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## Uncertainty, Risk Aversion and Risk Management in Agriculture

Hao Aimin

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Zhengzhou Institute of Aeronautical industry management, Zhengzhou 450015, China

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### Abstract

Uncertainty and risk are quintessential features in agriculture. After an overview of the main sources of agricultural risk, this paper tries to reveal whether farmer's decision is risk averse or not through census data, and then the elements which affect farmer's decision under risk so as to produce the efficiency of crop planting. This is followed by a basic analysis of farmer's decision on the selection of agricultural products under risk, including some comparative static results from stylized models. Selected empirical topics are surveyed, with emphasis on risk analyses as they pertain to production decisions at the farm level. We draw conclusion as follows: farmer's decision under risk can cause the increase of intercropping of the farm products and reduce the quantity of agricultural product the price of which fluctuates greatly, and farmer's decision under risk can also hinder the adoption of new agricultural technology. Finally, risk management is then discussed; we put forward some countermeasure of risk management and government interference which can help farmers to reduce the negative effects of farmer's decision under risk.

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*Keywords:* Farmer; Uncertainty; Risk Aversion; Risk Management

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### 1. Introduction

Risk and uncertainty are two terms which are basic to any decision-making framework. Risk can be defined as imperfect knowledge where the probabilities of the possible outcomes are known, and uncertainty exists when these probabilities are not known (Hardaker). It would be difficult to imagine an industry where risk and uncertainty are more important than in agriculture. Considerable research has been devoted to exploring questions connected with the effects of uncertainty and risk in agriculture, and these efforts have paralleled the related developments in the general economic literature.

For an individual farmer, risk management involves finding the preferred combination of activities with uncertain outcomes and varying levels of expected returns (Harwood, et. al.).

In this paper we set out to review a number of these studies, especially as they relate to farm-level production decisions. It was discussed previously that agricultural producers are most concerned about the probability of an

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\* Corresponding author. Tel.: +8613838255173;

*E-mail address:* ham126@163.com.

adverse outcome. In short this directly relates to the farm's risk-bearing ability. The farm's risk-bearing ability is directly related to liquidity and solvency measures.

## 2. Main sources of uncertainty and risk in agriculture

The sources of uncertainty and risk in agriculture are numerous and diverse, ranging from events related to climate and weather conditions to animal diseases; from changes of prices in agriculture products to fertilizer and other input; and from financial uncertainties to policy and regulatory risks. Agricultural risks are not independent, but rather are linked to each other and as part of a system which includes all available instruments, strategies and policies designed to manage risk. A holistic approach is thus necessary.

First, farmers face considerable natural uncertainty and risk. This uncertainty and risk are due to the uncontrollable elements, such as weather, plague of insects, disease, and play a fundamental role in agricultural production.

Second, there is what can be broadly defined as market uncertainty and risk in agriculture. Decisions on Agriculture production have to be made far in advance, so the market price for the output is typically not known at the time when these decisions have to be made. Market uncertainty, of course, is all the more relevant because of the inherent volatility of agricultural markets.

Third is family risk. Family risk is the loss of labor for the family members because of disease or accident etc.

Fourth, policy uncertainty and risk also play an important role in agriculture. Economic policies have impacts on all sectors through their effects on such things as taxes, interest rates, exchange rates, regulation, provision of public goods, and so on.

The risk and main behavior of uncertainty are around: (1) Rural market growth esteems insufficiency. Because of the insufficiency and asymmetry in information, the ability for the peasants to face the strain of marketplace risk still needs to improve. (2) Non-agricultural undertaking has an uncertainty. Returning to rural area if city unemployment may bring about “a peasant laborer” would make income of the peasant household gains come down. (3) Social security system in rural area is far from being perfect.

## 3. Theoretical analysis on decision making under uncertainty and risk

According to the differences in risk preference, the peasants can be divided into three types: risk-loving, risk-averse, and risk-neutral. There are great differences among these three types in their supply response.

There exist high-risk features in the production of agriculture, but ordinary farmers do not have the experience and ability to cope with market risk. (Dujon, 1997).

Based on the principle of risk-returns reciprocity, the planting of high-yield combinations require higher investment, and correspond to the higher risk. In the case of imperfect insurance markets, considering risk aversion, ordinary farmers will choose the planting of low-investment, low-reward, and low-risk planting combinations thereby reducing the possibility to increase investment. Rosenzweig and Binswanger (1993) found that small farmers will choose to lower the risk of crop combination in order to reduce risk, cropping patterns that bring a higher income than the optimal combination of income from cultivation of lower 45% in India. The research on the family land system to St. Lucia indicates that, for small farms, it is the property rights of the land to determine their stability, and the level of investment is not the key factor. Low level of investment in land is to avoid risks, to avoid losing their land position.

