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Development Path for Agricultural Modernization of Shaanxi Province from the Perspective of Technological Progress

Lufeng DUAN*

Institute of Industrial Economics, Xi'an University of Posts and Telecommunications, Xi'an 710061, China

Abstract The lag in technological innovation is a bottleneck for modern agricultural development, so technological progress is an inevitable path to break this bottleneck. On the basis of introducing theory of technological progress, this study presents 4 paths for promoting agricultural modernization development in line with current situations of agricultural development and technological progress in Shaanxi Province.

Key words Technological progress, Agricultural modernization, Path selection

As a special type of economic balance state, traditional agriculture mainly features constant technological situation. The key to transforming traditional agriculture is to introduce modern factors of production and promote reduction of costs for agricultural input. The essence is to promote changes of key factor, namely, technology for economic growth. On the basis of introducing classical theory of technological progress, I analyzed current situations of traditional agricultural production models of Shaanxi Province, and present 4 paths for development of agricultural modernization, in the hope of providing reference for agricultural modernization of Shaanxi Province.

1 Current situations of agricultural development and technological progress in Shaanxi Province

1.1 Much mountain land and little level land increase the difficulty of mechanized agriculture Zonal natural soil in Shaanxi Province includes chestnut earth, black loessial soil, cinnamon soil and brown soil. Due to long time of cultivation and erosion of natural force, natural soil of Shaanxi Province has become complex and diversified agricultural soil. The whole province has 1.848 million hm² agricultural land (cultivated land, forest land, garden land and pasture land), and 1.002 million hm² unused land. Major features of land resource in Shaanxi Province are much mountain land and little plain. Rivers, creeks, and alluvial fan area below 800 m only account for 10% of the area of the whole province. Land types mainly include mountain land, hilly area, plain, river, sand land and marshland. Special landform leads to simple agricultural development model. Grain crops and industrial crops are major type. Most agricultural land is middle-and-low-yielding fields. It is difficult to carry out mechanized cul-

tivation, and management is excessively separate. These factors seriously restrict agricultural modernization and technological progress of Shaanxi Province.

1.2 Low educational level and high age of agricultural labor forces Shaanxi Province is rich in agricultural labor forces, but their educational level is low and aging degree is relatively higher. Some are conservative and small peasant mentality is deeply rooted. Most are satisfied with a small wealth, lack pioneering spirit, lack knowledge of new things and technologies, and have no professional skill. Left-behind children have become a major problem influencing sustainable development of agricultural labor forces. It not only restricts supply of agricultural labor forces in Shaanxi Province, but also influences extension of new technologies, and further limits agricultural modernization development of Shaanxi Province.

1.3 Unreasonable industrial structure and low brand awareness Industrial structure of agriculture is not reasonable in Shaanxi Province. Planting and breeding emphasize increase in quantity, but neglect growth of quality. In addition, it lacks brand awareness. Problems of blind imitation and low level repetition occur frequently. Crop cultivation and aquaculture are separate, and there is still no scale effect. Agricultural product processing is mainly primary products, while few products are deeply processed. Furthermore, agricultural products contain little science and technology and low added value, so the competitive power is weak. Both secondary and tertiary industries develop slowly in rural areas. As a result, economic benefit is generally low, and the support for increase of farmers' income becomes considerably weak.

1.4 Agricultural capital market not formed and desperate shortage of agricultural input Low capital formation capability of agricultural development in Shaanxi Province has become a major bottleneck hindering agricultural modernization. Agriculture-related finance industry still remains monopoly state, leading to poor openness and competitiveness. State-run commercial banks take up a larger portion, and rent-seeking causes large fund for agriculture to flow to developed areas, finally lead to serious shortage

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* Corresponding author. E-mail: duanlf999@126.com

of supply of fund for agricultural modernization development. With low income, residents will not have effective demand, and local finance have small contribution to this.

1.5 Small contribution of agricultural technology In 2010, the contribution rate of agricultural technology to agriculture in China reached 52%, firstly exceeding contribution rate of land, labor force and material input elements. Nevertheless, compared with developed countries where the contribution rate of agricultural technology to agriculture is about 70% – 80%, China's agricultural technological level still remains low^[1]. At present, the contribution rate of agricultural technology to agriculture in Shaanxi Province is relatively low, only about 40%^[2].

