Chapter 5

Agricultural Production Risk Management Strategy

Agriculture producers always try to decrease risk to carry out the target of production and management. They need to consider the strategy of decrease risk which mainly includes production strategy, sale strategy and finance strategy. Because all kinds of strategies includes different the aims, and carry on in the certain homework or the finance movable scope in actual work, so that risk result for the producer loss is not usually decided by the single factor. It also explains the importance of owning a risk management system, we usually needs to adopt comprehensive strategy, then can obtain producers expect of production and management. For the sake of convenience we firstly discuss the production risk management strategy, which generally includes on producers choice stable item, diversified portfolio, operating flexibility strategy, as well as risk programming and stochastic dominance methods. If a producer is risk aversion, it is difficult to go around for these risks, this chapter also relates to the importance of risk diversification to utilize agricultural insurance market tool. The latter is an important part of building a modern market system.

5.1 The Selection of Stable Agricultural Production's Item

When we consider to adjust or optimize agriculture production structure, the mainly risk comes from the change of production variety, technical knowledge, law and government activity. The natural risk can't resist, so we have to try our best remediable, dispersion and instauration. For production decision risk, technical risk and policy risk, we should reduce and avoid risk through mastering agriculture production regulation, obtaining more information about science and technology, strengthening the technical guidance of agriculture production and adjusting the policy continuously. Through a comprehensive risk measurement, if we discover that the change of yield is higher than price fluctuation, we can consider the production have bigger supply flexibility, then should concentrate on researching the production strategy and do not need more efforts for scaling and

financing risk management. Choosing the stable agricultural production item, adopting various management measures for dispersion risk, raising the flexible agriculture production management and adapting optimal program, those are the methods to strengthen the internal risk management.

5.1.1 The Stability Conception of Agricultural Production and Measurement

The so-called the stability of agricultural production means that producer can acquire stable earnings from one production circle to next production circle. It can be identified by long-term production experience of producer or the statistics of average profit. The farmers in China usually have a different production scale, so they decide to produce cotton, food, vegetable or flower, forest and so on in the limited land, depending on the knowledge of production technique they acquire and expectation income, which the regulation of production structure depends on their own judgment.

Hebei province ever gave out five kinds vegetables of farmer's pure income situation, as historic data we can take it as an example to analyze their production risk decision choice. According to the research, we can use average value and variance to choose a stable agriculture production. Lets R_{ti} as a certain production revenue, and the C_{ti} as the production cost of i^{th} item in different period t. So the mean value of revenue can be expressed by $AR_i = \sum_t (R_{ti}/C_{ti})$, i=1, 2, …, m. After several production periods, by means of the formula computation, we can judge which production is the most stable through comparison all kinds of revenue mean value. That is the mean value method described in the previous sections.

According to calculations in Table 5.1, we found that the mean value principle infers cucumber highest income, followed by tomatoes, radishes have

lowest average income. Therefore, the history scenario of the analysis and development of vegetable industry in Hebei Province is consistent.

Table 5.1 *Revenue Risk Analysis Statistical Indicators for Hebei Province Vegetables.*

Unit:(Yuan/Mu)		Tomato	Cucumber	Eggplant	Cabbage	Radish
Average Value		1372.80	1453.83	1029.06	748.27	698.60
Variance		167723.60	193382.20	151458.40	64443.64	49479.83
Standard Deviation		409.541	439.75	389.18	253.86	222.44
Deviation Coefficient		0.298	0.302	0.378	0.339	0.318
Correlated Coefficient Matrix	Tomato	1				
	Cucumber	0.9263	1			
	Eggplant	0.2750	0.4470	1		
	Cabbage	0.5878	0.6908	0.6206	1	
	Radish	0.7692	0.5850	0.1967	0.5849	1

Source: "Hebei Rural Statistical Yearbook" (1995-2001). Economic Science Publishing House. This calculation based on historical research data, which calculated after-tax vegetable farmers' pure income per Mu.

5.1.2 The Analysis Method of Deviation Coefficient

Generally speaking, the volume of income has direct proportional with the labor strength and the knowledge contents of science and technology. But sometimes mean value is same or similar, so it isn't enough to just consider it. The risk of the producer concern should also include comparing yearly changes of different production activity, so we should compute the value of variance. In fact, from the discussion of Chapter 4, we know that it is not completely reasonable to take variance as index of measuring risk. Usually we compute standard deviation:

$$\sigma_i = \sqrt{\sum_i (R_{it} - AR_i)^2} .$$

After computing variance, then get deviation factor by using standard deviation divide mean value, analyzing the choice of stable production item with deviation coefficient C.V ($CV = \sigma_i / AR_i$) is the only dependable choice.

Table 5.1 is a case of reduce agriculture production risk computing with this kind of method. From the calculation result, firstly, we can find that Hebei province produce tomato with higher economic benefit, smaller income change (C.V=0.298), and the most stable market. Secondly, the cucumbers economic revenue in Hebei is the highest, so we are better to produce cucumbers if only considering average profit, but the production risk of cucumber is slightly higher than tomato's. Though farmers can also choose grow eggplant for considering profit, the risk of producing eggplant is the highest (C.V=0.378). This analysis result matches people comprehension for production experience of long time.

We hope that producer can make weigh and choice between the high income and the high risk under the consideration of local resources, water and soil condition, as well as the local market and the habit of vegetable farmers. Using the coefficient of variation C.V we can also analyze the agricultural structure and its stability, such as analysis of risk levels for different industries. Recent analysis results of risk level in Hebei Province, grain, vegetable cultivation and aquaculture industry in order: Milk> Cotton> Vegetable> Eggs, Meat> Grain> Fruit. (Zhao Junyan, 2013, Qiao Lijuan, 2015)

5.2 Diversification Management Strategies

5.2.1 Correlation Coefficient and Production Composing

It can be dispersion or lower risk by combining agriculture production activity of negatively related or the smallest correlation coefficient for the revenue, and by various management method to improve the flexible of management activity [17] [44]. The typical example is combining corn and soybean together to carry on a mixture growing, that can not only reduce revenue loss which is take by only grow corn, but can make use of the root germ of soybean for the complement of the nourishment of corn growth, it have

the function for the stability of income and dispersing risk. Such as Figure 5.1 show, produce flower can acquire higher revenue, but the fluctuation is bigger every year; Produce vegetable can just acquire lower revenue, but change is smaller. Therefore, it can lower risk through put them together while adjusting agriculture production structure.