We can use graphics to explain risk market. As is shown in Figure 3-4, the horizontal axis refers to agricultural production inputs, the vertical axis output. Farmers face two situations: a good year and bad year for  $Y_1$ ,  $Y_2$  respectively, in good times and bad year for the output curve;  $EY$  is a comprehensive considering two possible years for the expectations of yield curve,  $Tc$  is the total cost curve. When the total cost curve slope and the slope of the curve is equal to total output, ( $MC = MR$ ), farmers achieve profit maximization. If farmers are risk-neutral, they will choose  $X_E$  factor inputs, and then expect the greatest revenue which is equal to  $gh$ . However, in the  $X_E$  input, since there is risk market, once a bad year for truly becomes a reality, the farmers get income  $hi$ . In this case, farmers may not be able to survive (survival of the level of the farmers here, in fact assuming zero income). Thus, risk-averse farmers will choose  $X_2$  factor inputs, when expected income is less than  $gh$ , that is, farmers do not maximize profits.

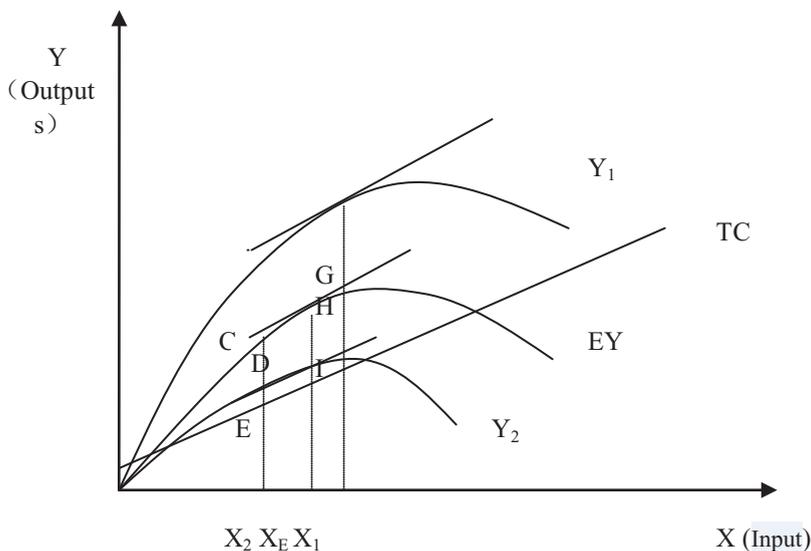


Figure 1: Farmers behaviour under the Market-risk

4. Some survey evidence on decision making under uncertainty and risk

This section is focused on empirical analysis based on the preceding theoretical analysis and framework. This part is mainly about farmers’ decision-making features under risk.

The analysis here is mainly based on census data which we get from gaoyangdian town in Pingyu County and guandu town in Zhongmu County and Daling town in Zhengyang of Henan Province in 2007-2008. We are based on a survey of 200 households in the three places, and a total of 189 valid questionnaires on the decision-making behaviour of farmers were obtained.

4.1. The analysis on Farmers planting decision under risk

Table 1 planting proportion of project selection decision-making Unit: %

	To keep abreast of the market price over the previous year	To make decision Empirically	To see other people’s decision	To Read government guidance	To continue growth despite of a sharp price fluctuations in agricultural products over recent years,
Pingyu	75.45	67.22	64.23	25.22	23.25
Zhengyang	78.33	68.33	58.67	24.33	25.37
Zhongmou	88.23	49.22	35.68	16.77	26.89
Average	80.85	60.32	51.32	22.75	25.12

Note: This item is a number of options, the sum of proportion may exceed 100%

We can see from the table the market price has become the main basis for farmers’ planting decision. At the same time, if price fluctuations in agricultural products are sharp in recent years, that is, market risk is large, the farmers will choose to decline the planting proportion of this agricultural product. It also indicates that a subjective judgment in its decision-making also plays a very important role. The next is just simple imitation. Some farmers’ planting decisions are risk-averse and lack rationality, and from the three comparisons, it is indicated that the more developed an area is, the more market-oriented the farmers’ decision-making tend to be. Empirical evidence implies that planting proportion is increasing if prices of agricultural products are stable in recent years.

