAN (%)	73.18	********	100.00	75
CORN (%)	********	52.27	0	0

From Table 4-10, we know that the risk minimizing combination for wheat and soyabean is 26.82% of wheat and 73.18 % of soyabean, for wheat and corn is 47.73% of wheat and 52.27% of corn, and for soyabean and corn is 100% of soyabean and 0% of corn. Since the probability of default minimizing approach developed allows only pair wise comparisons a trial and error approach for all possible combinations of the three crop was also used. The trial and error method determined best combination to be 25% of wheat, 75% of soyabean and 0% of corn. This is consistent with the pair wise comparison method.

However, combinations in Table 4-10 are subject to agronomic constraints. From an agronomic point of view, we cannot grow one single crop year after year, especially soyabean, and we have to follow the crop rotation system.

4.2.5 Concluding comments on State Farm 852

1. On State Farm 852 a small number of mechanized family farm cultivate a large amount of land (72.2%). The large number of non-mechanized family farm cultivate only 27.8%.

2. The average land area is approximately 1500 mu for mechanized family farms and 30 mu for non-mechanized family farms.

3. In the combination of wheat and soyabean, soyabean has higher return (expected gross margin) and higher risk than wheat. The return and risk ratios of wheat and soyabean are 1.43 and 1.02 respectively. Therefore, the risk minimizing crop combination is 26.82 percent of wheat and 73.18 percent of soyabean.

4. In the combination of wheat and corn, corn has higher return and higher risk than wheat. The return and risk ratios of wheat and corn are 1.34 and 1.23 respectively. Thus, the risk minimizing crop combination is 47.73 percent of wheat and 52.27 percent of corn.

5. In the combination of soyabean and corn, soyabean has higher return and lower risk than corn. The return and risk ratios of soyabean and corn are 0.934904 and 1.202026 respectively. Therefore, the risk minimizing crop combination is 100 percent of soyabean and no corn at all.

6. In the three crops case, the trial and error approach was used. The estimated risk minimizing crop combination is approximately one quarter of wheat and three quarters of soyabean and no corn at all.

7. All of the best combinations are subject to agronomic constraints.

4.3 Tieli State Farm

4.3.1 Description of the Farm

Tieli State Farm is located between 46°51'--47°20' northern latitude and 127°31'--128°51' east longitude, in the southern part of The Small Xing'an Range, and adjacent to Tieli and Qing'an counties. It is 55 kilometers from south to north and 27 kilometers from east to west, covering 1,485 square kilometers of area.

The climate in Tieli State Farm is an inland and seasonal climate in the frigid and temperate zone. The average annual temperature is 1.1°C, with the maximum in July and minimum in January. From 1955 to 1985, the maximum daily temperature was 34.6° (June 27, 1978), the minimum -43.8°C (January 16, 1980). The useful accumulated temperatures that are above 10°C is 2,306°C, starting May 15 and ending September 20. The average soil surface temperature from May to September is 19.6°C. The average velocity of wind is 3 meters per second, with maximum at 28 meters per second (April 17, 1963).

There are 110-120 frost-free days per year. The average temperature, soil temperature and frost-free days increase from north to south.

The average annual precipitation is 647 millimeters. From 1955 to 1985, the maximum annual precipitation was 876 millimeters (1961), the minimum was 443.7 (1967). There is a little precipitation during winter and spring and a lot during summer and fall. The precipitation during July, August and September accounts for 60-70 percent of the total precipitation.

The sunlight hours are long and the intensity of radiation is strong. The total hours of sunlight per year is 1,640-2,350.

The rainfall, temperature and sunlight all can satisfy the needs for crops to grow and to mature. However, weather disasters occur often as in the case of low temperatures, windstorms, ice hailstorms, continuous overcast raining, frost and freezing, and so on. Among these, low temperatures, and continuous and overcast raining were the most frequent.

Tieli state farm is a middle sized state farm in Heilongjiang Reclamation Area. It was established in 1955. It has 195,591 mu of farm land and employs 44,035 people (staff). The major crops are soybean, wheat and corn. There are 16 production teams on the farm. In 1987, each production team was a contract or accounting unit. In 1988, each production team set up 5 to 6 mechanized family farms. Each family farm has at least two tractors, one combine, one truck and a complete set of farming implements and tools.

4.3.1.1 The Results from Questionnaire

The questionnaire covered 7 production teams on Tieli state farm, and in total 26 family farms. Some general information is shown in Table 4-11. The average age of farm manager is 37 years, with the youngest being 26 and the oldest 52 years of age. This indicates that the age structure of farm managers covers a wide range. Of the 26 farm managers, 18 managers finished their junior high school (8-9 years), 7 senior high school (10-12 years) and one with only elementary school (5-6 years) education. The education level is low and needs to be strengthened.

Table 4-11. Demographic Data for Tieli State Farm

	N	AVE	Sta-Dev	Min
Age of Manager	23	37	8	26
Education Level:				
elementary school	1			
junior high school	18			
senior high school	7			
Number Workers:				
family members	26	17	13	2
hired workers	8	24	16	6

The data from the questionnaire are summarized in Table 4-12. The expected gross margins for soyabean and corn are high relative to wheat. The factors to be paid out of gross margin are farm machinery costs, labour and contract quota

Table 4-12. Average Expected Margins for 1988

	Number of mu	GM / mu	Total GM/farm
Wheat	614.65	29.71	20,380
Soyabean	2,016.89	74.56	150,041
Corn	146.65	79.23	9,105
Total farm	2,778.19		172,005

In addition to the crops reported in Table 4-12 there were 46 mu of canola and 55 mu of barley. These are not included in the table because variable cost data were not available.

4.3.2 Crop Yield Data

The historical crop yields for wheat, soyabean and corn are collected and summarized in Table 4-13.

