Chapter 4

Measuring Agricultural Production Management Risk

After identifying the risk, under an ideal situation, we can seek for complete information about entire probability distribution of loss and the different decision-making method influence the distribution. The risk is the possibility of the loss generated in agricultural production management, and this possibility is decided by probability standard. The risk measure mainly is to seek a science way to carry estimate on the related probability distribution. The random variable is a variable which contains the uncertainty. The related random variable information has been aggregated in its probability distribution. According to this, we can obtain a series of mathematical statistics indexes, which may be used to measure the risk of agricultural production management.

4.1 Risk Probability Distributions and Digital Characteristics

The probability distribution describes the results that are possibly appeared in each kind of risk. Decision-making in risk management highly relies on a kind of probability distribution of loss, when the probability distribution expresses the loss distribution. To understand the probability distribution is the key to analysis the risk. The probability distribution generally has continual, the separate or the fuzzy, the continual probability distribution defines by their density function, the separate probability distribution defines by the probability mass function, the fuzzy probability distribution estimates by the subordination function. The density function, the mass function, the subordination function is decided by one or many parameters. The parameters generally have several kinds of basic types such as the shape, the criterion, the position and the modal so on. It doesn't say all distributions have the complete parameter, moreover, the random event probability distribution possibly continues more than one shape parameter and only the fuzzy probability distribution of the blurs event has the modal parameter. So we need to understand and firstly analysis the main types of probability distribution which are used in this book [35] [46].

4.1.1 Continuous Distribution of Risks Events

I. Uniform Distribution

The uniform distribution describes the characteristics of the random variable of the possible risk events between the minimum and the maximum value. Regarding to a uniform distribution which has minimum value a, and maximum value b, if a ≤ x ≤ b, its distribution function is.

$$F(x)=\begin{cases} 0 & \text{if} \quad x\langle a \\ \dfrac{x-a}{x-b} & \text{if} \quad a \le x \le b \\ 1 & \text{if} \quad x\rangle b \end{cases}$$

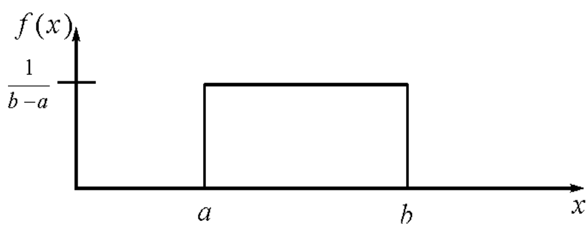

Figure 4.1 *Probability Density Function of Uniform Distribution.*

This uniform distribution may indicate by the Figure 4.1, its density function is $f(x)=1/(b-a)$, the mathematical expectation is $(a+b)/2$, the variance is $(a+b)^2/12$ a is the location parameter, (b-a) is the criterion parameter.

II. Normal Distribution

Normal distribution describes by the common bell shaped curve, it is commonly used in the risk research. The normal distribution is symmetrical and has the nature that median is equal to average value. Although the zone of x has infinite boundary, the majority of density is bunches to the mean value. Its characteristic portrays by two parameters: mean value μ (location parameter) and variance σ^2 (criterion parameter). The normal distribution probability density function is:

$$f(x) = \frac{e^{-(x-\mu)^2/2\sigma^2}}{\sqrt{2\pi\sigma^2}} \quad -\infty < x < \infty \,.$$

The normal distribution may observe in many natural phenomena, such as some natural disasters, the grain yield, the service time, the tolerance in processing. The density function of this kind of distribution does not have a closed graph. The Figure 4.2 has illustrated an approximate graph of standard normal distribution, when $\mu = 0$ and $\sigma = 1$. Assumption $t = \frac{x-\mu}{\sqrt{\sigma^2}}$, then the area of standard normal distribution represents the probability between negative infinite and the spot which is situated at the right (left) of the mean value and with t times of standard deviation. According to "3σ rules", the value of normal random variable nearly definitely falls on the sector [μ-3σ, μ+3σ].

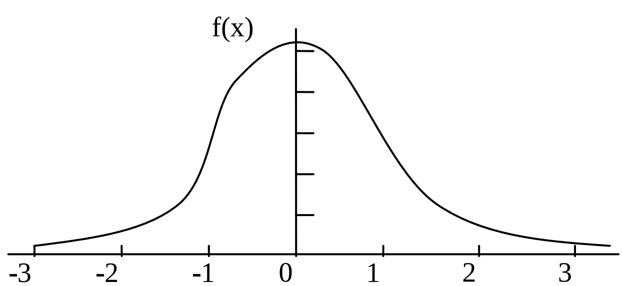

Figure 4.2 *Normal Distribution of μ=0, σ=1.*

III. Triangular Distribution

The triangular distribution may be defined by three parameters: the minimum value a, the maximum value b, with most possible value c. From the Figure 4.3, a is the location parameter, b-a is the criterion parameter, c is the shape parameter. In the price forecast and some certain technical analysis, may usually use it to approach the normal distribution.

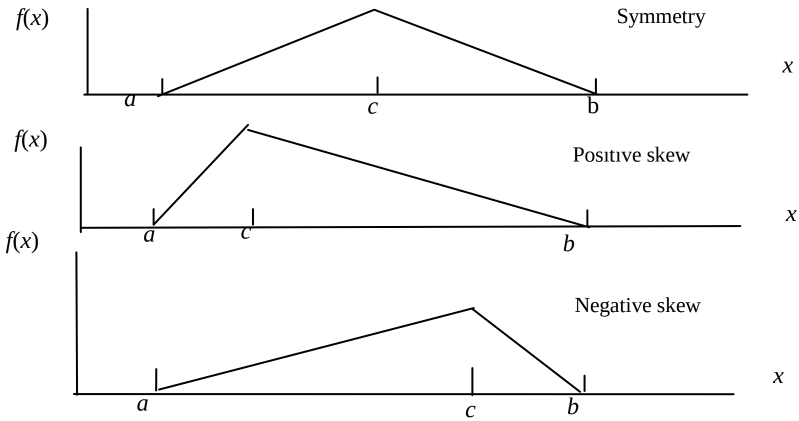

Figure 4.3 *Triangular Distribution Situations.*

The appearance opportunity of the result which approaches to the most possible value is bigger than which is located at the endpoints. Through changing the position of the most possible value to endpoints, the triangular distribution may be symmetrical, or skewed to left or right, its probability density function f(x) as following:

$$f(x)=\begin{cases}\dfrac{2(x-a)}{(b-a)(c-a)} & if \quad a\le x\le c\\[2ex] \dfrac{2(b-x)}{(b-a)(b-c)} & if \quad c<x\le b\\[2ex] 0 & others\end{cases}$$

Its distribution function F(x) is:

$$F(x)=\begin{cases} 0 & if \quad x<a \\ \dfrac{(x-a)^2}{(b-a)(c-a)} & if \quad a\le x\le c \\ 1-\dfrac{(b-x)^2}{(b-a)(b-c)} & if \quad c<x\le b \\ 1 & others \end{cases}.$$

The mean value of triangular distribution can calculate according to $(a+b+c)/3$, the variance is $(a^2+b^2+c^2-ab-ac-bc)/18$. The triangular distribution often serves approximate as other distributions, like the normal distribution or uses when lack of complete data. Because it is determined by three simple parameters and it can shows each kind of shape, it appears extremely flexible when establishes the model at various supposition. However, its shortcoming is the nature of boundary limitation, which caused the possibility of originally perhaps to be able to appear the extreme deviation value to be removed.

