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China's Cultivated Land Balance Policy Implementation Dilemma and Direction of Scientific and Technological Innovation

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Abstract

The cultivated land balance policy, which is a remedial measure for the expansion of cultivated land occupied by industrialization and urbanization, is an important part of the cultivated land protection system in China. At present, the cultivated land balance is confronted with the dilemma of the exhaustion of cultivated land reserve resources, the high demand for cultivated land occupied by construction land and ecological land. The alienated behaviors of local government, such as supplementing cultivated land with insufficient quantity and poor quality, has threaten the national food security and ecological security. Under the background of cultivated land protection system transformation, it is necessary to deeply understand the long-term, extreme and complex nature of the contradiction between people and land in China. It is necessary to clarify the irreplaceable role of land balance policy in protecting land resources, optimizing land space, and promoting balanced development between urban and rural areas. We propose that the key solution is to use scientific and technological innovation to systematically recognize arable land and improve the technical support of management. We suggest that: (1) accelerate the formation of a new balance system with cultivated land quality and production capacity as the core; (2) using differential method to manage the balance of cultivated land; (3) research and develop regional engineering technology system of land ecological improvement; (4) improve the monitoring and supervision capacity of key elements of cultivated land resources. In conclusion, China should carry out national cultivated land resources security science and technology projects as soon as possible, that will comprehensively improve the scientific decision-making and intelligent management level of China's cultivated land protection supervision, and support the development of cultivated land protection in the comprehensive direction of quantity, quality, and ecology.

Keywords

cultivated land protection; cultivated land resources security; cultivated land balance; countermeasures and suggestions; scientific and technological innovation

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China's Cultivated Land Requisition-Compensation Balance Policy Implementation Dilemma and Direction of Scientific and Technological Innovation

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Abstract: The cultivated land requisition-compensation balance policy, which is a remedial measure for the expansion of cultivated land occupied by industrialization and urbanization, is an important part of the cultivated land protection system in China. At present, the cultivated land requisition-compensation balance is confronted with the dilemma of the exhaustion of cultivated land reserve resources, the high demand for cultivated land occupied by construction land and ecological land. The alienated behaviors of local government, such as supplementing cultivated land with insufficient quantity and poor quality, have threatened the national food security and ecological security. Under the background of cultivated land protection system transformation, it is necessary to deeply understand the long-term, extreme and complex nature of the contradiction between people and land in China. It is necessary to clarify the irreplaceable role of land balance policy in protecting land resources, optimizing land space, and promoting balanced development between urban and rural areas. We propose that the key solution is to use scientific and technological innovation to systematically recognize arable land and improve the technical support of management. We suggest to (1) accelerate the formation of a new balance system with cultivated land quality and production capacity as the core, (2) use differential method to manage the balance of cultivated land, (3) research and develop regional engineering technology system of land ecological improvement, and (4) improve the monitoring and supervision capacity of key elements of cultivated land resources. In conclusion, China should carry out science and technology projects for national cultivated land resources security as soon as possible. That will comprehensively improve the scientific decision-making and intelligent management level of China's cultivated land protection supervision, and support the cultivated land protection in the comprehensive direction of quantity, quality, and ecology. **DOI:** 10.16418/j.issn.1000-3045.20200313002-en

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The Chinese government carries out strict cultivated land protection system as cultivated land is the especially precious resource. The cultivated land requisition-compensation balance (RCB) policy is an important measure to alleviate the contradiction between land demand for economic and social development and cultivated land protection and ensures the dynamic balance of total cultivated land. The RCB policy has important meaning for keeping the cultivated land resources and ensuring the material basis of national food security. However, with the rapid development of China's economy and society and the increasing demand of cultivated land for non-agriculture use, the problem of supplementing cultivated land with insufficient quantity and poor quality occurs in local areas during the implementation of the policy. During the investigation, the journalists of *China Comment* found that there were typical problems such as qualified land for construction while barren land for agriculture, basic farmland for other purposes than growing grain crops, data distortion, institutional deficiency, and weak supervision in many local places [1].