#### 4.2. Technology adoption under risk

**Table 2 The reasons for farmers not adopting new technologies. Unit: %**

	Fear of risks	No guidance	Lack of funds	Too little arable land	Others
Pingyu	64.14	9.23	26.34	6.78	1.51
Zhengyang	59.33	9.89	22.69	3.45	4.63
Zhongmou	36.78	6.78	4.34	50.99	1.11
Average	53.45	8.98	19.34	16.08	2.15

In the survey, we note that farmers generally consider it unnecessary to adopt new technologies because of its higher risk. In Pingyu, as the average household income is the lowest, farmers are comparatively conservative. It can also be indicated from the table that what prevents the use of agricultural technology is the lack of funding. When the government provides subsidies and low-interest loans, farmers willing to adopt new technologies will increase by 40%. Therefore, a risk-averse farmer will use less new technologies than a risk-neutral farmer.

## 5 Results and discussion

### 5.1 Governments might be necessary to help the formation of risk-sharing markets

Risks can and do create inefficiencies in markets. Having effective risk-sharing markets is important for improving the efficiency of the farm sector. Governments should be responsible for helping the formation of risk-sharing markets

Society can gain from insurance (and other contingent claims) markets. When decision makers are risk-averse, they are willing to give up some income to protect themselves from future events that may cause them to lose large amounts of income. Well functioning risk-sharing markets allow firms to protect themselves from risk and pursue the advantages that come from specialization. Since Adam Smith, it has been a fundamental argument among economists that society gains from the specialization of firms. In fact, that the markets are built with subsidies, like other subsidies, insurance subsidies will not reach the ultimate objective. Over time, the beneficiaries are landowners, who are in many cases not family farmers. Further, farmers will take on more risk to reach a level of risk that is similar to what they had before the risk subsidies were introduced.

### 5.2 The necessity of future markets to help farmers manage market risks

There has been significant progress in making the risk-sharing markets more efficient. The key is to turn risks that have been previously considered nondiversifiable into diversifiable risks that can be spread around the world. For example, if the United States has crop losses, it is unlikely that some other parts of the world will be experiencing the same problems.

Price instability has several negative consequences (see chapter 1). While prices higher than expected can be partly saved by farmers as protection against future price declines, these possibilities for self-insurance are generally limited - most farmers simply have too much stress on their cash flow. So when prices are lower than expected, they hardly have the means to make up for the deficit out of their savings. The result is economic hardship, making it difficult, for example, to prepare for the next crop season. Price risk management, also called hedging, is a way to reduce the consequences of price instability on a farmer's cash flow - he will be able to plan his business better. When hedging short-term price movements will no longer have a major impact on his business - it has happened in some countries that farmers burned down their coffee trees in response to exceptionally low prices, with the result that they were unable to benefit from the tripling of coffee prices which occurred just a few years later. With price risk management, one can take a longer-term perspective. The farmer will also be able to ensure others (such as banks) of the value of his products, which improves his access to credit. Hedging is the use of marketing or financial tools in order to counterbalance the effects of an unfavourable commodity price movement on one's anticipated income. It is the opposite of speculation. For a producer or a buyer, speculation consists of doing nothing to hedge

his price risk. If the price goes up, the seller will make profit; and if not, he will make a loss. Different tools are available on the physical market and commodity exchanges, and some tools are also offered by banks.

## 6 Conclusions

It is abundantly clear that considerations of uncertainty and risk cannot be escaped when addressing most agricultural economics problems. Reform in agriculture policy has been difficult. Recent changes in the price-support mechanisms for basic commodities were touted as moving agriculture toward markets. In this paper we have emphasized theoretical and applied analyses as they pertain to production decisions at the farm level. Now it seems that everyone thinks we can fix the problems in agriculture with risk-management instruments like crop and revenue insurance. Insofar as the set of relevant markets is not complete, then this market failure has the potential of adversely affecting resource allocation, as well as resulting in less than optimal allocation of risk-bearing. Indeed, the incompleteness of risk markets for agricultural producers has often been cited as a motivation for agricultural policies in many developed countries. But arguably neither existing markets nor government policies have solved the farmers' risk exposure problems, and risk continues to have the potential of adversely affecting farmers' welfare, as well as carrying implications for the long-run organization of agricultural production and for the structure of resource ownership in the agricultural sector. This paper reviews the transition from past policies and describes current approaches that distinguish between the trade-related fiscal consequences of commodity market volatility and the consequences of price and production risks for vulnerable rural households and communities. Current policies rely more heavily on markets, even though markets for risk are incomplete in numerous ways. The benefits and limitations of market-based instruments are examined in the context of risk management strategies, and innovative approaches to extend the reach of risk markets are discussed.

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