IV. Distribution of Lognormal

If random variable x is a normal natural logarithm, then x has the lognormal distribution. Its mean value is $e^{\mu+\sigma^2/2}$, the variance is $e^{2\mu+\sigma^2}(e^{\sigma^2}-1)$. σ is the shape parameter and it must be bigger than 0. Its probability density function is:

$$f(x)=\begin{cases} \dfrac{1}{x\sqrt{2\pi\sigma^2}}e^{-[\ln(x)-\mu]^2/2\sigma^2} & if \quad x>0 \\ 0 & others \end{cases}.$$

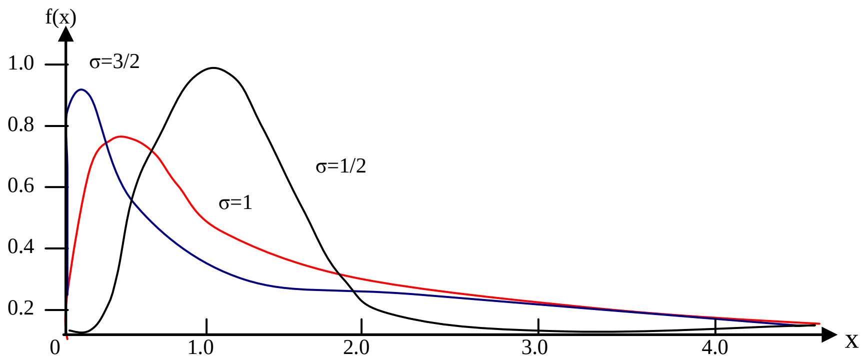

Figure 4.4 *Mean=1 and Standard Deviation for 3/2, 1, 1/2 and the Lognormal Probability Density Function.*

Figure 4.4 has given μ =1 and σ =1/2, 1, 3/2 lognormal density function. When σ takes greater value, distributes starts from 0 to take the maximum value, afterwards it gradually tends to 0 with the x toward ∞. Regarding $\sigma < 1$, the distribution skewness reducing, also nearly becomes the shape of normal distribution, only has the slightly towards right skew of the tail part. μ is a criterion parameter and can take the arbitrary real number. Lognormal distribution is positive skew, and it is taking 0 as the lower bound. Thus, it can establish the model for certain phenomena in using big and positive value, but have small probability (e.g. time of completion task). Other common examples include stock price and real estate price. The log normal distribution also be commonly used "the peak" in the service time, namely its time as 0 and probability is very small, or the most possible value just to be bigger than zero. Lognormal distribution is usually applied to analyze the transmission and the dissipation of risk.

V. Exponential Distribution

Exponential distribution can construct the model of events with stochastic reproduction. Usually it can be used to establish the model, such as in time interval frequently arriving for the customer service system, or agricultural machinery, electronic components and business management system and so on. It's operating failure before expiration. The main property of exponential distribution is memory-less, the current time cannot affect the final effect. For example, no matter how long agricultural machinery already revolved, it continues to revolve to appear the time which the breakdown experiences always to have the similar distribution. The exponential distribution density function and the distribution function separately illustrated as following:

$$f(x)=\begin{cases}\lambda e^{-\lambda x} & x\geq 0\\ 0 & x<0\end{cases} \qquad F(x)=\begin{cases}1-e^{-\lambda x} & x\geq 0\\ 0 & x<0\end{cases}$$

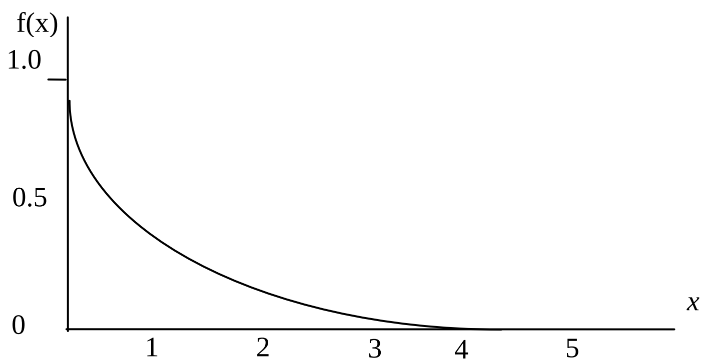

Figure 4.5 *Mean=1 of the Exponential Density Function.*

The mean value of exponential distribution is 1/λ, the variance is $(1/\lambda)^2$, and variance is the square of the mean value. In the formula, λ is the criterion parameter. However, the exponential distribution does not have the shape parameter and the location parameter. Figure 4.5 has given the approximate graph of exponential distribution. The exponential distribution is taking 0 as lower bound, the highest density is in 0, and has the nature that the density reduces along the x-axis.

4.1.2 Digital Characteristics of Probability Distribution

In the risk analysis, we must carry on the comparison frequently on the different random variable probability distribution. So the risk-decision meant how to change the probability distribution. If we want to understand how affects the probability distribution to make the decision-making optimized, more importantly is carrying on the comparison to the digital characteristic of probability distribution, including expected value, variance, standard deviation, deviation correlation coefficient and so on.

I. Expected Value

The expected value of probability distribution also called the mathematical expectation or the mean value, the significance is: in average view, where the risk will be incurred possibly. That means centralized position of random variable x, such like central position of changes for output and price. Regarding the discrete random variable, the definition of mathematical expectation is:

$$\mathrm{E(x)} = \sum_{i=1}^{n} x_i p_i$$

(Pay attention $\sum_{i=1}^{n} p_i = 1$). However, for continuous random variable the density function is the f(x), then its mathematical expectation is:

$$E(x) = \int_a^b xf(x)dx.$$

Therefore, the expected value of discrete events was equal to each kind of possibility multiplied by its corresponding probability, then summation. The expected value of random variable x is first-order origin moment of the x (or quality center coordinate). Suppose there are random variables x_1, $x_2\ldots$, x_m, we can prove that mathematical expectation has the following nature:

(i) If an arbitrary constant c, E(c) = c;

(ii) For m arbitrary constants c_i, (i=1, 2,…, m) the mathematical expectation has the linear relations, such as

$$E(\sum_{i=1}^{m} c_i x_i) = \sum_{i=1}^{m} c_i E(x_i);$$

(iii) If there are m random variables mutually independent, x_i (i=1, 2,…, m), then the mathematical expectation of m random variables is $E(x_1, x_2, \cdots, x_m) = \prod_{i=1}^{m} E(x_i)$;

(iv) If function f(x) = E(y-x)^2, when x=E(y), can get minimum value D(y).

