Journal of Agricultural Science

www.ccsenet.org/journal.html

Vol. 1, No. 1

June 2009

The Grey Situation Decision Analysis on Regional Distribution of Grain and Oil Crops ------A Case Study of Sichuan Province in China: In Respective of Food Supply

Jun'an Chen, Fang Wang (Corresponding author) & Hong'an Xiao

College of Economics & Management, Sichuan Agricultural University

No.46 Xin Kang Road, Ya'an, Sichuan 625014, China

E-mail: icehot225@126.com

This paper is funded by the project "Research on Stable Production and Supply of Hog in China" (N1501) sponsored by the Agricultural Census Office of the State Council, and the project "Research on Existing Circular Agricultural Industry Chain Development in the Hilly Region of Middle Sichuan Province and Countermeasures" (SC07B059) sponsored by the Philosophy and Social Science Funds of Sichuan Province.

Abstract

Regional crops distribution is an import subject for developing modern agriculture now. Based on existing distribution of 7 grain and oil crops in Sichuan province, this paper chose 5 economic evaluation indexes to discuss the regional distribution of grain and oil corps in Sichuan with the method of grey situation decision. According to the row decision and column decision, this paper shows that the sorting result of the advantage grain and oil crops in 21 cities and prefectures of Sichuan province and the adaptability sorting result of 7 grain and oil crops in each region in Sichuan province, which provides scientific basis for the distribution of grain and oil industry in Sichuan province.

Keywords: Regional distribution, Grey situation decision, Grain and oil crops

Agricultural distribution is, in certain spatial scope, to study and program the adjustments and changes of agricultural production structure from a spatial angle, based on existing agricultural production distribution, and identify the internal contradictories in former agricultural distribution, offering services for regions providing macro sorting directions and micro implementations for agricultural production (Regional Economics Study Institute of Renmin University of China, 1996). Crops distribution is an important part of agricultural production distribution, which helps to realize the optimal production effect in the whole region by distributing crops in space scientifically. Today, developing modern agriculture becomes the theme of new countryside construction. How to improve the crops distribution is one of important subjects for all regions developing modern agriculture.

Most studies on crops distribution focus on qualitative analysis, drawing conclusions according to subjective senses or experiences, and seldom on quantitative analysis. Theoretical studies on the distribution methods are few (Dehua Jiang, 1983, p188-195; Dianting Wu & Chuanzhou Wang, 1998, p554-558). The mathematical models for industrial distribution includes linear programming model, economic metrology model, multi-objective programming model, non-linear programming model, dynamic programming model, fuzzy programming model, etc. The linear programming model is widely used in researches on agricultural crops distribution (Hongyan Zhai, 2006, p82-83; Feihong Gong & Tianfu Liu, 1986, p29-36). But because of the changeable nature of objective function along with the time sequence, the application of linear mathematical method faces some problems (Tianshun Li, 1987, p31-34). The gray situation decision model is also widely used for agricultural crops distribution (Xinyu Tong, Yuhui Liu & Jianfeng Zhou, 1993, p121-123; Daobo Wang, Xiaoguo Zhou & Guanglu Zhang, 2004, p16-18).

Along with the unification of urban area and countryside, and the urbanization, food safety has already become an urgent issue. Sichuan province, as an agricultural giant in middle China, has excellent natural and geographical conditions for developing agriculture. The development of grain and oil industry is meaningful for realizing regional food safety. Sichuan province must raise 6.8% of Chinese population by 4.2% of national cultivated lands. More people with less cultivated lands gives more pressure on the cultivated lands. To stabilize the areas of cultivated lands for crops and implement a scientific regional distribution of grain and oil crops, by improving the unit yield, is meaningful for driving the development of grain and oil industry, releasing the contradiction between population and lands, realizing optimal agricultural structure, and transferring rural surplus labor powers. This paper adopts the grain situation decision model from the grain system theory, takes 7 grain and oil crops in Sichuan province as objects, based on existing grain and oil production distribution in 21 cities (states) in Sichuan province, select 5 economic evaluation indexes, analyze the comparative advantages of different regions in grain and oil production, and discusses the regional distribution of grain and oil crops in Sichuan province, with the hope of offering scientific basis for the structure adjustment of grain and oil industry in Sichuan province.

1. The gray situation decision analysis method

The gray situation decision (Julong Deng, 2005) is a decision analysis method that uses a mathematic language and makes decisions match up with incidents by taking all decision factors into consideration. The gray situation decision is maybe single-objective decision or multi-objective decision. This paper adopts the multi-objective decision. Its mathematical principle and process are as follow.

