academicJournals

Vol. 8(31), pp. 4239-4246, 15 August, 2013
DOI: 10.5897/AJAR11.1399
ISSN 1991-637X ©2013 Academic Journals
http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Eco-farming models and their regional differentiations of Shaanxi, China

Jiang Che[1], Yun Cheng Liao[1]*, Xiao Hui Ding[2] and Yan Liu[1]

[1]College of Agriculture, Northwest A&F University, Yang ling, 712100, China.
[2]College of Resources and Environment, Northwest A&F University, Yang ling, 712100, China.

Accepted 8 August, 2013

By statistical analysis and cluster analysis, the study investigated eco-farming models and their regional distributions of twelve counties of Shaanxi Province. It categorized the eco-farming models into seven basic models and analyzed the distributions of the basic models of the different counties. Its results showed that of the sampled counties of Shaanxi, the average number of the eco-farming models was 6.2 and the average coverage degree of the models was 88.1%; and the proportion of the crop planting model was the highest and the proportion of the courtyard based model was the lowest. According to its cluster analysis results on the proportions of the different eco-farming models, the study divided the twelve sampled counties under four groups, and analyzed and revealed the distribution characteristics of the natural resources and environments of the groups, put forward the priorities for the different regions to practice the different eco-farming models, and provided research methods on eco-farming models and their distribution of other regions.

Key words: Shaanxi, eco-farming model, regional differentiation pattern.

INTRODUCTION

Shaanxi province is commonly divided into Central, South and North Shaanxi and this division is done in terms of its natural geographical conditions. The study separately screened four counties of the three regions as its research targets, which were the District and countries of Yangling, Meixian, Dali and Chang'an of Central Shaanxi, the counties of Mianxian, Chenggu, Xixiang and Ningqiang of South Shaanxi and the counties of Jingbian, Luochuan, Suide and Zichang of North Shaanxi. The study carried out on-site surveys of these countries and collected the data of the counties from relevant year books concerned with them. The study conducted its processing and analysis of the data thus obtained to probe into the countries. It is well-known that to practice eco-farming has become one efficient approach and one inevitable choice for sustainable agricultural development, and eco-farming models has been the essence and concrete reflection for the different regions to practice eco-farming (Krishna., 2011; Kurosh and Saeid, 2010), and thus to investigate eco-farming models and their distribution characteristics of different regions is helpful to orienting regional eco-farming development, helpful to comparing the limiting factors for different regions to practice eco-farming and solve their main problems while their practicing eco-farming, helpful for similar regions to learn how to practicing eco-farming, so as to promote eco-farming development (Liu and Jiao, 2002) . The two methods that the study adopted and the statistical analysis and cluster analysis that the study carried out have different research targets and the research results obtained by them are different as well; the study carried out its statistic analysis to probe into the basic situations

*Corresponding author. E-mail: chejiang2011@sina.com, yunchengliao@nwsuaf.edu.cn.

of the different countries concerned and considering that statistic analysis is the basis of cluster analysis, cluster analysis could be carried out to categorize similar regions and thus to set up corresponding categorization patterns and as a result the research results thus obtained will be of very great practicality (Wackernagel et al., 2002). Although there are related researches in eco-farming models, they are not deep enough and their analysis are not penetrative enough as well, so that it is necessary to do further research on eco-farming models.