II. Variances and Standard Deviation

When we regard risk as the deviation for the expected value, then variance and standard deviation can be used to measure it. The information expressed by variance of the probability distribution is the result of the expected value deviation possibility and the size which the distribution appears. It measures the change in the degree of the distribution value around the expected value. The distribution variance smaller, the actual result more approaches to the expected value. Otherwise, the distribution variance bigger, the distribution actual results more far away from the expected value. Therefore, for the variance value comparing higher means the result is difficult to forecast, which the decision-making will face more uncertainty. Thus variance is usually directly used to measure risk, but sometimes to use the square root of variance (Standard deviation) is more convenient, the definition index of risk measurement is:

$$Var(x) = \sum_{i=1}^{m} p_i [x_i - E(x_i)]^2$$

$$\sigma_x = \sqrt{Var(x)} = \sqrt{\sum_{i=1}^{m} p_i [x_i - E(x_i)]^2}$$

Regarding continuous random variable x value, if it's scope between b and a, the probability density is f(x), and its variance definition is:

$$Var(x) = E[x - E(x)]^2 = \int_a^b f(x)[x - E(x)]^2 dx = E(x^2) - [E(x)]^2$$

The variance also has its unreasonable aspect as a risk measure index. When the programs scale has difference, we should not use mean-square deviation as the risk measure index. A habitually method is, when we deal with this kind of scale issue, using the deviation σ_x divided by the expected value E(x), the result is obtained a coefficient of variation, that CV_x can be expressed as following.

$$CV_x = \sigma_x / E(x)$$

4.2 To Measure the Risk and Profit

Above we discussed the risk probability distribution and its digital features. Risks are often associated with a series of operational objectives of agricultural production (agricultural production scale, output, cost, price, profit), and the improvement of farmer's social welfare and living standards. Just like we seen in the production function analysis, there are many risks and the uncertainty factors influence the stability realization for the production management anticipated target. In order to process each kind of goals possibly existed contradictions, we need to facilitate the coordination between the risk and the profit. Thus, before considering risk-decision we must determine the size of each kind of risk firstly.

4.2.1 Conventional Risk Determination Method

The risk determination method and the management strategy are different, the management strategy is established after the operational risks, it is a strategy adopts to carry out a kind of management policy. The latter is decided by the policy maker's attitude to risk, risk management approaches as well as tool. Along with the development of uncertainty economic and management research, there are more and more risk determination method, besides several commonly used methods introduced following, theory of utility, mathematical programming, stochastic process, non-linear theory, fuzzy mathematics, neural network, VaR, AHP and so on, which all are used by people to measure and analyze the risk of agricultural production and management.

Method 1: Partial pilot calculation and minimum revenue. This method first analysis input and output of agricultural production in order to repay load interest and compensation management fee, makes the production returns ratio two times as the interest rate. The principle in processing risk question is not considered the climate and other natural factors create change year by year, carries on different pilot calculation to the agricultural production, generally the worst case scenario possibly 10-33%. According to this choose a highest average return level. The low income level may choose the low risk plan; the high income level perhaps the risk amateur may choose the high risk, the high profit plan.

Method 2: Marginal analysis of risk revises. When recognize risk we once discussed possible influence of uncertainty factor to each kind of economical principle. For example the principle of profit maximization is MR=MC, so risk analysis must consider probability distribution of stochastically input. In actual production, the input may divide into stochastically (rainfall, temperature, illumination) and controllable (amount of fertilizer and weed killer). The general method is choosing the scope of controllable inputs seeking the Max expectation profit.

Method 3: Method of profit matrix. In profit matrix analysis, profit is an earning that is brought by controllable decision-making, risk is the weights of uncontrolled event earnings. Namely under the uncontrolled natural condition, profit is farmers obtained earnings by the controllable inputs, it finally displayed as a management effect of nature and socioeconomic interactivity. The profit matrix structure may show in Table 4.1.

Table 4.1 *Revenue and Risk Analysis Results of Shenzhou Science and Technology Park*[6]*.*

Solution of market(θ) (θ)	**Poor harvest**	**Medium harvest harvest**	**Good harvest**	**Expected value(EV)**
Probability(P)	0.30	0.50	0.20	$\Sigma P_i l(a_j\theta_i)$
Project a_1 (10^4) Yuan) +Yuan)	970	1260	1450	1211
Project a_2 (10^4) Yuan) Yuan)	750	988	1235	966
Project a_3 (10^4) Yuan) Yuan)	1000	1100	1200	1090

Source: Study Report. "Case for 3 different plans in Shenzhou of agricultural science and technology Demonstration Park, have made the probability pilot calculation and the supplement according to the investigation".

Based on this decision-making method, in this example, we should select a bigger EV value, such as the project a_1 in the table.

Method 4: Decision tree method. The decision tree method draws the event which all possibly appears according to the order in a tree graph, then in turn calculates the probability value of each decision-making, elects the superiority. Its decision-making criterion is: The profit is the result of decision-making probability; the risk is equal to the n probability of natural state and the market shift. The decision tree method may divide into two kinds, "utility function method" and "certainty equivalent method". We used decision tree method when each decision-making includes many possibility result, each decision-making may appear according to the orderly succession, also can estimate accurately each event probability. Because it is usual difficult to determine the value of utility, thus agricultural production risk management analysis often uses the certainty equivalent method. Decision tree method

6 Shenzhou City is located in Hebei province of China, there are several the agriculture science and technology parks. This was one of an early designed program for forest nursery and garden flowers demonstration.

commonly uses the block as decision-making node; each node may draw a group of branches. The block is similar to the marginal analysis and profit matrix controllable variables. The random variable drawing is circle to express the event with the variable node, then drawing out certain probability branches.

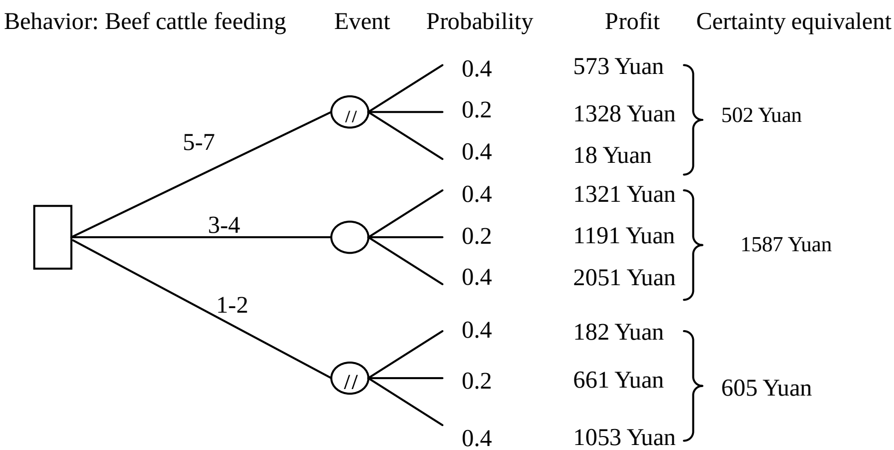

Figure 4.6 *Decision Tree Analysis of Certainty Equivalent on Feeding Beef Cattle.*

The case results analysis: Like Figure 4.6, it is the certainty equivalent decision tree analysis of the Hebei Province Linzhang County farmer household (multiple occupations farmers) raises the beef cattle. The data was from the different years cost and revenue reports in the Hebei Province Linzhang County, the farmer households feeding livestock has different scale beef cattle. According to the certainty equivalent analysis, it indicated the average per household raising beef cattle optimal scale should be 3-4 heads. This is consistent with the plain rural region actual situation, and the related conclusion of the investment rate return analysis. In order to change this kind of animal production level, they had better to use effective new technical measures.

