

## ORIGINAL RESEARCH ARTICLE

# Exploration of practice and optimization of strategies for conservation of cultivated land resources in contemporary China's rural areas—Centering on black soil conservation and others

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### ABSTRACT

Cultivated land resources are the basic elements for rural development and farmers' survival in China. Strengthening the protection of cultivated land is an important measure to ensure national food security and practice the strategy of "storing grain in the land and technology", and it is also an inevitable requirement to promote the high-quality development of agriculture. The protection of cultivated land in contemporary China has gone through three stages: the initial exploration period of reconciliation between economic development and the number of cultivated land, the institutional development period of construction occupation and cultivated land quality management and protection, and the transformation and improvement period of "Trinity" in the new era. In the new era, cultivated land protection has achieved phased results, but it still faces practical constraints from the actors, technical environment, institutional environment and so on. In view of this, we should explore the breakthrough path to further promote cultivated land protection from the aspects of strengthening organizational guidance and technical training, strengthening the top-level design of differentiated cultivated land protection, strengthening the research and development of new technologies and the construction of agricultural technology extension system.

**Keywords:** Cultivated Land Protection; Practical Exploration; Regional Differentiation; Strategy Optimization

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## 1. Introduction

Cultivated land is an irreplaceable agricultural production factor to ensure national food security. China feeds 20% of the world's population with 10% of the world's arable land and 6% of the world's water resources. However, the acceleration of industrialization and urbanization and the predatory development and utilization of "reuse and light breeding" for a long time have led to the continuous reduction of the number of cultivated land, the continuous decline of the quality of cultivated land, and the continuous deterioration of rural water and soil resources and environment. On the whole, the situation of China's cultivated land environment is not optimistic. The results of the 2014 National Soil Pollution Survey Bulletin showed that compared with other land types, the over standard rate of cultivated land soil points in China was the highest, 19.4%. On a regional scale, it is mainly reflected in the degradation of black soil in Northeast China, overexploitation of groundwater in North China Plain, increased vulnerability of ecological environment in Northwest China, soil acidification pollution in southern rice region and other problems, which have seriously threatened food

security and sustainable agricultural development<sup>[1]</sup>. Since the 1980s, the central and local governments have attached great importance to the protection of cultivated land, and “cherish and make rational use of every inch of land and effectively protect cultivated land” has been taken as a basic national policy to implement the strictest cultivated land protection system in the world. However, the early warning of the quantity and quality of cultivated land has never stopped, and the protection of cultivated land still has a long way to go<sup>[2]</sup>.

The existing literature on the protection of cultivated land resources in contemporary China mainly focuses on the following aspects: first, based on the historical evolution perspective, long-term analysis of the evolution and optimization of China’s cultivated land protection system<sup>[3,4]</sup>; second, evaluate the implementation effect of a specific cultivated land protection policy<sup>[5,6]</sup>; third, analyze the problems and solutions of cultivated land protection in a certain region based on the micro scale of farmers or the macro perspective of ecological protection and food security<sup>[7,8]</sup>. In fact, cultivated land protection not only has time scale differences, China has a vast territory, and there are also significant regional spatial differences in cultivated land resources and environmental problems. However, the existing literature lacks practical exploration to investigate the protection of rural cultivated land resources in China from the perspective of time and space. In view of this, this paper starts from the dual perspective of time and space, combs the evolution process and stage characteristics of cultivated land protection, takes black soil protection as the core, takes into account other regions, and deeply analyzes the practical exploration, practical constraints and regional differentiation of cultivated land resource protection in different regions, in order to provide decision-making reference for formulating differentiated cultivated land protection policies and supporting measures.

## **2. Practical exploration and results of cultivated land resource protection in rural China**

### **2.1 Evolution and characteristics of cultivated land resource protection in rural China**

At the beginning of the founding of the People’s Republic of China, under the background of population pressure and serious food shortage, increasing cultivated land for food production by opening up wasteland, and taking “cultivated land protection” as a way to promote agricultural production increase is the early exploration stage of the awakening of China’s awareness of cultivated land protection and the formation of the concept of cultivated land protection policy. The protection of rural cultivated land in China mainly started in the 1980s, which can be roughly divided into three stages: the initial exploration period (1978–2003) of the reconciliation between economic development and the number of cultivated land, the institutional development period of construction occupation and cultivated land quality management (2004–2011), and the transformation and improvement period of the “Trinity” in the new era (2012 to now).