2 Classical technological progress theories

2.1 Neutral technological progress theory of Hicks Hicks contended that selection of proper production technology should be determined from relative changes in marginal product of production factors resulted from application of the technology into actual production. Take labor and capital as examples, if the increase rate of labor marginal product exceeds that of capital marginal product, less labor will match more capital. Such technological progress is deemed as labor-saving technological progress. On the contrary, it will be deemed as capital saving technological progress. After adding factor of technological progress, if the change does not affect the balance of labor and capital, it will be considered to be Hicks neutral.

For labor saving technological progress, economic growth of developing countries and regions is mainly promoted by technology intensive or capital intensive technology progress. In certain period, it saves labor and brings maximum benefits from limited production factors. Besides, it promotes regional economic development through large capital input and introduction of new high technology. Nevertheless, both capital intensive and technology intensive technological progress need accumulation of huge development fund in short term, and need high cultural quality labor forces, which are weaknesses of developing countries and regions. For capital saving technological progress, regional economic development is mainly driven by labor intensive technological progress through matching more labor forces with less capital or technology. Developing countries and regions just have rich labor forces. The neutral technological progress theory is considered moderately technological progress. It can increase output without changing combination of capital and labor. In reality, the type of technological progress always has inclination, and it is difficult to form neutral technological progress. As for actual situations of Shaanxi Province, labor forces are abundant in early stage of economic development, while it lacks funds and technology, so it is suitable for adopting capital saving technological progress theory. However, with economic development, capital accumulation and changes in regional resources, such capital saving technological progress type is inclined to changing to neutral technological progress and labor saving technological progress type.

2.2 Induced technical innovation theory Yujiro Hayami et al. set forth the induced technical innovation theory with agricultural technological progress as example. According to assumption of the induced technical change, in the condition of market economy, farmers, influenced by changes of relative price of factors, will make effort to seek technology that can replace scarce production factors^[3]. This theory regards agricultural technological progress as dynamic reflection of resource endowment and demand growth, rather than product of spontaneous progress of science and technology. Specifically, inductive mechanism of technological progress lies in changes in relative price of factors and growth of product demand. In other words, technological progress is endogenous, instead of exogenous. In the induced technical innovation theory, technological progress, as source of economic growth, can make explanation within the economic system. On the basis of this theory, developing countries must develop and introduce science and technology in accordance with actual conditions, so as to give impetus to technological progress. This means that the difference in relative abundance of factor endowment in an economic entity will lead to difference in effective path for technical changes. This theory will have great significance to agricultural modernization development of Shaanxi Province.

2.3 Resource development theory As the earliest agricultural development theory, the resource development theory states that developing natural resource is the source of agricultural and economic development, and increasing cultivated land and grazing land is the major approach to expanding agricultural production. At early stage, agricultural production is restricted by productivity level, and major method of reproduction depends on extensional approach, namely, expansion of cultivated land area. However, agricultural production is seriously limited by natural resources, and natural resources are limited. In consequence, expansion of agricultural development and shrinkage of natural resources cause that the economic and agricultural growth simply relying on natural resource development becomes not suitable for modern social development, and is gradually being abandoned by all countries. Yujiro Hayami et al. believed that resource development based agricultural growth is not sustainable in a long term. To realize sustainable growth, agriculture must get rid of simple resource development model, turn to focus on development of resource saving or augmenting technologies, replace natural soil fertility with modern industrial input products, and put forth effort to develop new crop varieties.

2.4 Hypothesis of urban industry influencing agricultural development This hypothesis originates from Thunen's agricultural location theory. Through analyzing the relationship between transportation cost of agricultural product and profit, Thunen found that the present agricultural land use type and intensification degree not only depend on natural characteristics of land, but also rely on economic situation, especially the distance to consumption place of agricultural products. In the 1950s, Schultz raised the hypothesis of urban industry influencing agricultural development.

Firstly, economic development happens in specific location center, mainly industrial cities. Secondly, factors and production market of regions with rapid urban industrial development can bring into better play than those regions that have not entered into industrial stage. Thus, this hypothesis has greater directive significance to developing countries and regions, while the guiding significance to less developed regions, especially poor regions, is little.