THEORY

Main eco-farming models and their regional classification of Shaanxi

Eco-farming models

The classification of eco-farming models is crucial to studying, promoting and expanding eco-farming as well as setting up development and assessment standards of eco-farming. Because most of eco-farming models are generalized from practical experiences, many scientific workers summarize eco-farming models by regional example enumeration or practical classification. In the recent years, some scholars try to systematically sort, sum up and classify typical eco-farming models. Qi (1992) proposed that depending on the scales or administrative ranks of the regions that they cover, eco-farming models be classified into cities, countries, townships(towns), villages and farms and households of eco-farming; depending on their natural, social and economic conditions of the regions where they are practiced, they be classified into plain-based eco-farming, mountainous eco-farming, hilly eco-farming, aquatic eco-farming, grassland-based eco-farming, courtyard-based eco-farming and littoral eco-farming and urban eco-farming; depending on their products, eco-farming models be classified into single-product and multi-product models; depending on their farming types, eco-farming models be classified into crop-planting models, forest plus fruit tree models, animal-raising models, farm model, business models; depending on their resource exploiting modes, eco-farming models be classified into multi-layer resource-exploiting models, integrated resource-exploiting models, recyclable resource exploiting models, self-cleaning resource models and bio-ring-added resource exploiting models (models with bio-rings added to or removed from their biological chains and symbiotic model). Li (2000) put forward what simplified the aforementioned classifications, holding that eco-farming could be classified according to the scales and natural, social and economic conditions plus main products, or three kinds of classification standards of main industries of the regions where the models were practiced, that is, according to the scales or administrative ranks of the regions where eco-farming was adopted, expanded and practiced, eco-farming models could be classified into into cities, countries and townships, villages and households of eco-farming; according to the natural, geographic, social and economic conditions of the regions where they were practiced, eco-farming models could be classified into plain based models, mountainous models, hilly models, aquatic models, grassland based models, courtyard-based models, littoral models and urban plus suburb models; according to the major products or major industries of the regions where they were adopted, eco-farming models could be classified into single product-or single industry-dominated models, or at least two or three product- or industry-dominated integrated models. Li (2008) divided eco-farming models of China into four groups, multi-layer substance-exploiting models, symbiotic models, resource-exploiting models and environment-controlling models, tourism attraction models according to its agricultural development characteristics, social and economic developments and resources status quo. In their study of the Standard Systems and Important Technical Standards of Eco-farming. Qiu and Ren (2008) adopted the classification method developed by Li (2008). Currently, the understanding on the classifications of eco-farming still need to be unified. The basic types and their intensions of eco-farming models are shown in Table 1.

The study put forward that the classification of eco-farming models was one basic classification and other classifications of eco-farming models carried out in light of their purposes were not excluded.

The afore-described nuclear classifications of eco-farming models showed that there are seven basic eco-farming groups, that is, seven basic models. Of course, this modification is not absolute and in production practices, different basic eco-farming models mutually penetrate into and interact with one another, so that basic eco-farming models can be extended to form an integrated model by adding such non-farming industries as processing and tourism to them.

Classifications of main eco-farming models of Shaanxi

Eco-farming models of Central, South and North Shaanxi were classified on the basis of on-site survey data and their statistical analysis results of the regional distributions of the main eco-farming models of the three regions and according to the requirements of basic eco-farming models (Bicknell et al., 1998). The classifiers of the classification, taking the form of region+serial number+ type, are shown in Table 1. For example, YL1-Y1 stands for a crop planting dominated eco-farming model, which is practiced in Yang ling, that is, YL, and whose serial number is 1. Table 2 presents main eco-farming models and their basic models of Yang ling.

Table 1. Basic eco-farming model.

Model code	Basic eco-farming model	Citing (basic intension)
Y_1	Crop planting model	Being aimed at improving farmland environments and properly arranging crop-planting modes on farmlands
Y_2	Forest plus fruit tree model	Being aimed at promoting ecological forests and fruit trees and improving land use efficiencies
Y_3	Animal-raising model	Being aimed at promoting ecological raising dominated by aquatic culture and animal husbandry
Y_4	Courtyard based model	Being aimed at promoting courtyard economies
Y_5	Business model	Being aimed at properly processing agro-products and producing organic agro-products
Y_6	Environment-conserving model	Being aimed at improving eco-environments and environment qualities
Y_7	Tourism attraction model	Emphasizing on conserving natural landscapes and promoting sustainable tourism

Table 2. Main eco-farming models and their basic types of Yang ling.

