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ORIGINAL RESEARCH ARTICLE

Comprehensive evaluation of modern agricultural development level in contiguous destitute area of Lvliang Mountain, Shanxi Province

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ABSTRACT

An evaluation model was established using a combination of AHP and multi-objective linear weighted function methods to comprehensively evaluate the development level of modern agriculture in the contiguous poverty-stricken areas of Lvliang Mountain in Shanxi Province. The results show that: (1) As a whole, the contiguous poverty-stricken areas have a low degree of agricultural modernization and are in the initial stage of development. The degree of modernization of agricultural production conditions, agricultural production results, and farmers' living standards is gradually decreasing; at the municipal level, the degree of agricultural modernization in the three cities is the same. Not high, the order is Xinzhou City > Linfen City > Lvliang City; at the county level, the degree of agricultural modernization varies greatly. The counties in Xinzhou City are in the high-level sub-stage of the initial stage, and the counties in Lvliang City are in the low-level sub-stage of the initial stage. The overall degree of agricultural modernization in counties shows a spatial pattern of low in the middle and high in the north and south; (2) The contributions of agricultural production conditions, production results and farmers' living standards to modern agriculture are 16.4%, 29.7% and 53.9% respectively. The low level of agricultural electrification and mechanization and backward production conditions are bottlenecks in the development of modern agriculture. The backward agricultural production conditions lead to inefficient production results, low disposable income of farmers, and low living standards of farmers, which are the root causes of the slow development of modern agriculture in the region.

Keywords: modern agriculture; degree of modernization; Lvliang Mountain contiguous destitute area; Shanxi Province

Underdeveloped areas are affected by conditional restrictions and unbalanced development strategies, and there is a large gap between the development level of developed areas and developed areas. However, they are rich in resources and the environment has not been seriously damaged. With the deepening of reform and social development, there are opportunities in the new round of economic growth. It is possible to achieve rapid development[1]. In order to achieve balanced regional development, underdeveloped areas are key areas for national development and a series of supportive policies have been introduced[2]. Underdeveloped areas have also implemented a "leapfrog" or "catch-up" development strategy, but this has not allowed them to The gap with developed regions has narrowed[3]. Therefore, the economic development of underdeveloped areas has

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become a difficult problem that restricts the improvement of China's overall development level. Contiguous poverty-stricken areas are "underdeveloped areas" among underdeveloped areas. Relying on the ecological civilization construction strategy and targeted poverty alleviation policies, it is an urgent task to get rid of poverty and become rich, and to narrow the development gap.

The economic structure of the contiguous poverty-stricken areas of Lvliang Mountain is single, and excessive agricultural development has caused damage to the ecological environment[4]. The deterioration of the ecological environment has made the people's living environment and agricultural production more difficult, forming a vicious circle[5]. With agriculture as the entry point, modern agricultural construction is the starting point and a practical way to get rid of poverty. The development of modern agriculture is an important task of the country's new rural construction. Many studies have been carried out on its development model[6]. The construction of a modern agricultural development evaluation system to guide practice has become a research focus. As the main body of agricultural economy, counties are particularly critical to evaluating the development of modern agriculture in counties[7]. However, there are currently few reports on the evaluation of modern agriculture in counties in underdeveloped areas.

Domestic modern agriculture evaluation presents two major characteristics: (1) The research objects are mainly urban agriculture and are concentrated in the central and eastern regions. For example, Huang and Shi[8], Gao et al.[6], and Ma et al.[9] evaluated and analyzed examples of the development level of urban modern agriculture in Beijing, Zhengzhou, and Suzhou. (2) The study areas are mostly provincial and municipal areas, and do not break the restrictions of administrative divisions. For example, Wang and Bao[10] and Zhao et al.[7] evaluated modern agriculture in Ningxia and Shenyang and proposed improvement measures. Foreign modern agricultural research mostly focuses on the interaction between indicators and model construction[11]. For example, the PSR (pressure-state-response) framework for the evaluation of modern agricultural development in the United Kingdom focuses on the guiding role of agricultural policies in agricultural development and emphasizes the participation of farmers[12]. However, this framework only analyzes the pros and cons of indicators, does not determine the target values of each indicator, and does not conduct a comprehensive evaluation of British modern agriculture. Whether the evaluation index system currently constructed at home and abroad is suitable for underdeveloped areas, especially contiguous poverty-stricken areas, deserves further study. Therefore, based on the Lvliang Mountain contiguous poverty-stricken areas planned in the "China Rural Poverty Alleviation and Development Outline (2011–2020)", this article selects 13 particularly poor counties in Shanxi Province as research areas, establishes a modern agricultural evaluation index system, and evaluates its development level. Conduct a comprehensive evaluation with a view to providing support for targeted poverty alleviation and poverty alleviation in the district.