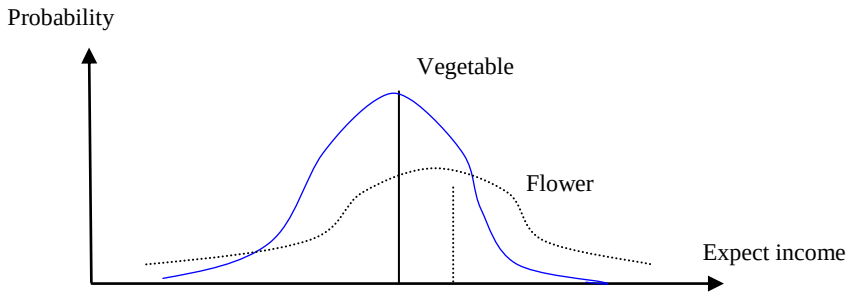


Figure 5.1 *The Risk Composition of Flower and Vegetable.*

As the basis of decision, we should look for the agro production combination with negative or minor related coefficient. Still take Table 5.1 for example, the result show that the producer composing the radish and the eggplant has the minimum correlated coefficient, followed is combination of tomato and eggplant, but from the view of income that former composition mean value is too low. However, produce combination of tomato and cucumber has the Max risk, then the correlation coefficient is too high. So, consider the benefits and risks relation, tomato and eggplant are the superior combination strategy of vegetable produce, whether from the stability of risk revenue, or from the angles of diversity management.

5.2.2 The Case Analysis of Crops Production in Hebei Province

Refers to currently Hebei agricultural production system, it have already seldom to use rotation system or inter cropping system facing to the market for guarding against the producer to manage risk. We should develop diversity management system including carrying on the regulation for big agriculture

structure (like agriculture, forestry, animal husbandry, fishery), and carrying on combination for different types of crops in the same plant or the same crop type of different crop species, it should also give consideration in the process of the extension of production scale and to develop the specialization production. To enter the agricultural socialized big production stage, rather than the traditional peasant economy. To develop the professional ranks of farmers, the use of new technology to produce the standardized products, must establish a modern market system.

Table 5.2 shows the calculation of deviation coefficient and correlated coefficient of Hebei food and cotton from 2001 to 2013. By analyzing, the cotton production and food production currently negatively related, the food production have very strong positive relation, but the average revenue of rice is the maximum among the food crop, the product combination of cotton and food should be the minimum risk production combination strategy. Where, the mean value infers cotton income is the highest among the five crops, wheat CV minimum means that it has the best stability of production, but for risk composition the first choice should be corn and cotton, followed will be rice and wheat. At certain rural or region how to make decision should consider many factors such as basic situation of resource, environment and social economic development.

Table 5.2 *Deviation Coefficient and Related Coefficient of per Mu Reduction Tax Net Revenue of Hebei Main Food and Cotton Crop from 2001 to 2013 (unit: Yuan/Mu).*

Years		Wheat	Corn	Cotton	Rice
2001		69.33	126.83	247.52	108.47
2002		46.66	108.96	428.17	135.51
2003		104.32	212.01	816.02	261.25
2004		201.47	191.79	315.13	499.58
2005		134.75	138.31	398.88	408.49
2006		88.41	212.23	320.15	504.71
2007		129.42	289.52	467.91	325.9
2008		158.42	158.53	-34.04	203.07
2009		230.03	296.2	272.73	253.82
2010		122.23	337.39	1104.91	513.31
2011		154.16	435.68	146.73	460.05
2012		137.38	424.71	86.22	317.38
2013		195.75	381.21	38.46	81.47
Average Value		136.3331	254.8746	354.5223	313.3085
Standard Deviation		52.8049	113.7994	314.0094	154.8713
Deviation Coefficient		0.3873	0.4465	0.8857	0.4943
Related Coefficient matrix	Wheat	1	-	-	-
	Corn	0.449363	1	-	-
	Cotton	0.32956	-0.09611	1	-
	Rice	0.123031	0.219541	0.370138	1

Source: Hebei Rural Statistical Year Book 2002-2014 [70].

5.3 The Strategy of Enhancing Management Flexibility

The flexibly means the agriculture producer keep space of changing production combination and technical, when they draw up agriculture production plan. It mainly includes as follows.

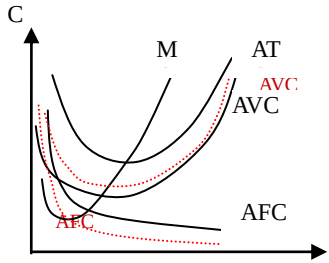
5.3.1 The Flexibility of Cost

Generally speaking, it is represented by the ratio which equals variable cost (VC) divided by the total cost (TC), the bigger the ratio, and the higher of the flexibility of producer management. The reason is variable expense is often

good at flexible controlling, but the fixed property and equipments, house building...etc, usually is specialize. For example, according to our investigation in 2015, each Mu the average wage of grain production was nearly 500 Yuan, and average production cost was 1220 Yuan, then the ratio between them was 41%. However, the average wage of vegetable production was 2200 Yuan/Mu, average production cost was 4240 Yuan/Mu, and the ratio of them was 52%. It conclude that the dependence degree of vegetable production for workers are larger than grain productions, variable cost was higher, which the experiences prove the vegetable producers generally have higher production flexibility.