Eco-farming model	Basic model
The model of “Straw composting and incorporation into soil”	YL1-Y_1
The model of “fruit tree and grass intercropping”	YL2-Y_2
The model of “pig raising-biogas generation –fruit tree planting”	YL3-Y_3
The model of safe latrine and waste stacking and composting	YL4-Y_4
The model of processing byproduct and urban organic waste recycling	YL5-Y_5
The model of countryside tree planting and polluted land rehabilitation	YL6-Y_6
The model of developing the city of Agricultural Sciences and Technology Yang ling as a tourism attraction	YL7-Y_7

METHODS

Proportions and coverage degrees of the eco-farming models

Depending on main eco-farming models and their basic models of the different regions of Shaanxi (Bastianoni et al., 2001), the study calculated the percentages of the different eco-farming models of the different regions, or the proportions of them, that is, the proportion of the number of one individual eco-farming model of one region to the total number of all the eco-farming models of the region (y_{ij}), whose computation formula is as follows:

$$y_{ij} = \frac{\text{Number of the eco farming model of j of the Region of i}}{\text{Number of all the eco farming models of the Region of i}} \times 100\% \quad (1)$$

In which *i*=1,2,3,…,11 which stand for the different regions; *j=1,2,* …,7, which stands separately for the crop planting model, the forest plus fruit tree model, the animal-raising model, the courtyard based model, the business model, the environment-conserving model and the tourism attraction model.

Therefore, the value of y_{ij} indicates how important the different models are to some extent. In addition, the study calculated the coverage degrees of the different models (C_i), which was the percentage of the number of the models practiced in one region to the total number of the models of the region and the total model number of the study was seven. C_i was calculated by the following formula:

$$C_i = \frac{\text{Number of the models practiced by the Region of i}}{7} \times 100\% \quad (2)$$

Similarities of the eco-farming models by cluster analysis

As described before, the establishments of eco-farming models and their basic groups of different regions are closely related to the local social, economic and environmental conditions of the regions (Coleman et al., 1992). Thus, the proportions of different eco-farming models (y_{ij}) of different regions can be used as the original cluster analysis variables to find out similar regions for different eco-farming models as well as the social and economic or environmental characters of these regions, so that a scientific foundation for promoting and adopting and practicing eco-farming can be provided (Tilley and Swank, 2003). Here, the study adopted the un-weighted pair group method with arithmetic means (UPGMA) to conduct its cluster analysis (Brown and Buranakarn, 2003). In which:

$$x_{ij} = \frac{y_{ij} - \bar{y}_j}{S_{ij}} \quad (3)$$

Table 3. Percentages (proportions) and coverage degrees of the different eco-farming models of the different regions.

Region	Crop planting	Forest plus fruit tree type	Animal-raising types	Courtyard based type	Business types	Environment-conserving type	Tourism attraction type	Number of models	Coverage degree (%)
Yang ling	13.2	26.4	26.8	10.6	15.5	2.5	7.8	7	100
Mei xian	28	30.5	10.2	5.3	14.5	0	5.2	6	85.7
Chan gan	20.4	14.8	15.3	11.5	12	2.3	20.5	7	100
Da li	18.6	29.2	27.6	9.8	18	0	15	6	85.7
Mian xian	30.1	10.2	12.5	0	15	10.5	13.5	6	85.7
Cheng gu	27.6	8.4	9.8	0	20.8	9	10	6	85.7
Xi xiang	21.4	20	15.9	0	14.8	12.9	8.8	6	85.7
Ning qiang	40.8	18.9	11	10.5	0	5.7	6.9	6	85.7
Luochuang	20.5	32.1	5.3	0	10.4	15.1	6.9	6	85.7
Jing bian	30.6	18.9	6.5	0	25.1	19.3	5.1	6	85.7
Sui de	33.5	29.2	7.1	5.1	0	17.2	4.2	6	85.7
Zi chang	36.8	27.9	6.2	6.2	0	19.1	9.8	6	85.7
Average	26.8	22.8	12.8	4.9	12.2	9.5	9.5	6.2	88.1

of which i and j mean the same as afore mentioned;

$$\overline{y_j} = \frac{1}{11}\sum_{i=1}^{12} y_{ij} \quad (4)$$

of which y_{ij} is the average of the proportions of the eco-farming model of j; and

$$S_{ij} = \sqrt{\frac{1}{12-1}\sum_{i=1}^{12}\left(y_{ij} - \overline{y_j}\right)^2} \quad (5)$$

of which , S_{ij} is the standard deviation of the proportions of the eco-farming model of j.
And then, the distance between two regions could be represented with the Minkowski distance of $d_{ij}(q)$, which was calculated by the following formula:

$$d_{ij}(q) = \left[\sum_{k=1}^{m}\left|x_{ik} - x_{jk}\right|^q\right]^{1/q} \quad (6)$$