4.2.2 Method of Game Theory

The game theory is often used in the venture decision questions which cannot anticipate beforehand, also cannot use the statistical method to survey its statistical distribution characteristics. These uncertainty factor possibly comes from the different system stratification such as uncertainty of natural environment in overall environment, macroscopic economy circumstance, social economy policy and politics, uncertainty of product and factor market in industrial development and on profession competition; uncertainty in agricultural production management process, like production behavior, transaction behavior, application of new technical, credit and investment measure and so on. There are many uncertainty factors influencing decision-making, but the policy-makers can make t corresponding decision-making rest on the different principle. Still take table 4.1 as the example, the probability which the hypothesis different management condition year occurs unknown, then rests on the decision-making which each kind of uncertainty situation and each plan corresponding income makes to have following five kinds of principles.

I. Maximum Value Maximization Criterion

This principle formula is $a_j = \max_j \max_i [l(a_j, \theta_i)]$. This principle is born in optimistic faction, in pursuing all previous years' greatest income objective point at the Max income which possibly obtains for each kind of strategy, picks up the maximum one. In table 4.1, we should select plan a_3 in the crop failure years, select a_1 in medium income year, a_1 plan is the best in 3 kinds of years (good harvest year income 14.500 million Yuan) and therefore we should select a_1 as the decision-making plan.

II. Minimum Value Maximization Criterion

This principle formula is $a_j = \max_j \min_i [l(a_j, \theta_i)]$. This principle supposition policy-maker inborn pessimistic, always is afraid of the worst result to occur, he chooses the Max one in smallest income of various strategies is often called “craven’s choice”. In table 4.1, based on this kind of conservative principle, the choice are made among a_1, a_2, a_3, the most corresponding disadvantageous result respectively is 970, 750, 1000, a_3 plan (poor harvest also can obtain in 10 million Yuan) is the most advantageous result in disadvantageous, therefore chooses a_3 plan as decision-making.

III. Maximum Regretted Value Minimum Criterion

This principle formula is $a_j = \min_j \{\max_i [l(a_j, \theta_i)] - \max_j [l(a_j, \theta_i)]\}$. The goal is to select a kind of strategy which has the Max opportunity and the smallest loss. Therefore, under each kind of possibility condition, the absolute value of each income subtracts the Max income in this row obtains the opportunity cost. The opportunity cost is the “regretted” value, it expressed the lost not chosen the preferred plan creates under the assign condition. The rational policy-maker should choose a plan of Min regretted lost value. Usually transforms Table 4.1 matrix as the regret matrix, as following Table 4.2 shows the decision-making plan should choose a_2.

Table 4.2 *Regret Matrix in Shenzhou Science and Technology Park.*

Solution of market(θ)	**Poor harvest**	**Medium harvest harvest**	**Good harvests**	**Regret value**
Probability (unknown)	-	-	-	Max
Project a_1 (10^4 Yuan)	30	0	0	30
Project a_2(10^4 Yuan)	250	272	215	272
Project a_3(10^4 Yuan)	0	160	250	250

Source: Transform from Table 4.1

IV. Hurwicz-α Decision Criterion

This criterion is situated between the max-min criterion and the max-max criterion, the policy-maker draw up a weight rests on own favor. Optimistic coefficient α, calculates to each kind of strategy possibly causes greatest and the smallest income weighted average takes the basis of the venture decision. Suppose the weight a ranges from 0 to 1, namely (0< a< 1), the plan formula may be represented as.

$$a_j = \max_j w_i = \max_j \{\max_i [l(a_j, \theta_i)] + (1-\alpha)\min_i [l(a_j, \theta_i)]\}$$

The application table 4.1 data, takes the optimistic coefficient according to the compromise principle α is

$$\text{So } W_1=1450+(1-0.6)\times 970=1838;$$

$$W_2=1235+(1-0.6)\times 750=1535;$$

$$W_3=1200+(1-0.6)\times 1000=1600 \text{ so } a_1=\max\{Wi\} = 1838$$

So we selected a_1 as the decision-making plan.

V. Bayes-Laplace Principle

Because obtaining each kind of situation probability distribution is unable under the uncertainty condition, the policy-maker supposes each kind of situation have the same probability distribution 1/n. If we can obtain the data, then at the basis of corresponding probability distribution, we can calculate the expected value of each strategy, so as to select the highest expectation income for the most superior strategy.

That the formula table is $a_j = \max_j \sum p_i [l(a_j, \theta_i)]$, when each kind of situation has the same probability, $p_i=1/n$. According to table 4.1 probabilities appears which supposition each kind of year's harvest condition is equal probability ($P_i=1/3$), so as,

$$a_1=1/3\times(970+1260+1450)=1226.67;$$

$$a_2=1/3\times(750+988+1235)=991.67;$$

$$a_3=1/3\times(1000+1100+1200)=1100.$$

Therefore, we selected plan $a_{1.}$

4.3 Information Risk

How to measure and analysis the relation between information and risk? Embarks from the realistic system, to the information peoples direct request are the information can realize the high efficiency management when it has accurately, comprehensive, prompt and so on characteristics. Whether the information plays the role, which it should have, we also must consider other factors. Kenneth J. Arrow said. The decision making where is the function of information which it receives. This means the information is relating in all decision-making risk and the information is scarce or needs to pay. For an operator if without information, which has to pay the very great price, the information insufficient must pay certain price, thus these constitute the absolute information risk. Difference holds regarding the existence information, namely the information "the asymmetry" this question, the discussion is most early, most are about the second quality item market, the reversion choice, the request- proxy, the moral risk, the drive design of mechanism and so on, until now it still belongs to the front theory economic research, we might summary it as "the relative information risk". With rapid development of information technology nowadays, obtaining and using the information manpower and the technical capital investment which the information needs to increase day by day, "in these costs is most important and thorniest is to individual information-handling capacity limit. We may call h this kind of risk as "skill risk information" which caused by f individual information-handling capacity limit [12].

Here can induce three questions about measuring and analysis of information risk. (i) No information or lack of information, it will be able to bring the big risk, needs to study the absolute risk of information. (ii) Certain kind of risk which was brought by the existence of information asymmetrical, then we must study the relative risk of information. (iii) If held certain information or peripheral has already filled information, only as a result of individual or the collective information-handling capacity limit, appeared to the phenomenon “the delay” response to the information, had to study the skill risk information. It will be able to cause the information risk in these three kinds of situations, so we call the measure method of risk in information as “information risk method” and give to discuss separately.