1. Data and methods

1.1. Overview of the study area

The Lvliang Mountain contiguous destitute area covers 13 counties in Shanxi Province and is located in the central and eastern parts of the Loess Plateau. It has harsh natural conditions and serious soil erosion, which restricts agricultural development[4]. Agriculture plays an important role in economic development. Based on the 2016 socioeconomic statistics, among the three industries, agriculture accounts for 19.3%, which is much higher than the province's average of 6.1% for the primary industry; the per capita disposable income of rural residents in the district is only less than the province's average of 45%, and even less than 30% in Daning County and Shilou County; and the proportion of agricultural employees among rural residents is 67.9%, much higher than the provincial average of 55.4%. Although agriculture is an important economic pillar and the main source of income for farmers in this area, the economic welfare obtained from it is low, the development of

modern agriculture is slow, and its driving role is not significant.

1.2. Data sources

The indicator data mainly comes from the "Statistical Yearbook of Shanxi Province" (2000–2016), "Statistical Data on Comprehensive Agricultural Development of Shanxi Province" (2000–2016), "Compilation of Agricultural Census Data of Shanxi Province", and the 2016 National Statistics of Lvliang City, Xinzhou City, and Linfen City. Economic and social development statistical bulletin, etc.

1.3. Research methods

1.3.1. Establishment of evaluation indicator system

Modern agriculture widely applies science and technology, production materials and scientific management methods, provided by modern industry. The basic feature is the widespread use of agricultural machinery, such as tractors, combine harvesters, agricultural aircraft, and various machines in forestry, animal husbandry, and fishery[13]. Agricultural production conditions determine production results to a certain extent. Agricultural production results directly affect farmers' living standards. Farmers' living standards determine the quality of agricultural production conditions. The three are interdependent. Based on the definition of modern agriculture and field investigation, 18 indicators were selected based on agricultural production conditions, agricultural production results and farmers' living standards to construct an evaluation index system for the development level of modern agriculture (see **Table 1**). The system includes the target layer (A), criterion layer (B) and indicator layer (C). Agricultural production conditions are considered from the aspects of mechanization level, water saving, transportation, irrigation, electricity consumption, etc.; five indicators such as per capita grain output and end-of-year orchard area are selected to reflect the production results; farmers' living standards are selected from per capita primary industry gross production, five indicators include the per capita disposable income of rural residents. The selected indicators were recognized by local farmers, agricultural science and technology personnel and agricultural administrative department personnel, and were used for the first time in the evaluation of modern agriculture in the contiguous poverty-stricken areas of Lvliang Mountain.

Table 1. Weight of indexes of comprehensive evaluation of modern agriculture in the Contiguous poverty-stricken area of Lvliang Mountain.

Target layer	Criteria layer	Indicator layer	Single weight	Total weight
Modern agricultural development level A	Agricultural production conditions B1 0.164	Number of large, medium and small agricultural tractors C1	0.063	0.010
		Number of agricultural drainage and irrigation machinery C2	0.031	0.005
		Number of agricultural transport vehicles C3	0.045	0.007
		Number of irrigation electromechanical wells C4	0.113	0.019
		Agricultural electricity consumption C5	0.151	0.025
		Fertilizer usage C6	0.189	0.031
		Proportion of effective irrigated area C7	0.322	0.053
		Afforestation area of the year C8	0.085	0.014
	Agricultural production results B2 0.297	Per capita food production C9	0.610	0.181
		Cotton yield per unit area C10	0.116	0.035

Table 1. (*Continued*).