#### **2.1.1 The preliminary exploration period for the reconciliation between economic development and the number of cultivated land (1978–2003)**

After the reform and opening up, the implementation of the household contract responsibility system and the progress of modern agricultural science and technology have effectively improved the agricultural production capacity, and the long-term serious shortage of grain in China has been preliminarily reversed. Accompanied by this, the problems of farmers’ building houses and township enterprises’ disorderly occupation of cultivated land occur frequently, leading to the gradual escalation of the contradiction between economic development and the protection of cultivated land resources. For this reason, since 1981, the basic concept of cultivated land protection has been clarified for the first time in policy texts such as the Government Work Report, the Emergency Notice on Stopping the Occupation of Cultivated Land by rural housing construction, and the Notice of the State Council on Strictly Implementing the Regulations on Land Requisition for National Construction, and it is

proposed to strictly restrict the abuse of agricultural land for building houses or supplementing construction land. The promulgation of the land administration law and the establishment of the State Land Administration Bureau in 1986 marked the beginning of legal basis for cultivated land protection in contemporary China. On this basis, a number of cultivated land protection policy documents have been issued, including the Interim Measures for the Handling of Land Violations, the Regulations on the Protection of Basic Farmland, and the Notice on Further Strengthening Land Management and Effectively Protecting Cultivated Land. Since then, with the acceleration of industrialization and urbanization, a new round of “geo-thermal use” has been launched. The decline in the number of cultivated land poses a serious threat to food security, and the party and the state have significantly strengthened the protection of cultivated land. In 1998, the State Council established the Ministry of Land and Resources, and assigned the responsibility for the protection of cultivated land use to specially established functional departments. At the same time, the newly revised Land Management Law clarifies the way of land management from the aspects of farmland occupation and compensation balance, basic farmland protection, land use and other content dimensions. In 1999, the Ministry of Land and Resources issued the Notice on Effectively Balancing the Occupation and Compensation of Cultivated Land to implement the cultivated land compensation system proposed in the land management law from the aspects of responsibility, measures, management and monitoring. In 2001, the Notice on Further Strengthening and Improving the Balance of Cultivated Land Occupation and Compensation proposed to control occupation and supplement according to law, and implement the cultivated land supplement plan based on the principle of “occupation and compensation”. In 2003, the State Council issued the Notice on Cleaning up and Rectifying All Kinds of Development Zones and Strengthening the Management of Construction Land and the Emergency Notice on Suspending the Approval of All Kinds of Development Zones to investigate the responsibility of sud-

den approval and sudden establishment of development zones.

In a word, this stage is a preliminary exploration period for the reconciliation of the contradiction between national economic development and the number of cultivated land, and its characteristics are mainly reflected as follows: first, the connotation of the concept of cultivated land protection is gradually deepened; second, the cultivated land protection policy has changed from a single regulation to both economic incentives and legal regulation; third, the cultivated land protection policies and safeguard measures are not perfect, and a systematic cultivated land protection policy system has not been formed.

### **2.1.2 System development period of construction occupation and cultivated land quality management and protection (2004–2011)**

In order to deal with the problems of sharp reduction in the number of cultivated land and compensation for the poor caused by the “land finance” of local governments, the party and the state further strengthen the attention to the protection of the quantity and quality of cultivated land. In 2004, the revised Land Management Law clearly distinguishes the concepts of “expropriation” and “requisition”. In 2004, the State Council issued the Decision on Deepening Reform and Strict Land Management, which proposed to “implement the strictest cultivated land protection system”. In order to implement the above decision, the Ministry of Land and Resources successively issued several policy texts in 2005, such as the Notice on Carrying out the Basic Work of Converting the Quantity and Quality of Supplementary Cultivated Land by Grade, and the Standard for Investigating and Dealing with Land Violations. At the same time, the State Council issued the Assessment Measures for the Objectives of Provincial Governments Cultivated Land Protection Responsibility in 2005, clarifying the responsibilities of local governments in the protection of cultivated land and basic farmland; in 2006, the Notice on Issues Related to the Establishment of a National Land Supervision System was issued to strictly supervise and inspect illegal

land use. In 2007, the Government Work Report stressed that the red line of 1.8 billion mu of cultivated land should be strictly observed. In 2008, it was proposed to designate permanent basic farmland. In 2009 and 2010, the Ministry of Land and Resources carried out the “double guarantee action” and “double guarantee project”, respectively, further deepening the implementation of the policy requirements of the red line of cultivated land.

In short, this stage is the institutional development period of construction occupation and cultivated land quality management and protection, which is mainly characterized by: first, it is proposed to strictly abide by the red line of 1.8 billion mu of cultivated land and delimit permanent basic farmland; second, economic compensation and regulatory constraints work together on cultivated land protection; third, we began to pay attention to the management and protection of cultivated land quality, but the policies and measures for the protection of cultivated land quality need to be further strengthened, and the ecological protection of cultivated land has not been paid enough attention.

### **2.1.3. The transformation and improvement period of the “Trinity” in the new era (since 2012)**

Since the 18th National Congress of the Communist Party of China, under the condition of increasingly tight resource and environmental constraints, the central government has further strengthened the management of cultivated land ecological environment. In 2012, the Ministry of Land and Resources issued the Notice on Improving the Level of Cultivated Land Protection and Comprehensively Strengthening the Construction and Management of Cultivated Land Quality, which marked that China’s cultivated land protection has entered a transformation and improvement stage integrating “quantity, quality and ecology”. Based on the above policy positioning, China’s cultivated land resources protection policies and measures mainly include the following aspects: first, strengthen the construction of high standard farmland. The High Standard Farmland Construction Standard issued by the Ministry of Land and Resources in 2012 and the Opinions on Comprehen-