4.3.1 Absolute Risk of Information

First, we need to prove the direct relations between information and risk or equal relations. According to Shannon’s information entropy definition, $H(P)=\sum_{i=1}^{m} P_i \log P_i$ is about the measure of information, choice and uncertainty, P_i is the probability of the i^{th} result in a random experiment, i=1, 2… m. This random event entropy function is decided by the probability nature, which has many natures and the main basic characteristics: [9] [50]

(i) H(P) only relates to the probability which occurs with the event, but has nothing to do with the event content.

(ii) H(P) is the corresponding probability’s ($0 \le P_i \le 1, \sum P_i = 1$) only reduced and real-valued function, the higher probable value is, the smaller entropy value is; Regarding the inevitable event (Pi=1) or the impossible event (Pi=0), stipulate corresponding entropy value is 0 based on the proof.

(iii) H(P) is a non-negative real number.

(iv) Regarding to the independent random event, entropy value H(P) has the additive mutually.

Risk is the loss of the anticipated income, whether the information reduces absolutely becomes the loss of the anticipated income? Although Shannon's information concept neglects the value of information, risk and anticipated income are related to the probability of event occurs. When some scholars research the risk level of long-term investment decision-making, they used the information entropy directly to define the risk of invest plan, such as net cash flow, economic life and so on [51] [52]. They thought: "If the investment plan $X=(x_1, x_2, \ldots, x_m)$ is a random variable in R^m, its probability distribution is $P(x_i)$, $P(x_i) \in [0,1]$, i=1, 2,…, m, and

$$\sum_{i=1}^{m} P(x_i) = 1 \text{, then } h(x) = -\sum_{i=1}^{m} P(x_i) \ln P(x_i)$$

is the risk degree of plan X". In fact, the uncertainty of investment plan is bigger, h(x) is bigger; the uncertainty of investment plan is smaller, h(x) is smaller. If the investment plan X takes the determination value, then h(x) is zero, thus investment plan has no risk (when P=1). Therefore, risk may regard as the information entropy in the same nature. The information is the negative measurement of uncertainty, but "the risk degree" is not the direct risk value, it with the risk has non-price signal economic relation.

P. Jorion systematically studied the risk of financial market with VaR first (1997). VaR (Value at Risk) is called the risk value, "is the anticipated lost most greatly under the fiduciary level and the goal time interval which assigns. When Penza's., Bansal. V. K. (2001) measures the market risk in the research with VaR pointed out that, It is refers to when an organization (for example bank) faced with the "normal" market fluctuation, the lost its own property combination possibly suffers most greatly [53]. Some scholars abroad once explored measuring the price risk of agricultural products with this method (Yang, S. R. and Brorsen, B. W., 1992, 1993) [22] [54].

Under normal supposition, VaR of sole property can calculate with formula $VaR = \alpha\sigma P\sqrt{t}$, here in the formula: α is the corresponding Z value of the probability level; σ is the standard deviation of the property returns ratio in assigned time; P is the current market value of property; $\sqrt{t}$ is adjust factor, surveying the situation of property returns ratio.

It is a fact that VaR and information entropy (risk degree) are all in reverse with the probability level, moreover the lost cannot surpass VaR, meant that VaR is the maximum lost corresponding the risk. In order to establish the relation in the value, when the expected value is zero, the standard deviation is σ, the information entropy value when normal distribution density obtains maximized (to see the literature for the proof “Information economy and Management” theorem 3, P.57): $\max h(x) = \ln(\sigma\sqrt{2\pi e})$. Obviously, the maximum information entropy merely relies on the standard deviation σ, so the relation between σ and max h(x) is [50].

$$\sigma = \frac{e^{\max h(x)}}{\sqrt{2\pi e}} \approx 0.242 e^{\max h(x)}$$

In order to explain the corresponding relation between the maximum information entropy max h(x) and standard deviation σ, according to the formula, suppose choice σ=(0.01~0.95), the calculations as Table 4.3. It shows, if max h(x)≧0, then σ≧0.242, while max h(x) is increased with σ augment.

Table 4.3 *Correspondence Value of the Maximum Information Entropy and Standard Deviation.*

Max H(x)	**-3.186**	**-2.493**	**-2.088**	**-1.577**	**-1.107**	**-0.884**	**-0.478**	**-0.191**	**0.000**	**0.033**	**0.215**	**0.369**
σ	0.01	0.02	0.03	0.05	0.08	0.10	0.15	0.20	0.242	0.25	0.30	0.35
Max H(x)	0.503	0.620	0.729	0.821	0.908	0.988	1.062	1.131	1.196	1.256	1.312	1.368
σ	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95

Through the descriptions of Figure 4.7, we can see the functional relation Max h(x) =f (σ), namely, h(x) is a logarithmic function of σ. When the normal distribution takes 0 as the expected value, σ as standard deviation, the maximum information entropy and the standard deviation are diminishing change in the same direction. Substituting σ in VaR formula, we can obtain the corresponding relation between the Value at Risk and the Max risk degree (or Max information entropy).

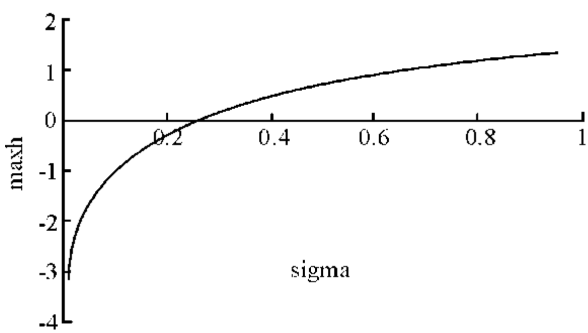

Figure 4.7 *Relationships of Max Information Entropy and Standard Deviation.*

Thus, the approximately formula is shown as follows:

$$VaR = P\alpha e^{\max h(x)} \sqrt{\frac{t}{2\pi e}} \approx 0.242 P\alpha e^{\max h(x)} \sqrt{t} \,.$$

In the actual computation, we found that the result of using standard deviation and Max information entropy is the same. For example, if the anticipated time is designed, hypothesis it is 1 day (t=1); either relied on the experience or through the simulation we choose the probability level (or confidence), there is an assurance of 95%; now the Max anticipated change was $\alpha\sigma = 1.645 \times 0.05 \approx 8.23\%$. Then the Max lost occur in 1,000,000 (US dollars) properties in 1st is possibly 82,300 (US dollars). Similarly, calculation using the information entropy, $\max h(x) = \ln(\sqrt{2\pi e}\sigma) \approx 1.9167$ is the Max risk degree of this choice, value at risk (VaR) is 82,300 US dollars. The significance of calculating value at risk using the information entropy or the risk method is, so long as we had known the risk probability distribution, chosen the time scope and the probability level, substitutes this distributed Max information entropy value to be possible to calculate value at risk correspondingly. In the former example, if the probability level is 99%, σ=2.326, max h(x)=2.263, VaR=23,263 (US dollar).

