

# **Chapter 8**

## **Decision Support System of Agricultural Risk Management**



In the previous chapter we have established the concept of a system of agricultural production and business risk, discussed the relevant theories and models about the system of agricultural production and business risk, because from the angle of open and giant complicated system studied the establishment of risk system, these theories and research models toward the whole risk management, problems and application should have a certain universal application. Since agriculture is a natural reproduction and closely intertwined with the socio-economic reproduction of the material production sector, which makes more complex of agricultural production and business risk research. This chapter will address the complexity and issues of agricultural risk management and decision system, and further explore the methods of decision system.

## **8.1 System Management and Decision of Agricultural Production and Business Risk**

### **8.1.1 The Basic Idea of Risk Management**

Taking a wide view about risk management nowadays, there are only several major measures. The first is risk dissolve; the second is risk dispersion; the third is risks control; the fourth is risks reduction; the fifth is risks prevention; the sixth is risks utilization.

The so-called risk dissolve, that mean turn peril into safety, cancellation risk, if want to exterminate risk still have to remove risk concealed suffer from, make it become naught, this be a kind of exhaustive risk treatment.

The so-called risk dispersion, that mean scatter the risk, carry out the risk total load in which people can bear of the scope, this is a kind of measure of coordination.

The so-called risk control, that mean limit the risk in the certain scope, carry on appease to the risk, limit its dissemination spread, it is also a rules and regulations risk, but don't let it injure people's basic benefits.

The so-called risk reduction, that mean make the strong risk become small risk, but not only is to carry on dispersion to the risk, the key wants to contract the whole scale of risk existence, namely reduce have already exist of uncertainty factor.

The so-called risk prevention, that is subjective to strengthen the defense and away from risk, hedge taken measures to contain the risks must be of good control and prevention in subjective.

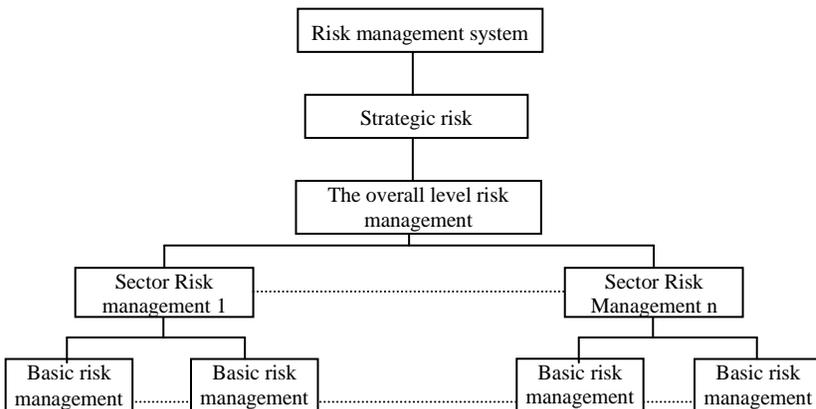
The so-called risk utilization, including turn bad luck into a good of plan, exactitude confidence risk since is an opportunity, and then is the contradiction of risk, tend benefit to avoid harming, acquiring a risk speculation income.

Risk in anywhere is an objective, the procedure of risk management decision is to identify the risk at first, and secondly to measure the risk against an analytic risk, finally is to adopt a valid counter plan. Face and discusses the complicated risk management and the risk problem is a huge mission. Take the basic target of risk management with subjective wishes, we considers the system problems of risk management at first, from the macro view we need a perfect society guarantee system, then is the science method which controls a risk management, science processing risk affairs. Therefore, the risk management is to point organization or personal make use of various tools, include the management of resources, finance of system inner part and it develops tool, insurance market, information technique or other tools, the risk which makes use of method and procedure of science to face in front carries on a monitor and controls and carry out thus above-mentioned relevant exterminate risk, reduce loss, guard against and evade risk, even obtain a risk speculation the risk management target of the income. The not-proper risks that the system can

avoid some risks in the risk management, can adopt a negative risk management counter plan, actively rounded or avoid, For some risks it can scatter or transfer outward, can transfer to a company of the risk speculation and more risks can't transfer, can't also get around of, including stay of risk, these risks only passed the risk management activity of system itself to solve.

### 8.1.2 The Agricultural Production and Business Risk Management System

Agricultural production and business risk is an importance constitute part of national macroscopic risk management system, is also a part of global risk system. There have many consistencies, which are much similar structure on the macro view and methods of exterior risk management. But the usage in the internal resources of the risk system due to special process of agricultural production and business make it some special complexities in the risk source, risk identify and risk processing. Therefore, the risk management organization should build up from top to bottom such as the stereoscopic type of the strategic risk management, total level of risk management, section and the grass-roots level risk management system. The three dimensional risk management systems are shown below in Figure 8.1



**Figure 8.1** The Three Dimensional Risk Management System.

The management of risk system needs to build up perfect system, at first thoroughly avoiding the existing risk tools and means. Actually control realm in the risk management and loss, better performance of pure risk in the management market, include an insurance industry, newly arisen financial risk management market and it develops product bargain in an industry. Because these two great risk managements market is providing more and more effective channels, ways and its combination for people, is exactly also mainly pass these two great markets, which make people so fear to material risk no longer. Second is to make use of modern information technology network to moderate the movement of complicated system. Therefore, the risk management system needs to insist some basic principle of system decision: (i) Evading the risk needs to consider the principle that the current benefits combines together with farsighted benefits; (ii) Handling the partial risk and whole risk need to consider a coordination principle; (iii) Insisting principle of coordination and progressive; (iv) The risk policy analysis needs to take metered research as a basis; (v) Handling the risk needs to fully consider combine together between internal resources and exterior condition; (vi) Insist setting out from the objectivity principle actively discover and guard against a latent risk factor in the meantime; (vii) Processing the relation of bearing the risk and obtain a benefits need to obey the law, principle and morals standard.

### **8.1.3 Management Strategy of Agricultural Production and Business Risk System**

The decision of agricultural production and business risk involved many factors, mainly: (i) The change in unit output; (ii) The change in prices; (iii) The variance of new techniques or new knowledge; (iv) The level of changes in agricultural investments; (v) The change in policy; (vi) The change in law; (vii) The change in consumer's preference etc. Agricultural producers face a lot of risk factors is always trying to reduce risk, achieve its operational objectives.

Pass measuring risk and profit by implementing appropriate risk management strategy to achieve the coordination and profits, formed a series of non-deterministic relationship of the risk of decision-making method.

In the traditional sense, mainly strategy of reducing the risk has three big kinds, namely production strategy, sales strategy and financial strategy. But in the modern market economy, the measure of reducing each kind of risk form one whole set of risk combination strategy, for example, considered how adjusted the agricultural production structure, discovered the identical farmers managed the different crops, its risk management was different. First must consider in the related scale, the income, the cost and the price risk question to the farmers. But the financial risk refers to the safety degree of a big scale of agricultural production unit in finance, the agriculture business and the credit association takes the agricultural unit extremely in the financial safety degree, usually must inspect them regarding fund payment ability certain targets, decide whether discharges the loan. Therefore many production activities, the technical and business organizations activities, the transaction activity, the financial finance activity and so on intertwine in the same place, constituted system of agricultural production and business risk which we must inspect. When according to system viewpoint consideration agricultural production and business process venture decision, because the risk have many factors, goal relations are complex between the system, must utilize the thinking of risk system, uses the risk combination strategy. Each kind of strategy carries on in the certain practical work in the finance sphere of action, always we must synthesize the uses of many kinds of strategy, achieve the expected goal at the same time, it also further showed “the thinking of risk system” importance. Among them, we have carried out many related chapters on the discussion about the concrete measures of agricultural production and business risk

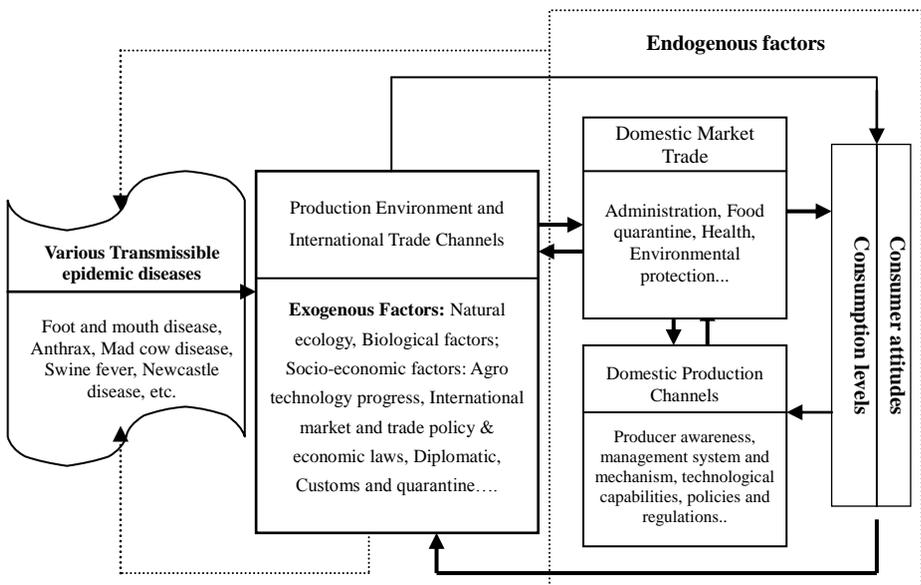
management, they are certainly extremely important and the basic tool in the system of risk management.