Table 4-13. Crop Yield from Tieli State Farm (jin/mu)

YEAR	WHEAT	SOYABEAN	CORN
1955	144	176	
1956	123	60	
1957	128	79	
1958	84	157	
1959	175	183	
1960	63	64	
1961	90	56	
1962	108	109	
1963	111	109	
1964	142	76	
1965	129	113	
1966	130	109	215
1967	155	134	343
1968	200	229	313
1969	128	76	154
1970	167	171	274
1971	165	188	345
1972	186	86	190
1973	66	109	180
1974	235	251	388
1975	274	311	407
1976	338	146	86
1977	296	227	233
1978	301	212	396
1979	221	141	228
1980	311	254	390
1981	309	227	265
1982	212	240	247
1983	328	274	432
1984	325	297	374
1985	175	183	176

The regression equation for wheat is:

$$y_1 = 137 + 8.50\,(T - 1965)$$

where:

T is a year.

Predictor	Coef	Stdev	t-ratio
Constant	136.89	29.69	4.61
Wheat	8.496	2.478	3.43

Standard error of Y estimate = 63.91

R-sq = 39.5%   R-sq(adj) = 36.1%

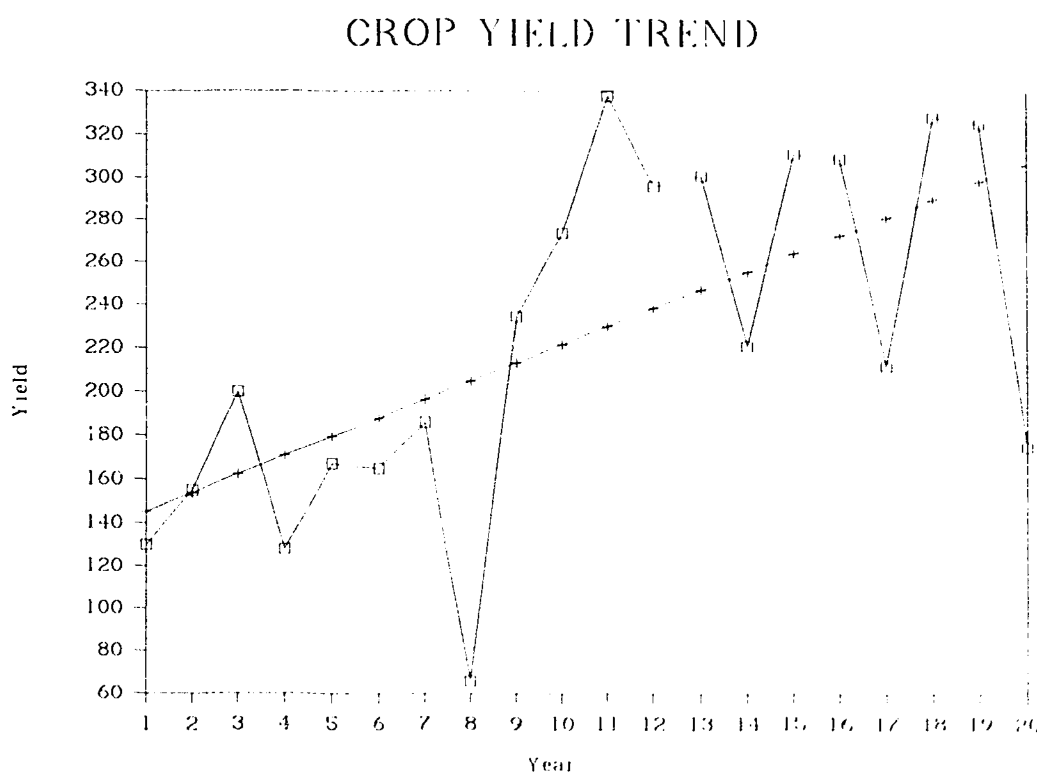

Figure 4-4. Crop Yield Trend for Tieli State Farm (wheat)

The regression equation for soyabean is:

$$y_2 = 123 + 6.66\,(T - 1965)$$

where:

T is a year.

Predictor	Coef	Stdev	t-ratio
Constant	123.33	27.55	4.48
Soyabean	6.659	2.300	2.90

