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China's rural revitalization and development: Theory, technology and management

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Abstract: The urban-rural transformation from dichotomy to integration is a gradual process. Like rural areas in many countries, Chinese rural society is experiencing a decline in all spheres due to depopulation, aging, lack of economic opportunity, and so on. Aiming at solving the serious rural issues, China proposed the implementation of a rural revitalization strategy and the promotion of an integrated urban-rural development for the first time in 2017. This proposal marks the transformation of the urban-rural relationship, and the integrated urban-rural development reflects a significant conceptual change. Researches on issues of rural decline are urgently needed to determine the most effective method for rural revitalization and development from the perspective of the urban-rural dynamics. In this context, this paper focuses on studying the theory, technology and management of rural revitalization and development. We construct a theoretical framework for urban-rural integration based on population-land-industry-right between the urban and rural systems, regarding land engineering for land capacity building as the technical support and the rural land system reform and reconstruction as the policy support for management. This research will provide theoretical support for the implementation of China's rural revitalization strategy.

Keywords: rural revitalization; rural decline; urban-rural integration; land capacity building; land consolidation engineering; China

1 Introduction

Industrialization and globalization have transformed rural areas through different ways, resulting in various types of countryside globally. Some rural regions experience economic and social prosperity under driving forces like rural tourism promotion and counter-urbanization stimulation (Canoves, 2006; Lowe and Ward, 2007) while some rural regions are trapped in a vicious cycle of decline (Liu and Li, 2017). Rural decline, as a global issue, is inevitably accompanied by increasing global levels of urban development

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(Markey *et al.*, 2008). In the context of the broader structural trends wrought by globalization, industrialization and urbanization, emerging rural issues have swept through both developing and developed countries and hindered rural sustainability, including out-migration of working-age residents, rural depopulation and exodus, empty housing units, abandoned land, rural poverty, industrial recession, culture decline, and environmental pollution, etc (Milbourne 2007; Smith 2007; Long *et al.*, 2011; McManus *et al.*, 2012; Chen et *al.*, 2014; Liu *et al.*, 2014; Hedlund and Lundholm 2015). In developed countries, such as Sweden, many young people left the countryside for good education and better paid work in the growing metropolitan regions (Hedlund and Lundholm, 2015). Meanwhile in developing countries, such as Latin America, rural out-migration was induced by climate change and agriculture intensification (García-Barrios *et al.*, 2009; Gray, 2009). Nigeria, India and China have also experienced rural population decline, labor shortage and social degradation in recent decades. Rural areas are abandoned for reasons including mobility, poverty, technology, biased policy and inadequate land management (Liu and Li, 2017). As a result, the development capacity of rural areas has weakened, threatening their sustainability and resilience.

As responses to these problems, many countries have made ameliorative efforts through rural renewal, revitalization and restructuring (Allison and Hobbs, 2004; Woods, 2005; Li *et al.*, 2016; Liu and Li, 2017). Especially, rural restructuring involves multi-dimensional characteristics— including the process of economic, social, demographic and environmental changes—driven by the twin forces of technological and social modernization as well as globalization (Woods, 2005; 2009). They formulated goals and strategies for turning the rural decline. Britain regarded key settlement policies as a panacea for the ills existing in all types of rural area by implementing rural planning system like development plans and later structure plans to solve the problems of rural out-migration, infrastructure shortcomings since the 1950s (Cloke, 2013). French territorial planning was implemented during the "30 Glorious Years" period, which has constructed an endogenetic and long-term rural revival mechanism aiming to solve the unbalances of territorial development (Cai, 1987; Benko and Feng, 1988; Tang, 2013). Demonstration Cities and Metropolitan Development Act of 1966 was enacted in the U.S. to advance urban renewal and promote development of small- or medium-sized cities or towns. During the 1960s, the strategy of rural industrialization arose to encourage the movement of capital to rural areas as a means of creating employment, reducing poverty rates and generally alleviating the relatively depressed economic conditions in nonmetropolitan areas in the U.S (Summers and Gene, 1986). New village movement (*Saemaul Undong*), strongly guided by the government, started in South Korea to solve the imbalance between industrial and agricultural development and escape from rural poverty, which scattered from countryside to all over the country (Chen *et al.*, 2006; Zheng, 2006; Piao, 2011). Meanwhile, these countries emphasize on implementation of agricultural support plans and rural environmental protection acts to promote rural restructuring.