Qian Xuesen pointed out in 1989, in fact the complex system question was dynamics characteristic of the open complex great system. The author believed that the open complex great system risk management must consider the four big laws of motion of this system, this may have many different with the traditional decision-making method, therefore we should aim at the complexity of the agricultural production and business risk question, does further research on the open complex great system administration from the decision-making angle <sup>[97]</sup>. Ecological environment and international trade channel exogenous includes the natural ecology, biological factors, socio-economic factors, technological, economic, diplomatic, and economic and trade policy, customs and quarantine. Therefore, the endogenous factors should include the business administration, food quarantine, health, environmental protection, industrial policies, laws, and management system and producer consciousness.

## **8.2 The Optimal Design of Agriculture Risk Management System**

How to design an efficient risk management system, we can give fully play organizational efficiency when dealing with the issues of risk is one of the important decision-making problems in the researching of the risk management system. We take the risk transmission of agriculture, aquaculture and industry as an example for discussion. About the occurrence and the transmission of poultry epidemic diseases, may divide into epidemic disease which the international trade channel brings to disseminate, the local poultry disease, the production and consumption channels infection and so on. If poultry epidemic disease, the external species invasion and so on, first it spreads through the international trade channel, they should limit by the trade country economics, trade policy

and the non-customs duty measures, and affects the country’s trade policy and the diplomacy. Adopts inevitably measures through a series of departments in the domestic market, simultaneously strengthens the production management in the production process carries on the strict control in the expense process. If production in the natural environment and the infection with the humanity and the domestic poultry, then we should perform to isolate and protection. Therefore, we test like Figure 8.2 to describe the situation and kinds of poultry epidemic diseases possible spread process and the influence factors.



**Figure 8.2** Channels of Animal Diseases Transmission.

The aquaculture not only affect by the natural disaster, but also injury by epidemic disease, because some epidemic disease production come from overseas, some come from the home, how establishes an effective management system to guard against poultry epidemic disease to spread to the home from the overseas, simultaneously also prevented the domestic epidemic disease passes to the international market, takes strict precautions and controls these animal

disease become more important in the open economy time. In the safe responsibility has the strong dissemination ability or harm extremely several big kinds of epidemic disease as shown in Table 8.1.

**Table 8.1** *Property Insurance Clauses Poultry Disease That Can Be Spreadable.*

Milk (meat) cattle diseases	Bus bacillus disease, anthrax, foot and mouth disease, Net traumatic gastritis, acute gastric distension, bowl disease.
Pigs diseases	Classical swine fever, swine erysipelas, lung disease, foot and mouth disease
Chicken poultry diseases	Newcastle disease, fowl cholera, Mare’s disease, chicken infectious bursal disease

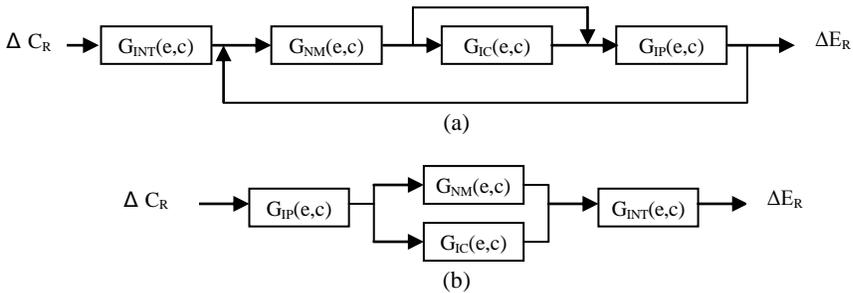
Source: According to the Chinese People’s Insurance Company of Hebei Province branch, “Agricultural insurance policy” in the property insurance liability<sup>[98]</sup>.

## 8.2.1 The Risk Transmission Model of Poultry Epidemic Disease

### I. Model Building

In the above example, poultry epidemic disease must pass through a series of transmission channel to be able to transmission spread, and master control factor of the risk transmission is management structure in the corresponding system. Regarding main channel spread as shown in which epidemic disease passes through figure 8.3 (a), regarding main channel spreads as shown in which epidemic disease passes through figure 8.3 (b). First defines Kernels of the system: Supposes  $G_{INT}(e, c)$  is the world environment and the international trade management channel;  $G_{NM}(e, c)$  is the domestic market channel;  $G_{IC}(e, c)$  is the domestic consumption channel;  $G_{IP}(e, c)$  is the domestic production channel. Also makes  $\Delta C_R$  to indicate the cause of the reason of risk change,  $\Delta E_R$  to mark the risk of the response of the affection after the system administration. The risk’s transmission relations may be seen from the figure, once poultry epidemic disease will occur and spreads by the way of the international market, first will enter the domestic market or the consumer who will be transmit its product for certain international markets, then or will transmit to the channel by the domestic market or the poultry the production

system, again will be enlarge after the production system and returns to the domestic market or the international market, which will create the vicious circle. When it returns to the international market channel, it can be further disseminates and spread to the domestic market or the consumer by produce the channel. Therefore, controls the risk to be decided effectively dependent to the system of the organizations and agencies management potency.



**Figure 8.3** Animal Disease Risk Transfer Model.

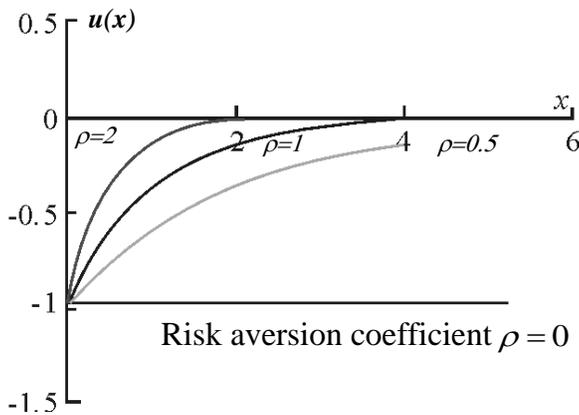
In order to utilize the theory of the risk transmission to carry on the analysis to the question, it must calculate the management system potency display through the probability distribution expected utility, the variance or the system entropy. In optimized design of this management system structure, considered the main risk transmission route, we have established the transmission relational model which are shown in Figure 8.3, and supposes the causal relation to conform to the following relations in the system  $\Delta C_R \propto \Delta E_R; \Delta C_{RB} \propto \Delta E_{RB}$ . Then we may use the utility function, the variance or the entropy function and so on to establish the transmission function and the system structure optimization model. We may infer according to Figure 8.3 (a) and (b) derived formula (8.1) and type (8.2), which expresses the system of the risk transmission process separately.

$$\frac{\Delta E_R}{\Delta C_R} = \frac{(G_{IC} + 1)G_{NM}G_{IP}}{1 - (G_{IC} + 1)G_{NM}G_{IP}} G_{INT}; \tag{8.1}$$

$$\frac{\Delta E_{BR}}{\Delta C_{BR}} = G_{IP} (G_{NM} + G_{IC}) G_{INT} . \tag{8.2}$$

## II. Analyze the Kernels of the Risk Management System

From the above formula, spreads to the poultry epidemic disease risk by the international trade channel, may expand by the domestic bad channel management of trade, produces, expends. In fact, we generally believed from the risk management angle, risk management principle of the channel of poultry epidemic disease transmits should be take prevents, elimination or reduction as the goal, therefore all management structure should be the risk circumvention. Regarding a series of such subsystems has the risk circumvention function; their risk utility function should be the concave shape. We test the second chapter of the risk utility function to establish the analysis model.



**Figure 8.4** Utility function  $u(x)$ .

Supposes, each management structure has an Arrow-Pratt absolute risk aversion coefficient  $\gamma(x) = \rho$ . That, when  $\rho > 0$ , they are risk aversion. Notes regarding venture capital or risk management utility function along with risk event  $x$  occurrence is negative, may express is  $u_i(x) = -\exp(-\rho x)$ . Therefore, defines this utility function territory is  $u_i(x) \in [0, -1]$ , generally takes its

absolute value to explain economic problem. Considered two nature of theorem 1 and theorem 2 give risk aversion coefficient, we use it to study the administration utility of the above risk system, analysis system complexity. Figure 8.4 has given utility  $u_i(x)$  function image.