Standard error of Y estimate = 59.31

R-sq = 31.8%   R-sq(adj) = 28.0%

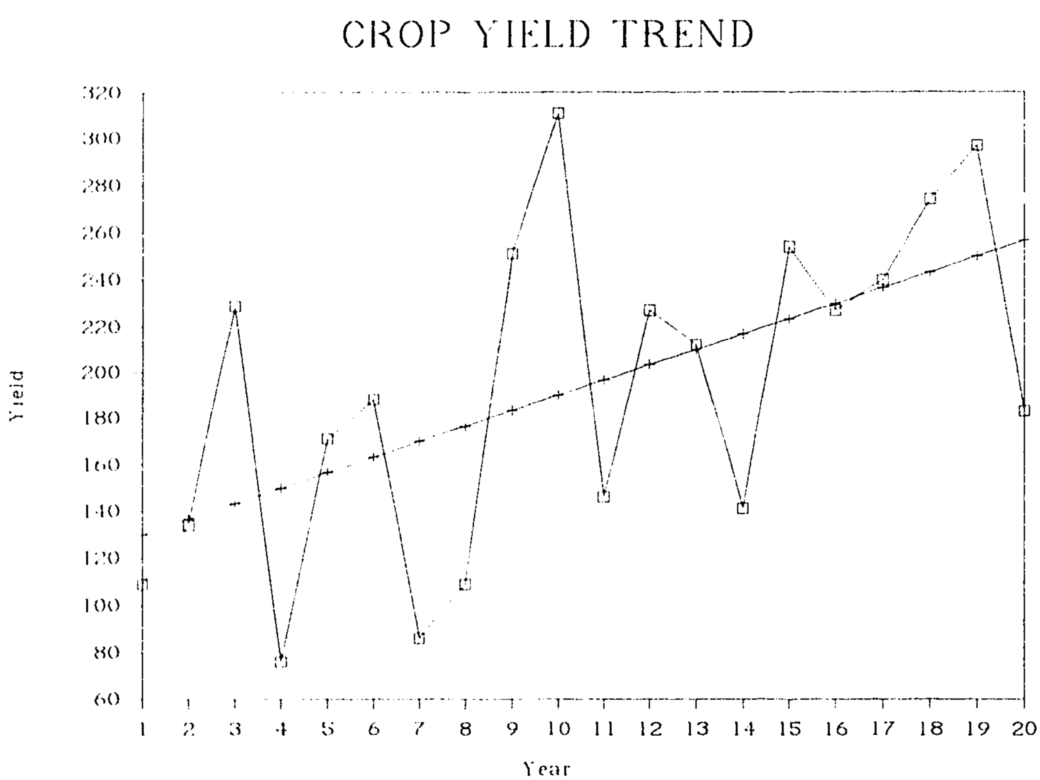

Figure 4-5. Crop Yield Trend for Tieli State Farm (soyabean)

The regression equation for corn is:

$$y_3 = 253 + 2.74\,(T - 1965)$$

where T is a year.

Predictor	Coef	Stdev	t-ratio
Constant	253.02	46.77	5.41
Corn	2.741	3.904	0.70

Standard error of Y estimate = 100.7

R-sq = 2.7%   R-sq(adj) = 0.0%

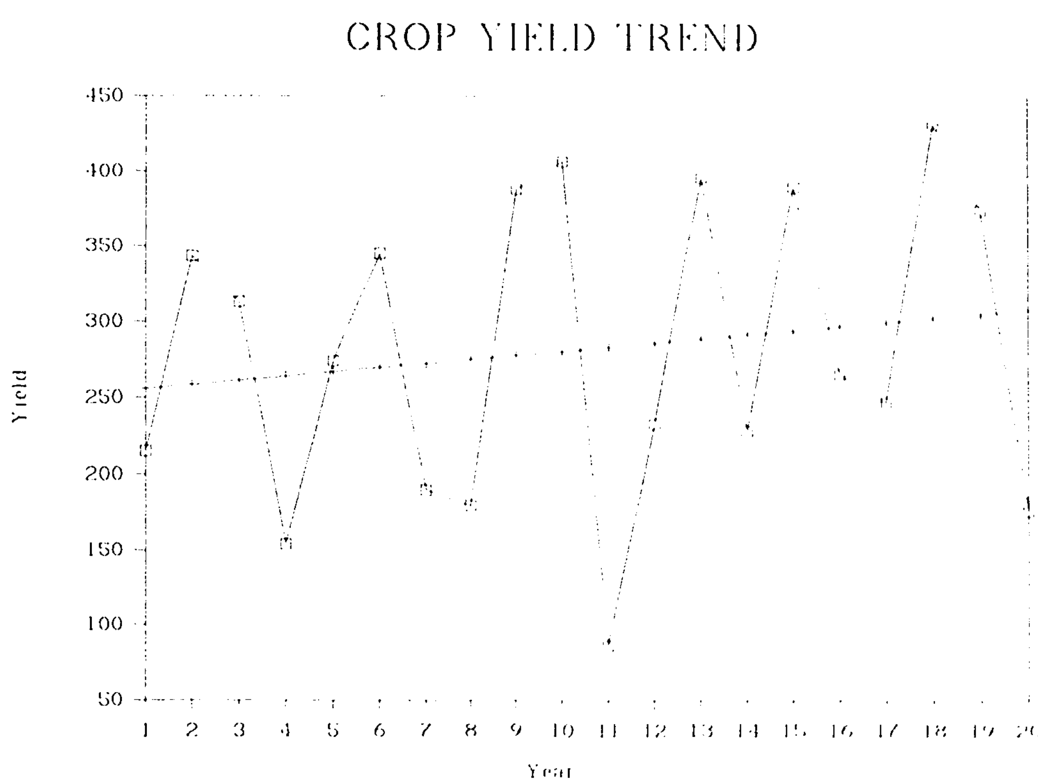

Figure 4-6. Crop Yield Trend for Tieli State Farm (corn)

Table 4-14. Description of Yield Data (Tieli)

	N	MEAN	MEDIAN	STDEV	MIN	MAX
wheat	20	226.1	216.[illegible]	80.0	66	338
soyabean	20	193.3	200.0	69.9	76	311
corn	20	281.8	269.5	99.3	86	432

Table 4-15. Detrended Variances and Covariances of the Data (Tieli)

	wheat	soyabean	corn
wheat	4,085	3,791	6,436
soyabean	3,791	3,518	5,973
corn	6,436	5,973	10,135

Table 4-16. Detrended Correlation Matrix of Data (Tieli)

	year	wheat	soyabean	corn
year	1.000	0.628	0.564	0.163
wheat	0.628	1.000	0.692	0.390
soyabean	0.564	0.692	1.000	0.735
corn	0.163	0.390	0.735	1.000

4.3.3 Price and Cost Data

The expected price and cost data from the questionnaire are summarized in Table 4-17.

Table 4-17. Expected Prices and Costs of Three Major Crops

	Wheat	Soyabean	Corn
Price (yuan/jin)	0.20	0.36	0.16
Fertilizers (yuan/mu)	8.93	8.06	13.39
Seeds and Plants(yuan/mu)	9.92	6.42	2.38
Pesticides(yuan/mu)	0.47	0.00	0.00
Cost of variable input(yuan)	19.33	14.48	15.78

4.3.4 Risk Minimizing Crop Combinations

The data are mostly from the questionnaire which was done in the spring of 1988. However, we also assume that agricultural taxes are 150.00 yuan and apportioned expenses are 120.00 yuan, so total overhead cost would be 270.00 yuan. The expected value and estimated data are summarized in Table 4-18.