Here, the study adopted Euclidean distance to represent the distance coefficient between two regions concerned (De Koeije et al., 1987,), that is, q=2. Then,

$$d_{ij}(2) = \sqrt{\sum_{k=1}^{7}\left(x_{ik} \quad x_{jk}\right)^2} \quad (7)$$

Then the cluster distance was calculated as follows:

$$D_{pq}^2 = \frac{1}{n_p n_q}\sum_{X_i \in G_p}\sum_{X_j \in G_q} d_{ij}^2 \quad (8)$$

The recurrence formula was as follows:

$$D_{ir}^2 = \frac{n_p}{n_r}D_{ip}^2 + \frac{n_p}{n_r}D_{iq}^2 \quad (9)$$

In which np and nq separately stand for the numbers of regions that involve Gp and Gq, and nr stands for the number of the regions that involve Gr , a new group formed from Gp and Gq by merging them, and that nr= np+nq .

RESULTS

Proportions and coverage degrees of the different eco-farming models of the different clusters of the different regions

So far, the study obtained the percentages (Proportions) and coverage degrees of the different eco-farming models of the different clusters of the different regions (Table 3).

From Table 3 we can see that the minimum proportions of the different eco-farming models of the different regions, that is, the regions where the minimum proportions appeared, showed that the proportion of the crop planting model of Yang ling was 13.2%, the proportion of the forest plus fruit tree model of Chengu was 8.4%, the proportion of the animal-raising model of Luochuan was 5.3%, Mianxian no longer practiced the courtyard based model, Ningqian no longer practiced the business model, Meixian no longer practiced the environment-conserving model, and the proportion of the tourism attraction model of Suide was 4.2%. The minimum proportions of the different eco-farming models revealed that Yangling, located in Central Shaanxi, had an well developed economy and as result its traditional crop planting model shrunk; Chenggu, situated in an plain area, had a weak capacity to practice the forest plus fruit tree model because of its climatic constraints; Luchuan as a traditional big apple producer did not pay much attention to its animal raising so that it did not widely

practice the animal raising model; Located in South Shaanxi, Mianxian had did not widely adopted the courtyard-based model because the County had poor transportation and information accesses and that the model was a newly emerged one. However, the authors of the paper held that Mianxian still had too low a proportion of the courtyard based model and that the county had the capacity and necessity to widely practice the model. Ningqiang as a mountainous county poorly practiced the business model, but the authors of the paper considered that Ningqiang had its own advantages, such as medicinal herbs, which could be fully exploited while it practiced the business model. Meixian, located in Central Shaanxi, an economically well developed region, generally paid more attention to its economic development but ignored its environment conservation. Suide as a remote county had poor transportation accesses, and thus it was constrained to practice the tourism attraction model, but the county had quite a few tourism attractions, so the country needed to strength its practicing the tourism attraction model. It follows that some eco-farming models are not preferentially practiced on priority by all the regions and no doubt this was because of the local conditions of these regions, but these model needed to be improved and their practicing need to be strengthened.