Supposes each management structure is able to averse the risk on own initiative, supposes “Kernels (Kernels)” satisfy the related to the condition and theorem <sup>[99] [100]</sup> of Kernels in various subsystems model, we select the utility function to express, therefore

$$G_{INT} = u'_T(x) = \rho_T e^{-\rho_T x}$$

$$G_{NM} = u'_N(x) = \rho_M e^{-\rho_M x}$$

$$G_{IP} = u'_P(x) = \rho_P e^{-\rho_P x}$$

$$G_{IC} = u'_C(x) = \rho_C e^{-\rho_C x}$$

Supposes with  $dx$  expresses the change of venture capital, and  $dy$  expresses result change (system output utility). Then the formula (8.1) may be replaced by equation below.

$$\frac{dy}{dx} = \frac{(\rho_C e^{-\rho_C x} + 1)\rho_M \rho_P \rho_T e^{-(\rho_M + \rho_P + \rho_T)x}}{1 - (\rho_C e^{-\rho_C x} + 1)\rho_M \rho_P e^{-(\rho_M + \rho_P)x}}. \quad (8.3)$$

From the above analysis, the poultry epidemic disease risk spread by the international trade channel, may expand by the domestic bad channel management of trade, produces, expends. The formula (8.1)-(8.3) indicated that, Supposes each management structure is able to positive to averse the risk on own initiative, then  $G_{INT}, G_{NM}, G_{IP}, G_{IC} > 0$ ; If their one of them is equal to 0, or the risk circumvention coefficient causes  $dy/dx=0$ , then explained its system management may expire. Regarding transmission of international trade channel poultry epidemic disease risk  $G_{INT}$ , when  $(G_{IC}+1)G_{NM}G_{IP} < 1/2$ , the risk

expansion, explained the domestic market and the production management lack the efficiency, When  $(G_{IC}+1)G_{NM}G_{IP}>1/2$ , the risk reduce showing domestic market and the production management is effective, Because  $(G_{IC}+1)G_{NM}G_{IP}<1$  reflected the transmission effect of the system risk management, then stipulated  $1/2<(G_{IC}+1)G_{NM}G_{IP}<1$  for the system structure reasonable design scope, indicated each management structure displays the potency should above 50%. Therefore, through strict check of the international trade channel, the domestic market and the production process, all may extremely effective control or elimination the risk, but may not only through expend the channel to consummate the risk management, because  $(G_{IC}+1)$  indicated, consumption was already very passive in the process to epidemic disease risk management, moreover was the finally strobe.

From Figure 8.4, the coefficient of risk aversion of risk management channel is bigger, its management utility increase quicker, if supposes each management subsystem absolute risk circumvention coefficient is 1, and then equation (8.3) may write:

$$dy / dx = \frac{(e^{-x} + 1)e^{-3x}}{1 - (e^{-x} + 1)e^{-2x}} = \frac{e^{-x} + 1}{e^{3x} - e^x - 1}.$$

Known, the function reasonable value territory is  $dy/dx > 0$ , namely  $e^{3x} - e^x - 1 > 0$ . Then get solutions as:  $x_1 > 0.3775$ ;  $x_2 > \ln(0.8668e^{28.2426i})$ ;  $x_3 > \ln(0.8668e^{-28.2426i})$ .

Obviously, this function is one of the periodic hyperbolic function, that it also proves the management system is a non-linear complex system. If each sub-system of coefficient of evade hypothesis is 1, expresses the system of total utility with  $y$ , then absolute coefficient of risk aversion of the system may by  $d \ln(dy / dx) / dx$ , and it also is a complex hyperbolic function.

If epidemic disease produces in domestically, may using the formula (8.2), after the domestic poultry epidemic disease occurrence also may by the channel of produce enter the domestic market or to the channel of expend, spreads to the international market. Because this kind of risk submits in the series form, if can strict control in produce the link from the very beginning, as well as strict check in international trade, not only strict management in the market and moreover in the expense, may effective control risk circulation expansion.

### 8.2.2 Risk Management System Optimization Model

We already prove the three have the following equal relations from above: Expected utility maximized  $\sim$  the variance minimum  $\sim$  system entropy minimum. Therefore, if we design the system organizations and agencies can satisfy this extreme value condition, explained they might effectively aversion and guard risk transmission, have achieved the goal which the organizations and agencies optimized. Needs to point out, actually each channel possibly have one complex, the multi-link subsystem, therefore each sub-system “Kernels” expressed by available vector.

$$\text{Suppose } G_K = (g_{ij}(e, c)), \Delta C_R = (\Delta C_{Ri}), \Delta E_R = (\Delta E_{Rj});$$

From above about risk transmission relational model, we may design the most superior risk management system model using the variance or the entropy function minimum, namely realization risk management system optimization. For example, suppose a kind of variance function  $f(\sigma_{ij}, g_{ij})$ , in this management system the risk transmission process available following model expression:

$$\begin{aligned} f(\sigma_{ij}, g_{ij}) &= \text{Min} \\ \text{st. } \quad \frac{\Delta E_R}{\Delta C_R} &= f(g_{ij}) \\ g_{ij} &> 0. \end{aligned}$$

In the model, the objective function of system risk is the smallest; But the constraint condition is the management system whether has displayed its management function fully in the risk transmission controlled process, therefore, should guarantee system reasonable design scope effective reduction risk according to the request. If has achieved this goal and the system constraint condition, meant this risk management system has realized the structure optimization, has the highest risk management efficiency.

The ecology risk refers to the possibility harm event creates the destruction in ecosystem certain essential factors or the ecosystem, this kind of persecution function may cause ecosystem structure and the function has variation. In order to minimum risk in the ecological environment, may refer to 3rd chapter of 3.2.2 of risk formula to analyze, obviously obtain a minimum of this type, namely the sufficient condition is  $dR=0$ , the essential condition is  $d^2R > 0$ . In the far away balanced state ecology economical system, the system inherent internal entropy (*dis*) always increase, but the people can perform to control or intervention the systematic exchange entropy (*des*) increase. May have several kind of situations of  $des > 0$ ,  $des < 0$   $des = 0$  according to the dissipation structural theory, the manual intervention goal causes  $des < 0$ . Therefore, the exchange entropy direction is decided by the system input material and energy in nature. Therefore, simultaneously has one to reduce the risk essential condition in the formula, must obtain information increase (*dI*), the information increase assumes the inverse correlation regarding the risk increase, form the negative entropy flow. Therefore, supposes, thus the system optimization goal which the risk accumulation value available integral form expresses is the minimum risk value of *R*. The available formula expression as follows:

$$R = \int dR = \int \frac{\partial f}{\partial s} (dis + des) - \int \frac{\partial f}{\partial I} dI = \min$$

Obviously, the system has two control Kernels. First is the system the partial derivative which changes regarding its entropy, it is e system entropy and exchange entropy composite function. The second control Kernels is the system regarding information change partial derivative, which is decided by regarding system observation, namely system measurable change. The system entropy's method is system complex measure, we had once proven equal relations of expected utility maximization, variance minimum and the entropy minimum, here we utilized the system entropy method to make further discussion. Hoped this become important direction of macroscopic agriculture risk management and decision-making research.

### **8.3 Environmental Analysis of Macroeconomic Policy**

In the macroscopic economical stochastic undulation causes total national economy appear some kind of periodic frequently rule. Because there are many factors which causes macroscopic total quantity undulation, like politics, economy, advance in technology, as well as international factor and so on, when risk accumulations possibly have some kind of sudden change, description or grasps the rule of macroscopic economical change, discovered leadership (forward) factors, for use the suitable economic policy which control the trend of macroscopic economy development is extremely important. At the same time, for the management of agricultural production and business risk, we also must pay attention to the development of macroscopic economic situation and policy change uses the different agricultural management measure according to the different economic situation. Now make further analysis unified the trend of the founding of total national economy of China.

In the macroscopic economical research, national income (GDP) is referred to certain time (usually referred to for a year), a country completely produces final product and services according to the total sum of market value

computation. In fact this output value affects by many uncertainty factors. For example factors of each products and service price, output cost element and so on. The Keynesian principle thought was the effective demand has decided the national income, but the currency principle and the rational anticipated school of thought presented different opinions. The currency principle believed that, the people might adjust to the future anticipated according to the past anticipated deviation, in the short-term made the inflation without enough time accurately anticipated, but long-term wrong anticipated will obtain the revision, therefore this will be one compatible anticipated viewpoint, The rational anticipated school of thought believed that, the people to the future anticipated will be rational, no matter short-term or in a long-term, they will all be able to accurately anticipate future inflation. Therefore, the non-Keynes principle viewpoint is one random viewpoint, namely the compatible anticipated viewpoint is a continual readjustment anticipated probability, the rational expectant is a definite anticipated probability, but the Keynesian principle is determinism. The fractal fundamental research looks extremely complex of the national income and the social effective demand relations. Though the relations are non-linear between them, also incompletely stochastic, Moreover, sometimes their relations are periodic, even chaos.

### 8.3.1 Elastic Fractal Dimension Model

An economic elastic fractal dimension definition is:  $D_e = d \ln Y / d \ln X$  <sup>[101]</sup>.

That is

$$D_e = d \ln Y / d \ln X = (dY / Y) / (dX / X) = E_{xy}$$

In order to facilitate inter-annual data calculation, we used the average elasticity formula, for example <sup>[115]</sup>:

$$E_{xy} = \frac{\Delta Y / Y}{\Delta X / X} = \frac{(Y_t - Y_{t-1}) / (Y_t + Y_{t-1})}{(X_t - X_{t-1}) / (X_t + X_{t-1})}$$

Economical elastic fractal dimension  $D_e$  responded sensitivity of national income regarding social effective demand, this is one kind of irregular change, affect by many kinds of uncertainty factors, sometimes presented periodicity and sometimes bifurcation enters the chaos. Generally speaking, when  $D_e$  is small, the national income have small demand stimulation influence, the demand policy cannot effective to the national income increase. When  $D_e$  is big, national income of demand counter-strain become very sensitively. The government should adopt each kind of policy to stimulation effective demand for the national income promptly. The macroscopic agriculture risk management should positively use this kind of environmental factor change, increase farmland capital construction investment, development agriculture science and technology project, improvement agriculture infrastructure condition and so on causes the agriculture to resist each kind of risk ability and the level has a bigger enhancement.