sively Deepening Rural Reform and Accelerating Agricultural Modernization issued by the State Council in 2014 all emphasize the implementation of the national high standard farmland construction. Since then, the Action Plan for Soil Pollution Prevention and Control issued by the State Council in 2016 and the Opinions on Strengthening the Construction of High-standard Farmland and Improving the National Food Security Guarantee Capacity issued in 2019 have gradually promoted the construction of high-standard farmland from the aspects of standards, management and measures. The second is to establish a system of cultivated land rotation and fallow. After the “13th Five Year Plan” proposed to explore and implement the cultivated land rotation and fallow system, the State Council issued the Pilot Plan for Exploring and Implementing the Cultivated Land Rotation and Fallow System in 2016, emphasizing the problem orientation and implementing zoning and classification policies in heavy metal polluted areas, underground funnel areas, rocky desertification areas and areas with ecological function degradation. In 2020, the pilot area of cultivated land rotation and fallow will reach 1.8 million hectares. Third, balance the occupation and compensation of cultivated land across the country. In 2017, the Ministry of Land and Resources issued the Notice on Improving Management Methods and Effectively Implementing the Balance of Cultivated Land Occupation and Compensation, which proposed to establish a new mechanism for the balance of cultivated land occupation and compensation based on quantity and production capacity. In 2018, the National Integrated Management Measures for Cross Provincial Supplementary Cultivated Land was issued, which clearly pointed out that areas with insufficient reserve resources of cultivated land or poor natural endowment conditions can apply for national integrated supplementary. The fourth is to build a land space management mechanism for cultivated land protection. In 2019, the State Council issued Several Opinions on Establishing a Land Space Planning System and Supervising Its Implementation, which proposed to include cultivated land protection into the land space management system and establish



the corresponding supervision mechanism. Subsequently, the Land Management Law revised in 2019 clarified the above-mentioned high standard farmland construction, rotation and fallow system, balance of occupation and compensation, and land and space management in the form of legal provisions.

In short, this stage is the transformation and improvement period of the “Trinity” cultivated land protection in the new era, which is characterized by: first, the ecological protection of cultivated land is included in the consideration of cultivated land quality; second, the cultivated land protection policy is more administrative and scientific, and has gradually formed a cultivated land resource protection policy system based on the use control as the core, with high standard farmland construction, permanent farmland protection, cultivated land ecological management, land transfer and requisition as the main content.

## **2.2 Practical exploration and region of cultivated land resource protection in rural China**

China has a vast territory, and there are obvious regional differences in natural geographical environmental conditions, resource endowments, agricultural production characteristics and agricultural technology levels in different regions, which leads to significant regional differences in agricultural resources and environment in various regions, mainly manifested in the serious degradation of cultivated land in the black soil region of the northeast, the overexploitation of groundwater in the North China Plain, desertification and salinization in the arid and semi-arid region of the northwest, soil acidification and heavy metal pollution in the rice region of the south, etc. Therefore, it is particularly important to explore the protection technology of cultivated land resources in different regions according to local conditions<sup>[9]</sup>. This paper focuses on the northeast black soil area as the core, taking into account North China, northwest and South China, to explore the practice and regional differences of rural cultivated land resource protection in different regions.

### **2.2.1 Northeast black soil area**

Northeast black soil area is one of the only “three black soil belts” in the world, and is China’s largest commodity grain base. For many years, it has played an important role as a “ballast stone” in ensuring national food security. However, since the 1980s, with the acceleration of industrialization and urbanization, the predatory development and utilization of “reuse and light breeding” for a long time, the increasingly distant planting and breeding relationship, and the single planting system have made the black soil layer “thin”, and “hard”, resulting in the reduction of soil organic content and the decline of water storage and moisture conservation capacity, which has seriously restricted the potential of grain production in the black soil region of Northeast China<sup>[10]</sup>. For this reason, since the 1980s, China has introduced and demonstrated the application of subsoiling, no tillage, straw mulching and other conservation tillage technologies. However, restricted by the concept of agricultural production, the conditions of social and economic development and the level of agricultural technology and machines, it was only tested and applied in some areas in this period. Until entering the 21st century, the concept of black land protection began to deepen gradually, entering the early exploration period of black land protection. In order to reverse the deteriorating trend of the ecological environment in the black soil area, since 2002, the Ministry of Agriculture has allocated 170 million yuan of special funds for five consecutive years to support the research of conservation tillage equipment technology and the demonstration and promotion in northern areas (including western Liaoning), which has laid a good foundation for the promotion and application of conservation tillage technology in the black soil area of Northeast China. Since 2003, the Ministry of Water Resources has started to implement the pilot project of comprehensive prevention and control of soil and water loss in the black soil area of Northeast China, with a total investment of about 200 million yuan for three consecutive years. Different control measures such as engineering, technology and ecological restoration have been taken in different prevention and control areas in the black soil area. Since 2005, the Ministry of Ag-

riculture has carried out soil testing and formula fertilization actions and pilot subsidies in Jilin, Liaoning, Inner Mongolia and other five provinces and autonomous regions across the country, and gradually expanded pilot areas and subsidy support. In 2006, the Ministry of Agriculture launched a new round of five-year fertile soil project planning, with northeast black soil region as one of the key implementation areas. As an important part of national cultivated land protection, blackland protection is scattered in various national policies and measures for cultivated land protection, and no policy system has been formulated specifically for cultivated land protection in black soil areas.