From Table 3 it could be found that, the maximum proportions of the different eco-farming models of the different regions in the table, that is, the regions where the maximum proportions appeared, showed that the proportion of the crop planting model of Ningqiang was 40.8% , the proportion of the forest plus fruit tree model of Luochuan was 32.1%, the proportion of the animal-raising model of Dali was 27.6%, the proportion of the courtyard based model of Chang'an was 11.5%, the proportions of the business model and the environment-conserving model of Jingbian were separately 25.1 and 19.3%, and the proportion of the tourism attraction model of Chang'an was 20.5%. the rationale for these were that: Niqiang was a remote county with abundant water resources so it had a high proportion of the traditional crop planting model, but because its proportion of the model was too high, the county needed to strength practicing the other models. Luochuan had such geographical advantages as high elevation above sea level so that it extensively practiced the forest plus fruit tree model. Dali was located in the economically well developed area and thus its newly emerging animal raising model expanded widely. Chang'an was a metropolitan suburb county, easy to get access to new ideas and information, and thus the County practices the courtyard based model extensively. Jingbian had abundant reserves of petroleum and natural gas and thus the county had many related enterprises, with consequence that it extensively practiced the business model. Nonetheless, Jingbian still practiced the environment-conserving model widely, and this was a welcoming phenomenon, which indicates that enterprises traditionally thought as polluters (Donald et al., 2002) could be completely transformed into non-pollution ones. Chang'an widely practiced the tourism attraction model, because the County, as aforementioned, had well developed transportation systems as well rich tourism resources. The maximum proportions of the different eco-farming models clearly indicated what eco-farming models the different regions should mainly adopt and practice.

The coverage degrees of the different eco-farming models showed that Yangling and Chang'an, for instance, had the highest coverage degrees which amounted to 100% , and the reason for this was that the both of them are located in economically well developed areas and have favorable natural conditions and thus they had such high coverage degrees; and the coverage degrees of the different ecological models of the different regions no doubt depend on the social and economic conditions and actual eco-environments of the regions, however, they cannot be separated from the administration of the local governments of the regions (Antle and Mcaucking, 1993).

According to the sampling survey on the different regions of Shaanxi, the average number of the eco-farming models of the sampled counties is 6.2 and the average coverage degree of the models of the counties was 88.1%. The crop planting model had the highest proportion (26.8%), followed by the forest plus fruit tree model (with a proportion of 22.8%), which indicated that these two models still were the key eco-farming models, and the courtyard based model had the lowest proportion of only 4.9%, so that Shaanxi mainly practiced the traditional crop planting model, but the province also widely practiced the newly emerging forest plus fruit tree model, which indicates that the province was right in its orientation for eco-farming construction, but considering that its courtyard based model has a proportion of 4.9%, the province did not practice the models in a balanced manner, thereby needing to promote its adopting some models.

Average coverage degrees of the eco-farming models of the different clusters and the average proportions of the eco-farming models obtained by cluster analysis

By programming and computer operation, results obtained by cluster analysis are given in Figure 1. Considering its realities, the study carried out its classification with the distance coefficient D^2 =17 as its classification threshold, thus obtaining the four clusters shown in Table 4.

The first cluster included Yangling, Chang'an and Dli, the second cluster included Meixian and Luchuan, the third cluster included Mianxian, Chenggu, Xixiang and