1.1 Construct the decision matrix

Suppose there are m incidents in the gray situation decision, namely a_i (i = 1, 2, ……, m); In correspondence to m incidents, there are n decisions, namely b_j (j = 1, 2, ……, n). Name the combination of incident a_i and decision b_j as situation $s_{ij} = (a_i, b_j)$. It means the j decision (b_j) is for the i incident (a_i). The effect measurement value of situation s_{ij} is r_{ij}. Every element in the decision matrix is a decision unit, namely:

$$\frac{r_{ij}}{s_{ij}} = \frac{r_{ij}}{(a_i, b_j)}$$

The decision matrix is:

$$M = \begin{pmatrix} \frac{r_{11}}{s_{11}} & \frac{r_{12}}{s_{12}} & \cdots & \frac{r_{1m}}{s_{1m}} \\ \frac{r_{21}}{s_{21}} & \frac{r_{22}}{s_{22}} & \cdots & \frac{r_{2m}}{s_{2m}} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{r_{n1}}{s_{n1}} & \frac{r_{n2}}{s_{n2}} & \cdots & \frac{r_{nm}}{s_{nm}} \end{pmatrix} \quad (1)$$

1.2 The effect measurement

The effect measurement is to quantitatively measure the effect generated from the situation. It is a specific measurement of practical effect of the situation by comparative analysis. The effect measurement includes three types, namely:

(1) The top effect measurement, $r_{ij} = \frac{u_{ij}}{u_{\max}}$

(2) The bottom effect measurement, $r_{ij} = \frac{u_{\min}}{u_{ij}}$

(3) The medium effect measurement, $r_{ij} = \frac{\min(u_{ij}, u_0)}{\max(u_{ij}, u_0)}$

Here, u_{ij} is the practical effect value of situation s_{ij}. $u_{\max}$ is the maximum practical effect value of all

situations s_{ij} . $u_{\min}$ is the minimum practical effect value of all situations s_{ij} . u_0 is an appointed medium value.

In practice, it is the nature of decision objective that determines the type of measurement. If we pursues for the largest objective value, we can select the top effect measurement. If we want the smallest objective value, we can adopt the bottom effect measurement. If we prefer to a proper value, we can take the medium effect measurement.

1.3 The matrix for calculating the integrated effect measurement

Suppose the situation has p objectives. The effect value of objective k is $r_{ij}^{(k)}$ and its decision unit is $\frac{r_{ij}^{k}}{s_{ij}}$. By the decision matrix $M^{(k)}$, we can construct the multi-objective integrated decision matrix, namely:

$$M^{(\Sigma)} = \begin{pmatrix} \frac{r_{11}^{(\Sigma)}}{s_{11}} & \frac{r_{12}^{(\Sigma)}}{s_{12}} & \cdots & \frac{r_{1m}^{(\Sigma)}}{s_{1m}} \\ \frac{r_{21}^{(\Sigma)}}{s_{21}} & \frac{r_{22}^{(\Sigma)}}{s_{22}} & \cdots & \frac{r_{2m}^{(\Sigma)}}{s_{2n}} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{r_{n1}^{(\Sigma)}}{s_{n1}} & \frac{r_{n2}^{(\Sigma)}}{s_{n2}} & \cdots & \frac{r_{nm}^{(\Sigma)}}{s_{nm}} \end{pmatrix} \tag{2}$$

Here in this matrix, $r_{ij}^{(\Sigma)}$ is the integrated effect measurement value of situation s_{ij} . It is the final effect value by integrating multiple objectives. If we endow with each objective with average weight, the calculation is:

$$r_{ij}^{(\Sigma)} = \frac{1}{p} \sum_{k=1}^{p} r_{ij}^{(k)}$$

1.4 Make decision

According to the multi-objective integrated decision matrix, we can use two ways to select the situation with the most excellent effect, or select the maximum integrated effect measurement value $r_{ij}^{(\Sigma)}$ among the matrix $M^{(\Sigma)}$.

(1) Row decision. Select the largest integrated effect measurement value $r_{ij}^{(\Sigma)}$ from the each row of the multi-objective integrated decision matrix $M^{(\Sigma)}$. The situation s_{ij} is the best, what means the decision b_j is the best choice for the incident a_i .

(2) Column decision. Select the largest integrated effect measurement value $r_{ij}^{(\Sigma)}$ from each column of the multi-objective integrated decision matrix $M^{(\Sigma)}$. The situation s_{ij} is the best, what means the incident a_i is most appropriate incident for the decision b_j .