"It is dangerous to be playful with the RCB policy, and there will be an accident one day." The existing cultivated land quantity balance system cannot meet the requirement of practical management in theory explanation, information acquisition, supervision, and engineering technology. How to understand the RCB policy, improve the policy system through scientific and technological innovation, and enhance supervision and implementation has become an important issue to be solved during the transition process of China's cultivated land protection system, which is also a major strategic requirement to support China's food security, economy security, and resource security.

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1 Implementing RCB policy is the inevitable choice based on profound understanding of China's basic conditions of cultivated land resources and an irreplaceable long-term measure

1.1 RCB is the policy response to the China's contradiction between people and land

China's fundamental reality of a large population with relatively little cultivated land necessitates the protection of the cultivated land for ensuring the grain safety of over a billion people. (1) In terms of resource endowment, per capita cultivated land area of China is less than 40% of the global average level, and the high-quality cultivated land is less than 30% of the total. (2) In terms of external dependence, the gap of China's cultivated land resources (calculated based on the grain import in 2018) exceeds 700 million mu (1 mu = 666.7 m^2), which is 35% of the existing cultivated land and over 8 times of the cultivated land reserve nationwide. (3) In terms of variation, every 1% increase in urbanization rate in China will lead to a decrease of around 2 million mu of cultivated land. There will be a loss of 20 million mu of cultivated land to reach the urbanization rate of 70% by 2023, most of which is high-quality cultivated land with high productivity. (4) In terms of ecological construction, the cultivated land area decrease caused by reforestation and fallow rotation is inevitable. The continuous decrease of high-quality cultivated land and the intensive utilization of existing cultivated land is hard to be substantially addressed [2]. Under the background of upcoming population peak and international political and economic pattern adjustment, the Chinese scholars regard the present as the most difficult period concerning food security and cultivated land security in China [3,4].

In the case of the deficiency of cultivated land quantity, poor water and land suitability, and intensive land utilization, implementing the RCB policy is an effective measure to resolve the tensions between construction land and cultivated land during industrialization and urbanization and maintain the holding volume of cultivated land by the remedy and compensation for cultivated land resources. Therefore, it is necessary to adhere to the strictest cultivated land protection system and carry out the RCB policy.

1.2 RCB policy is the important forcing mechanism of optimizing national land space and improving land use efficiency

As the production basis of agricultural products, cultivated land has lower economic benefit than construction land. The short of cultivated land resources in China mismatches with the important role of cultivated land in social security and ecological conservation. The RCB policy manifests the economic value of cultivated land as a rare element. Increasing the cost of transforming cultivated land to construction land will restrict the transformation in local places to some extent and guide the local control of the exploitation scale of construction land as well as the efficient exploitation of stock land potential. Meanwhile, the RCB policy links up urban and rural areas as well as developed and undeveloped areas at different stages of economic development and with different land utilization modes, forming an integrated element flow mechanism. In addition, it brings funds to regions bearing the supplementary cultivated land through ways such as land consolidation projects and supplementary cultivated land quota transaction, thus improving agricultural production and rural living conditions and utilization efficiency. Moreover, it optimizes the space structure of national land and the regional economic structure to promote balanced regional development in a coordinated manner.

1.3 Continuous innovation supports the cultivated land protection in the comprehensive direction of quantity, quality, and ecology

The Central Committee of the Communist Party of China (CPC) and the State Council released the *Notice on Further Strengthening Land Management to Protect Cultivated Land* in 1997 and amended the *Land Administration Law of the People's Republic of China* in 1998. Since then, China has established the RCB policy featuring the link of cultivated land occupation by construction projects with land development and reclamation projects, market-based transaction of supplementary cultivated land, and RCB assessment, which provides a workable way to solve the contradiction between protecting cultivated land and guaranteeing development.

China is still at the stage of rapid urbanization. Besides, the arduous task of ecological civilization construction, as well as the contradictions between cultivated land protection and occupation by construction and ecological land, leads to severe loss of high-quality cultivated land resources. Even if China basically finishes industrialization and urbanization by 2035, the national land space structure still needs to be optimized for urban-rural integration and regional coordinated development. Meanwhile, the protection and restoration of cultivated land resources guided by the idea of the mountains-rivers-forests-farmlands-lakes-grasslands life community still face problems such as lack of engineering technology system, imperfect management system, and huge fund gap.