5.3.2 The Flexibility of Equipments

The producer should adopt tools and equipments with a multipurpose, such as the joint operation of the work machine to construct building facilities with multipurpose. The agriculture technical innovation and invention should consider multi-function machine, it not only can reduce direct production cost, but production item have advantages to transfer from disadvantageous target market to beneficial target market, raising efficiency of this activity. Therefore, production process generally avoids purchase and constructs expensive permanent equipments and facilities. It must evaluate the effect and risk for using machine before purchasing it. Such as Figure 5.2, with the progress of production technical and improving of multipurpose and variety of facilities, unit variable cost in production can be adjusted for the proportion of average fixed cost. If the ratio of the variable cost account for fixed cost can raise, higher the average variable cost, lower the average fixed cost, so the flexibility of agricultural production cost will be improved.



From the firm's average cost curve, we can see, increase the average variable cost (AVC) and reduce average fixed cost (AFC). The adjustment of cost structure often makes the firm to transfer the liquidity resources or funds to other agricultural production sections. By this way, the firm can have the production flexibility, when it encounter bigger risk can transfer to other market becoming easily.

Figure 5.2 *Effect Analysis of Enhancing Cost Flexibility*.

5.3.3 The Flexibility of Production Time and Products

In short-run production function, if we can adjust the ratio between variable cost and fixed cost, the speed of liquid funds round circle will accelerate. Production circle is short and then funds liquid is quick. Obviously, forests and fruits produce circle are longer than farm crop's which produce every year, the time of animal husbandry production is much longer than feeding domestic fowl. If we put together the agricultural item with different production, can raise the time flexibility of production process and attain the purpose of decreasing agricultural production risk. In the meantime, this also can make full use of the resources. But it has disadvantageous factor too, the increase of production item will raise the complexity of production process, higher administrative expense and lower production efficiency. And the item with short production has lower profit rate.

The flexibility of the product means that it has a certain choice on product developing, using and selling. We should keep flexible in expanding market, such as target market, intermediate company's market, industry chain etc. The terms of agricultural product's transportation, processing and industry change also making positive effect against risk management. Various market measures such as schedule goods protecting value, contract order and the support price etc, all can effectively lower the management risk of the agricultural product.

5.4 Optimal Production Portfolio Strategy Model

When we face various possible production risks, and consider various measure of raising the flexibility of agriculture production, we also need establish reasonable agriculture produce structure from the angel of optimizing system comprehensive, not choose or evaluate for a single item. Hence, it put forward the problem of superior combination of production risk profit (or risk effect).

The research for the problem general method is about quadratic programming. Suppose, the vegetable farmers not only consider diversify management, but production stability, and hope to promise certain net revenue under the minimum risk circumstance. Such as, a big vegetable farmer can make use of investigating date to draw up his vegetable production plan.

5.4.1 Quadratic Programming of the Least Revenue Variance

Markowitz (1959) put forward a risk portfolio model [59], which prove that the minimum variance equals the maximize utility. Supposing a vegetables farmer in Hebei want to arrange produce plan of five kinds of vegetables, we make use of net revenue data to form variance matrix by computing as follow.

$$\Omega = \begin{bmatrix} 167723.6 & & & & \\ 166832.2 & 193382.2 & & & \\ 43835.03 & 76507.58 & 151458.4 & & \\ 61109.27 & 77120.69 & 61315.33 & 64443.64 & \\ 70075.5 & 57220.34 & 17024.88 & 33026.48 & 49479.83 \end{bmatrix}$$

The producer has them own revenue expectation, if we suppose planed pure income of vegetable farmers are no less than 100,000 dollars, the scale control (vegetable plot area) is 100 Mus, and plant scale of the Max item should not above 60%, the smallest can't be low 5%, it can meet the needs at the same time of embodying to avoid various management risk. So control condition for:

Namely:

$$Ax = b \Rightarrow \begin{bmatrix} 1372.8 & 1453.8 & 1029.1 & 748.3 & 698.6 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & & & & \\ & 1 & & & \\ & & 1 & & \\ & & & 1 & \\ & & & & 1 \end{bmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{pmatrix} = \begin{pmatrix} 100000 \\ 100 \\ 40 \\ 60 \\ 15 \\ 30 \\ 10 \end{pmatrix}.$$

The problem then constitutes a typical portfolio programming model as follows:

$$\min_x \ f(x) = x'\Omega x$$
$$st. \qquad Ax = b.$$

The target function in the model means the minimum of revenue risk; Control condition is the level of planned target revenue and the limit of production scale. The target is that attaining producer satisfaction for certain revenue level is no lower than the ideal level, but we also consider various problems, such as market demand, produce technique and produce ability, etc.

5.4.2 The Solution of the Model

At present, there are many tools for solving mathematics programming. A solution with LINDO to treat quadratic programming models [59] has some characteristics of simple input and output information rich. And, it can aim at optimization result to adjustment for input control, and solve again and again to satisfy various requests. Through computing many times, the model computing result as follows:

Vegetable Production Quadratic Programming Output Report

QP OPTIMUM FOUND AT STEP 15

OBJECTIVE FUNCTION VALUE

1） 0.0000000E+00

VARIABLE	VALUE	REDUCED COST
X1	40.000000	0.000000
X2	5.000000	0.000000
X3	15.000000	0.000000
X4	30.000000	0.000000
X5	10.000000	0.000000
X6	0.000000	7052.500977
UNITY	-17790378.000000	0.000000
X8	346771.125000	0.000000
X9	0.000000	55.000000
X10	9100975.000000	0.000000
X11	9843790.000000	0.000000
X12	12465492.000000	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2）	0.000000	-40.000000
3）	0.000000	-5.000000
4）	0.000000	-15.000000
5）	0.000000	-30.000000
6）	0.000000	-10.000000
7）	7052.500977	0.000000
8）	0.000000	-17790378.000000
9）	0.000000	346771.125000
10）	55.000000	0.000000
11）	0.000000	9100975.000000
12）	0.000000	9843790.000000
13）	0.000000	12465492.000000

NO. ITERATIONS= 15

Set up model and operation needs to acquaint with the Karush-Kuhn-Tucker theorem and the La Grange condition limit of pole to make sure a restraint condition. From the model calculation report, we can see if the vegetable farmers want to acquire stability profit, and make minimum risk, his superior

vegetable plants structure should be: The tomato is 40%, the cucumber is 5%, and the eggplant is 15%, the big cabbage is 30%, and the radish is 10%. That optimization project can promise vegetable farmers to acquires 107052 Yuan net revenue after tax.