2. Demonstration on the gray situation decision analysis method

2.1 Select evaluation indexes

This paper aims at studying the regional distribution of grain and oil crops in Sichuan province. The crops include rice, wheat, corn, legume, potato, rapeseed, and peanut. Select five evaluation indexes displayed in table 1. According to data in Sichuan Statistical Yearbook in recent four years (Statistics Bureau of Sichuan Province, 2004-2007), we calculate the decision matrix and finally get the integrated effect measurement matrix.

2.2 Results of model calculation

According to the similarities of time sequence, get the average of each index based on data of 2003 to 2006. Firstly, calculate the decision matrix of the five evaluation indexes based on model (1). Then, calculate the integrated effect measurement matrix based on model (2). In calculation, we endow the five indexes with average weights. Finally, we get the table 2 (display only integrated effect measurement values).

2.3 Make decision

Make decision according to the results of gray situation decision and identify the crops with comparative advantages in different regions. Results are in table 3 (three crops for each region).

Made decision according to the results of gray situation decision and get the sequence of 7 grain and oil crops according

to their comparative advantages in the 21 cities (states) in Sichuan province. Table 4 displays the results (list six regions for each crop).

3. Conclusion

This paper analyzes the regional distribution of grain and oil crops in Sichuan province by the gray situation decision analysis method. Based on data calculation, this paper orders the sequence of grain and oil crops according to their comparative advantages in the 21 cities (states) in Sichuan province. Results show that structures of grain and oil crops with comparative advantages in different regions are similar. Most regions possess comparative advantages in rice, wheat, and corn. The reason may lie in the relatively sound basis of land crops. By ordering the sequence of 7 grain and oil crops' regional integrated measurements in Sichuan province, establish the most appropriate regions for planting 7 grain and oil crops respectively in Sichuan province. By comparing the research result and existing regional distribution of grain and oil crops, we find that existing distribution strays away from this research result to certain degree. Present regional distribution of grain and oil crops is unscientific.

Considering the large population but less cultivated lands, to improve the regional distribution of grain and oil crops in Sichuan province is urgent and also an important issue for establishing regional development programs. In the overall programming distribution in Sichuan province, establish the regional adaptability of each grain and oil crop and increase the planting areas in the region with high adaptability. In the regional programming distribution, establish the comparative advantage of each grain and oil crop in one region and increase the planting area of the crop with high comparative advantage. This paper rightly offers scientific basis for the regional distribution of grain and oil crops in Sichuan province. We should coordinate different relationships, and implement the regional distribution scientifically and reasonably, hoping to realize the goal of ensuring food safety, releasing pressures from limited lands, transferring rural surplus labor powers, optimizing agricultural structure, and driving rural economic development.

References

Deng, Julong. (2005). *Basic Methods for Gray System* (2e). Wuhan: Huazhong University of Science & Technology Press.

Gong, Feihong & Liu, Tianfu. (1986). The effect of mathematical programming on crops planting structure ------ the crops planting structure and distribution in Xing County, Shanxi Province. *The Journal of Quantitative & Technical Economics*. No.3. p29-36.

Jiang, Dehua. (1983). On some quantitative analysis issues of crops distribution. *Acta Geographica Sinica*. No.38(2). p188-195.

Li, Tianshun. (1987). On fuzzy programming of crops distribution ------ a case study on Fengqiu County in Henan Province. *Chinese Journal of Ecology.* No.6(5). p31-34.

Regional Economics Study Institute of Renmin University of China. (1996). *Industrial Distribution Theory*. Beijing: China Renmin University Press.

Statistics Bureau of Sichuan Province. (2004-2007). *Sichuan Statistical Yearbook*. Beijing: China Statistics Press.

Tong, Xinyu., Liu, Yuhui & Zhou, Jianfeng. (1993). Application of gray situation decision in crops regional distribution. *System Sciences and Comprehensive Studies In Agriculture*. No.9(2). p121-123.

Wang, Daobo., Zhou, Xiaoguo & Zhang, Guanglu. (2004). Study on crops space distribution based on gray situation decision mode. *Culture with Planting*. No.2. p16-18.

Wu, Daiting & Wang, Chuanzhou. (1998). A pilot study on crops distribution optimized mode. *Journal of Beijing Normal University (Natural Science)*. No.34(4). p554-558.

Zhai, Hongyan. (2006). The application of linear programming (transportation issue) in crops distribution. *Modern Agricultural Science & Technology*. No.10. p82-83.

Table 1. The evaluation indexes for the regional comparison of grain and oil crops in Sichuan province.