Since the reform and opening up in 1978 in China, significant changes have occurred in the urban-rural regional system, such as economic growth, rural governance, land-use change, land system reform, social and cultural transition (Liu, 2007). A series of tightening policies or strategies with certain political tasks have been enacted to promote urban-rural transformation in their corresponding periods. The strategies in early stages give

preference and priority to the developments of city and heavy industry while macro strategies such as urban-rural coordinated development, new countryside construction and new-type urbanization are subsequently implemented to solve rural issues and narrow the gap between urban and rural areas. However, their effectiveness is finite and some contradictions and problems have been intensified (Liu and Li, 2017; Liu, 2018a). Currently, Chinese society faces a contradiction between unbalanced and inadequate development and the people's ever-growing needs for a better life. The government emphasized the pursuit of a new rural revitalization strategy, prioritizing the development of agriculture and rural areas. The core solution is to solve serious rural problems of urban-rural unbalanced and inadequate development, then compensate the rural short board for building a well-off society.

In this new strategy, researchers and policy-makers emphasize the close relationship between rural development and the urban-rural dynamic. The urban-rural dichotomy has existed since the origin of cities (Haas and Westlund, 2017), and the separation of industry and agriculture forms the main pattern of urban-rural opposition. After the industrial revolution, the balance of urban-rural relationships shifted towards the growing dependence of rural areas on urban economies (Davoudi and Stead, 2002). In the current post-urban world (Westlund, 2014), urban-rural dynamics are far more complex than the traditional, simple reciprocal exchanges between cities and villages. The urban-rural dichotomy has been dissolved (Haas and Westlund, 2017). The transformation of the urban-rural relationship from separation and opposition toward integration is a gradual process (Liu *et al.*, 2016). Meanwhile, researching rural issues and policies from the perspective of the urban-rural dynamic is becoming a hotspot. The urban-rural integration (*Chengxiang ronghe*) is a process that understands cities and rural areas as a universe web and that aims to promote the equal exchange of urban-rural factors (e.g., labor, capital and enterprise) as well as the balanced allocation of public resources (Liu, 2018a). China treats the urban-rural integration as the first way to achieve the goal of rural revitalization in the new era. This strategy is an innovation and breakthrough for global rural studies, which needs systematic research integrating its theory, technology and management.

This paper thereby aims to make a clear picture for the readers about China's rural revitalization and development based on the urban-rural dynamics. In the following sections, we firstly analyze China's rural development stages and review the key rural policies mainly in the 21st century in a historical context, which provides readers with the research context and describes the background for the following. Aimed at the solution-oriented rural revitalization strategy, this paper focuses on the research of the theory, technology and management of rural revitalization and development from the perspective of the urban-rural integration.

2 Chinese rural development stages and major rural policies

Since reform and opening up, with the acceleration of industrialization and urbanization, China's agricultural and rural modernization and urban-rural development experienced a sustained progress. Overall, the evolution of rural China presents an S-shaped curve (Figure 1). Rural development in China could be divided into three stages according to its phase ob-

jectives, i.e., the society with adequate food and clothing (1978-2005), building a well-off society (2005-2020) and achieving prosperity (2020-2035) (Liu *et al.*, 2019a; Liu, 2020a). Accordingly, the rural system shows three modes from the perspective of regional function, including single agricultural system (1978-2005), multi-functional rural system (2005-2020) and integrated urban-rural system (after 2020).