5.5 Stochastic Dominance Analysis on Agricultural Production Risk

Stochastic dominance theory is to adopt various statistical inference methods for distinguishing the superiority of the random variable distribution function [60] [61] [62]. The random advantage theory is developed from 1970s. Some scholars pointed out the shorthand of Markowitz's good and bad principle of "average variance-value" and its theoretical mistake [31]. Hence, using risk rate as the standard of risk choice, using the effect of risk concept and method for studying the risk management of agriculture production, especially when risk item in the system can be expressed by expecting effect which has opposite side variety with risk rate according to utility with order (deliver), continuous and independence assumption. Therefore, Stochastic dominance theory makes use of distribution function table illustrated method and discriminate by probability distribution, and it makes up the restriction which is necessary random variable obey normal distribution for directly using average value or variance as differentiated standard.

The research method of 1 or 2 orders stochastic dominance gets wide application in practical. From the discretion standard, the condition of one order stochastic dominance is suit for any who have a reasonableness choice, the second order stochastic dominance can just adapt to persons who disgust risk, the third order Stochastic dominance's condition is more narrow, it is just used for person with increasing curve utility of 3 order positive derivative. We can get further understanding from setting up mold process as follows.

5.5.1 The First Degree Stochastic Dominance

The definition of the first degree stochastic dominance(FSD) [60]: supposing the decision maker faces two agriculture investment projects, which is a and b, choosing a can be expressed by probability density function f(x), but the revenue of the invested project b is used to express the probability density function g(x). Given for all investment x, defining the investment a is the first degree stochastic dominance for b, which it should satisfy the formula:

$$\int_{-\infty}^{x} g(s)ds \geq \int_{-\infty}^{x} f(s)ds.$$

Hence, investing on project a may bring higher pay, if suppose when the integral of two distribute function doesn't intersect, so the investment on project a have larger stochastic dominance. In the decision making process, choosing standard generally have something to do with effect or hobby, investor generally will not consider the portfolio of inefficiency under the condition that they take no account of risk hobby. The most used efficiency standard is decided by the effect and revenue which present not to reduce a variety of regulation, namely the higher the revenue, the bigger the effects for investors. Therefore, for any distribute function F and G, if F and G are independently cave functions, while $F(x) \leq G(x)$, at least it exist a strictly inequality, the Figure 5.3 shows the integral of distribute, F is always on right side of function G, that explain the choice F is better than to choose G.

FSD can also use effect function to multiply distribute function of each choice, namely use the expectation value of effect to express or prove.

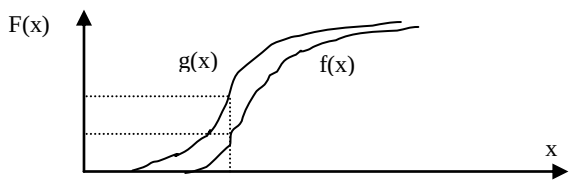


Figure 5.3 *Stochastic Dominance Comparison between two Investment Projects.*

$$E_F U(x) = \int_a^b U(x) f(x) dx; \qquad E_G U(x) = \int_a^b U(x) g(x) dx.$$

Noticing that each investment project has the same effect function U(x), but distributing function is different. If investment on F is better than to invest on G, hence defining difference of both is:

$$\Delta = E_F U(x) - E_G U(x) = \int_a^b [f(x) - g(x)] U(x) dx \le 0;$$

$$\Delta = [U(x)[F(x) - G(x)]_a^b + \int_a^b [G(x) - F(x)] U'(x) dx.$$

Because of F(a), G(a)=0 and F(b), G(b)=1, the first integral part of above formula is 0, then for x, if Δ >0, as positive U(x), it is always have $G(x) \ge F(x)$.

5.5.2 The Second Degree Stochastic Dominance

The definition of second degree stochastic dominance (SSD) [61]: the necessity and full condition for the choice of F is better than to choose G, is necessary to meet as follows integral inequality for all decision makers:

$$\int_{-\infty}^{x} F(z) dz \le \int_{-\infty}^{x} G(z) dz, \forall x.$$

$$or \int_{-\infty}^{x} [G(z) - F(x)] dz \ge 0.$$

Stochastic dominance matches reasonableness investor of disgust the risk, this utility function for investment of avoiding risk is cave, so the result of second degree is a negative value. When it at least has one not equal, define difference of both:

$$\Delta = \int_a^b [G(x) - F(x)] U'(x) dx = \{U'(x) \int_a^b [G(x) - F(x)] dx\}\Big|_a^b + \int_a^b \{-U''(x) \int_a^x [G(z) - F(z)] dz\} dx.$$

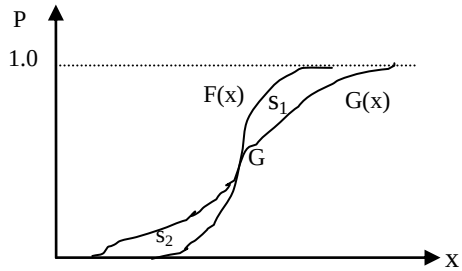


Figure 5.4 *Strictly Condition of Second Degree Stochastic Dominance.*

For all of x, if $\int_a^x [G(z) - F(z)]dz \le 0$, so it at least has one x strictly to make difference value Δ positive. Hence, for all risk disgusted person, corresponding to all values of investment x, if integral area under the F exceed the G's, namely only the integral area between G and F is not-negative value, such as the $S_1 \le S_2$ and then F better than G. It can explain by using Figure 5.4.

5.5.3 The Application of the First Degree Stochastic Dominance

Using the literature of "Hebei Rural Statistical Yearbook", which provides agriculture pure revenue after tax in 2001, we can analyze the first degree stochastic dominance of summer harvest crop in the certain place in Hebei. According to the level of pure revenue of each Mu after tax, it concludes stochastic distribute table for three kinds of crop by arranging for rising shown as Table 5.3, so that the relation of first degree stochastic dominance for three kinds of crops can be shown by the Figure 5.5.