No.	Index	Unit	Type of effect measurement
1	Unit yield of grain and oil crops in one region	kg/hm^2	Top effect measurement
2	Output per capita in agricultural industry	kg/per capita	Top effect measurement
3	Proportion of cultivated land for one crop to the cultivated land for all regional grain and oil crops	%	Top effect measurement
4	Proportion of regional cultivated land for one crop to the provincial cultivated land for this crop	%	Top effect measurement
5	Proportion of regional output of one crop to provincial output of this crop	%	Top effect measurement

Table 2. Integrated effect measurement.

Region	Rice	Wheat	Corn	Legume	Potato	Rapeseed	Peanut
Chengdu	0.75566	0.39553	0.22287	0.16630	0.25669	0.35385	0.14430
Zigong	0.65274	0.27367	0.28315	0.16350	0.29275	0.09269	0.12683
Panzhihua	0.47824	0.20859	0.30151	0.14358	0.14672	0.03463	0.04132
Luzhou	0.67157	0.22010	0.28126	0.19022	0.34556	0.07395	0.06956
Deyang	0.67333	0.44979	0.29917	0.15476	0.23488	0.31932	0.17443
Mianyang	0.54308	0.44817	0.39131	0.14113	0.25601	0.38667	0.28876
Guangyuan	0.45489	0.38982	0.39925	0.12118	0.23172	0.24439	0.26753
Suining	0.43597	0.40120	0.40747	0.21930	0.39474	0.22957	0.19234
Neijiang	0.48744	0.29345	0.35356	0.15454	0.35857	0.14207	0.16718
Leshan	0.53325	0.12535	0.27637	0.15000	0.27488	0.13834	0.08246
Nanchong	0.52065	0.48587	0.41404	0.40756	0.38447	0.31544	0.50396
Meishan	0.63249	0.36058	0.25608	0.12814	0.27028	0.20006	0.10783
Yibin	0.63307	0.28893	0.34327	0.16584	0.34198	0.09363	0.17658
Guang'an	0.61025	0.26385	0.30953	0.22869	0.32548	0.18432	0.15502
Dazhou	0.60909	0.26568	0.45274	0.31997	0.48069	0.38202	0.19175
Yan'an	0.41590	0.19581	0.34091	0.15603	0.23385	0.13291	0.06415
Bazhong	0.41841	0.34423	0.44607	0.12698	0.36725	0.23135	0.10993
Ziyang	0.45687	0.39643	0.46583	0.25391	0.43005	0.26707	0.25138
A'ba	0.11177	0.15159	0.34525	0.22278	0.21784	0.03890	0.00000
Ganzi	0.16637	0.20951	0.28568	0.16290	0.17776	0.04751	0.02261
Liangshan	0.36480	0.27108	0.46818	0.27553	0.37924	0.06190	0.04761

Table 3. The grain and oil crops with comparative advantages in different regions in Sichuan province.

Region	1	2	3	Region	1	2	3
Chengdu	Rice	Wheat	Rapeseed	Meishan	Rice	Wheat	Potato
Sigong	Rice	Potato	Corn	Yibin	Rice	Corn	Potato
Panzhihua	Rice	Corn	Wheat	Guang'an	Rice	Potato	Corn
Luzhou	Rice	Potato	Corn	Dazhou	Rice	Potato	Corn
Deyang	Rice	Wheat	Corn	Ya'an	Rice	Corn	Potato
Mianyang	Rice	Wheat	Rapeseed	Bazhong	Corn	Rice	Potato
Guangyuan	Rice	Corn	Wheat	Ziyang	Corn	Rice	Potato
Suining	Rice	Corn	Wheat	A'ba	Corn	Legume	Potato
Neijiang	Rice	Potato	Corn	Ganzi	Corn	Wheat	Rice
Leshan	Rice	Potato	Corn	Liangshan	Corn	Potato	Rice
Nanchong	Rice	Peanut	Wheat				

Table 4. The regional adaptability of grain and oil crops in Sichuan province.

Crop	1	2	3	4	5	6
Rice	Chengdu	Deyang	Luzhou	Zigong	Yibin	Meishan
Wheat	Nanchong	Deyang	Mianyang	Suining	Ziyang	Chengdu
Corn	Liangshan	Ziyang	Dazhou	Bazhong	Nanchong	Suining
Legume	Nanchong	Dazhou	Liangshan	Ziyang	Guang'an	A'ba
Potato	Dazhou	Ziyang	Suining	Nanchong	Liangshan	Bazhong
Rapeseed	Mianyang	Dazhou	Chengdu	Deyang	Nanchong	Ziyang
Peanut	Nanchong	Mianyang	Guangyuan	Ziyang	Suining	Dazhou