Table 4-18. Expected Value and Estimated Data (1988)

	wheat	soyabean	corn
Quota per mu (jin)	200	200	400
quota areas (mu)	10.00	10.00	10.00
yield estimates(jin)			
worst possible	223.05	224.83	411.11
most likely	271.88	253.69	511.11
best possible	323.24	283.30	633.33
EXPECTED YIELD(jin)	272.72	253.94	518.52
STANDARD DEVIATION	20.45	11.94	45.44
quota price estimates(yuan)			
worst possible	0.20	0.32	0.15
most likely	0.23	0.36	0.16
best possible	0.27	0.42	0.20
EXPECTED QUOTA PRICE	0.23	0.37	0.17
STANDARD DEVIATION	0.01	0.02	0.01
market price estimates(yuan)			
worst possible	0.25	0.40	0.20
most likely	0.34	0.46	0.25
best possible	0.37	0.52	0.32
EXPECTED MARKET PRICE	0.32	0.46	0.26
STANDARD DEVIATION	0.03	0.02	0.02
EXPECTED GR per mu	69.94	98.15	98.42
STANDARD DEVIATION	7.40	6.99	12.82
TOTAL VARIABLE COST	19.33	14.48	15.78
EXPECTED GM per mu	50.61	83.67	82.64
STANDARD DEVIATION	7.40	6.99	12.82

Using the Equation 3-27, the best combination (minimum risk) of three crops are obtained and summarized in Table 4-19.

Table 4-19. Risk Minimizing Crop Combinations (Tieli)

	Wheat-Soy	Wheat-Corn	Soy-Corn	W-S-C
E(GM)-FCC-Q (j)	1.794498	1.7698289	0.986252	3 CROPS
S(GM) RATIO (k)	0.944543	1.7326464	1.834373	TRIAL
CORRELATION	0.6920	0.3900	0.7350	AND
a1	-0.32642	0.6227551	1.216361	ERROR
WHEAT (%)	0.00	62.28	********	0.00
SOYABEAN (%)	100.00	********	100.00	100.00
CORN (%)	********	37.72	0.00	0.00

Table 4-19 shows that the risk minimizing combinations for two-crop case are 100% of soyabean and 0% of wheat, 62.28% of wheat and 37.72% of corn and 100% of soyabean and 0% of corn. For three crop case, the best combination is 100% of soyabean and 0% of wheat and corn.

However, combination in Table 4-19 are subject to agronomic constraints. From an agronomic point of view, we cannot grow one single crop year after year, especially soyabean, and we have to follow the crop rotation system.

4.3.5 Concluding Comments on Tieli State Farm

1. The education level is low and needs to be strengthened.

2. In the crop combination of wheat and soyabean, soyabean has a higher return and lower risk than wheat. That means that wheat is a risky crop, compared to soyabean. Therefore, the risk minimizing crop combination is 100 percent of soyabean and no wheat.

3. In the crop combination of wheat and corn, corn has higher return and higher risk than wheat. The return and risk ratios of wheat and corn are 1.77 and 1.73 respectively. Thus, the risk minimizing crop combination is 62.28 percent of wheat and 37.72 percent of corn. This is the case of higher return often associated with higher risk.

4. In the crop combination of soyabean and corn, soyabean has higher return and lower risk than corn. Therefore, the risk minimizing crop combination is 100 percent of soyabean and no corn.

5. In three crop case, the risk minimizing crop combination is 100 percent of soyabean and no wheat and corn at all.

6. Soyabean is the best crop for minimizing of risk of default, compared to wheat and corn.

7. However, the above best crop combinations are subject to agronomic constraints.

5 DISCUSSION AND CONCLUSION

The objectives of this research were to document interrelationships existing between the family farm concept and the state farm system and to develop a methodology to analyze risk situations with respect to crop enterprise selections.

Compared to Canada, China is a big agricultural country with huge population. Chinese agriculture is non-mechanized and labour-intensive. The state farm is one of two farming systems in China (the other is the countryside which is made up of peasants). The state farm system cultivates only 3 per cent of total farming land in China, however it is much more mechanized than the countryside. Since the economic reforms were carried out in 1980, a new concept, the family farm, was born on the state farm system. The interrelations that exist between the family farm and the state farm system is very complicated, just like an orange. The state farm represents the skin of the orange and each family farm is just like one piece of the orange. The state farm totally controls its family farms, thus family farmers do not have too much right to do what they like to do.

A model for selecting crop enterprise combinations which minimize the risk of defaulting on fixed cash commitments was developed. The model draws on a review of literature and is based upon the well known notion that high return is associated with high risk and non-systematic risk can be diversified away. The practical and computationally simple model requires the calculation of risk and return ratios from means, variance and covariance of individual crop enterprises.

Due to a lack of data extensive empirical testing of the model was not possible, however two case farms, from two different locations (State Farm 852 and Tieli State Farm) were developed. These cases were based upon historic crop yield data obtained from the state farms and from answers to questionnaires provided by family farm members during interviews.

From the research we conclude as follows:

(1) Agriculture in China is labour intensive and uses low industrial inputs. Most peasants still depend on simple, non-mechanized farming implements such as ploughs and ox.

(2) Since the contract responsibility system was introduced in 1978, the situation in rural areas has much been improved. Economic reform if appropriately implemented is a way for China to become better off. Adoption of suitable science and technology is urgently needed.

(3) The family farm is a new concept, having just been introduced. It is in the trial stage.

(4) The results of the questionnaires indicate that the education level of family farm managers is low.

(5) Prior to reforms individuals on state farms faced no risk from yield and price fluctuations. Since reforms, risks have become significant to family farmers, because they do bear risk from yield and price fluctuations.

(6) In both case farms, soyabean, within agronomic constraints, was an attractive crop for generating revenue while minimizing risk of default.

In summary, this paper has done a preliminary study on risk dimension of cropping system in the family farm setting of Heilongjiang province, P.R. China.

Further work needs to be done in gathering reliable data on family farm operations and the study should be enlarged to investigate the scale of family farms, the effect of government policies, and the risk of farming other than cultivating crops.