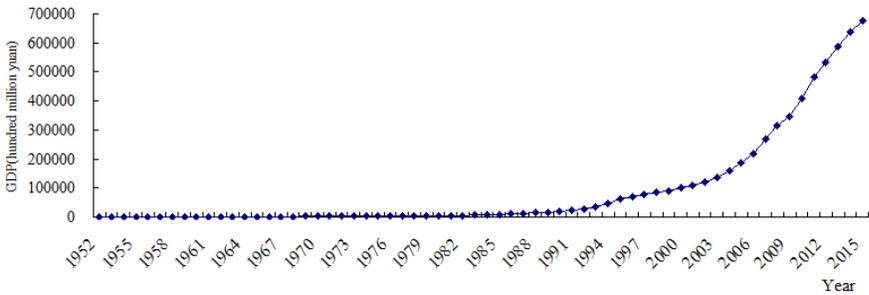
In the analysis we still take Chinese gross domestic product (GDP) as a macroscopic total quantity, take total investment, government expenditure as control variable in the effective demand, in which controls the total investment was difficult in the market economy, for the government easy hold is the financial policy, for all this, because some factors come from interior and exterior uncertainty usually causes the path of the national economy movement deviation national economy predetermined target. The nearly 63 year's statistical data for the national economy are shown in Table 8.2. It is also shown in Figure 8.5-8.6.

**Table 8.2** *Founding of National Income in 63 Years, Effective Demand and Elasticity Analysis.*

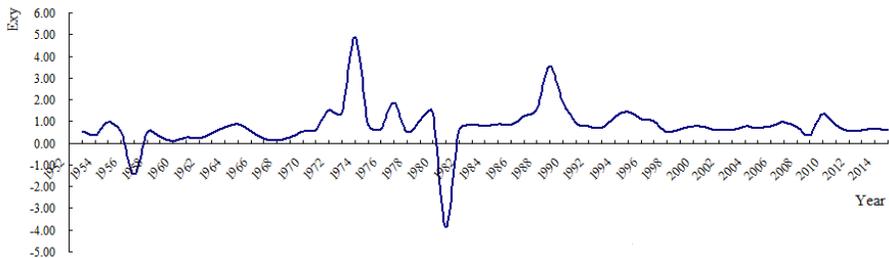
Years	Y=GDP	I	G	X=I+G	dY	dX	dY/Y	dX/X	Exy
1952	679.00	43.56	172.07	215.63	-	-	-	-	-
1953	824.20	91.59	219.21	310.80	145.20	95.17	0.1762	0.3062	0.5343
1954	859.40	102.68	244.11	346.79	35.20	35.99	0.0410	0.1038	0.3820
1955	910.80	105.24	262.73	367.97	51.40	21.18	0.0564	0.0576	0.9799
1956	1029.00	160.84	298.52	459.36	118.20	91.39	0.1149	0.1990	0.5516
1957	1069.30	151.23	295.95	447.18	40.30	-12.18	0.0377	-0.0272	-1.4295
1958	1308.20	279.06	400.36	679.42	238.90	232.24	0.1826	0.3418	0.4874
1959	1440.40	368.02	543.17	911.19	132.20	231.77	0.0918	0.2544	0.3301
1960	1457.50	416.58	643.68	1060.26	17.10	149.07	0.0117	0.1406	0.0780
1961	1220.90	156.06	356.09	512.15	-236.60	-548.11	-0.1938	-1.0702	0.2534
1962	1151.20	87.28	294.88	382.16	-69.70	-129.99	-0.0605	-0.3401	0.2022
1963	1236.40	116.66	332.05	448.71	85.20	66.55	0.0689	0.1483	0.4455
1964	1455.50	165.89	393.79	559.68	219.10	110.97	0.1505	0.1983	0.7396
1965	1717.20	216.90	459.97	676.87	261.70	117.19	0.1524	0.1731	0.8704
1966	1873.10	254.80	537.65	792.45	155.90	115.58	0.0832	0.1459	0.5520
1967	1780.30	187.72	439.84	627.56	-92.80	-164.89	-0.0521	-0.2627	0.2187
1968	1730.20	151.57	357.84	509.41	-50.10	-118.15	-0.0290	-0.2319	0.1373
1969	1945.80	246.92	525.86	772.78	215.60	263.37	0.1108	0.3408	0.2855
1970	2261.30	368.08	649.41	1017.49	315.50	244.71	0.1395	0.2405	0.5486
1971	2435.30	417.31	732.17	1149.48	174.00	131.99	0.0714	0.1148	0.6082
1972	2530.20	412.81	765.86	1178.67	94.90	29.19	0.0375	0.0248	1.5243
1973	2733.40	438.12	808.78	1246.90	203.20	68.23	0.0743	0.0547	1.3724
1974	2803.70	463.19	790.25	1253.44	70.30	6.54	0.0251	0.0052	4.8539
1975	3013.10	544.94	820.88	1365.82	209.40	112.38	0.0695	0.0823	0.8390
1976	2961.50	523.94	806.20	1330.14	-51.60	-35.68	-0.0174	-0.0268	0.6526
1977	3221.10	548.30	843.53	1391.83	259.60	61.69	0.0806	0.0443	1.8527
1978	3650.20	668.72	1122.09	1790.81	429.10	398.98	0.1176	0.2228	0.4981
1979	4067.70	699.36	1281.79	1981.15	417.50	190.34	0.1026	0.0961	1.0720
1980	4551.60	910.90	1228.83	2139.73	483.90	158.58	0.1063	0.0741	1.4589
1981	4898.10	961.00	1138.41	2099.41	346.50	-40.32	0.0707	-0.0192	-3.8552
1982	5333.00	1200.40	1229.98	2430.38	434.90	330.97	0.0815	0.1362	0.5818
1983	5975.60	1369.06	1409.52	2778.58	642.60	348.20	0.1075	0.1253	0.8501
1984	7226.30	1832.87	1701.02	3533.89	1250.70	755.31	0.1731	0.2137	0.7918

Years	Y=GDP	I	G	X=I+G	dY	dX	dY/Y	dX/X	Exy
1985	9039.90	2543.19	2004.25	4547.44	1813.60	1013.55	0.2006	0.2229	0.8890
1986	10308.80	3120.60	2204.91	5325.51	1268.90	778.07	0.1231	0.1461	0.8322
1987	12102.20	3791.69	2262.18	6053.87	1793.40	728.36	0.1482	0.1203	1.2502
1988	15101.10	4496.54	2491.21	6987.75	2998.90	933.88	0.1986	0.1336	1.5395
1989	17090.30	4410.40	2823.78	7234.18	1989.20	246.43	0.1164	0.0341	3.5662
1990	18774.30	4517.00	3083.59	7600.59	1684.00	366.41	0.0897	0.0482	1.9010
1991	21895.50	5594.50	3386.62	8981.12	3121.20	1380.53	0.1425	0.1537	0.9218
1992	27068.30	8080.10	3742.20	11822.30	5172.80	2841.18	0.1911	0.2403	0.7735
1993	35524.30	13072.30	4642.30	17714.60	8456.00	5892.30	0.2380	0.3326	0.6772
1994	48459.60	17042.10	5792.62	22834.72	12935.30	5120.12	0.2669	0.2242	1.2198
1995	61129.80	20019.30	6823.72	26843.02	12670.20	4008.30	0.2073	0.1493	1.4329
1996	71572.30	22913.50	7937.55	30851.05	10442.50	4008.03	0.1459	0.1299	1.1327
1997	79429.50	24941.10	9233.56	34174.66	7857.20	3323.61	0.0989	0.0973	1.0180
1998	84883.70	28406.20	10798.18	39204.38	5454.20	5029.72	0.0643	0.1283	0.4843
1999	90187.70	29854.70	13187.67	43042.37	5304.00	3837.99	0.0588	0.0892	0.6492
2000	99776.30	32917.70	15886.50	48804.20	9588.60	5761.83	0.0961	0.1181	0.8046
2001	110270.40	37213.50	18902.58	56116.08	10494.10	7311.88	0.0952	0.1303	0.7169
2002	121002.00	43499.90	22053.15	65553.05	10731.60	9436.97	0.0887	0.1440	0.5983
2003	136564.60	55566.60	24649.95	80216.55	15562.60	14663.50	0.1140	0.1828	0.6007
2004	160714.40	70477.40	28486.89	98964.29	24149.80	18747.74	0.1503	0.1894	0.7764
2005	185895.80	88773.60	33930.28	122703.88	25181.40	23739.59	0.1355	0.1935	0.6784
2006	217656.60	109998.20	40422.73	150420.93	31760.80	27717.05	0.1459	0.1843	0.7755
2007	268019.40	137323.90	49781.35	187105.25	50362.80	36684.32	0.1879	0.1961	0.9541
2008	316751.70	172828.40	62592.66	235421.06	48732.30	48315.81	0.1539	0.2052	0.7288
2009	345629.20	224598.80	76299.93	300898.73	28877.50	65477.67	0.0836	0.2176	0.3571
2010	408903.00	251683.77	89874.16	341557.93	63273.80	40659.20	0.1547	0.1190	1.3250
2011	484123.50	311485.13	109247.79	420732.92	75220.50	79174.99	0.1554	0.1882	0.8110
2012	534123.00	374694.74	125952.97	500647.71	49999.50	79914.79	0.0936	0.1596	0.5661
2013	588018.80	446294.09	140212.10	586506.19	53895.80	85858.48	0.0917	0.1464	0.6082
2014	635910.20	512020.65	151785.56	663806.21	47891.40	77300.02	0.0753	0.1164	0.6329
2015	676707.80	562000.00	175768.00	737768.00	40797.60	73961.79	0.0603	0.1003	0.5890

Source: Chinese statistical yearbook, 2001-2015<sup>[102]</sup>. (Unit: Hundred million Yuan)



**Figure 8.5** China GDP from 1952-2015.



**Figure 8.6** Aggregate Demand Variation and GDP Fractal Dimension Elasticity.

### 8.3.2 Macroeconomic Scenario Analysis

According to macroscopic trend of China national economy, may divide it into three economical development time on the whole, 1980s initial period before is time of implements planned economy, in this long time besides national economy statistics caliber different, because lack commodity economy development which cause the national income growth slow on basic, the national total output value has not surpassed 500,000 million Yuan. During hereafter 10 years of life China implemented had the plan commodity economy policy, practiced the socialist market economy system to 1992, the national total output value grows 2,665,200 million Yuan, passed through 10 year after today, the socialist market economy has accepted time test and has obtained the huge development, the national total output value grew 8% compared to the last year

in 2002, had broke through 10,000,000 million Yuan critical junctions. Since that at a rate of about 10% growth until 2010, China economy straight to climb to a new level of 10 trillion USD in (PPP), it became the world's second largest economy after only the USA.