Table 5.3 *Stochastic Distribute of Three Kinds of Summer Crops in Hebei.*

Pure income	Rice (1)	Corn (2)	Cotton (3)	1-2	1-3	2-3
18.42	0.0	0.0	0.0	0.00	-0.05	-0.04
83.15	0.0	0.0	0.1	-0.02	-0.11	-0.09
84.95	0.1	0.0	0.3	0.03	-0.18	-0.21
85.32	0.2	0.0	0.3	0.13	-0.11	-0.24
101.17	0.2	0.1	0.4	0.10	-0.18	-0.28
131.58	0.2	0.1	0.4	0.09	-0.15	-0.24
134.95	0.2	0.2	0.4	0.08	-0.17	-0.25
179.9	0.3	0.3	0.5	0.00	-0.14	-0.14
195.34	0.3	0.4	0.6	-0.03	-0.21	-0.18
211.42	0.4	0.4	0.6	-0.02	-0.23	-0.21
226.31	0.4	0.4	0.6	-0.03	-0.25	-0.22
228.37	0.5	0.5	0.7	0.03	-0.15	-0.18
232.31	0.5	0.5	0.7	0.03	-0.13	-0.16
251.17	0.6	0.5	0.7	0.04	-0.10	-0.14
281.87	0.6	0.6	0.7	-0.02	-0.11	-0.09
286.42	0.6	0.7	0.7	-0.02	-0.08	-0.06
295.9	0.7	0.8	0.7	-0.10	-0.08	0.03
307.53	0.7	0.8	0.8	-0.11	-0.11	0.00
354.77	0.7	0.8	0.8	-0.15	-0.14	0.00
370.74	0.7	0.9	0.8	-0.19	-0.13	0.06
400.59	0.7	0.9	0.9	-0.18	-0.16	0.02
456.11	0.8	0.9	0.9	-0.12	-0.12	0.01
474.94	0.8	0.9	0.9	-0.13	-0.11	0.01
477.37	0.8	0.9	0.9	-0.12	-0.13	-0.01
529.69	0.9	0.9	1.0	-0.06	-0.07	-0.01
580.88	0.9	1.0	1.0	-0.07	-0.06	0.02
690.66	0.9	1.0	1.0	-0.06	-0.06	-0.01

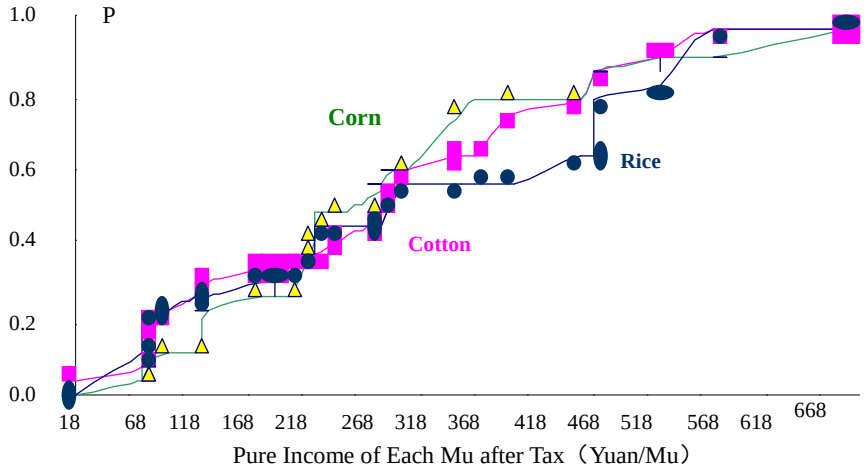


Figure 5.5 *First Degree Stochastic Dominance of Three Kinds of Crops.*

Source: The calculation according to data from "Hebei Rural Statistical Year Book" 2001.

From the description and analysis by the FSD, we can see that stochastic dominance for three kinds of crops income, rice is higher than cotton, cotton is higher than corn. This method not only can be applied in stochastic dominance analysis of farm crop, but can be applied in other agriculture produce item for stochastic dominance analysis. According to analysis stochastic dominance, and choosing the production item that can evade risk and can get invested income, it is also worth discussing for studying risk spread in the complicated system.

5.6 Measures of Agriculture Insurance

The agricultural insurance is an inevitable outcome of the merchandise economic development. Insurance is an economic compensation system for dispersing risk and economic loss, because of ineluctable natural disaster or man-made calamity in agricultural economic activities need to solve the problem by means of social mutual aid, freemasonry. In real meaning, management measure except of self retention risk is to develop agriculture

insurance. On this meaning, agriculture insurance is a way of transferring agriculture risk to whole society, is not only depending on individual producer's risk management decision-making.

The PICC agricultural risks have covered more than 20 sorts, since 1982 it recovered to deal with agriculture insurance business. Among them, plant insurance is divided into five categories, such as food crop, cash crop, other crop, forest and fire insurance of farm crops, such as, insurance of planting wheat, rice, cotton, tobacco leaves, fruit and vegetables etc. The aquaculture insurance is also divided into five categories; it contains big animal, small animal, domestic fowl, marine aquaculture and other insurance etc, such as insurance of breeding cow, meat cow, milk cow, pig and chicken etc.