China has built a dual system of urban-rural demarcation during the period of planning system. Then in 1978, the establishment of the rural household contract responsibility system realized the separation of ownership and contractual management rights, which mobilized the farmers' enthusiasm and facilitated the rapid increase of food production and agricultural modernization (Lin, 1992; Zhou *et al.*, 2020). Yet, the subsequent urban reform led to the rapid development of cities and the widening gap between urban and rural areas. Due to the long-term influence of the urban-biased strategies, China experienced massive urban expansion and rapid economic growth at the beginning of the 21st century. And the three rural issues concerned agriculture, rural areas and peasants became increasingly prominent. Rapid urbanization led to an expanded city scale and extended industrial park construction, resulting in rural decline, a widening of the urban-rural gap, and severe rural problems (Liu and Li, 2017). Rural functions emphasized the strengthening of social stability maintenance and the security guarantee of peasants' livelihoods. This emphasis introduced a long-term lack of traditional agricultural restructuring and a general imperfection of modern agricultural functions. Rural development lagged far behind urban development due to these unbalanced policies. Commenters and researchers have been concerned about these serious problems in rural China and have appealed to the government to promote rural development since the 1990s.

Responding to these public voices, the central government introduced a series of policies aiming to promote rural development. In 2002, balancing urban and rural development was proposed for urban-rural coordination. Through agriculture restructuring and rural construction, this strategy aimed to eliminate the influence of the urban-rural dual structure system, coordinate the urban-rural relationship by taking the combination of urban and rural development mode. Due to the increasingly severe rural problems, China successively launched several major development strategies, such as "five-coordinated strategies" (urban-rural development, regional development, socio-economic development, harmonious man-nature development, and domestic development) (2003), and "construction of new socialist countryside" (2005), etc. Consequently, important implementations were provided for achieving the development of urban-rural coordination and integration.

By 2012, the development of the urban-rural relationship in China had been further improved, and a gradual transformation from opposition to coordination and integration had taken place. Then, solving the "three rural problems" still remained an important content for rural development. In the context of a new era and a new normal, urban-rural transformation provides a guarantee for the further improvement of the urban-rural relationship, as manifested in the factor transfer, strategy change, and mechanism conversion of the urban-rural regional system. In the process of urban-rural transformation, important measures including targeted poverty alleviation (2013) and new-type urbanization construction (2014) were implemented. In particular, rural areas are experiencing a gradual development and improve-

ment in terms of infrastructure, industry, and eco-environment. However, rural impoverishment still poses a significant obstacle to the rural development of China and, without solving this problem, either coordinated urban-rural development or a prosperous and well-off life for peasants are almost impossible to realize.

In 2017, China proposed the implementation of the rural revitalization strategy and pointed out that the path of integrated urban-rural development is the first-choice for the realization of rural revitalization; it represents a significant conceptual change that both rebalances and reshapes the urban-rural relationship, and aims to create a new-type of urban-rural relationship characterized by mutual promotion of industry-agriculture, urban-rural mutual complementation, comprehensive integration, and common prosperity. This strategy aims to solve five main categories of rural problems, including the rapid loss of agricultural production elements (e.g., agricultural labor, cultivated land, etc.), excessively fast aging and weakening of agricultural social subjects, the increasing vacancy of rural houses and waste of construction lands, the severe pollution of rural ecological environment, and the deep impoverishment of rural poverty-stricken areas (Zheng and Liu, 2018; Liu, 2018a). The strategy requires adhering to the priority development of agriculture and rural areas according to the overall demands of industrial prosperity, ecological livability, rural civilization, effective governance, and prosperous life (Figure 2). In 2018, three stages were set to achieve rural revitalization, i.e., basically forming its institutional framework and policy system during 2018-2020; making decisive progress in rural revitalization and realizing the modernization of agricultural and rural areas by 2035; and fully revitalizing rural areas with realization of strong agriculture, beautiful countryside and rich farmers by 2050. Especially, the institutional framework and policy system of rural revitalization will be initially improved by 2022. Figure 1 also shows the future direction of rural development, i.e., promoting urban-rural integration and rural revitalization by 2025, basically forming the urban-rural integration and development system by 2030 and finally realizing urban-rural equalized development by 2050. In addition, rural revitalization should be promoted tightly