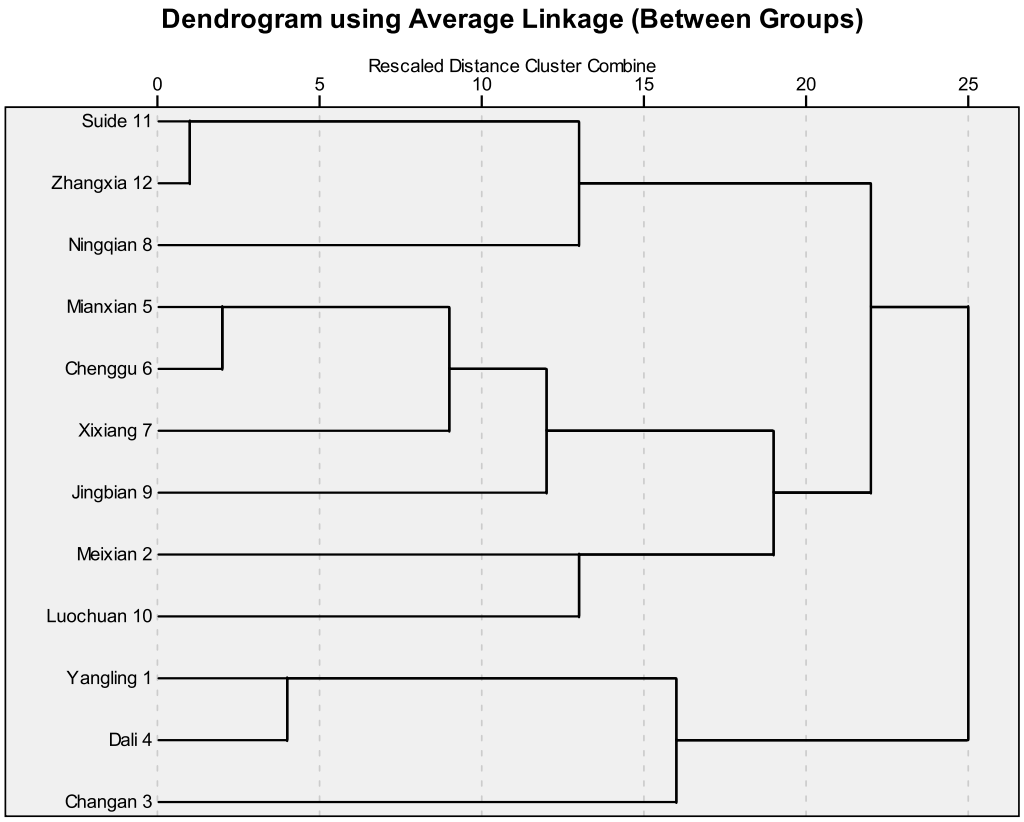

Figure 1. Clustering analysis.

Table 4. Four clusters obtained by cluster analysis.

Case	4 Clusters
1:Yangling	1
2: Meixian	2
3: Changan	1
4: Dali	1
5: Mianxian	3
6: Chenggu	3
7: Xixiang	3
8: Ningqiang	4
9: Jingbian	3
10: Luochuan	2
11: Suide	4
12: Zichang	4

Jingbian, and the fourth cluster included Ningqiang, Suide and Zichang.

So far the average proportions and the average coverage degrees of the different eco-farming models of the different clusters were obtained (Table 5).

From Table 3 we can find that, the first cluster covered three counties and the coverage degrees of its eco-farming models were the highest, averaging 95.2%; and of the three counties, the coverage degrees of the eco-farming models of two counties reached 100%, the coverage degree of the forest plus fruit tree model was the highest, amounting to 23.5%, and the coverage degree of the environment-conserving model was the lowest, amounting to only 1.6%. it can be seen that all the three counties were located in economically well developed regions and had favorable natural conditions so that they could provide favorable material conditions for practicing the different eco-farming models, but they had too low a coverage degree of the environment-conserving model, which was a common problem of environment conservation ignorance frequently occurring in newly emerging regions with well developed economies (Wackernagel et al., 2011), so that they needed to strengthen its environment conservation. Generally speaking, the new eco-farming models of the regions belonging to the first cluster expanded quickly but the environment conserving model expanded slowly.

The second cluster covered two and the coverage degree of its eco-farming model were 85.7%; and of the counties, the coverage degree of the forest plus fruit tree model was the highest, amounting to 31.3%, and the coverage degree of the courtyard based model was the

Table 5. Average coverage degrees and the average proportions of the eco-farming models of the different clusters.

Cluster	Coverage (%)	Crop planting	Forest plus fruit tree type	Animal-raising types	Courtyard based type	Business types	Environment-conserving type	Tourism attraction type
The first cluster	95.2	17.4	23.5	23.2	10.6	15.2	1.6	14.4
The second cluster	85.7	24.3	31.3	7.8	2.7	12.5	7.6	6.1
The third cluster	85.7	27.4	14.4	11.2	0	14.4	12.9	9.4
The fourth cluster	85.7	37	25.3	8.1	7.3	0	14	7

lowest, amounting to 2.7%. However, the two counties were located in two regions and the reason for this was that Meixian was near a mountain although economically well developed and Luochuan had a quickly growing apple industry presenting a bright economic development future although it was located in an economically underdeveloped mountainous area. In the meantime, Meixian depended on kiwi production for its economic development and thus the two counties widely adopted the forest plus fruit tree model, but they expanded the new Courtyard based model slowly so that they had a slightly low coverage of the model.