In 2007, the Northeast Institute of Geography, the Chinese Academy of Sciences, and the China Agricultural University, with the assistance of the Lishu County Agricultural Committee and the Agricultural Technology Extension Station, took the lead in applying the straw full coverage technology to Lishu County, a major agricultural production county, and launched a long-term experimental demonstration study of the black soil conservation tillage technology and its mechanism and effect for more than a decade, and finally created a mechanized technology system of corn straw coverage suitable for the regional characteristics of black soil areas. A unique “Lishu model” that can be popularized and replicated has been formed, which also marks a breakthrough in the technology and machinery of blackland protection. In addition, the central and local governments began to introduce policies and measures specifically for the protection of black land. Taking Jilin Province as an example, since 2009, Jilin Province has promulgated and implemented the Regulations of Jilin Province on the Protection of Cultivated Land, the Technical Specifications for the Evaluation of Soil Fertility of Black Soil Cultivated Land, and the Technical Regulations for the Monitoring of Soil Fertility of Cultivated Land, which provide strong technical support and legal protection for the protection of blackland. With the improvement of agricultural mechanization and modern agricultural technology, blackland protection technology tends to be mature, and the policy incentives and constraints

for blackland protection behavior are increasingly standardized, which has accumulated rich experience for the promotion and application of blackland protection technology in a wider range.

In 2015, the Master Plan for the Treatment of Prominent Agricultural Environmental Problems (2014–2018), issued by the National Development and Reform Commission in conjunction with six departments, included blackland protection into major engineering projects, emphasizing the implementation of blackland protection pilot projects to achieve the integration of blackland use and breeding, and improve the fertility of blackland. In 2015, the country’s first academician workstation for blackland protection and utilization was established. From 2015 to 2017, the central government allocated 500 million yuan of special funds every year for three consecutive years to carry out pilot projects for the protection and utilization of blackland in 17 counties (cities) in four provinces (autonomous regions) in Northeast China. In 2017, the Ministry of Agriculture, together with the National Development and Reform Commission and other six ministries and commissions, jointly issued the Outline of the Northeast Blackland Protection Plan (2017–2030), which made specific arrangements of black land protection for the overall idea, key tasks, implementation mode, safeguard measures, etc. In 2020, the Ministry of Agriculture and the Ministry of Finance issued the Northeast Black Soil Conservation Tillage Action Plan (2020–2025), which placed the promotion plan of conservation tillage in the northeast black soil area at the national strategic level, and proposed that the central government should vigorously support the development of conservation tillage in the northeast black soil area and gradually build a conservation tillage policy support system and technology promotion system. In addition, Northeast China has successively launched many projects, such as the pilot of rotation fallow system, the construction of high standard farmland, the prevention and control of agricultural irrigation water pollution, the resource utilization of livestock and poultry breeding waste, and the reduction and replacement of chemical fertilizers, which have played a positive role in the treatment

of agricultural non-point source pollution and the protection of cultivated land in black soil area. At present, the central government has placed blackland protection in a national strategic position. Based on the central and local levels, it has issued a series of policies and measures around the promotion of conservation tillage technology and the treatment of agricultural non-point source pollution in black soil areas, carried out active exploration and attempts on a large scale, and formed a relatively mature blackland protection technology integration demonstration mode and operation mechanism suitable for different regions, and achieved obvious ecological and economic benefits in some areas.

### **2.2.2. North China**

North China Plain is an important major grain producing area and vegetable production base in China, which plays an important role in ensuring the supply of agricultural products. However, over the years, agricultural production in North China has been characterized by high input, high consumption, high output and high pollution, especially the long-term overexploitation of groundwater has made the North China plain the largest groundwater funnel in the world. Therefore, the central government attaches great importance to the control of groundwater overexploitation in this region, and has issued a series of policies and measures. At the end of 2002, the state launched the South-to-North Water Diversion Project, which included Beijing, Tianjin, Hebei, Shandong and Henan into the water receiving area of the South-to-North Water Diversion Project in 2013, and expanded the governance scope to Shandong, Shanxi and Henan provinces in 2018. In 2019, the State Council, together with relevant departments, issued the Action Plan for the Comprehensive Treatment of Groundwater Overexploitation in North China, proposing to gradually achieve the balance of groundwater exploitation and recharge in North China by taking “one reduction” and “one increase” comprehensive treatment measures. By 2020, the cumulative water transfer to Beijing, Tianjin, Hebei and Henan by using the water storage project of the middle route of the South-to-North Water Transfer Project has reached

38.006 billion m<sup>3</sup>, and the problem of groundwater overexploitation has been effectively alleviated.