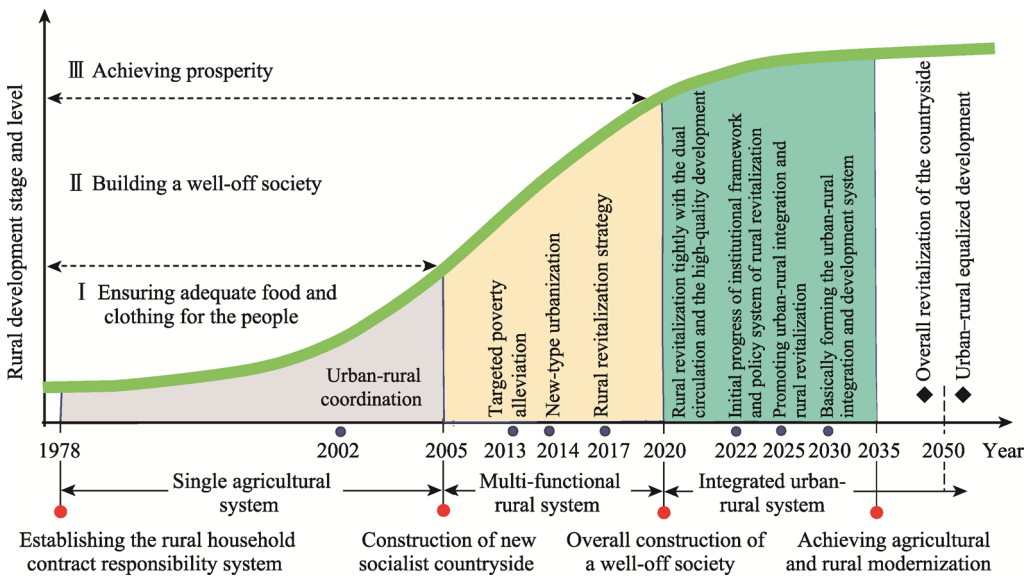

Figure 1 The rural development stage and level of China from 1978–2050

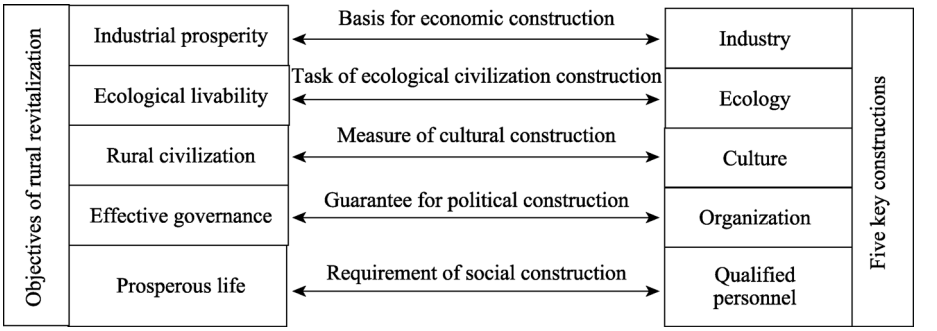

Figure 2 China's rural revitalization and its objectives

with the dual circulation in the context of a changing world and the high-quality development. The world faces a profound change that has not been seen in a century and China enters a new stage of development during the 14th Five-Year Plan Period. More efforts should be made to promote the high-quality development and accelerate the establishment of a dual circulation development pattern in which domestic economic cycle plays a leading role while international economic cycle remains its extension and supplement.

3 Theoretical framework of the rural revitalization

Urban-rural integration is the first way to realize China's rural revitalization strategy in the new era which is aimed at solving the main social contradictions and prominent problems of rural regional system and narrowing the gap between urban and rural areas. The object of urban-rural integration and rural revitalization is a regional multi-body system, which mainly includes urban-rural integration, rural complex, village-town organism, and housing-industry symbiosis. The implementation of the rural revitalization strategy often takes the county as the object, the village as the unit, and the farmer or the enterprise as the cell, and emphasizes the comprehensive revitalization of the multi-body system of rural areas. Rural revitalization focuses on promoting the reconstruction of urban-rural integration system and constructs a multi-level goal system which includes networks of urban-rural infrastructure, zones of rural development, fields of village-town space and poles of rural revitalization (Figure 3) (Liu, 2018a). Its core is to promote rural polarization development through organization reconstruction, industrial reshaping and spatial restructuring of rural system.