Over the past two decades, the connotation of RCB policy has been updated continuously, and information-based approaches such as remote sensing and dynamic monitoring have been employed to enhance supervision, thus promoting the marketization, socialization, and industrialization of the policy. In 2017, the Ministry of Land and Resources established the new requisition-compensation mechanism which takes quantity as the basis and productivity the core, laying a foundation for the cultivated land protection in the

comprehensive direction of quantity, quality, and ecology. Persisting in innovation is the only way to solve the difficulties in cultivated land protection.

2 The implementation of RCB policy faces severe challenge

2.1 Cultivated land quantity balance leads to rapid loss of high-quality cultivated land

From 2001 to 2015, over 6 million mu of cultivated land was compensated across China, exceeding the total area of cultivated land requisitioned by construction and natural disasters in the same period. Objectively, the RCB policy has a certain positive effect in controlling requisition and ensuring compensation. However, most of the high-quality cultivated land is close to the fringe of cities and towns and vulnerable to the sprawl of urbanization. The supplementary cultivated land, on the other hand, is usually remote, with poor supporting facilities and water and land conditions, and its quality is usually inferior to the land occupied, aggravating the marginalization of cultivated land [5]. Alienated phenomena such as requisition without compensation, more requisition and less compensation, requisition of high-quality land but compensation with poor land, entire requisition but fragmentary compensation, and requisition of paddy fields but compensation with dryland exist universally. In particular, the well-facilitated farmland built with high price and with stable yields despite drought or flood and the permanent farmland is also occupied massively [6]. As the price of rapid development, the lost high-quality cultivated land is hard to be re-built, and thus it is hard to block the loss of high-quality cultivated land only by depending on quantity balance.

The red line of cultivated land is about not only quantity but also quality. When implementing the RCB policy, we cannot occupy the high-quality land and compensate with the poor land, hillside land, and newly reclaimed land. Otherwise, although it gets balance in the account, the quality deficit is severe.

2.2 The quality and ecological imbalance endangers the safe production of cultivated land

According to results of the evaluation on cultivated land quality grade renewal, the average cultivated land grade in China changes little. The high-quality cultivated land in the east has decreased, while large areas of cultivated land are newly reclaimed in the north and west. The center of China's cultivated land keeps drifting toward the northwest with poor-quality cultivated land [7].

(1) In developed areas in the east and mountainous areas in the south, the requisition, conversion, and non-grain production of cultivated land are severe, while the compensated cultivated land is mainly in remote mountainous areas and usually scattered, fragmented, and in small scale. This not only makes it hard to compensate the cultivated land of the same quality but also causes the supplementary cultivated land to be abandoned or left unused because of inconvenient cultivation. It has been reported that the abandonment rate in mountainous areas and counties in Zhejiang, Jiangxi, Hunan, Guangxi, Chongqing, and Sichuan already exceeds 20% [8].

(2) The phenomena of transforming wetland and forest for cultivation are common in Northeast China, where water and heat resources match well with cultivated land resources. Northeast China is the region with the most newly developed cultivated land since the founding of the People's Republic of China, contributing to the reversion of traditional south-to-north grain transportation. Heilongjiang and Jilin are even considered as the ballast of national food security, which leads to the excessive exploitation of cultivated land. In Heilongjiang, over 70% of the cultivated land is in slight or above soil nutrient deficiency [9], and the quality of black soil shows degeneration.

(3) The farming-grazing transitional zone in northern China and ecologically fragile area in southern China have very limited water resources, fluctuated inter-annual precipitation, and great difference of economic benefit between agriculture and animal husbandry. Therefore, the transformation of different utilization ways of land resources in such zone occurs frequently. Due to the lack of ecological balance and differentiated protection mechanisms, the existing cultivated land protection policy, to some extent, results in the formation of food producing areas at the price of losses of grassland, wetland, and ecological land, and intensifies the contradiction between agriculture and animal husbandry in such zone. For example, there is improperly a large increase in the area of unstable cultivated land located within forests, grasslands, and control lines of highest flood levels of rivers and lakes and on slopes >25° in Inner Mongolia, Gansu, Ningxia, and Xinjiang. According to the data of the investigation and evaluation of national unstable cultivated land, unstable cultivated land takes up 4.11% of the total area of cultivated land in the arid and semi-arid regions in northwestern China, and the proportion even reaches 11.57% in northeastern China [10].