### **2.2.3. Northwest China**

The northwest arid and semi-arid region is not only one of China’s important grain production bases, but also an important ecological function barrier. However, due to its inland location, drought and little rain, and uneven spatial and temporal distribution of water resources, the agricultural ecological environment is fragile. Therefore, during the “12th Five Year Plan” period, the northwest region has effectively curbed desertification in the northwest region by relying on national key projects such as “returning farmland to forests”, “Three North shelterbelts”, “natural forest protection” and the protection of the Yangtze River Basin. Since 2013, many measures have been taken in the northwest region, focusing on saline alkali land treatment through farmland irrigation and drainage, land remediation, soil improvement and farmland forest network construction. In 2017, the Ministry of Agriculture and Rural Areas, focusing on the northwest region, launched and implemented the action of agricultural film recycling, which has a significant effect on the treatment of “white pollution”.

### **2.2.4. Southern region**

Southern China is an important major rice producing region in China, including 16 provinces in the middle and lower reaches of the Yangtze River, Southwest China and South China. However, unreasonable production and management methods such as excessive application of chemical fertilizers for a long time have led to soil acidification and heavy metal pollution in southern rice areas, which in turn affect food production and the quality and safety of agricultural products. In order to solve the problems of soil acidification and heavy metal pollution, in 2014, the Ministry of Agriculture launched the pilot project of heavy metal polluted cultivated land restoration and cultivated land rotation fallow system in Zhutan area, Hunan Province. At the same time, through the promotion of technical measures such as deep tillage, rotary tillage, increased application of organic fertilizer, straw returning to the field and planting green manure, a

“composite” planting and breeding combination model such as rice-fish model was established. According to local conditions, we have explored a comprehensive management system of paddy fields in the south, which integrates “fallow, management and fertilization”. In addition, the State Council issued the National Agricultural Sustainable Development (2015–2030) and the Action Plan for Soil Pollution Prevention and Control in 2015 and 2016 respectively, which included the problem of heavy metal pollution in cultivated land into the key content of agricultural ecological environment treatment, and strengthened the prevention and control of soil pollution through ten aspects, such as soil pollution investigation, legislation, management and remediation.

### **3. Analysis of practical constraints and problems in the protection of cultivated land resources in rural China**

As China’s economic development enters a new stage, with the strong support of national policies, the protection of cultivated land resources has achieved phased results, but the overall situation of the quantity and quality of cultivated land is still not optimistic, and there are still many challenges and outstanding problems in the practice and exploration of cultivated land protection. This paper summarizes the practical constraints existing in cultivated land protection as “behavioral subject constraints”, “technical environment constraints” and “institutional environment constraints”.

#### **3.1 “Behavior subject constraint” of cultivated land protection**

As the practice subject and benefit subject of cultivated land protection, farmers play an important role in the utilization and protection of cultivated land. However, due to the limitations of their own endowment characteristics and external environment, farmers have many practical problems that are not conducive to their main role, which are highlighted in the following three aspects:

First, farmers’ awareness of the main body of cultivated land protection is weak. Based on the

survey data in the black soil area of Northeast China, from the perspective of farmers’ cognitive characteristics, 85.7% of farmers generally recognize that unreasonable farming methods and excessive application of agricultural chemicals will lead to the decline of cultivated land fertility. However, when asking “who do you think is responsible for cultivated land protection”, the proportion of farmers who think they have the responsibility to participate in cultivated land protection is only 39.5%. Most farmers believe that cultivated land protection is something that governments at all levels and village cadres should do, which has little to do with themselves. This dependence psychology and weak subject consciousness of farmers lead to the limited role of farmers in the protection of cultivated land. The possible reasons are that, on the one hand, farmers lack the awareness of modern cultivated land protection due to the limitations of traditional farming ideas and their own endowment characteristics such as older age; on the other hand, the current farmland protection policies and regulations in China have weakened the farmers’ environmental protection responsibility, and lack feasible incentive policies and implementation measures, resulting in the implementation of farmers’ farmland protection responsibility is often a mere formality<sup>[10]</sup>.

Second, the overall quality of the labor force is low, and the ability to protect cultivated land needs to be improved. Taking the investigation of black soil area in Northeast China as an example, most farmers have realized the importance of cultivated land quality for increasing crop yield and income, and also realized that the current extensive management behavior such as excessive fertilization is an important reason for soil hardening and fertility decline. However, the proportion of farmers who really adopt conservation tillage measures in actual production is only 49.3%. Among them, the proportion of farmers adopting no tillage technology, rotation, straw returning to the field, soil testing and formula fertilization, and applying organic fertilizer is 18.6%, 27.4%, 23.1%, 8.0%, and 25.6% respectively. From the perspective of farmers themselves, the possible reason for the low actual adoption rate of farmers’ conservation tillage measures is that



cultivated land protection has high requirements on Farmers' ability to master and apply technology, while China's agricultural labor force generally has problems such as small business scale, weakening aging, low overall cultural quality, insufficient ability to master technology, and farmers' acceptance and demand for new technology are low. And before the conservation tillage technology has not been widely applied and produced ideal benefits, most farmers under the risk aversion attitude hold a wait-and-see attitude.