Compared with the developed countries in the world, China's agricultural insurance started late, but it is currently in the stage of rapid development. In the US there is no risk-specific insurance, but yield insurance covers most risks. It ranges from the basic or catastrophic coverage (CAT) which guarantees 50% of the average yield of the farm, to 80 or 100%. Livestock insurance is not very developed. The United States of America and Canada have also developed revenue and income insurances. In the USA, 73% of the premiums come from revenue insurances products that includess: area index revenue insurance; livestock prices insurance; livestock gross margin insurance and whole-farm income insurance. The three standard revenue insurance products are Crop Revenue Coverage (CRC is the most popular), Revenue Assurance (RA) and Income Protection (IP). CRC offers the possibility to get a higher price if the market price increases. These products apply for the main field crops: corn, soybeans, wheat, rice, cotton and etc. As a case study of agricultural insurance, takes wheat insurance analysis in Hebei as follows:

5.6.1 Insurance Premiums and the Amount Calculation

Since November 1, 2000, new item of agriculture insurance which includes the cotton plants disaster caused by hail, Wheat disaster caused by hail, the plastics big booth plants, milk cow insurance, meat cow insurance, raise pigs, keep chicken is carried by Branch of Chinese people insurance company in Hebei. On the disaster of the insurance responsibility, according to concrete circumstance in every place the insurance company should measure probability of disaster and loss rate, to estimate disaster degree, to confirm insurance indemnity and the insurance charges standard. According to the above disaster insurance indemnity rate (namely premium rate), stand as the guarantor of above-mentioned disaster, everyplace branch company can decide for the Table 5.4 range scopes according to the circumstances of management business of the last few years.

Table 5.4 *Agricultural Insurance Standard Rate of PICC of Hebei Province.*

Main sorts of insurance	Wheat Disaster caused by hail	The cotton plant disaster by hail	The plastics big booth plants	Milk cow insurance	Meat cow insurance
Insurance rate	1-3%	4-7%	5-10%	10-15%	4-8%

Table 5.4 *Continue.*

Main sorts of insurance	Raise pigs insurance			Keep chicken insurance	
	1 type	2 type	3 type	Meat chicken	Egg chicken
Insurance rate	5-6%	7-8%	9-10%	8-12%	12-16%

Source: Chinese People's Insurance Company of Hebei Province branch offices, September 6, 2000 [63]

The insurance analysis which aims at the wheat disaster caused by hail is shown in Table 5.5. For explaining insurance yield, insured amount and the calculation of premium by 2015 data of the statistics of Hebei rural, the average yield of the wheat in Hebei is 5834 kilograms/Hectare during the years 2012-2014. The wheat yield insured can be calculated according to the provision in the crop plant insurance contract of PICC, and it is determined by the local average yield of the past 3-5 years and insured from 30% to 60% (contain). The insurance price

pointed as the front year's national wheat the lowest protection price. Computing wheat each hectare insured yields are divided as three different levels, relying on the land productivity respectively is: 3500.40, 2625.30 and 1750.20 (Kg/Ha). Each insured amount is determined by insurance yields multiplied by insurance price. The premium rate imposed is (1-3%), which was provided by the insurer (here we calculated is 2.7%). The concrete insurance term is decided by the contracted insurance policy. Such as Table 5.5 illustrate:

Table 5.5 *Calculation of Yield Insurance, Insured Amount and Premium for Wheat Disaster Caused by Hail.*

Yield grade	Insurance yield (Kg/Ha)	Insurance price (Last year the nation's lowest protect price 2.36 Yuan/kg)		
		Insured amount	Premium	Insurance term
The high yield (60%)	3500.40	8260.94(Yuan/Ha)	247.8 Yuan/Ha (3%)	April 1 to harvest
The medium yield (45%)	2625.30	6195.71(Yuan/Ha)	123.9 Yuan/Ha(2%)	April 1 to harvest
The low yield (30%)	1750.20	4130.47(Yuan/Ha)	41.3 Yuan/Ha(1%)	April 1 to harvest

Source: Calculated according to Hebei Rural Statistics Yearbook (2015), Crop Plant Insurance Contract, 2001 by PICC[7]

Concerning plant industry insurance, the calculation difference with United States in this form is that in China premium of each wheat disaster caused by hail= nation insurance price × each insured amount × fee rate. But the US based on market prices has established for crops whole insurances. In addition to the circumstances of bad management and the loss (output reduction) less than 25%, according to disastrous degree to be divided into different yield loss grade to compensation. The federal government crop whole insurance item, divide an average yield of region several years as three grades, namely yield of 50%, 65% and 75%. The price which can provide the farmers to choose also have three grades, the generally tallest price grade is about 90% of market price. As a result,

7Note: Current considering China carry on agro and insurance subsidies, for grain production per hectare is 1875Yuan, for insurance per hectare is 180Yuan, totally is 2055Yuan/Ha. In this case, the premium is kept in constant without yield difference, which coverage yield and revenue of agricultural insurance. In this point, to compare with our calculated in 10 years ago, it is different. (Unit: 1Hectare=15Mus ≈2.471 Acres).

the farmers can make choice from nine kinds of strategies combination of three yields grades and three prices levels.

5.6.2 Disaster Claims

The insurance companies pay for the cost of production of wheat by which the extent of the hail disaster of wheat. General insurance period from April 1 that the wheat turns green to the wheat harvests and leaves from the fields; The amount of insurance is on the basis of local wheat production costs in each hectare 12000-13000 Yuan to the extent determined, the rate of premium is from 1% to 3%. The following three conditions, the insurers are not responsible for compensation. (i) The insured mismanagement; (ii) Once a hail disaster occurred, the insured destroyed or abandoned their own insured of wheat or re-plant other crops without the consent of the insurer; (iii) Other reasons of insurers are not responsible for insurance claims. For the insurance responsibility based on the losses there are three criteria provided as below:

Table 5.6 *Computational Method of "Crops Planter Insurance Contract" Stipulated Wheat Hail Disaster Compensation.*

Loss situation		Compensation Standard
I. All losses (Total crop failure)	Turning green to jointing Stage before	insurance amount ×30%
	Jointing to heading ago	insurance amount ×40%
	Heading until harvest ago	insurance amount ×80%
	During the harvest	insurance amount ×100%
II. Partial Loss	Yield greater than normal yield 10%	(Insurance Yield-Actual Yield) ×Insurance Rates
III. Whether or not the loss	By insured from load 20%	No compensation: when Actual Yield ≥ the insurance production of wheat

Note: To calculate payout ratio according to the country climate and growth pattern of wheat.