In fact, the maximized information entropy of non-normal distribution also expresses the maximum risk degree in corresponding probability event, also may act according to known or the estimate distributed type, calculates the risk of the Max lost with its Max information entropy. The Table 4.4 compared the relation between the maximum information entropy and standard deviation (easy to get from variance) with three kinds of typical distributions.

Table 4.4 *Max Information Entropy and Variance in Three Kinds of Distribution* [9] [50].

Distribution types / Max entropy and Variance	Uniform distribution	Exponential distribution	Normal distribution
Max information entropy	$\ln(b-a)$	$\ln(\lambda \cdot e)$	$\ln(\sigma\sqrt{2\pi e})$
Variance	$\frac{(b-a)^2}{12}$	$(1/\lambda)^2$	σ^2

This result has further indicated the direct dependent relation between risk and information. Therefore, Myron S. Scholes (2000) professor once pointed out that information technology in precious resources is playing a more and more important role in present era. Especially under the vigorously impetus of computer network development, no doubt the information technology can directly provide risk managers with a powerful technical support.

4.3.2 Relative Risk of Information

The relative information risk produces in the information asymmetry. The asymmetrical information means that a litigant knows the information while another litigant did not know. As a matter of fact, asymmetrical information in the economic activities involved many economic problems, we can frequently observe it especially in agricultural insurance market operation, venture capital assignment and risk assessment. The illustrative case in terms of relative information risk analyzing is in the request proxy in agricultural insurance.

For example, the insurance object of managing a big awning vegetable (subject-matter insured) is the big plastic awning and it's inner vegetables, the vegetable farmer can take out insurance confirming to the following condition (insurance condition). (i) Big plastic awning confirms to have the construction specification, it is normally used when the farmer insured; (ii) The vegetables plant in the awning conforms to technology specification requirement, and it is normally used when the insured efficient for awning vegetable planting. "Law of insurance" has stipulated the insurance responsibility request, the insurance deadline, the insurance and the insurance premium and so on.

We can establish a request-proxy that the policy holder (vegetable farmer) as principal, the insurance company as the agent. The agent has obtained principal's authorization, carries on the appraisal and the insurance payment for agricultural risk after the disaster. However, when the insured side can affect the possibility and the degree which the compensation event occurs, it will appear the moral risk. Regarding to a vegetable farmer who did not insure, he certainly use the fire protection and wind proof measure, the possibility which the disaster occurs is 0.5%. If he does not use the protective measure, the possibility which the disaster occurs is 1%. So when insurance company chooses the insurance clause is in a dilemma, If including the protective measure, the insurance premium must increase, extremely possibly appears the reversion choice. If not including the protective measure, the probability the disaster occur is 1%. When the insurance company gains the related risk information difficultly, the principal has the possibility that no longer take the disaster prevention measure positively extremely, this is the moral hazard.

Equilibrium analysis model of principal: supposing that the policyholder likes to insure for a big awning vegetable whose value is v, insured value c according to the price is p, which the probability of disaster occurs is P. The policyholder's expense at disaster prevention measure (confirms to certain insurance condition of big awning construction and plant technology and so on) is e, so P (e) means the possible influence of disaster prevention measures, an effect of probability. When the disaster occurs, its lost is b, the payment volume is d, p=c/d, if d $\geq$ b, then the policyholder does not have the enthusiasm of disaster prevention (e=0). Now suppose d< b, principal's income is x_1=v-b-c-e+d when the disaster occurs; At what time the disaster does not occurred, a policyholder's income is x_2=v-c-e. So obtain the maximum expected utility is policyholder's optimal choice, the expression is:

$$\max_{c,d\geq 0} \phi(e,d) \equiv P(e)u(x_1) + [1 - P(e)]u(x_2). \tag{4.1}$$

Solute the first order condition of optimal disaster prevention disbursement, let $\phi_e' = 0$, then:

$$P'(e)[u(x_2) - u(x_1)] = P(e)u'(x_1) + [1 - P(e)]u'(x_2). \tag{4.2}$$

Policyholder's preventive disbursement is the function insures of insurance compensation, e = e(d). Supposes, the relations between the insurance premium and the compensation is c= c (d), and the disburse expense of prevent e can be an observed and expected value. Therefore, x_1(d)=v-b-c(d)-e(d)+d, x_2=v-c(d)-e(d), and the question can be expressed by formula (4.3).

$$\max \psi(d) \equiv P(e(d))u(x_1(d)) + [1 - P(e(d))]u(x_2(d)). \tag{4.3}$$

For solving the question use the first order condition about d, let $\psi'_d = 0$, so:

$$P'e'u(x_1) + Pu'(x_1)x'_1 - P'e'u(x_2) + [1 - P(e)]u'x'_2 = 0. \tag{4.4}$$

Therefore, use dx_1/dd =1-de/dd-dc/dd and dx_2/dd=-de/dd-dc/dd, and substitutes (4.2) into (4.4), we get:

$$c' = \frac{dc}{dd} = \frac{Pu'(x_1)}{Pu'(x_1) + (1-P)u'(x_2).} \tag{4.5}$$

The right side of equation (4.5) expressed the demand change or demand curve D (d) of the policyholder, namely the change of insurance premium regarding to the compensation. When the prevent disbursement e can observe, all insured are identical. If the insurance market is perfect competition, then the insurance company long run average profit (incomes and expenditures in balance) is zero, $(1-P)c - P(d-c) = 0$. That means c(d)=P(e)d, thus dc/dd =P(e)+P'e'd=D(d), which has decided principal's equilibrium insurance quantity. To compare the case of principal's behavior invisible, such as e=0, the equilibrium condition becomes D(d)=dc/dd=P(e). So that, information asymmetry bring about moral hazard in insurance market.

4.3.3 Information Skill Risk

The information skill risk mainly because the information transmission process technical aspect or the information user's knowledge skill are not completely. The information reaches the end from the source, if the information is not prompt or effectiveness, it can create the reduction of organization efficiency or the income loss. This is because the fault in information transmission and the treating processes technical or the information manipulator's limit information-handling capacity. Therefore, it can be explained with two kinds of models.

I. Information Transmission Model

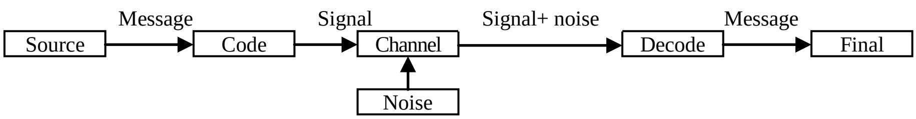

Figure 4.8 *General Communications System Model.*

By information communications system model of Figure 4.8, as Shannon described in information theory, we can inspect the situation that the information transmits from the source through the channel to the final receiver.