Third, farmers' short-sighted management behavior was driven by interests. According to Schultz's theory of "rational small farmers", all the behavior activities of farmers, such as resource allocation and production factors, are rational decisions made after comparing and weighing costs, benefits and risks. Under the pressure of survival and development, farmers' pursuit of maximizing short-term income will inevitably lead to their neglect of the rarity of resources and environmental carrying capacity, and take the extensive and short-term management as an important way to increase production and income. There are two main reasons for this behavior: first, institutional factors failed to stimulate farmers' enthusiasm for farmland protection. The implementation of the household contract responsibility system and the agricultural subsidy policy have greatly stimulated the enthusiasm of farmers to engage in agricultural production, but in the early stage, they did not pay attention to and effectively regulate the behavior of farmers to protect the quality of cultivated land. On the contrary, under the agricultural subsidy policy, increasing the application of chemical agricultural materials such as fertilizers and pesticides has become an important way for farmers to obtain land productivity, further accelerating soil acidification and hardening<sup>[11]</sup>. At the same time, the imperfect land circulation system leads to the instability of the land circulation period, which is very easy to weaken the long-term investment behavior of farmers to adopt conservation tillage measures, and take predatory production behavior for the contracted land. Second, the degree of farmers' part-time employment has increased, and the aging trend of ag-

ricultural labor force is obvious. In the process of transition from a planned economy to a market economy, the development of industrialization and urbanization has led to the phenomenon of deinvolution. More and more farmers and families show intergenerational division of labor. The main mode is that "the old, young and women" left behind families are mainly engaged in agricultural production activities, young and middle-aged labor force go out to work during slack seasons and engage in agricultural production activities during busy seasons. Statistics show that the proportion of Chinese farmers' household operating income from agriculture fell from 60.6% in 1996 to 33.5% in 2016. With the improvement of the degree of part-time farming, farmers' non-agricultural income gradually occupies the dominant position in household income. Part-time farmers usually pay less attention to agricultural production efficiency and invest less energy than full-time farmers, even in Northeast China, which has a high degree of affluence of agricultural resources.

### **3.2 "Technical environmental constraints" of cultivated land protection**

Modern conservation tillage technology is the main measure to promote cultivated land protection, which has important value in protecting the farmland ecological environment, improving agricultural production efficiency and enhancing the ability of agricultural sustainable development. Taking the development of conservation tillage in blackland as an example, this paper analyzes the technical environment of cultivated land protection. Foreign research on conservation tillage technology began with the "black storm" event in the United States in the 1930s. Since then, the United States has gradually explored a farming technology model that can replace traditional tillage and conserve water and soil. Now, conservation tillage with straw mulch management as the core has become the mainstream farming method in the United States. China's research on Conservation Tillage Technology for blackland in Northeast China began in the 1980s, such as the pilot no tillage technology for wheat in Heilongjiang state-owned farms, and the develop-

ment of tillage methods combining tillage, loosening and harrowing on the basis of ridge farming. However, under many constraints, conservation tillage technology has not been widely popularized. Since the beginning of the 21st century, the conservation tillage technology of blackland has been gradually improved in basic research and development, demonstration and promotion by relying on a number of projects such as soil testing and formula fertilization, straw returning to the field, and blackland protection pilot projects. According to the natural characteristics of different regions in Northeast China, an integrated mode and operation mechanism of conservation tillage technology suitable for different regions have been formed. Some pilot areas are improving soil fertility and reducing soil erosion. Remarkable achievements have been made in improving the economic and ecological benefits of agricultural production. However, there are still many bottlenecks to be solved in the supporting technology and promotion system, which are highlighted in the following aspects:

First, agronomy is divorced from agricultural machinery, and the corresponding supporting technology is insufficient. Over the years, China's conservation tillage technology has mainly focused on the R & D and application of agricultural machinery and tools such as no tillage sowing, deep scarification and deep ploughing and their corresponding management technologies. For the promotion of modern conservation tillage technology, there is a general lack of theoretical and scientific basis for agronomic technology such as relevant core technology operation principles, standards, scope of application, and a conservation tillage technology system combining practice and theory has not yet been formed. Taking straw returning to the field as an example, the technology of straw returning to the field is relatively mature and has been widely used, but so far, there is no clear scientific theoretical basis for the "how much" of straw returning to the field and what negative effects it will produce after returning to the field, and there is a lack of corresponding normative and authoritative technical guidance, which is not conducive to eliminating the doubts of farmers. In addition, the current conserva-

tion tillage technology has not formed an effective configuration combination with conventional cultivation technology and farming technology. For example, under the condition of long-term no tillage, it is likely to have a certain adverse impact on the physical and chemical properties of the soil. However, there is no definite standard for the operation of the rotation tillage technology that can solve this problem, and the corresponding supporting technologies are insufficient, resulting in the obstruction of the large-scale promotion of conservation tillage technology.