Target layer	Criteria layer	Indicator layer	Single weight	Total weight
		Oil crop yield per unit area C11	0.054	0.016
		Output per unit area of other cash crops C12	0.013	0.004
		Orchard area at year-end C13	0.207	0.062
	Farmers' living standards B3 0.539	Per capita GDP of primary industry C14	0.220	0.119
		Per capita disposable income of rural residents C15	0.553	0.298
		Growth rate of gross output value of agriculture, forestry, animal husbandry and fishery C16	0.057	0.031
		Total retail sales of rural consumer goods C17	0.157	0.084
		Per capita cash policy subsidies for farmers C18	0.013	0.007

1.3.2. Determination method of index weight

Different indicators have different impacts on the development of modern agriculture, and their relative importance needs to be determined. The combination of expert opinion consultation method and analytic hierarchy process (AHP) is the mainstream method of evaluation research, which can express expert opinions and ensure objectivity[14]. The basic steps are as follows:

1) Construct a judgment matrix. Compare the indicators of this layer against the upper-level indicators and construct a matrix. Let A be the upper-level element, Bn be the lower-level element, and bij represents the relative importance of the lower-level indicator Bi to Bj for the upper-level indicator A. Use the proportional scale to quantify the importance and construct the initial judgment matrix at each level in the modern agricultural evaluation index system (not listed due to limited space).
2) Indicator weight calculation method. According to the judgment matrix, the weights of indicators at each level are calculated. Consistency testing is required during calculations to test the consistency of thinking in the judgment process. After calculation, each indicator layer passed the consistency test. The index weights are shown in **Table 1**. The single weight represents the weight of the index in the criterion layer, and the total weight represents the weight of the index in the entire evaluation system.

1.3.3. Standardization method of indicator data

The indicators in the evaluation system have different meanings and dimensions and are not directly comparable. Comprehensive evaluation requires converting indicators into numerical values that can be uniformly compared, that is, standardization. The standard value of the indicator is X0. If the indicator value Xi ≥ X0, then the indicator has reached the modernization level, and its standardized value S_i = 1. If Xi < X0, S_i = Xi/X0. The degree of modernization of the indicator $H_i = S_i \times 100$.

1.3.4. The measurement index of the development level of modern agriculture in Lvliang Mountain

The indicators reflect various aspects of modern agricultural development from different angles, and the development level is the result of the comprehensive action of multiple factors. After determining the index weight, the multi-objective linear weighting function method is used to comprehensively evaluate the development level. Its mathematical model is as follows:

$$Z = \sum_{i=1}^{n} S_i \overline{W_i} \times 100 \quad (1)$$

$$Z_k = \sum_{j=1}^{m} S_{kj} \overline{W_{kJ}} \times 100 \quad (2)$$

Equation (1) calculates the comprehensive evaluation value of modern agricultural development level, where Z is the comprehensive evaluation value, S_i is the standardized value of the i-th indicator, and $\overline{W_i}$ is the weight of the i-th indicator in the entire indicator system. Equation (2) calculates the evaluation value of each subsystem, where Z_k is the evaluation value of the kth criterion layer, S_{kj} is the j-th indicator standardized value in the k-th indicator layer, $\overline{W_{kj}}$ is the jth indicator value in the k-th indicator layer The weight of an indicator, m is the number of indicators in the kth criterion layer. Based on the standardized values and weights of each indicator, the comprehensive evaluation results of the modern agricultural development level of the contiguous poverty-stricken areas of Lvliang Mountain in Shanxi Province were obtained (see **Table 2**).

Table 2. Evaluation results of modern agriculture in the contiguous poverty-stricken area of Lvliang Mountain.

Comprehensive evaluation level	Affiliated city		County	Overall score	Rank
45.94	Xinzhou City	49.09	Jingle County	32.82	13
			Shenchi County	49.96	5
			Wuzhai County	56.02	3
			Kelan County	57.58	2
	Linfen City	47.97	Ji County	59.55	1
			Daning County	53.18	4
			Xi County	42.50	9
			Yonghe County	45.78	7
			Fenxi County	38.85	10
	Lvliang City	40.24	Xing County	46.40	6
			Lin County	43.75	8
			Shilou County	36.59	11
			Lan County	34.21	12

Based on expert consultation and related research results, the development of modern agriculture in the study area was divided into four stages according to the comprehensive evaluation value: (1) Initial stage ($30 \leq Z \leq 60$); (2) Rapid development stage ($60 < Z \leq 80$); (3) Basic realization stage of development ($80 < Z \leq 95$); (4) Mature stage of development ($95 < Z \leq 100$).