In the information transmission process, the quality of signal transmission and transformation is mainly influenced by the code, the decoding technology and the channel noise jamming. The system sensitivity improvement and the filter effect are questions which the course of communications must consider. When considering risk question what we cared about is in the process of probability distribution, probability structure can express abstractly between the source the end as shown in Figure 4.9.

Supposes X is signal set which source sends out; Y as signal set which the final receives.

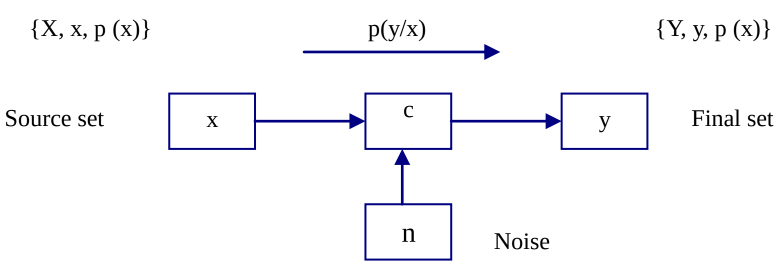

Figure 4.9 *Probability Frame of Communication System.*

Definition 1: The possibility space constituted by $\{X, x, p(x)\}$ is an information source, which produces messages or signals.

Definition 2: For all x∈X, y∈Y combine with conditional probability P(y/x) and two sample X, Y, which use the medium to transmit messages and form a three elements system [X, P(y/x), Y] we call it the information channel. For all x ∈ X and y ∈ Y, if P(y/x) takes an independent value 0 or 1, we say the channel does not have the noise; If it takes other values, we say the channel has the noise.

Definition 3: The possible space constituted by $\{Y, y, p(y)\}$ is the end of information receives, the possible function P(y) may computation as follows: $P(y) = \sum_{x \in X} p(x) p(y/x)$

Definition 4: $\{[X, x, p(x)], [X, p(x,y), Y], [Y, y, p(y)]\}$ is a combinations constituted by the sources, the channel and the final information, is called (none coding or decoding) communications system [9].

According to the possible space which provided by the source [X, x, P (x)] and the final information [Y, y, P(y)], as well as its communications system, according to Claude E, Shannon information definition may write:

$H(x) = -\sum_{x \in X} P(x) \log P(x)$ is a source of information entropy; (4.6)

$H(y) = -\sum_{y \in Y} P(y) \log P(y)$ is information entropy of the final receiver. (4.7)

Correspondingly in possible space $\{x \times y, (x, y), p(x, y)\}$, we may introduce the concept of entropy, where the joint probability p(x, y) satisfies the cindition p(x, y)=p(x)p(y), only when x, y independence. Then we define joint entropy is:

$$H(x, y) = -\sum_{x \in X} \sum_{y \in Y} P(x, y) \log P(x, y) \tag{4.8}$$

Moreover, considering the possible condition p(x/y), this conditional probability satisfies: p(x/y) =p(x, y)/p(y), is the conditional probability of x when the y is assigned; Similarly, the conditional probability p(y/x)=p(x, y)/p(x) is conditional probability of *y* when *x* is assigned. We also introduce Shannon entropy definition [50] to give conditional entropy:

$$H(x|y) = -\sum_{x \in X} P(x|y) \log P(x|y) \tag{4.9}$$

If the final receiver has received complete signal y∈Y, then the average amount information of receiving signal sample y is equal to the mathematical expectation:

$$\begin{aligned} H(x/y) &= \sum_{x \in X} P(y) H(x/y) \\ &= -\sum_{y \in Y} P(y) \sum_{x \in X} P(x/y) \cdot \log P(x/y) \\ &= -\sum_{x \in X} \sum_{y \in Y} P(y) \cdot P(x/y) \cdot \log P(x/y) \\ &= -\sum_{x \in X} \sum_{y \in Y} P(x,y) \log P(x|y) \end{aligned} \tag{4.10}$$

Using the above formula we can derive the relations of entropy as following:

$$H(x)+H(y/x)=H(x,y)=H(y)+H(x/y) \tag{4.11}$$

Therefore, we also discovered the following information entropy relations that can be establisshed.

$$0 \le H(x)-H(x|y) \le H(x) \tag{4.12}$$

Definition 5: We give the capacity value of a channel transmission information:

$$C = \max_{p(x)} \left[H(x) - H(x|y) \right]$$

Capacity C is most important characteristic of transmission information in channel, which comprehensive reflected the communications system information transmission efficiency. According to the discussions in section

4.3.1, the maximum information entropy value and the risk is corresponds. So, the information transmission risk value can be defined as the function of channel capacity value [9].

Definition 6: Supposes C is the channel capacity of an information system, if it can express the communications system efficiency in the existence noise jamming situation, then the definition system information transmission efficiency influences to its property value (V). Thus information transmission risk value (IRV) can be writen as IRV=v(t)F(C, t). Among them, v(t) is in certain time property value; F is the risk, degree it is in reverse proportion with channel capacity value C, is positive proportional with transmission time t [50].

II. Information Processing Model

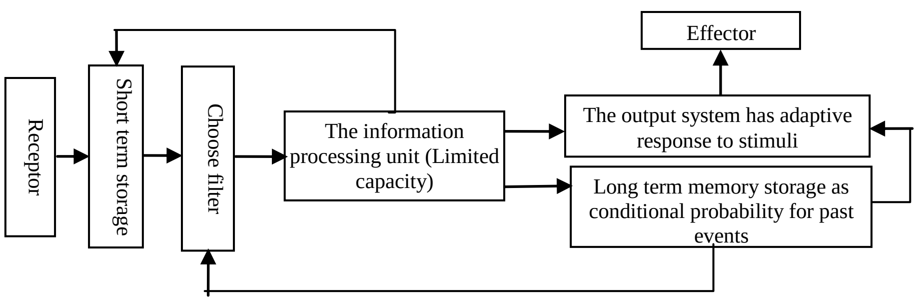

Figure 4.10 *The Human Information Flow Processing Model.*

The information transformation and processing process relates to human's information-handling capacity in the decision-making. Involves disciplines and so on systems science, information science and physiological psychology about human's information transmission and the processing characteristic research, at present already formed about the human body system when affected mutually with the outside to outside aspects and so on information feeling, transmission and processing “human's information transmission theory” [43]. Among many models, in which proposed by American D. E. Broadbent created was shown in Figure 4.10.

The human body is a coordination order system, the information transmission realizes mainly through human’s eyes, ears, nose, tongue, body. Human’s information transmission and the processing model have some suppositions are as following:

Human’s entire nervous system can be regarded as a channel with limited capacity, information processing unit in the channel is the essential unit and the channel capacity size is decided by this information processing unit handling ability. The selective filter is in front of the information processing unit, its function is the readout, lets the related information path information processing unit, carries on the generalized analysis there, other information keep in the short-time memory. The short-time memory in fact is a kind of buffer. Because the capacity of information processing unit is limited, the information which without selected is stored in the short-time memory. The information which have been processed by information unit, a part are passed to long-time memory, storage passed event by conditional probability there; another part of information’s are passed to the short-time memory, but some other parts are delivered to output system to affect in the effector again, makes the compatible response to the outside stimulation. The information in the long-time memory and short-time memory can be provided to the selective filter, takes it as the the reference datum of information selection.