Second, the availability of agricultural technology extension is insufficient. Agricultural technology extension system is an important carrier to promote the transformation of agricultural scientific and technological achievements into real productive forces. However, over the years, although China's agricultural technology extension system has been constantly changing, it has not yet made substantive changes, which makes there are many constraints in the promotion and application of blackland conservation tillage technology. Taking soil testing and formula fertilization as an example, the excessive application of chemical fertilizers over the years has not only caused serious agricultural non-point source pollution, but also led to a decline in the yield potential of cultivated land. Since 2005, the Ministry of Agriculture and Rural Areas has launched the soil testing and formula fertilization project and gradually expanded the pilot areas. So far, the soil testing and formula fertilization technology has been relatively mature, and its application scope basically covers every agricultural county-level unit in the country. However, in the survey, it is found that the use and promotion of this technology is not satisfactory. The adoption rate of soil testing and formula fertilization by farmers in the black soil area of Northeast China is only 8.0%. Some surveyed farmers reported that even if department staff tested the farmland, they could not get the final test results most of the time. The main reason for this phenomenon is that China's agricultural technology extension system is not yet mature and perfect, and the effective supply is insufficient. On the one hand, restricted by funds, management

methods, incentive mechanisms and other aspects, China's grass-roots agricultural technology extension practitioners generally show the characteristics of small number, low academic qualifications and single knowledge structure, which can not meet the requirements of modern agricultural technology extension. In addition, the scientific and technological achievements of scientific research institutions have low transformation ability, and a promotion platform combining "production, learning, research and application" has not yet been formed; on the other hand, although the formula fertilizer supply network with dealers as the main body has been established in most regions, in order to sell more fertilizer with high profits, the dealers have led to a low proportion of formula fertilizer sales, and the formula fertilizer is often shoddy, which really goes deep into the production process of farmers, so that farmers make less profits due to the adoption of soil testing formula fertilization technology.

### **3.3 "Institutional environmental constraints" on cultivated land protection**

From the perspective of system, the characteristics of cultivated land protection in developed countries are based on legislative guarantee, economic compensation as a tool, participatory management system, publicity, education and training as a form, forming a scientific, systematic and practical cultivated land protection policy system, which has important reference significance for China's cultivated land protection. Although the funds for research and development of cultivated land protection technology in China are increasing year by year, the effect of cultivated land protection is greatly reduced due to the lack of systematic legislative guarantee and perfect economic compensation policies<sup>[11]</sup>.

First, the legal system related to cultivated land protection is "fragmented". At first, compared with developed countries, China has introduced local laws and regulations indirectly related to cultivated land quality protection since the 1980s. However, in the current Land Management Law, Regulations on the Protection of Basic Farmland, Agricultural Law, Environmental Protection Law and other relevant

laws, the legislation on the protection of cultivated land mostly focuses on the protection of the number of cultivated land, and the provisions related to the ecological quality of cultivated land are relatively scattered, and the content is vague or even missing. In 2019, China began to implement the first law specifically aimed at the protection of cultivated land quality, namely the Law of the People's Republic of China on the Prevention and Control of Soil Pollution. The "fragmentation" of laws related to the protection of cultivated land quality and the lack of corresponding implementation measures make it difficult to effectively form a binding force. Second, cultivated land protection involves many departments such as land, agriculture, grassland, forestry and water conservancy. Due to unclear responsibilities and inconsistent regulatory standards among different departments, conflicts between cultivated land quantity and quality protection and ecological conservation land such as forest and grass are very easy to occur. Third, the regulatory measures for the use of blackland are not in place, which is prominently manifested in the acts of a small number of regulators, such as misappropriation, abuse, occupation of the superior and compensation for the inferior, resulting in a double decline in the quantity and quality of cultivated land.

Second, there is a lack of perfect incentive mechanism for ecological compensation of cultivated land protection. At present, China has not yet established a systematic and perfect cultivated land ecological compensation mechanism, which is mainly reflected in the following aspects: first, the current policies on cultivated land compensation mainly aim at ensuring food security and economic and social stability, and pay less attention to the ecological value of cultivated land. Second, although cultivated land compensation appears sporadically, there are still narrow compensation scope, small compensation intensity and single compensation mode. The imperfect compensation fund management system and other issues can not balance and meet the interests of cultivated land protection stakeholders, and ultimately affect the incentive effect of the compensation policy on ecological protectors. At present, the cultivated land subsidy

funds are still distributed to land contractors through the “one card” method, which is not linked to the specific behavior of farmers in the protection and utilization of cultivated land.

Third, there is a lack of education and technical training related to cultivated land protection. Developed countries, represented by the United States, pay great attention to the use of diversified channels such as agricultural associations, agricultural technology extension institutions, scientific research institutions, and mass media in the management and control of cultivated land protection, and publicize the cultivated land protection plan to farmers through conservation tillage technology pilot, field visits, technical training, etc., so as to improve farmers’ awareness and ability of conservation tillage, and finally integrate the government’s cultivated land protection objectives with farmers’ production interests form the endogenous driving force of farmers’ cultivated land protection. However, China mainly popularizes and propagandizes cultivated land protection and ecological construction through top-down administrative management, which is prone to the problem of “hot up and cold down”, so the mobilization of farmers’ enthusiasm for cultivated land protection is extremely limited. Among the surveyed sample farmers, 33.1% had not been exposed to the publicity related to cultivated land protection, and 57.2% had not participated in the training related to cultivated land protection technology. This is also an important reason for farmers’ weak awareness of cultivated land protection and insufficient awareness of conservation tillage technology.