2. Results and analysis

2.1. Development level and key influencing factors of modern agriculture in the contiguous poverty-stricken area of Lvliang Mountain

2.1.1. Overall development level of modern agriculture

The comprehensive evaluation score of modern agriculture in the contiguous poverty-stricken areas of Lvliang Mountain in Shanxi Province is only 45.94 points. The degree of agricultural modernization is low and it is in the initial stage of development.

At the subsystem level, the degree of modernization from high to low is agricultural production conditions > agricultural production results > farmers' living standards (see **Figure 1**). The degree of modernization of production conditions is relatively high, but its actual results are low, so agricultural production results are not related to farmers' living standards. The low level indicates that agricultural development in the contiguous poverty-stricken areas of Lvliang Mountain is characterized by high input and low output.

At the indicator level, the five indicators of chemical fertilizer use, the current year's afforestation area, cotton and oil crop output per unit area, and the growth rate of total agricultural, forestry, animal husbandry, and fishery output are in the stage of rapid development (see **Figure 2**), accounting for 27.8% of the total number of indicators. Among them, the modernization degree of the afforestation area reached 79.54, which is about to enter the third stage of modern agricultural development. This is due to the improvement of afforestation and greening technology and management level. The modernization of this indicator will improve the agricultural environment, ensure the sustainable development of local agriculture and is conducive to the future development of agriculture. The combination of forestry ecological management and poverty alleviation has become an important way to target poverty alleviation. 11 indicators are in the initial stage of development, accounting for 61.1% of the total. Among them, the output per unit area of other cash crops and the modernization level of orchard area at the end of the year are relatively high and are about to enter a stage of rapid development. There are two indicators that have not reached the initial stage of development, namely agricultural electricity consumption and the number of agricultural drainage and irrigation machinery. Agricultural electricity consumption indicates the level of agricultural electrification and is an important symbol of agricultural modernization. However, in the study area, its modernization degree is only 27.23. Agricultural electricity consumption is closely related to irrigation. There are a large number of agricultural drainage and irrigation machinery and developed irrigation system, and the electricity consumption will be large, and vice versa. The number of agricultural drainage and irrigation machinery in the study area scored the lowest, at only 19.46. It can be seen that increasing agricultural drainage and irrigation machinery and increasing agricultural electricity consumption are key breakthroughs that need to be made in the future development of modern agriculture in the study area.

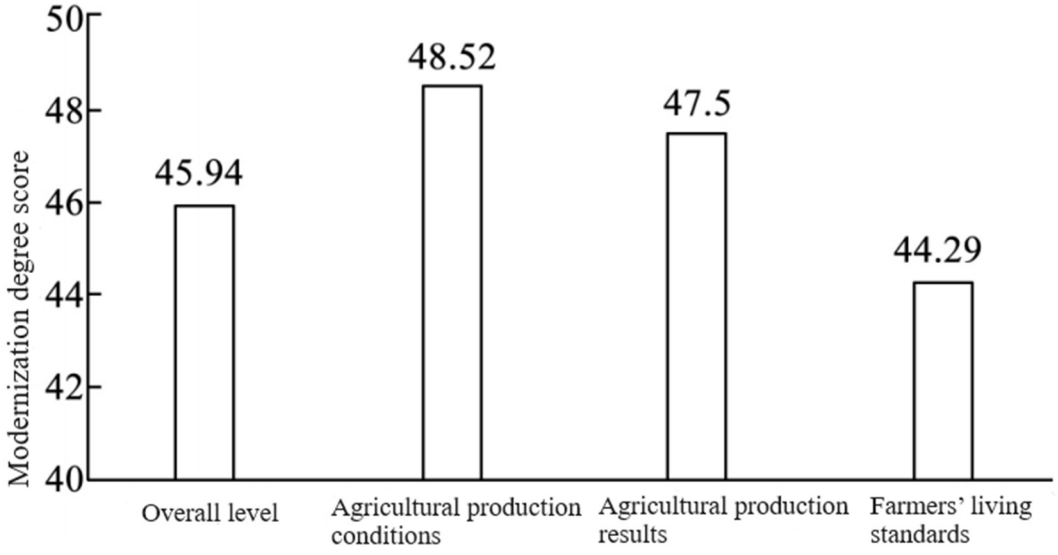

Figure 1. Agricultural modernization level of the contiguous destitute area of Lvliang Mountain, Shanxi Province.