After long-term development, the decrease in cultivated land productivity, water and soil erosion, groundwater overexploitation, soil degradation, and non-point source pollution aggravation have caused substantial harm to China's integrated food production capacity. The RCB policy must coordinate with the ecological red line policy and rehabilitation policy to adapt to ecological civilization construction [11,12].

2.3 RCB policy in trans-provincial areas must give priority to both efficiency and fairness

In 2017, the Central Committee of the CPC and the State Council released *Opinions on Strengthening Cultivated Land Protection and Improving Requisition-compensation Balance*, putting forward that it is required to explore national overall management of supplementary cultivated land and solve

practical issues such as growing scarcity of reserve cultivated land resources and the mismatch between land requisition and reserve resources. This will promote the construction land resources to incline toward central cities and metropolitan regions, thus improving the land utilization rate. In 2018, the *Measure for National Overall Management of Supplementary Cultivated Land in Trans-provincial Areas* was issued, further specifying that the funds for supplementary cultivated land in trans-provincial areas should be entirely used to consolidate poverty alleviation results and support the implementation of rural revitalization strategy. This measure will give full play to the complementation between funds and resources in developed areas and resourceful areas, and promote regional coordinated development.

The policy of national overall management of supplementary cultivated land in trans-provincial areas is never a signal that there is no need for developed regions to execute the RCB policy, nor does it slack the requirements of cultivated land protection. Instead, it indicates that the national public power will re-allocate resources from the national level for provinces and cities with restricted environmental and resource conditions. In addition, visualized economic benefits stimulate local enthusiasm for cultivated land compensation. Less developed regions will take all measures to collect and supplement cultivated land quotas for transaction, even take an overdraft of its own development space to get short-term economic benefits. In the long run, the neglect of land development rights in less developed regions will intensify the regional development imbalance, which is harmful to balanced social development [13]. Meanwhile, the reserve cultivated land resources of less developed regions are mainly in semiarid or ecologically fragile areas with insufficient water sources, and any imprudent development will go against the original intention of the RCB policy. Therefore, it is required to ensure the open and fair transaction of rare RCB quotas while maintaining the quality of supplementary land, thus ensuring that the cultivation activities during or after the exploitation of cultivated land resources will not cause any new disturbance to the environment. This requires the departments in charge of natural resources to comprehensively master the quantity and quality of national-level cultivated land, ecology essential data, and the ability of refined resources regulation and space allocation. This is also the basis of conducting strict local supervision and implementing the RCB policy in a reasonable, fair, and standard way.

3 Key scientific issues hindering the implementation of RCB policy

3.1 Inadequate cognition of cultivated land protection leads to alienated policy implementation

The central government's rigid requirement for cultivated land protection and local governments' realistic need for economic development brings forth conflicts and contradictions. Due to the inadequate cognition of cultivated land resources and national economic, social, and ecological systems, local governments, as direct supervisors of cultivated land, usually alienate the RCB policy as an access to construction land expansion [3] and occupy the cultivated land in the name of compensation. The difficult enforcement of the RCB policy is the concentrated embodiment of China's principal contradiction of imbalanced and inadequate economic and social development between urban and rural areas and between regions in the field of cultivated land. The policy of requisition without compensation for key regions and national key projects gives the local regions a ride. Facing the dilemma of economic development and cultivated land protection, the local governments take advantage of the existing policy deficiencies to lower the rising cost of cultivated land requisition as much as possible, allocating the development cost to be borne to the state and the whole society.