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7 APPENDICES

7.1 Appendix I. Development of Equations 3.27, 3.28 and 3.29

from equation 3.26 we have:

$$Z = \frac{FCC - E(GMT)}{S(GMT)}$$

from equation 3.24 we have:

$$E(GMT) = \alpha_1(\mu_{1y}\mu_{1m} - V_1) - A_1Q_1(\mu_{1m} - \mu_{1p}) + \alpha_2(\mu_{2y}\mu_{2m} - V_2) - A_2Q_2(\mu_{2m} - \mu_{2p})$$

$$= \alpha_1\mu_{1y}\mu_{1n} - \alpha_1V_1 - A_1Q_1(\mu_{1m} - \mu_{1p}) + (1 - \alpha_1)\mu_{2y}\mu 2m - (1 - \alpha_1)V_2 - A_2Q_2(\mu_{2m} - \mu_{2p})$$

$$= (\mu_{1y}\mu_{1m} - \mu_{2y}\mu_{2m} - V_1 + V_2)\alpha_1 + \mu_{2y}\mu_{2m} - A_1Q_1(\mu_{1m} - \mu_{1p}) - A_2Q_2(\mu_{2m} - \mu_{2p}) - V_2$$

as an intermediate step let:

$$\mu_{1y}\mu_{1m} = E_1 \qquad \mu_{2y}\mu_{2m} = E_2 \qquad E_1 - E_2 - V_1 + V_2 = D$$

$$A_1Q_1(\mu_{1m} - \mu_{1p}) + A_2Q_2(\mu_{2m} - \mu_{2p}) + V_2 = H$$

then: $E(GMT) = D\alpha_1 + F$

from equation 3.25 we have

$$S(GMT) = \sqrt{\alpha_1^2 S(GM)_1^2 + 2 \text{[illegible]} M)_1 S(GM)_2 + \alpha_2^2 S(GM)_2^2}$$

for simplicity let: $S(GM)_1 = \sigma_1$ and $S(GM)_2 = \sigma_2$

$$S(GMT) = \sqrt{\alpha_1^2\sigma_1^2 + 2\rho\alpha_1(1 - \alpha_1)\sigma_1\sigma_2 + (1 - \alpha_1)^2\sigma_2^2}$$

$$= \sqrt{(\sigma_1^2 + \sigma_2^2 - 2\rho\sigma_1\sigma_2)\alpha_1^2 + 2\sigma_2(\rho\sigma_1 - \sigma_2)\alpha_1 + \sigma_2^2}$$

$$Z = \frac{FCC - D\alpha_1 - E_2 + H}{\sqrt{(\sigma_1^2 + \sigma_2^2 - 2\rho\sigma_1\sigma_2)\alpha_1^2 + 2\sigma_2(\rho\sigma_1 - \sigma_2)\alpha_1 + \sigma_2^2}}$$

as an intermediate step let:

$$(\sigma_1^2 + \sigma_2^2 - 2\rho\sigma_1\sigma_2)\alpha_1^2 + 2\sigma_2(\rho\sigma_1 - \sigma_2)\alpha_1 + \sigma_2^2 = G \qquad FCC + H = F \qquad F - E_2 = B$$

then: $Z = \dfrac{B - D\alpha_1}{\sqrt{G}}$

$$Z' = \left(\frac{B - D\alpha_1}{\sqrt{G}}\right)' = \frac{(B - D\alpha_1)'\sqrt{G} - (B - D\alpha_1)(\sqrt{G})'}{G}$$

$$(\sqrt{G})' = \frac{G'}{2\sqrt{G}} = \frac{2(\sigma_1^2 - 2\rho\sigma_1\sigma_2 + \sigma_2^2)\alpha_1 + 2\sigma_2(\rho\sigma_1 - \sigma_2)}{2\sqrt{G}}$$

$$= \frac{\sqrt{G}}{G}\left[(\sigma_1^2 - 2\rho\sigma_1\sigma_2 + \sigma_2^2)\alpha_1 + \sigma_2(\rho\sigma_1 - \sigma_2)\right]$$

$$Z' = \frac{-D\sqrt{G} - (B - D\alpha_1)\frac{\sqrt{G}}{G}[(\sigma_1^2 - 2\rho\sigma_1\sigma_2 + \sigma_2^2)\alpha_1 + \sigma_2(\rho\sigma_1 - \sigma_2)]}{G}$$

$$= \frac{-DG\sqrt{G} - (B - D\alpha_1)\sqrt{G}[(\sigma_1^2 - 2\rho\sigma_1\sigma_2 + \sigma_2^2)\alpha_1 + \sigma_2(\rho\sigma_1 - \sigma_2)]}{G^2}$$

$$= \frac{\sqrt{G}}{G^2}\{-DG + (D\alpha_1 - B)[(\sigma_1^2 - 2\rho\sigma_1\sigma_2 + \sigma_2^2)\alpha_1 + \sigma_2(\rho\sigma_1 - \sigma_2)]\}$$

Since $Z' = 0$ and $G \neq 0$ it follows that:

$$-DG + (D\alpha_1 - B)[(\sigma_1^2 - 2\rho\sigma_1\sigma_2 + \sigma_2^2)\alpha_1 + \sigma_2(\rho\sigma_1 - \sigma_2)] = 0$$

$$D[(\sigma_1^2 - 2\rho\sigma_1\sigma_2 + \sigma_2^2)\alpha_1^2 + 2\sigma_2(\rho\sigma_1 - \sigma_2)\alpha_1 + \sigma_2^2] + (D\alpha_1 - B)[(\sigma_1^2 - 2\rho\sigma_1\sigma_2 + \sigma_2^2)\alpha_1$$
$$+ \sigma_2(\rho\sigma_1 - \sigma_2)] = 0$$