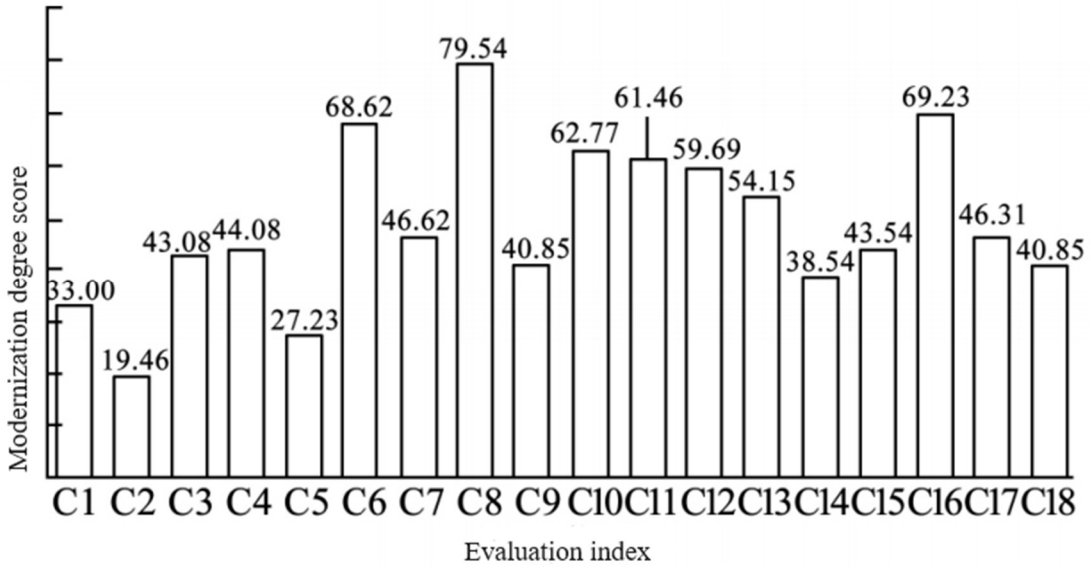

Figure 2. Modernization level of evaluation indexes of modern agriculture in the contiguous poverty-stricken area of Lvliang Mountain, Shanxi Province.

The above analysis shows that the development of modern agriculture in the study area has achieved certain results, which are reflected in the rapid development of forestry and fruit industry and cash crops. This effect is due to the improvement of the external agricultural environment and the large investment in chemical fertilizers. However, agricultural modernization is a symbol of agricultural modernization, but insufficient investment in agricultural electricity consumption and agricultural drainage and irrigation machinery has become a bottleneck for the development of modern agriculture in the region.

2.1.2. Key factors affecting the development of modern agriculture

The development of modern agriculture is affected not only by the external environment, but also by agricultural technology and management level. In the Lvliang Mountain contiguous poverty-stricken area, which factors promote and restrict the development of modern agriculture? This article analyzes in detail the key factors that promote and hinder the development of modern agriculture.

The study found that agricultural production conditions in the study area contributed the least to the development of modern agriculture, at 16.4%; farmers' living standards contributed the highest, at 53.9%. It can be seen that the improvement of farmers' living standards will significantly promote the development of modern agriculture in the study area. The improvement of farmers' living standards has enabled farmers to have sufficient funds to invest in agricultural production and has also enabled them to learn agricultural technology and improve management levels. Farmers' living standards are mainly affected by the per capita disposable income of rural residents and per capita primary industry GDP, with the two contributing a total of 77%. Although the proportion of agricultural employees in the district reaches 67.9%, which is significantly higher than the provincial level, the per capita GDP contribution of the primary industry is 21.6% lower than the provincial level. The agricultural efficiency is low, resulting in a low per capita disposable income for rural residents, only 45% of the provincial level. The low per capita GDP of the primary industry and the disposable income of rural residents seriously restrict the improvement of farmers' living standards, making it difficult for them to play a booster role in the development of modern agriculture.