3.2 Lack of differentiated RCB implementation mechanisms matching the geographical and national conditions

The demands for and models of cultivated land protection, ecological construction, and land development vary greatly between developed areas, major grain-producing areas, and ecologically fragile areas. The black soil degeneration in Northeast China, groundwater over-exploitation in North China, and land desertification in Northwest China prove that the simple guarantee of requisition-compensation balance in quantity does not agree with the development requirements at present and in the future. In addition, the universal application of the RCB policy, the unclear bottom-line requirements of the policy in different regions, non-comprehensive analysis of the relationship of cultivated land with population, resources, industry, economy, and environment, and lack of the supporting of basic data for all elements of cultivated land still exist. Finally, the exploration of different regions in differentially implementing the RCB policy has not been systematically studied.

3.3 Lack of workable technical means for the healthy production capacity balance of cultivated land

Production capacity is the foundation to maintain the production ability of cultivated land, and thus the RCB policy must highlight production capacity balance [14,15]. Currently, government management and protection still stick to the red line of cultivated land quantity, lacking a clear awareness of the urgency of enhancing the protection of production capacity and ecology of cultivated land, as well as the resolution and courage to implement the strictest cultivated land protection system. Due to the lack of workable measures for balancing the production capacity and ecology of cultivated land, many regions only pursue the quantity

balance of cultivated land, without considering to optimize national land space potential, improve the quality of cultivated land, and maintain the health of cultivated land. It is widely concerned that how long the RCB policy will last.

3.4 Inadequate capacity of innovation to ensure cultivated land resource security

Compared with developed countries, China lags behind in theories and methods supporting cultivated land resource security in China, with approximate 14 years of technological gap, especially in the background total elements and the data of cultivated land quality and key ecological parameters [16,17]. For the cultivated land resource degeneration in Northeast China, water resource crisis of cultivated land in North China Plain, environmental pollution of cultivated land in eastern and southern China, and desertification, stony desertification, and marginalization of cultivated land in the western China, the lack of timely and comprehensive analysis cause the failure of regular and institutionalized scientific and technological services for protection based on dynamic analysis of cultivated land resource evolution as well as a strong, independent, and wise policy response and decision support system.

4 Improve implementation efficiency of RCB policy with the support of innovation

4.1 Strengthening systematic cognition of cultivated land resource for the delineation of differentiated cultivated land red line

Rationally use of land and effective protection of cultivated land is a basic policy that must be persisted in for a long term. The red line of cultivated land is the bottom line that should never be breached. Differentiated red lines should be drawn for cultivated land protection at the national and provincial levels according to cultivated land resources and their relationships with population, economy, and society. (1) In developed regions, the first thing to do is to contain the extensive and expansive land utilization inertia, stabilize the holding volume of cultivated land, stick to the quantity balance and stable layout, improve the resource utilization efficiency, take the lead in implementing the RCB of cultivated land production capacity and permanent basic farmland, and optimize land space structure and layout with soil as the core. The metropolises represented by Beijing and Shanghai should be restricted from conversion of cultivated land and pursue zero decrease in cultivated land. Some coastal developed areas should improve the holding volume of cultivated land and define the proportion of permanent basic farmland. (2) In the main grain-producing regions, it is required to maintain the quantity, quality, and ecology of cultivated land, especially the permanent basic farmland, with focus on advantageous areas with good conditions of light, heat, water, and soil. According to water and soil conditions, the quantity and proportion of cultivated land to be protected in different regions of Northeast China, North China, and the middle and lower reaches of the Yangtze River should be determined, and Inner Mongolia should be excluded from grain-producing regions. (3) In ecologically fragile regions such as arid regions in northwestern China and mountainous regions in southern China, it is required to highlight the improvement of cultivated land quality and ecological restoration of permanent basic farmland. Some marginal cultivated land should be converted appropriately to lower the quantity and proportion of cultivated land in protection.

Implementing differentiated red lines of cultivated land is to maintain the quantity and layout of the high-quality cultivated land. It is the choice in the context of uneven distribution of China's land resources and upon the time and space conflict of cultivated land protection with the urban and ecological construction. Efforts should be made to grasp the principal contradiction of cultivated land protection, and avoid severer and even irreversible economic and ecological losses in the future. Meanwhile, it is required to implement the subdivision of cultivated land protection within the red line for classified management and control, introduce market mechanism, and coordinate local governments, rural economic organizations, and farmers.