$$-D(\sigma_1^2 - 2\rho\sigma_1\sigma_2 + \sigma_2^2)\alpha_1^2 - 2D\sigma_2(\rho\sigma_1 - \sigma_2)\alpha_1 - D\sigma_2^2 + D(\sigma_1^2 - 2\rho\sigma_1\sigma_2 + \sigma_2^2)\alpha_1^2 - D\sigma_2(\rho\sigma_1 - \sigma_2)\alpha_1$$
$$- B(\sigma_1^2 - 2\rho\sigma_1\sigma_2 + \sigma_2^2)\alpha_1 - B\sigma_2(\rho\sigma_1 - \sigma_2) = 0$$

$$[-D\sigma_2(\rho\sigma_1 - \sigma_2) - B(\sigma_1^2 - 2\rho\sigma_1\sigma_2 + \sigma_2^2)]\alpha_1 - [D\sigma_2^2 + B\sigma_2(\rho\sigma_1 - \sigma_2)] = 0$$

$$\alpha_1 = \frac{D\sigma_2^2 + B\sigma_2(\rho\sigma_1 - \sigma_2)}{-D\sigma_2(\rho\sigma_1 - \sigma_2) - B(\sigma_1^2 - 2\rho\sigma_1\sigma_2 + \sigma_2^2)}$$

$$= \frac{(E_1 - E_2 - V_1 + V_2)\sigma_2^2 + (F - E_2)\sigma_2(\rho\sigma_1 - \sigma_2)}{-(E_1 - E_2 - V_1 + V_2)\sigma_2(\rho\sigma_1 - \sigma_2) - (F - E_2)(\sigma_1^2 - 2\rho\sigma_1\sigma_2 + \sigma_2^2)}$$

$$= \frac{(E_1 - V_1 + V_2)\sigma_2^2 - E_2\sigma_2^2 + F\sigma_2(\rho\sigma_1 - \sigma_2) - E_2\rho\sigma_1\sigma_2 + E_2\sigma_2^2}{-(E_1 - V_1 + V_2)\sigma_2(\rho\sigma_1 - \sigma_2) + E_2\rho\sigma_1\sigma_2 - E_2\sigma_2^2 - F(\sigma_1^2 - 2\rho\sigma_1\sigma_2 + \sigma_2^2) + E_2\sigma_1^2 - 2\rho\sigma_1\sigma_2E_2 + E_2\sigma_2^2}$$

$$= \frac{(E_1 - V_1 + V_2)\sigma_2^2 + F\sigma_2(\rho\sigma_1 - \sigma_2) - E_2\rho\sigma_1\sigma_2}{-(E_1 - V_1 + V_2)\sigma_2(\rho\sigma_1 - \sigma_2) - E_2\rho\sigma_1\sigma_2 - F(\sigma_1^2 - 2\rho\sigma_1\sigma_2 + \sigma_2^2) + E_2\sigma_1^2}$$

as an intermediate step let: $$\frac{\sigma_2}{\sigma_1} = k$$

$$\alpha_1 = \frac{(E_1 - V_1 + V_2)k + F(\rho - k) - \rho E_2}{-(E_1 - V_1 + V_2)(\rho - k) - \rho E_2 - F\left(\frac{1}{k} - 2\rho + k\right) + \frac{E_2}{k}}$$

$$= \frac{k(E_1 - V_1 + V_2 - F) - \rho(E_2 - F)}{\frac{E_2 - F}{k} + k(E_1 - V_1 + V_2 - F) - \rho(E_1 - V_1 + V_2 + E_2 - 2F)}$$

then let: $$\frac{E_2 - F}{E_1 - V_1 + V_2 - F} = J$$

$$\alpha_1 = \frac{k - \rho J}{\frac{J}{k} + k - \rho - \rho J}$$

$$\alpha_2 = 1 - \alpha_1 = \frac{\frac{J}{k} - \rho}{\frac{J}{k} + k - \rho - \rho J}$$

for further clarification note that:

$$k = \frac{\sigma_2}{\sigma_1} = \frac{S(GM)_2}{S(GM)_1}$$

$$J = \frac{E_2 - F}{E_1 - V_1 + V_2 - F}$$

$$= \frac{E_2 - FCC - A_1 Q_1(\mu_{1m} - \mu_{1p}) - A_2 Q_2(\mu_{2m} - \mu_{2p}) - V_2}{E_1 - V_1 + V_2 - FCC - A_1 Q_1(\mu_{1m} - \mu_{1p}) - A_2 Q_2(\mu_{2m} - \mu_{2p}) - V_2}$$

$$= \frac{E_2 - V_2 - FCC - A_1 Q_1(\mu_{1m} - \mu_{1p}) - A_2 Q_2(\mu_{2m} - \mu_{2p})}{E_1 - V_1 - FCC - A_1 Q_1(\mu_{1m} - \mu_{1p}) - A_2 Q_2(\mu_{2m} - \mu_{2p})}$$

$$= \frac{\mu_{2y}\mu_{2m} - V_2 - FCC - A_1 Q_1(\mu_{1m} - \mu_{1p}) - A_2 Q_2(\mu_{2m} - \mu_{2p})}{\mu_{1y}\mu_{1m} - V_1 - FCC - A_1 Q_1(\mu_{1m} - \mu_{1p}) - A_2 Q_2(\mu_{2m} - \mu_{2p})}$$

7.2 Appendix II. Spreadsheet Printout for Case Farm

CROP ENTERPRISE ANALYSIS OF CHINESE FARMERS
((YIELD, PRICE AND REVENUE ESTIMATES))

	WHEAT	SOYABEAN
quota areas (mu)	15	15
QUOTA per mu (jin):	270	190
quota price estimates (yuan/jin):		
worst possible	0.20	0.32
most likely	0.22	0.35
best possible	0.25	0.40
EXPECTED QUOTA PRICE	0.22	0.36
STANDARD DEVIATION	0.01	0.02
yield estimates (jin):		
worst possible	260	165
most likely	300	200
best possible	340	235
EXPECTED YIELD	300.00	200.00
STANDARD DEVIATION	16.33	14.29
market price estimates (yuan/jin):		
worst possible	0.25	0.40
most likely	0.32	0.50
best possible	0.40	0.60
EXPECTED MARKET PRICE	0.32	0.50
STANDARD DEVIATION	0.03	0.04
EXPECTED GROSS REVENUE	70.00	72.77
STANDARD DEVIATION	6.06	7.83