Modern agriculture is a complex of agricultural production conditions, agricultural production results and farmers' living standards. Production conditions determine the production results and farmers' living standards to a certain extent. The proportion of effective irrigated area, chemical fertilizer usage and agricultural

electricity consumption in the study area contributed to agricultural production conditions by 32%, 19% and 15% respectively, and the cumulative contribution of the three was 66%. In addition to the high level of modernization in the use of chemical fertilizers, the effective irrigation area and agricultural electricity consumption are both low. The effective irrigated area ratio target in the district is 40%, but the actual average is only 19%. Insufficient investment in agricultural drainage and irrigation machinery prevents high-target effective irrigation, and small agricultural power consumption has become a key constraint on the development of modern agriculture in the region. Ensuring the safety of irrigation water sources, increasing the proportion of effective irrigation area, and improving agricultural production conditions are the basis and prerequisite for increasing agricultural production results and improving farmers' living standards.

The contribution of agricultural production results to the development of modern agriculture ranks second, at about 30%. The production results are represented by the per capita grain output, the unit area output of cotton, oilseeds and other economic crops, and the orchard area at the end of the year. The per capita grain output is the result of agricultural production. The first influencing factor, the contribution rate is 61%, followed by the orchard area at the end of the year, which is 21%. The contribution of cotton, oilseeds and other cash crops per unit area is relatively small. However, the unit area output of cotton, oilseeds, and other cash crops and the orchard area at the end of the year are highly modernized and have or are about to enter a stage of rapid development. However, the per capita grain output modernization degree is only 40.85, which is lower than the average level of the system of 47.5, which shows that it is relatively high. The contribution rate and per capita grain output with a low degree of modernization are the main reasons for the low degree of modernization of agricultural production results in this region.

In summary, although the external agricultural environment has improved significantly, the low level of electrification and mechanization has made the agricultural production conditions in the region backward. Although the economic crops and forestry and fruit industries have better economic benefits, their contribution to agricultural production results is small and the degree of modernization is low. The per capita grain output seriously restricts the modernization process of production results; although the proportion of agricultural employees is high, agricultural efficiency is low, and the low per capita disposable income of rural residents is the key to the difficulty in improving farmers' living standards. The backward production conditions lead to low production efficiency, which in turn results in low farmers' disposable income and low farmers' living standards. This is the root cause of the slow development of modern agriculture in the region. On the basis of improving the external agricultural environment, increasing investment in agricultural electrification and mechanization and improving the modernization of agricultural production conditions, these are the fundamental steps for the future development of modern agriculture in the region.

2.2. Development level of modern agriculture at city and county levels

2.2.1. Development level of modern agriculture in the city

At the municipal level, the contiguous poverty-stricken areas in the three cities are all in the initial stage of modern agricultural development, and the order is Xinzhou City > Linfen City > Lvliang City. Lvliang City, located in the center, has the lowest degree of agricultural modernization, with a score of 40.24; Xinzhou City, located in the north, and Linfen City, located in the south, are not much different. The ranking of the three cities in terms of agricultural production conditions is Linfen City > Lvliang City > Xinzhou City. Linfen City has the highest degree of modernization in agricultural production conditions, due to the fact that effective irrigation area, fertilizer usage and the number of agricultural transport vehicles are at the forefront. The degree of modernization of agricultural production results is ranked as Linfen City > Xinzhou City > Lvliang City. Linfen City still ranks first among the three cities. The reason is that the fruit demonstration base construction

project centered on Linfen West Mountain (i.e., the southern end of Lvliang Mountain) has significantly increased the number of orchards area, making the fruit industry the largest contributor to agricultural output. Xinzhou City has the highest degree of modernization of farmers' living standards. This is due to the fact that the per capita primary industry GDP and per capita disposable income of rural residents in the city's four contiguous destitute counties are much higher than those in the five Linfen and Lvliang counties. Among the three cities, Linfen City's agricultural production conditions and production results are at the forefront, but the modernization of farmers' living standards is the lowest. The main reasons are that the economic structure is single, the average yield of the fruit industry is low, the added value is small, and the population is relatively large.