3 Development paths for agricultural modernization of Shaanxi Province

3.1 Transforming agricultural industrialization into labor-intensive type relying on resource endowment Agricultural industrialized development of Shaanxi Province remains the starting stage. Shortage in funds and supply of technology, as well as backward development of urbanization, manifests that conditions are not satisfied for agricultural industrialization transforming to technology intensive from capital intensive type. However, to absorb huge agricultural labor forces and change population burden into advantage of human resource, Shaanxi Province must rely on resource endowment and take the labor-intensive road under the guidance of technical innovation theory.

Agricultural activity is seasonal. Except certain period of dynamic management in the process of production, farmers have much free time. For farmers in Shaanxi Province, the situation is similar. Although farmers have certain period to do other jobs, such as characteristic breeding, rough processing of agricultural byproducts, and working in cities, it is still very difficult for them to realize considerable growth of income through transformation of industrial model. Therefore, from the perspective of industrial development, on the condition of guaranteeing grain production, agricultural industrialization of Shaanxi Province should orient towards multiple, chain-type, characteristic and large scale development. Specifically, Shaanxi Province should rely on its resource endowment, take increasing farmers' income as the objective, and guide farmers to develop fruit industry, forest industry, knitting industry, green breeding and harmless planting industries in the models of leaving the farmland but not hometown, leaving farmland and hometown, and neither leaving farmland nor hometown. In addition, it should enhance brand awareness and supervision of quality management, to realize growth of these industries, increase of farmers' income, and increase fund accumulation for agriculture of Shaanxi Province.

In recent years, growth in people's living standard and awareness for environmental protection, as well as increase in demands for green food and daily necessities, provides a huge market for developing green fruit industries and environment-friendly wood and bamboo products in rural areas of Shaanxi Province. Besides, Shaanxi Province should fully explore skills of folk artists, combine these skills with new process, and weed out the old and bring forth the new. Furthermore, it is recommended to actively attract migrant workers to return to hometown to start undertaking, speed up upgrading and optimum combination of agricultural industrial

structure, and transform workshop type, separate and part-time farming into large scale, intensive and standardized model. Through developing labor intensive industry, it is expected to shift rural surplus labor, take full advantage of regional resource endowment, increase resource utilization efficiency and boost increase of farmers' income and accelerate agricultural industrialization.

3.2 Consolidating agricultural resources and quickening transformation of traditional agriculture to modern agriculture

Modern agriculture is mainly characterized by mechanized cultivation, scientific agricultural technology, large scale operation, knowledgeable farmers and integrated urban and rural areas. To realize agricultural modernization, Shaanxi Province should consolidate its agricultural resources and quicken the transformation of traditional agriculture to modern agriculture in accordance with characteristics of modern agriculture, through taking new agricultural cultivation technology as guidance and market demand as incentive.

Vast in territory, rich in sunshine, heat, water, land, stone, forest, animal husbandry, fishery and mineral resources, Shaanxi Province has advantage and potential to develop characteristic industry. According to theory of resource endowment induced technological progress, resource abundance of Shaanxi Province will determine technological model of regional agricultural industrialization, while the shortage of Shaanxi Province in fund and technology will be compensated by abundance of agricultural resources and human resources. Shaanxi Province should take full advantage of resources, develop characteristic industries, and take the road of "having what others don't have, having what better than they have, and having unique characteristics". It is recommended to quicken agricultural modernization, actively promote industrialization of village-wide economy, foster leading enterprises, simultaneously develop rough and fine processing, and promote agriculture through industry. Also, it is proposed to strengthen raw material production and processing bases of existing mining industry, cotton, fur, forest products, agricultural byproducts, and traditional Chinese medicinal materials, bring them to develop towards intensification. In policies, it should provide adequate support to make it become incubator of agricultural modernization development and transformation of Shaanxi Province.