From the macroscopic economical trend look effective demand influence on the national income grew, Figure 8.6 described Table 8.2 computation investment in the fixed assets and the government expenditure (I+G) change to the national total output value (GDP) elastic change. This chart probably can explain the gross national product rule of change and complexity, had several big undulation on the chart, respectively was in 1957, 1961-1962 years, in 1974, in 1981, in 1989. Theoretically, between national income and demand should be the same direction change, the negative growth situation is an extremely complex situation. Looked from the numeral, 1957 undulation mainly cause by demand reduction, the investment and the expenditure all reduced, the national income increased more than 40 hundred million, in 1961-1962 and 1967-1968 years, because investment and expenditure successive years reduce, the national income also successive years drops; In 1976 also appeared the demand reduction, the situation which the national income reduces, Then in 1981 mainly because the government expenditure reduced more than 50 hundred million, but the national income increased 34,250 million Yuan actually. In 1989 invested and the expenditure change scope is smaller than the national income scope, for this there are two groups of data, according to "Chinese Statistics Yearbook" it was a big undulation year, significant investment and expenditure shrunk. Statistically speaking, 1992-2007 had a higher economic growth rate. Until 2008-2009-2010 the economy fluctuations shown a saddle form changes. Optimistic about decade economic growth was in 2003-2012, then since 2011 the economy begun to slope down, in recent years, the weak economy, lack of the elasticity, but overall is relatively stable to compare with its history.

Economical elastic reaction national income regarding sensitivity of social effective demand, and moreover is one kind of irregular change. When,  $E_{xy}$  is generally small, national income become smaller affected by demand stimulation, requirements management policy cannot very effective to national economic growth (for example 1957-1960, 1967-1969, 1978-1081, 1982-1986, 1991-1993, 1998-2009); When  $E_{xy}$  is elastic, national economic growth is regarding to demand increasing reaction become very sensitive (such as 1972-1975, 1987-1991, 1994-1997, 2010-2011), the government should adopt each kind of policy stimulation effective demand to make the national income growth. From economic trends scenario, the majority of the year is the lack of elasticity, it can also be seen as a normal economic development.

This analysis indicated, when demand change is small or reduction, the output may be greater increase, this has some kind inevitably indirect or non-economic agent having an effect. The effective investment and the fiscal method must give an attention to the direction of effectiveness, when invests increases but output reduction, sometime not suitably uses economical method, especially appears the economic chaos process. Also may discover from the elastic undulation situation, China national economy has appeared in 3-5 year's short-cycle, and 9-10 year's medium cycle. With the "Twelve Five" plan is completed, China into the "Thirteen Five" program, its economy has entered a new normal of periodic. The agricultural production and business decision-making must consider this kind of macroscopic economical periodic change which brings the risk, at the right moment adjusts the production management strategy.

## **8.4 Using Info-tech and Network for Agricultural Risk Aversion**

In the research of complex great system, may decompose complex system into much quite small hierarchical structure or system. We may apply this kind of graduation hierarchical pattern and the thought to the aspect of the large-scale control management system. The modern information network technology may help to realize between many subsystems which possibly have various coupling relations, like organizes, function, economical aspect, geography aspect and so on. The information network technology application sets overall into the agricultural system, theoretically may help agriculture and the farmer realize averse each kind of risk, conformity the goal of economical resources. Already formed a five level of information network great system in China, but speaking of extended to the village, we yet not achieved this system construction to the ultimate objective in the technical function and the system administration, we sent complete hope next “Five Year” plan when China have fundamental significant breakthrough.

### **8.4.1 The Construction of China National Agriculture Information Network System**

Seeing from the information economy development in China, the period before the 80's of the 20th century based on informatics were the main research and development. After the early 80's, application of computer technology was the main stage of the development as 90's was the period of new economic development, the information technology revolution was a comprehensive, modern information revolution combining telecommunications and computer, which including information access, transmission, storage, identification and treatment formed a global or regional information network can be seen as a technology revolution of information network.

Since 1985 the programs on the construction of information systems in farming, fishery and application planning of computer had been proposed by China. The Ministry of Agriculture established Agricultural Information Center in 1986. The national programs of agricultural information system were formulated in 1992. LAN (Local Area Network) was built by the Ministry of Agriculture in 1993. The national information was presented in 1994, which is under unified planning and organization of state, information technology is applied in agriculture, industry, science and technology, defense and all aspects of social life to speed up the process of national modernization through in-depth development and extensive use of information resources. And a construction guideline was made, that is co-ordination planning, state-led, uniform standards, joint construction, interoperability links and resources sharing.

“The eight gold projects” were made during the “Ninth Five-Year Plan”, in which the “Golden Agriculture Project” that is “the agricultural information system of integrated management and services” launched construction of agricultural information system national wide. “Agriculture Engineering of Gold Project” was posed in December 1994 in a joint conference of the national economy information presented at the third meeting, the purpose is to accelerate and promote agricultural and rural information, the establishment of agricultural integrated management and service information systems. The National Center is the project core in the structure of engineering systems of gold agricultural engineering. Its main tasks are: First the control of the network management and information exchange service, including systems and other agriculture-related information exchange and sharing; Second the establishment and maintenance of national agricultural database group and its applications; Third coordinate the development of integrated information collection, published standards and for the regional and industrial center to implement technical guidance and management; Fourth organize agricultural information

services and the promotion of various types of modern computer applications, such as expert systems, geographic information systems, satellite remote sensing information system development and applications. The project of the engineering systems structure is based on national key agricultural counties, medium and large markets for agricultural products, mainly agricultural research, educational units, agricultural professional institutes and associations.

In the year of 2000, China further clarified the overall strategy, which was informatization promotes industrialization to realize leaping the development. The strategy emphasized that information is an inevitable choice to accelerate industrialization and modernization in China, which have been in overall situation. Since the 21 century, accelerating agricultural informatization become a key area for the agricultural sectors to transform functions in a new period, and information service facing “Agriculture, Rural, Farmer” as an important measure to train new farmers, develop modern agriculture and construct new socialist countryside, the state does everything possible to raise the level of agricultural informatization.

Agricultural informatization construction in China has entered a rapid development period since 2005. China increased the pace of agricultural informatization construction in "Eleventh Five-Year Plan" period. All levels of the agricultural sectors regarded information services as the core work, and paid closer attention to the network extension, resource development, and information dissemination, so more complete work system of agricultural information has been constructed. A group of agricultural sites were established, integrated office of administrative examination, e-government information systems, remote sensing and other applications of information systems were developed successfully to put into operation. The projects “Golden agriculture” and “Three electrics gather one” were launched, which we name it as “3Es to one”. Means have to combine telephone, television and computer as interconnection exchanges

merged as a whole. Therefore, villages and farmer households are through television, telephone, computer three ways as a key of agricultural information services. The level of information services for the “Agriculture, Rural, and Farmer” was improved greatly. Meanwhile, the agricultural sector strengthens the regulation, guidance, supervision and services of agricultural information to improve administrative efficiency. The Chinese Ministry of Agriculture set up a system of public service in agriculture and telephone number of 12316 dedicated and opened a new rural service hot-line in 2006.

According to the management and service needs, the agricultural sector actively apply precision agriculture, artificial intelligence, information systems, information technology have been penetrating gradually to all areas of agricultural production and operation. “3Ns to one” (by three-dimensional integrated through TV network, telecommunications networks and computer communication network) platform coverage was over all counties through the television, telephone or computer by means of “3Es to one” integrated information service platform of agriculture. Rapid advance of agricultural information will benefit from further strengthening of information technology infrastructure in recent years. According to the latest report released by China Internet Network Information Center, the scale of rural Internet users reached 1.0681 million in 2009, accounting for 27.8% of Internet users. To disseminate the information timely for farmers and to the villages and townships, some agencies of information in agricultural sectors at all levels were sound basically, and have developed more than 20 million rural information workers. Ministry of Agriculture established channels of information collection nearly 40, involving many steps of agricultural and agricultural production including marketing, supply and demand and other aspects, while agricultural information resources began to be integrated, and submission and treatment of information realized fully electronic processing. The influences of agricultural information

network in China is growing and the amount of visitors ranking in second place in the world, and the performance level of government websites in China is also ranked second. Especial web sites were set up in more than 80% of the prefectures (cities) and 60% of the counties in agricultural sectors around of 31 provinces and autonomous regions, which initially formed a national agricultural information network.