The third cluster covered four counties and the coverage degree of its eco-farming models was 85.7%. Among the coverage degrees of the eco-farming models of the four counties, the coverage degree of the crop planting model was the highest, amounting to 27.4% and the coverage degree of the courtyard based model was the lowest, equal to zero percent. Of the four counties, three counties, located in south Shaanxi, had moderate transportation access and moderate economic development and the other one, located in north Shaanxi, a economically poorly developed region, but Jingbian had its own unique advantage, that is, rich reserves of petroleum and natural gas, so that the county saw a quick economic development, which was comparable to those of the different counties of South Shaanxi. These regions with poorly developed economies were characterized by the dominance of the traditional models and slow expansion of the new models, but they expanded the newly emerging courtyard based model too slowly so that they needed to accelerate the expansion.

The fourth cluster totally covered three counties and the coverage degree of its eco-farming models was 85.7%. Among the coverage degrees of the cluster, the coverage degree of the crop planting model was the highest, amounting to 37% and the coverage degree of the business model was the lowest, equal to zero percent. Of the three counties, Suide and Zichang are located in North Shaanxi, a region with both poor transportation access and backward economies (Jin Lian et al., 2010), and the other county, Ningqiang, is located in South Shaanxi, a region with a relatively good economy, but it is a mountainous county. Because of their relatively backward economies and poor transportation accesses, the regions belonging to the cluster had a high coverage degree of the traditional crop planting model and say a slow expansion of the newly emerging business model, but because of their highland locations, they expanded the forest plus fruit tree model rapidly and because of the attention of China on environment conservation, they expanded the environment conserving model quickly (Larsen, 2010). In general, their expansions of the different models were imbalanced.

It can be seen from the above analysis that of the different regions of Shaanxi, the coverage degree of the different eco-farming models was 88.1% and this indicated that the eco-farming models of the regions of Shaanxi were rich and diverse and that the regions knew what their orientations towards the eco-farming models were and what main problems they needed to solve. It can be seen from the cluster analysis of the study that the regions belonging to the first and second clusters had higher proportions of the newly emerging forest plus fruit tree model and the business model and relatively lower proportions of the traditional models than the regions belonging to the other clusters and this just right revealed local natural conditions and economic developments of the regions. But in the meantime, it also revealed some problems. Regions with poorly developed economies had too high proportions of the traditional models and too low proportions of the newly emerging models (Gordon, 1991). For example, the regions belonging to the third and fourth clusters had too high a proportion of the traditional crop planting model and too low proportions of the business model and the forest plus fruit tree model; and this was doubtlessly related to the local characteristics and economic conditions of the regions, but it also indicted unbalanced expansion of the eco-farming models and the human factors resulting in slow expansion of the newly emerging models (Gonway, 1991).

DISCUSSION

The study investigated the eco-farming models and their regional distributions of Shaanxi, concluding that the models could be divided into four groups, and

summarizing some characteristics and patterns of the models that of the regions with well developed economies and favorable natural conditions, the proportions of the traditional models was lower and the proportions of the newly emerging models were increasing, meanwhile, the proportions of the different models were balanced; and of the regions with relatively backward economies and relatively poor natural conditions, the situations were opposite that the proportions of the traditional models was high and the proportions of the newly emerging models were lower, meanwhile, the expansions of the different models were hardly balanced. By statistical analysis and cluster analysis, the study accurately found out what problems there existed, what caused them and how they could be solved where the eco-farming models were practiced and expanded, so that it provided concrete and highly operable research methods for researching on solving similar problems as well as thinking approaches for eco-farming development and environment management.