Land is the basic resource rare in agricultural resource. In Shaanxi Province, the human – land conflict is prominent. Agricultural surplus labor forces should be arranged, and supply of grain, meat, egg, dairy product, fruit and vegetable should be guaranteed. From the perspective of induced technological progress, agricultural modernization of Shaanxi Province should take labor-intensive road. However, at present, land output income has become saturated, continuing to input labor forces will reduce marginal income of land. Therefore, surplus agricultural labor forces should be shift to other agricultural fields, to conduct mechanical, scientific and large scale planting on existing land. Nevertheless, the existing land property right system becomes a new

obstacle. According to development situations of agricultural modernization in Shaanxi Province, it is recommended to implement "agricultural land bank system" in proper regions. In this system, farmers hand their land to intermediaries like banks which will hire out land to other collectives or farmers for centralized operation, and farmers will obtain certain rental charges. This system not only can solve the problem of land abandonment and idleness resulted from farmers' work migration, but also can solve the problem of difficulty in realizing large scale operation of land, making transformation of agricultural industrialized development to modern agriculture possible in Shaanxi Province. Farmers can obtain certain rental charges from saving their land in "agricultural land bank", and can obtain wages from going to work in new land operation companies, forming the multi-win situation.

3.3 Upgrading industrial ideas and guiding upgrade of agricultural industrial structure of western regions For many years, backward agricultural development of Shaanxi Province is resulted from holding traditional industrial ideas and lacking new production factors, and it is difficult for agriculture-oriented traditional cultivation model to promote further development of rural economy. To find new opportunity in the construction of new socialist countryside and enhance economic strength of Shaanxi Province, it must bring into play agricultural modernization policies, such as promoting agriculture through industry, encouraging industry to support agriculture in return for agriculture, and encouraging cities to support rural areas.

Although agricultural modernization development of Shaanxi Province has created a considerable impact on traditional industrial ideas in recent years, small peasant thought of farmers is still ingrained, and farmers still follow blindly or do not accept service industries. What's worse, quality of labor forces quitting from agricultural field is not high, it is difficult to satisfy demand of high end services and new tertiary industry. Most farmers entering the tertiary industry are engaged in simple housekeeping, food and beverage service, and security, etc., which contain little technology. According to production factor saving technological progress theory and induced technological progress theory, the chief obstacle for Shaanxi Province to realize agricultural modernization is effective transfer of agricultural surplus labor. Thus, it is recommended to quicken upgrading farmers' industrial ideas, encourage them to move to surrounding cities through working in service industries, and focus on quality awareness, brand awareness, management awareness and service awareness.

At present, Shaanxi Province has developed some primary tertiary industries, such as sightseeing agriculture, facility agriculture, leisure agriculture, rural tourism, ethnic cultural festival, and ethnic cultural tourism. However, these have problems of small scale, chaotic management, short of supporting facilities, and poor service awareness, which restrict agricultural industrialization of Shaanxi Province to some extent. Thus, Shaanxi Province should energetically support development of existing tertiary industry, carry out standardized transformation, institutional manage-

ment, market operation, large scale development, and brand popularization and introduction of existing tertiary industry, to make the entire process of industrial development imbue with modern industrial development concept. In combination with regional characteristics, Shaanxi Province should extend advanced process of industry within the region through development of leading industry, pillar industry, auxiliary industry and infrastructure industry, build industrial clusters and groups and induce upgrade of agricultural industrial structure in the process of optimizing industrial structure.

3.4 Integrating into regional urbanization and extending agricultural industrial chain in the integration of urban and rural areas Shaanxi Province's urbanization has become a powerful growth pole of regional socioeconomic development. Rapid development of a lot of small and medium cities and towns not only absorbs surrounding agricultural surplus labor, but also provides opportunity for agricultural modernization of surrounding regions. Integration into these rising organic towns, central towns and satellite towns optimizes employment approach and environment of agricultural labor forces, and promote diversified development of surrounding agricultural industry and extend agricultural industrial chain through providing production and living necessities for cities and towns.

At present, urbanization and industrialization of Shaanxi Province interweave with construction of new socialist countryside, and the ultimate purpose is to realize further socioeconomic development. This means that Shaanxi Province should take serving urban demand as precondition, market development as direction, commercialized production as driver, and adjustment of agricultural industrial structure as objective, to realize complementation of urban and rural areas in industrial structure, convergence in living standard, simultaneous increase of residents' income, and expanding demands in consumption. Also, it should lay solid foundation for integrated development of urban and areas, and integrate industrial reconstruction of rural areas with acceleration of agricultural industrialization of Shaanxi Province, to promote development quality and speed of urbanization. Besides, it should take two-way flow of agricultural surplus labor and urban and rural resource elements. Through household register reform, it is expected to eliminate artificial barriers between urban and rural areas, and integrate urban and rural social and economic development, to incorporate rural areas into regional urbanization development.