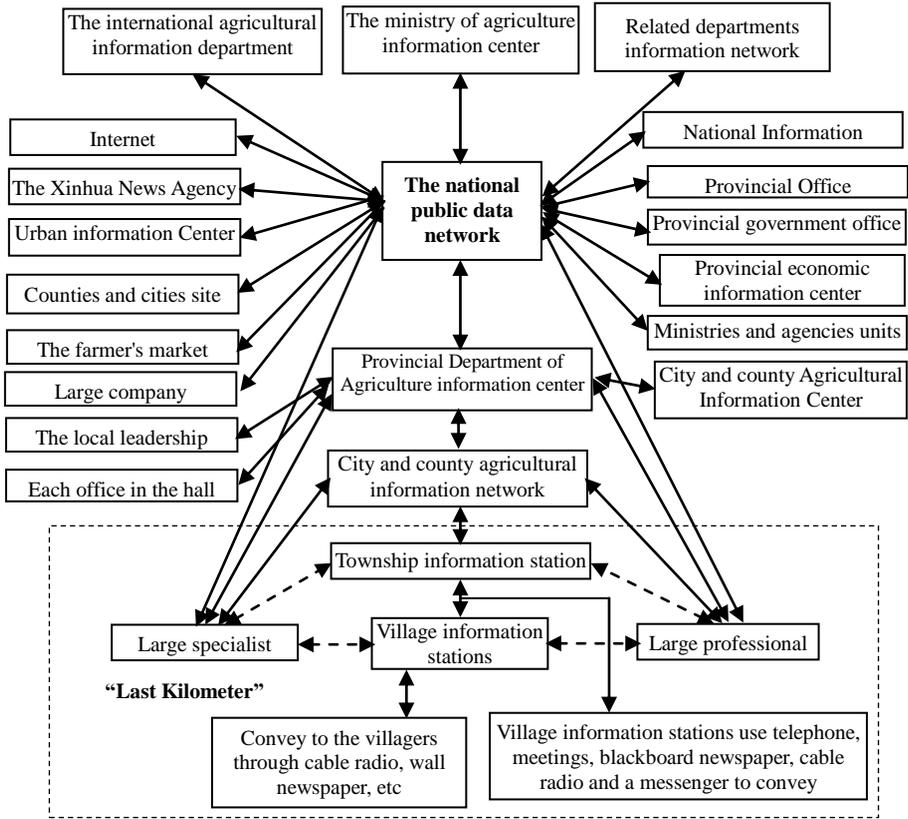
Under the support of national policy, information construction in rural is promoted to a new level. There are 98% of the country towns access to the Internet, 95% of the township were broadband transmitting, 27 provinces had achieved “townships access to the Internet,” 19 provinces had been basically realized “every village access to the Internet” by the end of 2008. The “Golden Agriculture Project” implemented by Ministry of Agriculture has basically built a monitoring and warning system of agriculture, supervision and information systems of agricultural products and production goods market, as well as the system of technical information service and rural market. From the information economy development in China, the period before the 80’s of the 20th century based on informatics was the main research and development. After the early 80s, application of computer technology was as the main stage of the development. 90’s as the period of new economic development, the information technology revolution was a comprehensive, modern information revolution combining telecommunications and computer, which including information access, transmission, storage, identification and treatment formed a global or regional information network can be seen as a technology revolution of information network. Since 1985 the programs on construction of information systems in farming, fishery and application planning of computer had been proposed by China.

The first phase(1995-2000) of the project: main building was the use of PSTN (Public Switched Telecommunication Network), China net, DDN (Digital Data

Network), Frame Relay, BSTN (Big South Television Network), VSAT (Very small aperture terminal) and broadcast television inverse way transmission of data, makes at all levels, inter-departmental timely transmission of information, exchange and access to databases, organization, coordination and guide the development of information resources, establish and improve a national database of agriculture and basic groups, build agricultural monitoring, forecasting, early warning and decision-making services such as macro-control applications and agricultural production situation, crop yield forecasting system, the establishment of disaster prevention and mitigation systems and agricultural services, information systems, research and development to promote greater economic and social benefits of software systems and application tools, construction of remote sensing information processing systems, including the National Agricultural Center for Remote Sensing Center and the regional construction as well as the provincial agricultural remote sensing stations, remote sensing information processing systems and GIS (Geographic Information Systems) technology application and development, etc, construction demonstration project and construction technologic educational information network.

The second phase (2000-2010) of the project, the construction of the main content have been to expand the information collection point scale, total 3,000, improve the provincial agricultural information transmission and processing center, with National Golden Agriculture Center for networking to reach at least 64K or more rate, and extended the contents of the first phase of construction to the provincial centers. The required investment for Golden Agriculture Construction in the central government input-oriented, local inputs as basis and by means of the national sectors, local communities and several other channels to raise, which means to take the financial allocation mainly with the bank loan as supplemented and using foreign capital as complimentary in a variety of solutions. The project was expected to invest 1.2 billion Yuan. The first phase of

investment 570 million Yuan, which accounted all levels of financial allocation for 87.5%, loans accounted for 12.5%. Second and third stages of investment would be 630 million and after the completion of gold agriculture project, agricultural production is expected to have a big leap and improve.



**Figure 8.7** Rural Economic Information Network System.

The agricultural informatization has extremely important strategic sense to China rural economy and social full scale of development. The massive facts indicated that, the agricultural informatization may cause farmer become rich, may enhance the large scale agriculture labor productivity, is helpful in the aversion of agricultural production risk management (aversion natural risk

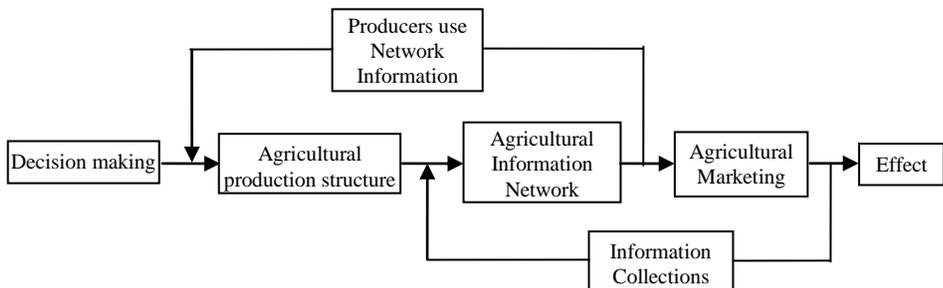
aversion and market risk aversion), moreover, the informatization request further enhances farmer's modern science and technology knowledge and the cultural quality, simultaneously may fundamentally improve countryside society culture living standard. From now on, agricultural informatization construction will conduct the thorough research in line with the information which is able to conformity agricultural production resources adapt the reform of market economy and the system innovation, impel the rationalization of agricultural structure evolution, promotion element of production and so on. The information technology took emerging pours technical factor into agriculture and countryside, once is grasped by trillion farmers, not only it is certainly economic growth factor which isolated has an effect, it inevitably conformity countryside ecology, economy, society, culture and organization system factors, promote rural economy and society's development fundamental and persistent effect.

In December, 1994, proposed national informatization “Nine Five” plan period “eight golden projects”, among, “the golden agro project” namely “the agricultural synthesis management and service information systems started nationwide scale agriculture information system construction. In 1995 established “the Chinese agriculture information network”, through the DDN way turning on internet, completed covers the national agriculture information network. In 29 provinces (city, area), 1/2 place (city) and 1/5 county completes the agricultural synthesis information service platform, and more than 1000 information gathering stations, 338 agricultural product and sale market provides the information networking equipment, carries on information inquiry and issue through the Chinese agriculture information network, realization and exchanges of all levels of international and domestic information networks. Therefore, solves the question of China agriculture informatization “the last kilometer”, which use many kinds of media way, China has already obtained some experiences and practice achievement, but not yet obtains universal

solution from the county to the village network, at present has formed system structure as shown in Figure 8.7.

In the current agricultural informatization work question and urgent duty are agricultural information website accounts for small proportion, low degree of utilization. The countryside information technology development is still quite backward. The city and the countryside, eastern part and the western area data gap are extremely obvious. Looked from the entire national informatization construction that, the information isolated island, low level repetition development question and so on long-term puzzles, are extremely disadvantageous to the national informatization economy and healthy development of social informatization work. Take national economy informatization construction as a complex systems, agricultural informatization construction must integrate national master plan and unifies standard, informatization construction needs to support system include the management system, standardized system and research system, needs to make whole agricultural informatization. The construction of agricultural information system has experienced two stages of rapid development, and has entered the third phase of development. To Internet + and mobile communication technology as the foundation, pursues the development of e-commerce and the Internet of things, smart agriculture as the new direction.