I. Complete Loss

The consideration of compensation is according to the agreed time and the proportion of payment of compensation which in "Wheat Hail Disaster Day Payout Ratio Table". The formula is, the amount of compensation per hectare = each hectare premium × disaster affected area × on the day compensation ratio ×(1-20%).

II. Partial Loss

After the scene investigation, through percentage loss forecast and review it before harvest. The compensation is according to the agreed time and the compensation proportion in "Wheat Hail Disaster Day Payout Ratio Table". The amount of compensation per hectare = each hectare premium ×disaster affected area ×on the day compensation ratio ×(loss rate -20%).

III. Whether How Much the Loss, 20% by Insured Farmer to Afford

The insurance loss of wheat in whole or in part is shouldered 20% by the insured. The reasons are, in first, the natural disaster caused by the wind and rain hail and so on is frequently intertwines mutually synchronize occurs, it does not belong to the insurance responsibility disaster lose should give the rejection; The second, when determining premium rates has considered the factor to exempt 20% compensated. Refers to China "Crops Plant Insurance Contract" to calculate the wheat hail disaster the compensation volume, the basic standard and the computation method are shown as Table 5.6.

5.6.3 Necessity of Joining Insurance and the Effect Analysis

The premium accounts into the cost and generally takes up 0.2% of the property or so face to agriculture risk and above-mentioned compensated conditions, how does the farmer make a production management decision? With the wheat produce for example, the step of computing earnings matrix as follows: The first make sure the variable cost that wheat produce; The second

estimate the expectation price of each kilogram wheat (the last year national minimum support price = the price of insurance); The third, estimate yield grade, choose a suitable compensated standard; The fourth, calculation usage insurance and don't use insurance the wheat's net incomes under two kinds of circumstances; The fifth, build up the earnings matrix of various combination.

A study in 2001, to compare whether Hebei's farmer should join disaster insurance of caused by hail, we had computed per hectare expected pure income was -487.5 Yuan for insured farm in Hebei province, if without joined insurance the expected pure income was -1036.5 Yuan / Hectare. This has prompted the government to increase the compensation for grain production, encouraging the development of agricultural insurance. In order to help farmers make insurance choice, this computation we using random number produced by the computer automatically, to be as a possible yield event took place on subjective probability. As illustrates in Table 5.7, currently in Hebei province average yearly wheat output was around 5834 Kg/ Ha (The three years average value for 2012, 2013 and 2014 we should used for 2015's calculation). It's much higher than in 2001's calculate 4656.7Kg/Ha. So that, the lowest yield chosen have to use its 10%, namely per hectare 583.4 kilograms is the lowest production boundary. If the highest yield assumes per hectare as 6380 kilograms (close to average yield), we can take those carry on the statistic analysis.

Table 5.7 *Pure Income Matrix of per Hectare Yield Wheat to Adopt Insurance.*

Event production (Kg/Ha)	Subjective probability (creation from random)	Adoption insurance(Yuan/Ha)			Pure income without insurance
		Compensation	Net Compensation	Pure Income	
<583.40	0.010067114	6608.76	6563.76	-4326.94	-10890.70
875.00	0.013422819	4956.76	4911.76	-3913.94	-8825.70
1167.00	0.016778523	4405.46	4360.46	-3776.12	-8136.58
1750.00	0.030201342	3304.76	3259.76	-3500.94	-6760.70
2142.00	0.035570471	2564.66	2519.66	-3315.92	-5835.58
2534.00	0.036912752	1824.56	1779.56	-3130.90	-4910.46
3017.00	0.036912752	912.66	867.66	-2902.92	-3770.58
3500.40	0.050335569	0	-45.00	-2674.76	-2629.76
3800.00	0.067114094	0	-45.00	-1967.70	-1922.70
4300.00	0.070469799	0	-45.00	-787.70	-742.70
4634.00	0.073825503	0	-45.00	0.54	45.54
5000.00	0.087248322	0	-45.00	864.30	909.30
5400.00	0.130872483	0	-45.00	1808.30	1853.30
5834.00	0.124161074	0	-45.00	2832.54	2877.54
6104.00	0.110738255	0	-45.00	3469.74	3514.74
6380.00	0.105369128	0	-45.00	4121.1	4166.10
Expected value				505.11	38.98

According to Table 5.6 standard calculations to correspond for each hectare of yield claim amount, among them, the net compensation means that their indemnification sum subtracts the premium. The calculation formula is: Per hectare pure income = per hectare yield × insurance price + net compensation + grain subsidies - production cost. During 2012~2014 year's average production cost in Hebei province was 12765.7 Yuan per hectare. Corresponding is the each hectare pure revenues of yield while relatively doesn't adopt insurance (Each hectare the yield × support price+ grain subsidies-production cost).

Pass to make use of subjective probability calculation, compare the expected net income of insurance and non-insurance in two cases, the result detection: in this case the wheat production of expected net income is 38.98 Yuan/Ha,

namely the wheat production is barely able to compensate for loss. Therefore, adopt insurance to decrease or compensate the disaster bring farmer's loss by will be more beneficial (the expected net income is 505.11 Yuan/Ha). From this point of view, join the insurance in the prevention of lower yield is to play a significant role, however, compared with the previous long-term farm lower income situation, the government grain subsidies have played a greater role.

While actually being wheat yield more than 4634 kilograms/hectare, then wheat production of per hectare net income will be positive value; When the actual yield be low at 3500 kilograms/hectare adopt insurance to have obvious of compensated function, because of, this yield is an actuary of for each insurance yield of high production wheat (namely the average real yield of 60%). So that, want to raise the wheat produce of each hectare pure incomes, have to adopt measure in keep wheat high output with stable production, to Insure a wheat per hectare yield to exceed 4634 kilograms, and then can dependability raise the revenue level of farmer. More than a decade, the price of wheat doubled and tripled the cost, per unit of production increased by only 1170 kg, therefore, depend on subsidies and insurance can give farmers wheat production gains.