## **4. Promotion strategies for the protection of rural cultivated land resources in China**

### **4.1 Strengthen organizational guidance and technical training, and improve farmers’ awareness and ability of main responsibility for cultivated land protection**

Aiming at the problems of farmers’ weak awareness of cultivated land protection and virtual responsibility, first, transmit the ecological early

warning of cultivated land quality degradation to the whole society through television, newspapers, mobile phone networks, village bulletin boards and other forms, and strengthen the publicity of the important strategic significance of cultivated land protection in rural revitalization, national food security and high-quality agricultural development, so as to create a good atmosphere for the participation of the whole society in cultivated land protection, and enhance the sense of responsibility and subject consciousness of farmers’ participation in cultivated land protection. Second, farmers are constrained by traditional experience and the original knowledge framework, and it is difficult to form a relatively complete understanding and evaluation of a new agricultural technology in a short time. There is an urgent need to give play to the role of agricultural cooperatives, agricultural technology promotion and other rural grass-roots organizations in cultivated land protection. Specifically, we can strengthen the exchange of experience through on-site lectures, technical training meetings, visits to demonstration bases, popularize the development process, technical types and technical efficiency of cultivated land conservation tillage measures to farmers, especially village cadres, large grain farmers, family farms, etc., improve farmers’ cognitive level and adoption ability of conservation tillage measures, and give full play to the demonstration and driving role of new agricultural business entities.

### **4.2 Strengthen the top-level design of differentiated incentive and regulatory policies for cultivated land protection**

Cultivated land is a rare resource. As a “rational economic person”, whether farmers choose to participate in cultivated land protection depends on the degree of benefit satisfaction brought by this behavior. Therefore, there is an urgent need to innovate cultivated land protection and collaborative governance policies according to local conditions, coordinate the interests of stakeholders, and balance the supply of government systems with the interests and needs of farmers. First, set up a special compensation fund for cultivated land pro-

tection, and constantly improve the compensation scheme and reward and punishment mechanism. The measures applicable to cultivated land protection, such as less no tillage, straw returning to the field, fallow rotation, soil testing and formula fertilization, and organic fertilizer replacing chemical fertilizer, will be included in the key compensation content, and the performance evaluation of cultivated land protection effect of governments at all levels will be strengthened. It is worth noting that due to the obvious regional differentiation of cultivated land resources and environmental problems in different regions, there are significant differences in the technical attributes and cost-benefit required for the adoption of cultivated land protection measures suitable for different regions. At the same time, under the background of farmers' differentiation, different types of farmers need to be based on regional differences, technical attributes and farmers' types due to the heterogeneity of business scale, production factor allocation and input energy, and formulate differential cultivated land protection strategies. Second, based on the field research and department interviews of large sample farmers, we should scientifically and reasonably build an ecological compensation framework, including compensation principles, compensation standards and compensation methods. Third, support legal protection and regulatory evaluation system. The smooth operation of cultivated land protection ecological compensation policy needs the protection of relevant laws and supervision and evaluation systems. Speed up the formulation of the top-level design of the legal system specifically for cultivated land protection and ecological compensation, and form the laws and regulations of the central and local supporting integration, so that there are laws to follow for cultivated land protection and rules to follow for the distribution of rights and responsibilities of stakeholders.

### **4.3 Strengthen the research and development of core technologies for cultivated land protection and the construction of agricultural technology promotion system**

In 2020, the No.1 Central Document proposed to “promote the application of more scientific and

technological achievements to the fields”. As the fundamental way to promote cultivated land protection, whether conservation tillage technology can be successfully and large-scale applied to agricultural production practice depends on the technical attributes of the technology itself, that is, whether the technology has the characteristics of cost-saving, labor-saving, high-yield, high efficiency, easy operation and so on, in addition to the constraints of the policy environment and the adoption group. Therefore, first of all, we should combine agricultural technology with agronomy, support the establishment of a research and development and integration platform for cultivated land protection technology with the cooperation of new business entities, scientific research institutions and technology extension institutions, promote the optimization of technical models and the upgrading of machinery and equipment, gradually establish a standard and normative system for the implementation of cultivated land protection technology, and improve the transformation efficiency of scientific and technological achievements of cultivated land protection technology. At the same time, we should strengthen the construction of agricultural technology extension and service system. By deepening the reform of agricultural technology extension system, strengthening the public welfare functions of township agricultural technology extension institutions, optimizing the assessment and incentive mechanism of agricultural technology extension personnel, solving the problems of unqualified professional ability and low enthusiasm of technical personnel in agricultural technology extension work, and further strengthening the construction of agricultural technology extension teams in township grass-roots units.

### **Conflict of interest**

The authors declare that they have no conflict of interest.

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