4 Conclusions

Technological progress theory plays an important theoretical role and has realistic significance in development economics. As a developing region, Shaanxi Province should make effort to realize agricultural modernization, which is of utmost importance to its socioeconomic modernization. Therefore, the discussion of agricultural modernization development of Shaanxi Province from technological progress theory not only has theoretical significance, but also has realistic guidance.

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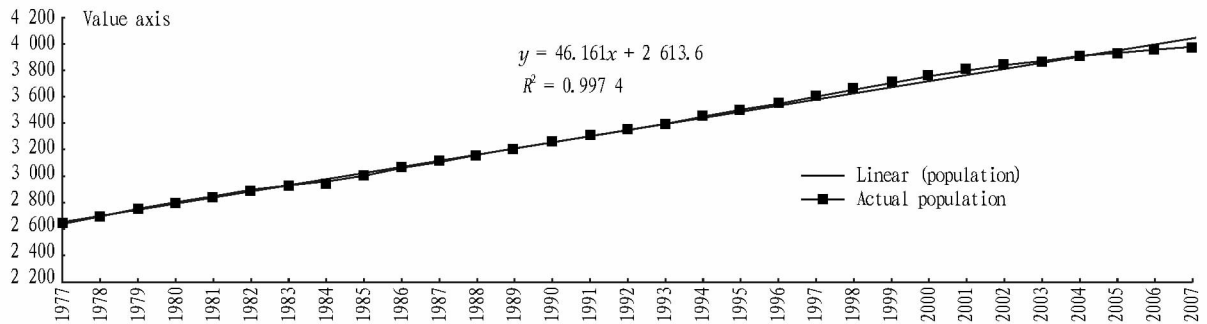


Fig.2 Unary linear regression model prediction

through visual judgment of residual error (θ) and MAPE. When neither θ nor MAPE exceeds 10% , the GM (1, 1) model will be deemed as high accuracy prediction model. According to residual error test, θ in the GM (1, 1) model for prediction of population of whole Guizhou Province is not higher than 8% , MAPE is 3.33% , and fitting accuracy is 96.67% . It can be seen that the GM (1, 1) model of the population of the whole province is high accuracy fitting prediction model.

3.4 Population prediction results of Guizhou Province

Since the natural growth method requires that natural growth conforms to arithmetic growth law, the prediction result is slightly low; the unary linear regression method sets constant population growth speed, the prediction result is relatively low; gray system GM (1, 1) model shows higher accuracy in the period with data available years accounting for about 1/3, the prediction result is slightly higher.

Considering the drawbacks of the above prediction methods, characteristics of population growth in Guizhou Province, prediction results of Guizhou Province's population, the proportion of Guizhou population into the whole national population, and future development trend, we estimated the mechanical growth factor of population change and got the total population of Guizhou Province of 46 to 47.5 million.

4 Discussion

(1) Based on comparison of various population prediction methods, this study adopts unary linear regression, natural growth method and gray system GM (1, 1) to predict the total population of Guizhou Province in 2020. The population prediction results should be a proper range, rather than a value, so it can ensure

proper and accurate prediction results, and can provide a margin for future population planning. Besides, along with rapid development of economy, the population of Guizhou Province will grow at a faster speed.

(2) Population growth is influenced by many factors, so the population prediction is a complex job. The study on population prediction models has not come to a conclusion, thus the present population prediction generally combines many prediction methods. Long term population prediction is a complex and difficult matter, but medium term prediction is possible. Through analysis of historical data and selection of models, it is possible to obtain accurate prediction results. However, it should not extend the prediction results, and it is extremely difficult to ensure accuracy of prediction for several decades or hundreds of years.

(3) Mathematical model only can predict total population. For gender and age structure, it is difficult to predict. Therefore, to obtain the information about population structure, it should use special population prediction software, which is to be further tackled by software developers.

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