It can be seen that the three cities in the contiguous destitute areas have different levels of modern agricultural development and different influencing factors. In the development of modern agriculture, improving agricultural production conditions is a necessary condition for increasing agricultural production results and improving farmers' living standards, but it is not a sufficient condition. Good agricultural production conditions and higher production results may not necessarily significantly improve farmers' living standards. Population, circulation, humanities and natural environment will all affect the improvement of farmers' living standards.

2.2.2. Development level of modern agriculture at county level

The degree of agricultural modernization in the 13 counties in the district ranges from 30 to 60, and they are all in the initial stage of development. Among them, Ji County has the highest score and is about to enter a stage of rapid development, and Jingle County has the lowest score. The initial stage of modern agriculture development is further divided into three sub-stages: 30 to 40 points as the low-level sub-stage; 40 to 50 points as the intermediate sub-stage; and 50 to 60 points as the high-level sub-stage. Classifying 13 counties, 2 counties in Lvliang City are in the low-level sub-stage; 2 counties in Linfen City and Lvliang City are in the intermediate sub-stage; 3 counties in Xinzhou City and 2 counties in Linfen City are in the high-level sub-stage. At the county level, although they are all in the initial stage of development, there are huge differences. Except for Jingle County, the other three counties in Xinzhou are all in the advanced sub-stage, with better modern agriculture development, followed by Linfen City; the counties in Lvliang City are relatively poor. Basically, in the middle and low-level sub-stage. Spatially, the level of agricultural modernization in counties shows a pattern of low in the middle and relatively high in the north and south. In the southern part of the contiguous destitute area, the level of agricultural modernization shows a decreasing trend from south to north, while in the north, with Kelan County as the center, the degree of agricultural modernization decreases from north to south (see **Figure 3**).

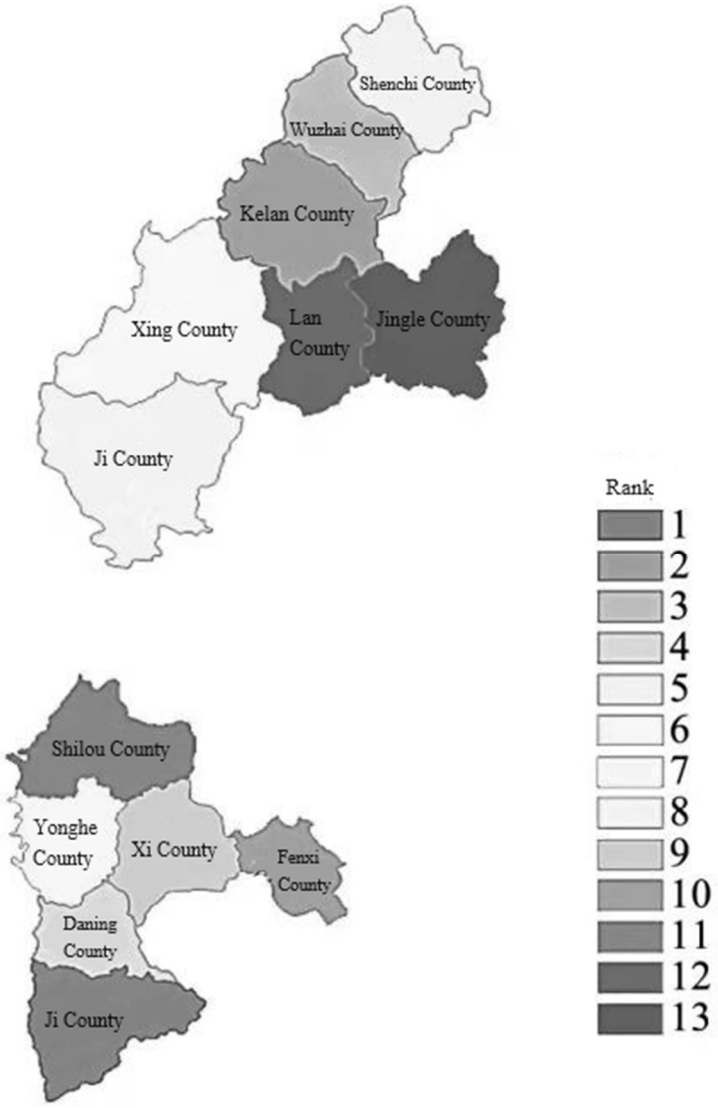

Figure 3. Spatial pattern of modern agricultural development level in 13 counties of Lvliang Mountain contiguous poverty-stricken area.