((VARIABLE COST ESTIMATES))

	wheat	soyabean
seed	10.00	6.50
fertilizer	9.00	8.00
pesticides	0.50	0.50
custom work	10.00	15.00
miscellaneous	2.00	2.00
TOTAL VARIABLE COST	31.50	32.00
EXPECTED GROSS MARGIN	38.50	40.77
STANDARD DEVIATION	6.06	7.83

((OVERHEAD COST ESTIMATES))

	total farm	per mu
agricultural taxes	150.00	5.00
apportioned expenses	120.00	4.00
TOTAL OVERHEAD COST	270.00	9.00

OPTION 1: (0% of wheat)

	wheat	soyabean	Total
areas to be seeded (mu)	0.00	30.00	30

((CROP ENTERPRISE STATEMENT))

	wheat	soyabean	Total Farm	per mu
EXPECTED GROSS REV	0.00	3000.00	3000.00	100.00
E(GR) AFTER QUOTA	-405.00	2591.50	2186.50	72.88
seed	0.00	195.00	195.00	6.50
fertilizer	0.00	240.00	240.00	8.00
pesticides	0.00	15.00	15.00	0.50
custom work	0.00	450.00	450.00	15.00
crop labour	0.00	0.00	0.00	0.00
miscellaneous	0.00	60.00	60.00	2.00
TOTAL VARIABLE COST	0.00	960.00	960.00	32.00
EXPECTED GROSS MARGIN	-405.00	1631.50	1226.50	40.88
STANDARD DEVIATION			235.03	7.83
Z VALUE			-4.06972	-4.06972
TOTAL OVERHEAD			270.00	9.00
EXPECTED NET INCOME			956.50	31.88
STANDARD DEVIATION			235.03	7.83

((FIXED CASH COMMITMENT ESTIMATES))

		Total Farm	accu. amt.
only variable costs:	level A	960.00	960
overhead cost:	level B	270.00	1230
living costs:	level C	600.00	1830
TOTAL CASH COMMITMENT		1830.00	

((PROBABILITY OF MEETING FIXED CASH COMMITMENTS))

Commitment	amount	default prob	success prob
-level A	960 *	0.000	1.000
-level B	1230 *	0.000	1.000
-level C	1830 *	0.065	0.935

OPTION 2: (25% of wheat)

	wheat	soyabean	Total
areas to be seeded (mu)	7.50	22.50	30

((CROP ENTERPRISE STATEMENT))

	wheat	soyabean	Total Farm	per mu
EXPECTED GROSS REV	727.50	2250.00	2977.50	99.25
E(GR) AFTER QUOTA	322.50	1841.50	2164.00	72.13
seed	75.00	146.25	221.25	7.38
fertilizer	67.50	180.00	247.50	8.25
pesticides	3.75	11.25	15.00	0.50
custom work	75.00	337.50	412.50	13.75
crop labour	0.00	0.00	0.00	0.00
miscellaneous	15.00	45.00	60.00	2.00
TOTAL VARIABLE COST	236.25	720.00	956.25	31.88
EXPECTED GROSS MARGIN	86.25	1121.50	1207.75	40.26
STANDARD DEVIATION			210.27	7.01
Z VALUE			-4.45972	-4.45972
TOTAL OVERHEAD			270.00	9.00
EXPECTED NET INCOME			937.75	31.26
STANDARD DEVIATION			210.27	7.01

((FIXED CASH COMMITMENT ESTIMATES))

		Total Farm	accu. amt.
only variable costs:	level A	956.25	956.25
overhead cost:	level B	270.00	1226.25
living costs:	level C	600.00	1826.25
TOTAL CASH COMMITMENT		1826.25	

((PROBABILITY OF MEETING FIXED CASH COMMITMENTS))

Commitment	amount	default prob	success prob
-level A	956.25 *	0.000	1.000
-level B	1226.25 *	0.000	1.000
-level C	1826.25 *	0.054	0.946

OPTION 3: (50% of wheat)

	wheat	soyabean	Total
areas to be seeded (mu)	15.00	15.00	30

((CROP ENTERPRISE STATEMENT))

	wheat	soyabean	Total Farm	per mu
EXPECTED GROSS REV	1455.00	1500.00	2955.00	98.50
E(GR) AFTER QUOTA	1050.00	1091.50	2141.50	71.38
seed	150.00	97.50	247.50	8.25
fertilizer	135.00	120.00	255.00	8.50
pesticides	7.50	7.50	15.00	0.50
custom work	150.00	225.00	375.00	12.50
crop labour	0.00	0.00	0.00	0.00
miscellaneous	30.00	30.00	60.00	2.00
TOTAL VARIABLE COST	472.50	480.00	952.50	31.75
EXPECTED GROSS MARGIN	577.50	611.50	1189.00	39.63
STANDARD DEVIATION			191.92	6.40
Z VALUE			-4.78847	-4.78847
TOTAL OVERHEAD			270.00	9.00
EXPECTED NET INCOME			919.00	30.63
STANDARD DEVIATION			191.92	6.40

((FIXED CASH COMMITMENT ESTIMATES))

		Total Farm	accu. amt.
only variable costs:	level A	952.50	952.5
overhead cost:	level B	270.00	1222.5
living costs:	level C	600.00	1822.5
TOTAL CASH COMMITMENT		1822.50	

((PROBABILITY OF MEETING FIXED CASH COMMITMENTS))

Commitment	amount	default prob	success prob
-level A	952.5 *	0.000	1.000
-level B	1222.5 *	0.000	1.000
-level C	1822.5 *	0.048	0.952