5.6.4 Establishment of Perfect Modern Agricultural Insurance System

In current agricultural insurance conditions of China, policyholders are generally voluntary. It is known that PICC has developed major agricultural insurances without directly operational risks. Insurance companies think that the agricultural insurance are out of pocket, the development of agriculture insurance is difficult, the state insurance agents have to pay higher taxes, of which the rates are determined by the law of large numbers and controlled by the country without the market adjusting, "moral hazard" certainly exist. Therefore we must fully understand the function of the agricultural insurance,

build and improve our national macro management system of agriculture risks in order to create a better external environment for agricultural production and stable life of the farmers. Such as Figure 5.6 will be an initial idea on the insurance system of China, which includes two sections for farmer's body and property insurances. In most situations, we used to take agricultural production and business risk into property insurance management.

The share of agricultural insurance disaster loss by the establishment insurance fund, itself has the purpose with absorbing funds, improving the agricultural disaster prevention, raising farmer responsibility and aggressive for safe property economy, mutual aid, total benefits and dispersion risk. The agriculture insurance can also protect the application of agriculture new technique, and accelerate the agriculture technical progress, raise agriculture rate of production. Comparing and learning experience of developed countries, considering it has the same track with international market for joining WTO, it should build up perfect modern agriculture insurance system, because making use of foreign capital and introducing foreign advanced technology and equipment and so on all depend on agriculture insurance, and the agriculture insurance as the constituent part of the whole financial insurance servicing business, should also absorb in developed nation for increasingly expanding international association, and make use of insurance to serve agriculture better. We should establish modern agriculture insurance system which mutually adapts market economy and is good for coming close to international market development. After China joining WTO, to improve agriculture insurance mechanism as a main national financial support policy, is possible to make use of "green box policy" to support national agricultural development.

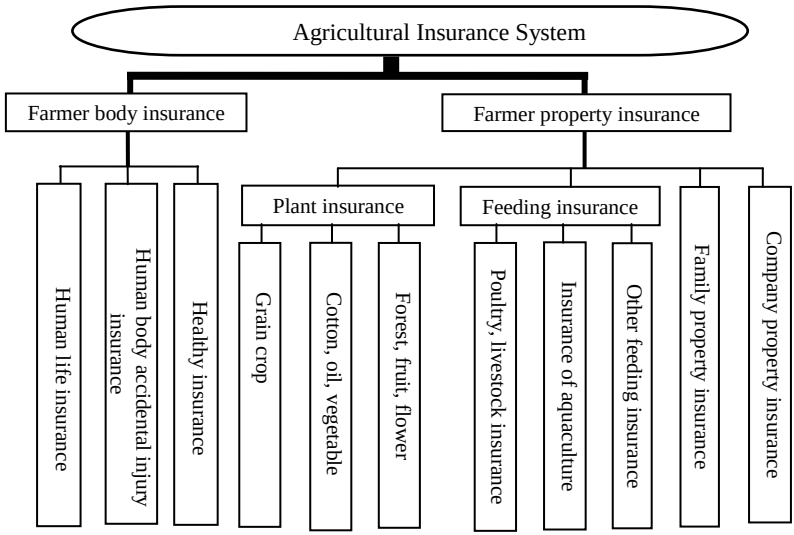


Figure 5.6 *Chinese Agricultural Insurance System Construction*.

Summary

This chapter conducted for the development of applied research to China's agricultural insurance market. In China insurance market is only an instrument that can disperse production risk. At the same time, this chapter has discussed a series of methods to avoid and reduce production risk. Through the actual case, we can select the best decision by making use of statistical analysis instrument which we have introduced before and establishing two-time plan model and random predominant methods.

First this chapter discussed to bring guard against of risk, risk decrease and insurance measures to overcome on uncertainty, such as natural disaster, technique and policy...etc. From the agriculture production line consideration decrease agriculture produce risk strategy, contact Hebei 90's in 20 centuries, the agriculture produce of actual circumstance, inquired into how to choose a stable agriculture production item to avoid from agricultural production risk.

The method use is a calculation to be partially related to coefficient with a certain agricultural produce be partial of several years related coefficient least for fully choose a project, got in recent years Hebei to plant an industry to take producing tomato and corn most as stable conclusions.

Secondly, this chapter discussed various management combinations strategy for dispersing risk. The principle of basis is to make the agricultural production activity which presently negative related coefficient to combine together to production. So it should compute related coefficient matrix.

Third, there are many measures for increasing the flexibility of agricultural production and operation discussed in this chapter, such as the flexibility of cost, technology and equipment, time and product. Improving the flexibility of agricultural production can avoid agricultural production and operation risks from the different aspects.

Fourth, the establishment of quadratic programming model can minimize the risks and guarantee a certain level of income. But this analysis for the dispose of agricultural production risk is based on the minimum variance.

Fifth, in order to overcome the above normal assumption restrictions of the risks distribution, the theory of random advantage method and the problems of its application are discussed in the succession of this chapter. In the retained risks circumstances of these measures, guarding against the risk of agricultural production and operation are of great significance. It should be explained that the analysis and calculation effect is based on historical data, due to detail record statistics of agricultural production short time history, fewer types generally made constrains. But with the elevation of agricultural informatization level, the analytic methods and standards decision-making for future research in agricultural production and management will certainly be of great helpful.

Sixth, the establishment of an agricultural insurance system is an objective and is inevitable trend for the development of the market economy, an effective

measure to disperse the agricultural natural risks. It is also a main risk management strategy of agricultural production, Therefore, to further explore on the issue of improving agricultural insurance system and it's conceive of the system construction in China are introduced in this chapter. Not only it introduces the agricultural insurance, the justifications for quotas, the analysis of profit matrix, but also further explores the measure to improve the relative issues in terms of agricultural insurance system in China.

To sum up, as for the actual agricultural production and the insurance system, this chapter takes the risk issues of agricultural production as a subsystem in the agricultural risk system. It mainly focuses on reply to defending the risks, risks reduction and insurance measures, which are brought by the natural disasters and technology, uncertainty of policy. The combination of the risk management theory and the practice of agricultural production is the most prominent characteristic of this chapter.