In the future, backward regions should be promoted to expand and practiced the newly emerging models by improving their transportation and information accesses and human qualities and in the meantime, the governments should increase their investment and guidance to create the conditions for these backward regions to practice and expand the newly emerging models. Regions with relatively well developed economies should step up their investments for environment conservation while promoting their economic development.

Meanwhile, where same types of problems are investigated in the future, attention should be paid first to the rationale and integrity for screening eco-farming models and then to developing the index system for the screened eco-farming models, so as to deepen the research on the problems.

ACKNOWLEDGEMENTS

The study was sponsored by the Cultivation Fund of the Key Scientific and Technological Innovation Project of the Ministry of Education of China (NO706054) and the New Century Excellent Talents in University (NCET-07-0700).

REFERENCES

Antle JM, Mcaucking T (1993). Technological innovation, agricultural Productivity, and environmental quality. Agricultural and Environmental Resource Economies. Oxford University Press, New York. pp. 175-220

Bicknell KB, Ball RJ, Cullen R, Bigsby HR (1998). New methodology For the ecological footprint with an application to the New Zealand economy. Ecol. Econ. 27:149-160.

Bastianoni S, Marchettini N, Panzieri M, Tiezzi E (2001). Sustainability assessment of a farm in the Chianti area (Italy). J. Cleaner Prod. 9:365-373.

Brown MT, Buranakarn V (2003). Emergy indices and ratios for sustainable Material cycles and recycle options. Resour. Conserv. Recycl. 38:1-22.

Coleman D, Codum EP, Crossley DA (1992). Soil biology, Soil ecology And global change. Biol. Fert. Soils 14(2):104-111.

Donald PF, Pisano G, Rayment MD, Pain DJ (2002). The Common Agricultural Poliey, EU enlargement and the conservation of Europe's farmland birds. Agric. Ecosyst. Environ. 89:167-182.

Jin L, Wang YP, Liu XL (2010). Summary of the Developmental Pattern of Special Agriculture [J]. J. Anhui Agric. Sci. 11:146-153. (in Chinese with English abstract).

Krishna BKC (2011). Modeling and measuring the economic success of farming families using remote sensing and GIS: An example from mountains of Nepal. J. Geogr. Reg. Plann. Vol. 4(7):4401-416.

Kurosh R-M, Saeid S (2010). Agricultural specialists' intention toward precision agriculture technologies: Integrating innovation characteristics to technology acceptance model. Afr. J. Agric. Res. 5:1191-1195.

Liu YF, Jiao LM (2002). The Application of BP Networks to Land Suitability Evaluation[J]. Geo-Spatial Inform. Sci. 1:55-61.

Li XP (2000). Theoretical Basis and Research Developments of Chinese Ecological Agriculture [J]. Res. Agric. Modernization. 6:33-47.

Li JC (2008). Categories of eco-agriculture models in China [J]. Chinese J. Eco-Agric. 5:16-20.

Larsen LB (2010). Strategic Implication of Environmental Reporting [J]. Corporate Environ. Strategy 7:276-279.

Qi XS (1992). An Approach on the Establishment of the Synthetical Index System of Eco-Agriculture Assessment [J]. J. Ningbo Univ. 2:25-27.

Qiu JJ, Ren (2008). Elementary study on the framework of standard system for eco-agriculture in China [J]. Chinese J. Eco-Agric. 5:55-61. (in Chinese with English abstract.

Tilley DR, Swank WT (2003). Emergy-based environmental systems assessment of a multi-purpose temperate mixed—forest watershed of the southern appalachian Mountains, USA. J. Environ. Manage. 69:213-227.

Wackernagel M, Schulz NB, Deumling D, Linares AC, Jenkins M, Kapos V, Monfreda C, Loh J, Myers N, Norgaard R, Randers J(2002). Tracking the ecological Overshoot of the human, economy[J]. Washington, DC, USA. 99(14):9266-9267.

Wackernagel M, Schulz NB, Deumling D, Linares AC, Jenkins M, Kapos V, Monfreda C, Loh J, Myers N, Norgaard R, Randers J. (2011).Taking the ecological overshoot of the humane economy [J]. Washington, DC, USA. 99(14):9266-9267.