OPTION 4: (75% of wheat)

	wheat	soyabean	Total
areas to be seeded (mu)	22.50	7.50	30

((CROP ENTERPRISE STATEMENT))

	wheat	soyabean	Total Farm	per mu
EXPECTED GROSS REV	2182.50	750.00	2932.50	97.75
E(GR) AFTER QUOTA	1777.50	341.50	2119.00	70.63
seed	225.00	48.75	273.75	9.13
fertilizer	202.50	60.00	262.50	8.75
pesticides	11.25	3.75	15.00	0.50
custom work	225.00	112.50	337.50	11.25
crop labour	0.00	0.00	0.00	0.00
miscellaneous	45.00	15.00	60.00	2.00
TOTAL VARIABLE COST	708.75	240.00	948.75	31.63
EXPECTED GROSS MARGIN	1068.75	101.50	1170.25	39.01
STANDARD DEVIATION			181.92	6.06
Z VALUE			-4.94854	-4.94854
TOTAL OVERHEAD			270.00	9.00
EXPECTED NET INCOME			900.25	30.01
STANDARD DEVIATION			181.92	6.06

((FIXED CASH COMMITMENT ESTIMATES))

		Total Farm	accu. amt.
only variable costs:	level A	948.75	948.75
overhead cost:	level B	270.00	1218.75
living costs:	level C	600.00	1818.75
TOTAL CASH COMMITMENT		1818.75	

((PROBABILITY OF MEETING FIXED CASH COMMITMENTS))

Commitment	amount	default prob	success prob
-level A	948.75 *	0.000	1.000
-level B	1218.75 *	0.000	1.000
-level C	1818.75 *	0.049	0.951

OPTION 5: (100% of wheat)

	wheat	soyabean	Total
areas to be seeded (mu)	30.00	0.00	30

((CROP ENTERPRISE STATEMENT))

	wheat	soyabean	Total Farm	per mu
EXPECTED GROSS REV	2910.00	0.00	2910.00	97.00
E(GR) AFTER QUOTA	2505.00	-408.50	2096.50	69.88
seed	300.00	0.00	300.00	10.00
fertilizer	270.00	0.00	270.00	9.00
pesticides	15.00	0.00	15.00	0.50
custom work	300.C0	0.00	300.00	10.00
crop labour	0.00	0.00	0.00	0.00
miscellaneous	60.00	0.00	60.00	2.00
TOTAL VARIABLE COST	945.00	0.00	945.00	31.50
EXPECTED GROSS MARGIN	1560.00	-408.50	1151.50	38.38
STANDARD DEVIATION			181.66	6.06
Z VALUE			-4.85235	-4.85235
TOTAL OVERHEAD			270.00	9.00
EXPECTED NET INCOME			881.50	29.38
STANDARD DEVIATION			181.66	6.06

((FIXED CASH COMMITMENT ESTIMATES))

		Total Farm	accu. amt.
only variable costs:	level A	945.00	945
overhead cost:	level B	270.00	1215
living costs:	level C	600.00	1815
TOTAL CASH COMMITMENT		1815.00	

((PROBABILITY OF MEETING FIXED CASH COMMITMENTS))

Commitment	amount	default prob	success prob
-level A	945 *	0.000	1.000
-level B	1215 *	0.000	1.000
-level C	1815 *	0.061	0.939

7.3 Appendix III. Questionnaire

A STUDY OF THE RISK DISTRIBUTION

ON FAMILY FARMS

IN HEILONGJIANG PROVINCE, CHINA

QUESTIONNAIRE NUMBER______________________________

DATE OF INTERVIEW______________________________

LOCATION OF FAMILY FARM ______________________(state farm)

NAME OF MANAGER______________________________

AGE OF MANAGER______________________________

EDUCATION OF MANAGER

elementary school __________
junior high school__________
senior high school__________
college_____________________ (specify)
university__________________ (specify)
other_______________________ (specify)

SIZE OF LABOUR FORCE

family members______________ (number)
hired workers_______________ (number)

LEVEL OF MECHANIZATION

own most of machinery_______
rent most of machinery______
custom hire machinery_______

ENTERPRISE STRUCTURE

hogs________________________ (number of head)
chickens____________________ (number of head)
beef cattle_________________ (number of head)
dairy cattle________________ (number of head)
other_______________________ (specify)

name of crop this year	no. of mu	anticipated yield jin/mu			COMMENTS: note special yield circumstances that may be encountered this year!	anticipated price yuan/jin			COMMENTS: note special price circumstances that may be encountered this year!
		A	M	B		A	M	B	
WHEAT									
CORN									
SOYBEANS									
RICE									
OTHER specify:									
OTHER specify:									
OTHER specify:									
TOTAL		xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxx	xxxxxxxxx	xxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxx

name of crop last year	no. of mu	last years yield jin/mu	in relation to my experience last years crop yield was					COMMENTS: explain why you think this yield was above or below your usual average	last year price yuan per jin
			(--)	(-)	ave (0)	(+)	(++)		
WHEAT								______________________ ______________________	
CORN								______________________ ______________________	
SOYBEANS								______________________ ______________________	
RICE								______________________ ______________________	
OTHER specify:______ ______________								______________________ ______________________	
OTHER specify:______ ______________								______________________ ______________________	
OTHER specify:______ ______________								______________________ ______________________	
TOTAL LAND BASE		xxxxxxxxx xxxxxxxxx	xxxxx xxxxx	xxxxx xxxxx	xxxxx xxxxx	xxxxx xxxxx	xxxxx xxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxx xxxxxxxxx

crop supplies and materials	WHEAT		CORN		SOYBEANS		RICE	
	this year	last year	this year	last year	this year	last year	this year	last year
FERTILIZERS: indicate kinds and amounts of fertilizers used								
SEED and PLANTS: indicate kinds and amounts of seed and plants used								
PESTICIDES: indicate kinds and amounts of pesticides used								
OTHER SUPPLIES and MATERIALS: indicate kinds and amounts of other supplies and materials used								