Simplifies human's information transmission and processing model, parallel in series in front of the machine and the environment system, we can form a Human-Machine-Environment System (HMES) information processing model in Figure 4.11 [43].

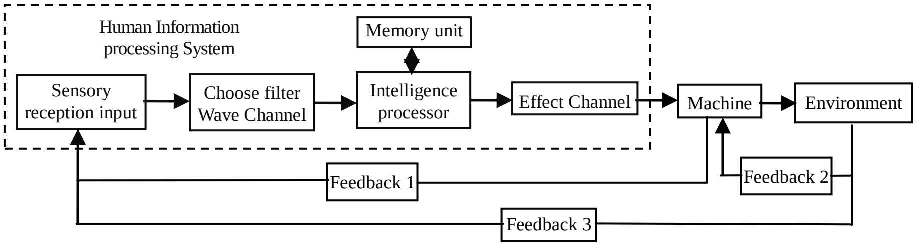

Figure 4.11 *Human-Machine-Environment Information Processing System.*

In human's information flowing and processing processes, human's feeling organ is the input end of outside information. The information processing unit has a decisive function to the information processing, also called the human intelligence processor. The human has the memory ability of short-term and long-term to the information, after the filter choice these two kinds of memory information is delivered to the information processing unit to carry on processes into the command information, again output to the effect or storage.

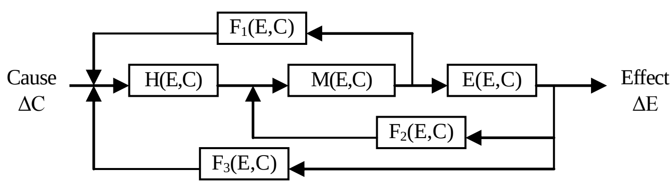

Figure 4.12 *Analysis the Cause-Effect Relationships for Information Processing in HOMES.*

Using Gary. M. Sandquist simulated method [55], H(E, C) expresses the kernel of human's information management system, M(E, C) expresses the kernels of machine system, E(E, C) expresses the kernels of environment system or effect. Suppose system function effect and reason is proportional when system takes function, namely $\Delta E \propto \Delta C$. And F_1(E, C), F_2(E,C), F_3(E,C) express system feedback separately, and the Kernels represent in human-machine, machine-environment, and human-environment three subsystems feedback process. Therefore, H, M, E, F_1, F_2, F_3 are all proportional function, if the above causal relation supposition establishment and suppose it confirms to standard kernels condition, then we can obtain quantification form of above causal relation through analysis and inferential, in the multi-variable situation, the model result can be expressed by following model [43].

$$\Delta E = \frac{H(E,C)M(E,C)E(E,C)}{1 - F_1(E,C)H(E,C)M(E,C) - F_2(E,C)M(E,C)E(E,C) - F_3(E,C)H(E,C)M(E,C)E(E,C)}\Delta C$$

The model shows: the information processing process in the Human-Machine-Environment System is generally a closed-loop control, each feedback kernel symbolizes the intellectualized degree, but human's information management system relates to three system levels looked from the control and the feedback link, taking a role that system core control. The overall system reliability is decided by each sub-system, their relations are "and". Once a system kernel H, M or the E is zero, the system can lose control completely. If system feedback kernels F1, F2, F3 are zero, then the system is called an open-loop control. Now, $|1\text{-}F_1HM\text{-}F_2ME\text{-}F_3HME|=1$, the system control effect only relies on three sub-system kernels H, M, E. In the equation, F_1HM is the feedback effect of human - machine system; F_3HME is the feedback effect of human-machine-environment; obviously, their reasonable value will be able to improve the system control effect.

(i) When $|1\text{-}F_1HM\text{-}F_2ME\text{-}F_3HME|<1$, the overall system is a positive feedback.

(ii) When $|1\text{-}F_1HM\text{-}F_2ME\text{-}F_3HME|>1$, the overall system is a negative feedback. Of course, human all hope obtain a negative feedback control effect in majority information transmission and control.

(iii) When $|1\text{-}F_1HM\text{-}F_2ME\text{-}F_3HME|\to 0$, the system has an extreme unstable situation; it can create destruction of the whole system.

The above discussion mainly take the system reliability as the goal, the reliable description the system ability finishing assignment and coordinated task accurately, promptly and completely under the stipulation condition and the stipulation time. But the safety and the risk system are correspondences in agricultural disaster risk analysis "the sum of safety and risk is 1 [57]. In a system which take "safe, highly effective, economy" as its goal [45], enhance the security and the reliability and reduces the risk are nearly the synonym, these three goals possibly has a contradiction in the ordinary circumstances, however, it will be disadvantage to realize three goals when the information processing aspect has the barrier. We are in the information age, on any surface of abstract human-machine-environment system, all has massively physical parameter which can change into some kinds of information, in order to enhance the system efficiency and improve the system function, and we must fully develop use of the modern information technology. At the same time, the premise of enhancing the labor productivity is t that the worker must have the work knowledge and the skill. According to human's information processing characteristic, such as "selectivity, abstractness, uncertainty, restrictive, compatibility, feedback of information and so on, the former four characteristics had mainly reflected the information receive handling ability of human itself; mainly decide the parameter characteristic of P in the model. The latter two can reflect information transmission and information-handling capacity in human machine and environment union process, such as the parameter characteristic of HM, HME, F_1HM, F_3HME.

Summary

This chapter first discussed each kind of statistical index when analysis and measure the agricultural production risk management. Some concise indexes related to probability distributions are frequently used. The loss probability, the loss degree, the loss expected value assigned in the time t, the variance and the standard deviation.

Next, regarding to conventional risk determination method about balance risk and profit, related to the Hebei Province investigation and study the actual data, introduced how applies it to carry on the venture decision in the practical work. In the uncertainty situation when the venture decision lacks the information completely introduce the game theory method commonly used related to the actual case.

Once more ‘‘wherever the decision was made it is the function of information received.’’ “The information is scarcity or needs to pay. In these costs the most important and thorniest is on individual limitation for information-handling capacity”. It can be said that, without information tool and information theory, it is impossible to make a scientific decisions in terms of risk management.

Based on the above, this chapter thoroughly discussed the relation between information and risk, and the information risk has three aspects: “Absolute information risk, relative information risk and information skill risks”. Firstly we analyzed the corresponding relations of VaR and the information entropy (risk degree) in the risk measurement, explains “the absolute information risk” with it; according to the risk question of the individual information-handling capacity, which is the most important and the thorniest in the cost constitution, we proposed for the concept of “information skill risk” for the first time, and based on this concept of related connotation, established the information transmission model and the information processing model in order to be helpful in studies human’s rule and the characteristic in information processing question, averse the information processing risk; regarding “Relative information risk” caused by asymmetrical information, we also have further discussed and take the moral hazard as the topic.