### 8.4.2 The Application of Agriculture Information Network



**Figure 8.8** Logical Structures of Farmers to Utilize Information Networks.

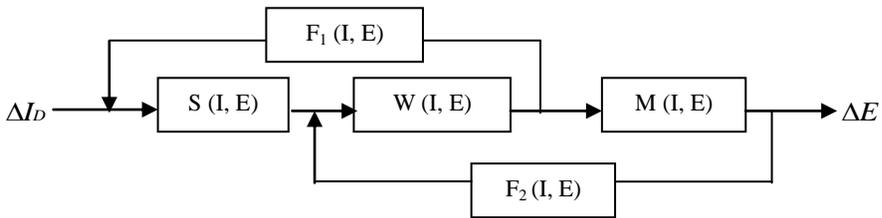
Under the support of information network, adjustment of agricultural production structure, must take massive agricultural market information as the formulation decision-making basis. The decision-making and the effect are information functions, its information logic control relations shown by the following Figure 8.8 <sup>[103]</sup>. Among them, transmit market information to agricultural information network after the gathering, for information network processing, transmission, demonstration gives the producer, producer formulates production structure according to own working condition and gain information and transmit product information to market again by the agricultural information network.

If producer has had microcomputer and suffer condition also may not after facilitating agency or organization which simplification middle link directly transmits supply and demand information carry on ordering and transaction from the net. Therefore, use agriculture information network, producer may make agricultural production in prenatal, medium, postpartum process implements scientific management, establishes a closer relation with the market. The agriculture information network application comprehensive effect appraisal may use a series of information technology economic indicator to carry on. Although, mature, perfect appraisal target system and method still during research, presently, take above chart supposes system for example to carry on the analysis. Supposes system management is decided by the decision information which obtains, between decision-making information content and management effect is increases monotonously. The decision information can satisfy certain timeliness requirements of the system, supposes management decision-making effect (E) and decision information ( $I_D$ ) has functional relation  $E=F(I_D)$ . The system movement short-term cost of operation includes, production adjustment cost C(S), network information cost C(W) and market transaction cost C(M). In this system quality synthetic evaluation, we take the

system movement reliability as technical effect evaluation criteria, take synthesize cost minimum as economic effect evaluation criteria.

**I. Reliability Analysis of Agricultural Information Network Application**

The analysis system utilization effect needs to give dual attention to system certain reliability and management operating cost. First in system of chart carry on definition and variable description as shown in Figure 8.9, definition decision information transforming function  $S(I, E)$ ,  $W(I, E)$ ,  $M(I, E)$  and feedback information transmission function  $F_1(I, E)$ ,  $F_2(I, E)$  also is called system kernels and the feedback kernels. Then relations of decision-making control between decision information  $I_D$  and decision-making effect  $E$  are shown below in the following Figure 8.9.



*Figure 8.9 Relationships between Feedback Control and System Decision.*

Therefore, according to relations of cause and effect control in this system, we may obtain following equation, and carries on analysis expression of the quantity relation.

$$\frac{\Delta E}{\Delta I_D} = \frac{S(I, E)W(I, E)M(I, E)}{1 - F_1(I, E)S(I, E)W(I, E) - F_2(I, E)W(I, E)M(I, E)}$$

(i) Under system open-loop control, namely non-feeds back link,  $F_1 = F_2 = 0$ ,  $1 - F_1SW - F_2WM = 1$ , system is a neutral gain situation. Indicated producer is not decision-making according to feedback information formulation, but carries on management and operation according to instruction plan. General

supposition  $1 \cong S, W, M \cong 0$ , its reliability and the decision-making effect are decided by  $S \cdot W \cdot M$ , namely system reliability and management effect are decided by each link of transmission function.

(ii) When system has feeds back link, namely  $F_1, F_2 \neq 0$ , calls it the closed-loop control system. If  $|\Delta E / \Delta I_D| < 1$ , also  $|SWM| < |1 - F_1 SW - F_2 WM|$  is called negative feedback gain, If  $|\Delta E / \Delta I_D| > 1$ , also  $|SWM| < |1 - F_1 SW - F_2 WM|$  is called regeneration gain. The general request management and operation control effect should increase for negative feedback, may cause system administration process to move close to stably to control the goal and thus makes system reliability to enhance unceasingly. This is must strengthen information resource development unceasingly in t realistic system, expands information channel, improves information quality.

(iii) In extreme situation,  $|1 - F_1 SW - F_2 WM| = 0, |\Delta E / \Delta I_D| \rightarrow \infty$ , then feedback gain can turn willfully in a big way, causes system to intensely unstable thus causes management to lose control.

## II. Economic Effect Analysis of System Application

We carry on appraisal system movement economic effect through short-term cost analysis. Supposes by  $C(S)$  expression agricultural production adjustment cost,  $C(W)$  expresses the network application information technology cost,  $C(M)$  expresses the agricultural product market transaction cost. Then management and operation total cost is:  $TC = C(S) + C(W) + C(M)$ . May establish following dual model according to different of this management system request technical economic target, but its analysis conclusion is the same.

(i) If certain technology reliability conditions ask management and operation expense of system to be lowest, then may suppose:

$$\begin{aligned} \text{Min TC} &= C(S) + C(W) + C(M), \\ \text{St. } E &= f(I_D), I_D \in E(S, W, M, F_1, F_2). \end{aligned}$$

(ii) If certain management and operation expense condition ask the technology reliability of system to be best, then may suppose:

$$\begin{aligned} \text{Max } E &= f(I_D), \\ \text{St. } TC_0 &= C(S) + C(W) + C(M), I_D \in E(S, W, M, F_1, F_2). \end{aligned}$$

Use above any model, we all may carry on analysis appraisal to system technical economic effect. Through the theoretical analysis we may propose a series of reasonable measures to agriculture information network construction, agriculture information resource development, agriculture management. In the improvement aspect of the technical performance system, firstly the utilization characteristics of the information network can enhance the system management and operation the independence and coordinated decision power, this kind of information interactive or closed-loop control itself can enhance the management decision-making greatly the reliability, therefore, it must widen the channel belt, enhances the information running rate. Secondly, it must take the software development besides the network and the hardware carries on the system classification, the processing, processing to the massive information, stores up and take advantage for the application to have the function complete good software. It must develop the more agriculture information processing special-purpose software, the agronomist system and the agriculture decision support system. Thirdly it must have on the rich net resources, and have various information involve in agricultural and the correlation domain. It must carry on the agricultural deeper technology level, more domains and in the bigger market scope information development, the increase agriculture database construction

and persists advanced, secure the manipulation, the extendibility and the Internet principle in the agricultural information database construction. Fourthly, it must strengthens the information management, trains, the equipment specialized technology talented person. Do well the network management, the resources development management, the information security management, the commercial marketing management and so on, it must have the specialty of the special information technology talented person. At the same time, must establish each kind of the perfect information laws and regulations, the system, the technology standard and the management standard.

In the aspect of enhancing the system operation economic effect, it can be analysis with the producer balanced theoretical analysis question that is the distribution of expense in the production and the management of each link reasonably, the optimized disposition resources, obtains the maximum benefit by the time with the smallest cost. The direct usage of network carried on the production management, operation and the transaction needs certain fixed cost, but the unit expense may reduce greatly, but at present few can the materialize. The indirect usage of information network is the most, by now the network was equal to a facilitating agency, but it had to pay much to the organization and the transaction unit expense. When calculate the cost fine to the system management and operation effect appraisal in the network indirect application must consider intermediary expense, credit rating, network cover, website characteristic, information service continuous and so on about five big key aspects, chooses good electronic commerce middle man, that makes it reliable to order on-line, to transport freight, aspects and so on also has the order track form and information consultant. Therefore, although the agricultural network development and the application “the last kilometer” the question cannot the very quick direct solution, but may obtain the indirect solution.

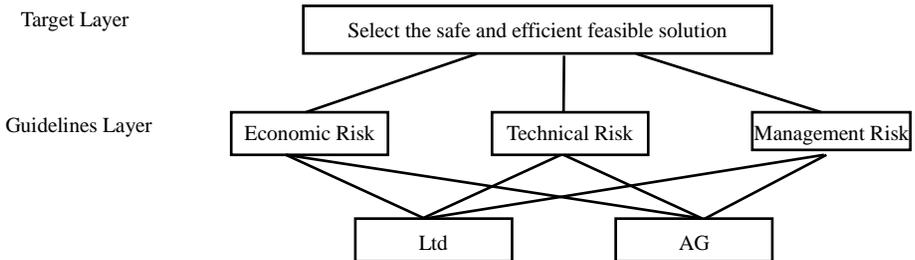
## 8.5 AHP Analysis

Analytic hierarchy process (i.e. AHP method <sup>[104]</sup>) was unable to arrange the quantification risk by the size sorting, distinguishes them with each other. This method is commonly when we analyzes and appraises the behavior of some kinds of system organizational structure. The analysis process has 5 main steps generally. (i) The establishment of hierarchical structural model (ii) The scale (iii) judgment matrix (iv) comprehensive matrix (v) judgment matrix disposable examination.

For example, when establishes the Shenzhou agriculture science and technology demonstration park have to consider the items of basic construction of the plan of the organization manages, according to various difficulties and the Max loss risk in the process of the garden area construction, determine that what kind of organization should be used to manage the plan, namely the enterprise system, that is proposes firstly when the garden area construction plan. At that time, we considered two kinds of plans. One is the limited company, and the other is the joint-stock company. This project proof must analyze the three aspects of the risks: economical risk, technological risks and management risk. The economical risk mainly considered the collection fund used to effect and the government invest repayment as well as questions of market prospect and so on. The technological risks mainly consideration the technical of each stage of garden area constructs, gets up the technological innovation and the promoted exemplary role. The management risk is mainly considered the long-term cooperation organization of all participation quarters, the local authority department, individual investor, the school technical personnel, use tenement and the exemplary role of society affect and so on.