3. Conclusion and discussion

Taking the contiguous poverty-stricken area of Lvliang Mountain in Shanxi Province as the research area, based on the logical relationship between agricultural production conditions, agricultural production results, and farmers' living standards, an evaluation index system for the modern agricultural development level of the contiguous poverty-stricken area of Lvliang Mountain was constructed, using the analytic hierarchy process. The method, combined with the multi-objective linear weighted function method, evaluated the development level of modern agriculture in the contiguous poverty-stricken areas of Lvliang Mountain at the three levels of the entire study area, city, and county, and analyzed the key factors that drive and hinder the development of agricultural modernization. The following results were obtained: in conclusion:

1) The level of agricultural modernization in the contiguous poverty-stricken areas of Lvliang Mountain in Shanxi Province is relatively low and is in the initial stage of development. The development of agricultural production conditions, agricultural production results and farmers' living standards is unbalanced. The degree of modernization of agricultural production conditions is relatively high, but the degree of modernization of farmers' living standards is relatively low.

2) In the contiguous poverty-stricken areas of Lvliang Mountain, agricultural production conditions contribute only 16.4% to modern agriculture. The forestry and fruit industry and cash crops have achieved certain results, thanks to the increase in greening area and chemical fertilizer input. However, the low level of agricultural electrification and mechanization has resulted in backward agricultural production conditions and has become a bottleneck for the development of modern agriculture. Farmers' living standards contribute 53.9% to modern agriculture. However, agricultural efficiency and per capita disposable income of rural residents are low, making it difficult for farmers' living standards with high contribution rates and low modernization levels to play their role as a booster in the development of modern agriculture. Increasing investment in agricultural electrification and mechanization and vigorously improving the modernization level of agricultural production conditions are the fundamental steps for the future development of modern agriculture in this region.
3) At the municipal level, modern agriculture in the three cities is all in the initial stage of development, but there are differences in the degree of development. Xinzhou City has the highest level of agricultural modernization, and Lvliang City has the lowest level. Affected by factors such as a single economic structure and a large population, Linfen City's better agricultural production conditions and agricultural production results have not improved farmers' living standards.
4) At the county level, modern agriculture in 13 counties is also in the initial stage of development. In comparison, the counties in Xinzhou City have a higher degree of agricultural modernization and are located in the advanced sub-stage of the initial stage, while the counties in Lvliang City have a low degree of modernization and are located in the low sub-stage of the initial stage. The overall degree of agricultural modernization in counties shows a spatial pattern that is low in the middle and relatively high in the north and south.

Based on field inspections and field surveys, this article established an evaluation index system for the development level of modern agriculture in contiguous poverty-stricken areas in the Lvliang Mountains, and comprehensively evaluated the development level of modern agriculture at the district, city, and county levels, expanding the research level and research area. Although the actual situation of modern agriculture in contiguous poverty-stricken areas was considered as comprehensively as possible when establishing the indicator system, some elements have not yet been selected due to the availability and quantification of data, such as management level, scientific and technological talent rate, and soil erosion control rate, etc.; this article uses expert opinion consultation and the analytic hierarchy process when quantifying the weight of indicators, which is more or less subjective; when setting the target value of each indicator, local farmers, agricultural science and technology personnel and administrative staff were consulted. Officials try to be as close to reality as possible, but some indicators will inevitably be set too high or too low, etc. Therefore, whether the evaluation of the modern agricultural development level of the Lvliang Mountains contiguous destitute areas in this article can truly reflect the actual local situation still needs to be proven in practice; Whether the evaluation index system for the modern agricultural development level in destitute areas can be replicated and applied to other underdeveloped areas requires further in-depth analysis.

Conflict of interest

The authors declare no conflict of interest.

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