4.2 Accelerating the development of land engineering technology system for the full-area comprehensive land consolidation

It is essential to implement the national strategy of storing grain in land based on technology, and strictly control the reclamation of unutilized land. We would rather leave the reserve resources undeveloped than exploit and supplement them improperly [18,19]. During the process of building a beautiful, prosperous, and powerful China, we should constantly improve national land planning and implement full-area comprehensive land consolidation step by step to ensure that every piece of land protected is well supervised. As the key measure of improving grain production and protecting national food security, high-standard farmland construction is the main path to supplement cultivated land. While strictly carrying out RCB policy and ensuring the quantity of supplementary cultivated land, we need to improve the quality of cultivated land and ensure the compensation with high-quality cultivated land.

The cultivated land restoration and ecological fertile farmland construction should be conducted following the idea of life community. For high-grade cultivated land, stress should be placed on protection, and reasonable utilization and healthy management should be implemented to avoid the degeneration of cultivated land productivity and ecosystem service. For medium- and low-yield farmland, reasonable reconstruction should be carried out to improve production capacity and risk resistance of cultivated land. Unstable cultivated land should be subjected to classified management.

No or less development should be conducted to marginal cultivated land in ecologically fragile regions. National land space reconsolidation, restructuring, and layout optimization should be employed as key approaches of cultivated land compensation.

4.3 Developing technology, equipment, and systems to acquire key elements of cultivated land resources for the improvement of cultivated land monitoring

Broadening the channels of requisition-compensation, namely balancing the overall account, means that in terms of land consolidation supported by funds of various sources and categories, the newly increased cultivated land can be used for compensation after approval, which increases the difficulty of approving and supervising the newly increased cultivated land [20]. Therefore, we need to control and manage from the sources of quantity, quality, and ecology. Specifically, a large database of cultivated land quality and health should be built to demonstrate the economic, social, and ecological values of cultivated land. Additionally, it is required to improve the all-element supervision ability for cultivated land resource protection with the productivity and health of cultivated land as the core.

With the technical support of full-process monitoring and information-based supervision, we should give overall consideration to land space planning and governance, land use regulation, land use management, and project supervision and assessment of the whole country. Further, we should clarify the responsibilities of departments and subjects of liability of cultivated land resource protection and supervision, cultivated land utilization regulation, and farmland soil and environment monitoring [21]. According to key process of source–process–consequence of cultivated land protection, relevant authorities such as the Ministry of Natural Resources, the Ministry of Agriculture and Rural Affairs and the Ministry of Ecology and Environment should serve as the leading departments in charge. In addition, it is essential to clarify the technical standards, procedures and responsibilities of competent departments at all levels, take information-based approaches to strengthen supervision, and prevent and resolve risks. It is important to avoid dispute over trifles among departments and separation between superior and subordinate.

4.4 Implementing major science and technology actions to support China's cultivated land resource security and provide full-chain systematic solutions

In terms of productivity, balanced production capacity between requisitioned and compensated cultivated land is technically achievable. However, when taking the sustainable use of cultivated land resources into account, we should not only ensure the quantity and production capacity but also protect the ecology.

(1) It is suggested to perfect the top-level design of national land technology innovation. Major science and technology actions should be taken to ensure China's cultivated land resource security. Guided by major national demands and scientific difficulties in land protection, we should establish our own theoretical and knowledge system of cultivated land resource security. Efforts should be made to improve innovation of key technologies in protection of quantity, quality and ecology, refined utilization, accurate restoration, and smart regulation. We should provide systematic solutions covering the dynamic monitoring, systematic diagnosis, risk assessment, and scientific decision making to improve cultivated land protection.

(2) It is required to give priorities to the planning, programs, and fund allocation related to major scientific and technological deployment of competent departments. In the design and implementation of major works such as land consolidation and ecology restoration, we should allocate a certain amount of fund to develop key technology, and fully mobilize market resources to participate in the technology innovation in the field.

(3) Equal importance should be attached to science popularization and technology innovation. The professional quality and practice of the personnel engaged in cultivated land protection need to be improved.

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