First, establishes the hierarchical structure model of the question. The goal will be considered the basic conditions for the next development t, determined which plan could realize “the risk altogether took on, profit sharing” the

principle well. The goal and three aspects of risks in the proposed question are not easy for quantification, therefore, the goal, the appraisal criterion and the course of action leaves together to structure the model. AHP structural model are shown in the following Figure 8.10.



**Figure 8.10** Structural Model of AHP.

Next, when determined each different factor is opposite in the previous various factors importance, the analytic hierarchy process must carry on the risk factor to w-to-w comparison scales. The w-to-w comparisons uses the scale method is shown in the following Table 8.3.

**Table 8.3** Pair wise Comparison Scaling Analysis of Hierarchy Process.

Scale $a_{ij}$ Degree	Definitions
1	i and j factors equally important factors
3	i factor is slightly more important than J factor
5	i factor more important factor than J
7	i factors more important factors than J
9	I j factor more important than many factors
2,4,6,8	The important of the middle two factors I and j are the comparison results of the above result.
Reciprocal	The importance of two factors j and I, I and j comparison results are two factors that number compare results

Third, is on the computation of judgment matrix. For w-to-w comparison scales, we may determine the important weight of the two different factors. Regarding the three factors of the appraisal criterion level, act according to

three factors from the importance of the Max organization plan of the risk to carry on to w-to-w comparisons, the computed results wrote judgment matrix A.

$$A = [w_{ij}] = \begin{bmatrix} 1 & 0.5 & 1.2 \\ 2 & 1 & 1.6 \\ 0.6 & 0.8 & 1 \end{bmatrix}$$

There are two plans regarding the scheme level. The evaluator obtains three judgment matrix  $A_1$ ,  $A_2$ ,  $A_3$ , from the economic, technical and the management angle, also have to carry on separately the limited company or the two factors of the joint-stock company comparison.

$$A_1 = \begin{bmatrix} 1 & 0.5 \\ 2 & 1 \end{bmatrix}, \quad A_2 = \begin{bmatrix} 1 & 0.8 \\ 1.6 & 1 \end{bmatrix}, \quad A_3 = \begin{bmatrix} 1 & 0.2 \\ 5 & 1 \end{bmatrix}.$$

Then we can calculate eigenvectors of judgment matrix. Regarding four judgment matrix A,  $A_1$ ,  $A_2$  and the  $A_3$  eigenvectors uses  $W$ ,  $W_1$ ,  $W_2$ ,  $W_3$  to indicate separately that and causes its standardization with the following formula (normalization).

$$W_k = \frac{\tilde{w}_i}{\sum_j \tilde{w}_i}$$

$$W = \begin{bmatrix} 0.2786 \\ 0.4737 \\ 0.2477 \end{bmatrix}, \quad W_1 = \begin{bmatrix} 0.3333 \\ 0.6667 \end{bmatrix}, \quad W_2 = \begin{bmatrix} 0.4091 \\ 0.5909 \end{bmatrix}, \quad W_3 = \begin{bmatrix} 0.1667 \\ 0.8333 \end{bmatrix}.$$

We can see through the above computed results, in the eigenvectors  $W$  three integers indicated that, from the risk aspect considered the deep state agriculture science and technology development demonstration garden area project, the maximum construction risk is the technological risks, next is the economical risk, once more is the management risk. We may carry on the plan comparison from other three  $W_i$  computation, indicated that from the aspect of the

economical risk, the technological risks and the management risk angle, since by now the various factors of the relative risk were small, it is ideal to established limited company, meanwhile also we may see that by the digital computation, at present the reason that has not established the joint-stock company, mainly is because of the economy which is specially manages the aspect of the risk (or difficulty).

Fourth, calculate comprehensive matrix. The comprehensive matrix meant embarks from the system overall goal to two plans carries on the appraisal. Therefore, we use the characteristic vector  $W_1, W_2, W_3$  first structure comprehensive matrix  $C$ , then asks new eigenvectors  $W_f$ . We can discover through the computation that, synthesized each aspect, the being established limited company must be smaller than the joint-stock company risk. Namely:

$$C = (W_1, W_2, W_3) = \begin{pmatrix} 0.3333 & 0.4091 & 0.1667 \\ 0.6667 & 0.5909 & 0.8333 \end{pmatrix};$$

$$W_f = CW = \begin{pmatrix} 0.3333 & 0.4091 & 0.1667 \\ 0.6667 & 0.5909 & 0.8333 \end{pmatrix} \begin{bmatrix} 0.2786 \\ 0.4737 \\ 0.2477 \end{bmatrix} = \begin{bmatrix} 0.3279 \\ 0.6721 \end{bmatrix}$$

Fifth, make judgment matrix uniform test. In order to examine tow-tow comparison in many object judgments whether it had the inconsistent problems, usually we must calculate a consistency index C.I.

$$C.I = \frac{\lambda_{\max} - n}{n - 1}$$

In the target formula,  $n$  is the judges matrix conclusion,  $\lambda_{\max}$  is judges matrix maximum eigenvectors. The computation C.I value is smaller, but its uniformity is stronger, so long as  $C.I \leq 0.1$  is generally may accept. But when the judgment matrix dimension is quite big, then judgment uniformity maybe becomes worse. Therefore usually uses more reasonable revision target C. R to

carry on the judgment. The corrected values R.I are shown below in Table 8.4, and the C.R formula is:

$$C.R = \frac{C.I}{R.I.}$$

**Table 8.4** Judgment Matrix of Stochastic Indicator R.I.

Dimension	1	2	3	4	5
R.I	0.00	0.00	0.58	0.96	1.12
Dimension	6	7	8	9	10
R.I	1.24	1.32	1.41	1.45	1.49

In this case  $\lambda_{\max}$  calculation method is, the first need to calculate the vector  $A_w=AW$ , then using the formula  $\lambda_{\max}$ .

$$\lambda_{\max} = \frac{1}{n} \sum_1^n \frac{(A_w)_i}{W_i}$$

Solution is,  $A_w=(0.8127, 1.4272, 0.7938)^T$ ;  $\lambda_{\max}=3.0449$ .

Therefore,  $C.I=0.0225$ , table look-up 8.4,  $R.I=0.58$ , therefore has  $C.R=C.I/R.I=0.0387<0.1$ . Therefore the judgment matrix A uniformity obtained has satisfied.

From the above two researches of the venture decision model, we discovered the complex system question either is observable, either is unobservable or is half observable. If it is observable it can provide to use the massive mathematical model and if it is half observable, it can be researches by the fuzzy mathematics method and the grey system theory. If the system is unobservable, then it should use a kind of analytic hierarchy process model, depends upon people's experience, the vast knowledge, the judgment and the intuition to carry on the inference and the decision-making. Although in recent years information technology and the information network popularization

development was rapid, but in the world rational decision-making and the procedure decision-making level still could not be very high. In fact, in the opening complex great system decision-making difficulty lies in that we have to combine various kinds of decision-making methods and until now it is impossible to find “the multi-purpose keys”, and if the things are like that, the system also unequal it for complex and giant.

## Summary

This chapter has discussed the agricultural production and business risk decision system method from the system angle. First, summarizes the issues of the people to deal with the risk in the daily idea foundation, has explored the basic idea and pursue the goal which the risk management policy-maker should hold. This proposed a simple procedure for our frequent risk management decision-making, namely the risk recognition, the weight or measuring the risk, analyzes the risk and takes the countermeasures. This text has proposed to establish the risks prevent system in macro-scope, perfect social security systems. As an important constituent of the country macroscopic risk management system, the construction of agricultural production risk management and the tentative plan of the macroscopic management system, has designed the embryonic form of “the three-dimensional risk management system”.

Next, this chapter discusses how to analyzes, optimizes and appraises a risk management system. As an example, in the relation of agriculture breeding and poultry raising, such as poultry epidemic disease, external species invasion questions and so on, from international trade channel, domestic market channel, home production manages and expands the channel to take the system analysis, the model and theory of risk utilization research and solution.

Third, this chapter uses the non-linear stochastic economic elastic fractal dimensional model to conduct the research of the macroscopic economic

problem. Related the People's Republic of China near for over 60 years macroscopic economic trends carry on description, saw China national economy for over 20 years leap development. From macroscopic economic GDP use elastic analysis effective demand primary control variable (investment and government expenditure) had discovered China national economy has the short period and the change of the periodic rule. For the agriculture risk management policy formulation, this is an important macroscopic decision-making basis.

Fourth, the system of total risk decision-making may be divided into the qualitative decision-making and quota decision-making. But facing the method of complex system of decision-making often uses these two big kinds of mix utilization methods.

Finally this chapter probed and devised a serial of decision-making analysis model from the point of systematic complexity, uncertainty, macroscopic and non-rational decision-making. And discussed the agriculture information network utilization system enable analysis and analytic hierarchy process has carried on exploration of these methods in the actual application of agriculture venture decision. For example, macroscopic poultry epidemic disease risk transmission and risk management optimization control model, macroeconomic policy analysis, information network model and hierarchical analysis method of organizational risk which can avoid systematic risk in agriculture and so on.