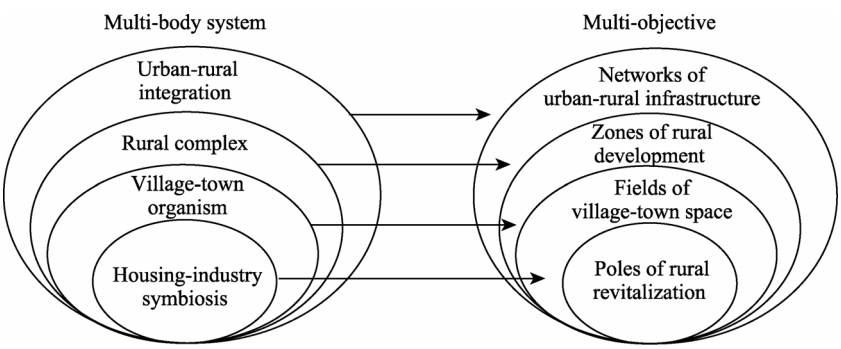

Figure 3 Multi-body systems and multi-level goals of rural revitalization in China (Cited from Liu, 2018a)

Human-earth science is a new interdisciplinary subject which focuses on the coupling mechanism, evolution process and complex interaction effects of human-earth system (Liu, 2020b). The human-earth areal system offers a theoretical basis for the research of urban-rural integration and rural revitalization. It is necessary to consider the urban-rural integration within the territorial rural system for the research of rural revitalization and development, given that integrated urban-rural development is a dynamic process with an ultimate goal of urban-rural equivalence. Rural revitalization aims to activate endogenous motivation of factors including rural population, land and industry (Liu, 2018b; Long *et al.*, 2019), so the synergistic combination of man-land-industry constitutes the key to developing urban-rural integration. The urban-rural integration represents interactions between urban and rural systems; moreover, the urban-rural integration is manifested in the factor transfer, strategy change, and mechanism conversion of the urban-rural regional system, including the transformation of the population pattern, industrial structure, land use, and spatial form. Population and land constitute core factors of the human-earth relationship, and the industrial structure offers a basic framework for the regional system of human-earth relationship. Moreover, rights, reflecting the relationships between people and between people and land, are requested to be equal between urban and rural areas as China's urbanization has sacrificed farmers' rights and interests. In this context, a solution-oriented rural revitalization strategy should fully implement the "four-revitalization" development of rural areas (i.e., revitalization of population, land, industry and right), effectively stimulate rural vitality, capacity, motivation and competitiveness, and systematically promote the urban-rural integration, coordination and equivalence.

Cities and rural areas constitute an organic whole, and a sustainable development can only be achieved through reciprocal interactions between urban and rural department. The urban-rural integration was created and has evolved by the interaction mechanisms between urban and rural systems. It has four cores: urban-rural strategic position equivalence, equal rights and interests for urban and rural residents, urban-rural factor allocation balance, and an integrated urban-rural development process. The theoretical framework of China's urban-rural integration can be summarized as shown in Figure 4.

The key for the success of the rural revitalization strategy lies in the "people". Currently, the rapid non-agricultural conversion of agricultural production elements has induced the loss of rural labor. Those migrating to cities are mainly young and middle-aged people, while those left behind are mainly the "three types of left-behind groups" (i.e., the elderly, women, and children) who cannot support modern agriculture and new countryside construction. In the process of urbanization, peasants should be entitled to freely choose between cities and rural areas, and efforts should be made to rationally solve problems related to peasant workers and their return to hometowns. At present, no institutional environment exists in which peasants are encouraged to move their whole families into cities, especially when considering the most important factors restricting their settlement in cities, such as housing and children's education.

Land provides an important resource for the survival and development of mankind, and it constitutes the core of rural socio-economic development. However, rapid industrialization and urbanization have caused a massive loss of high-quality cultivated land. Moreover, the

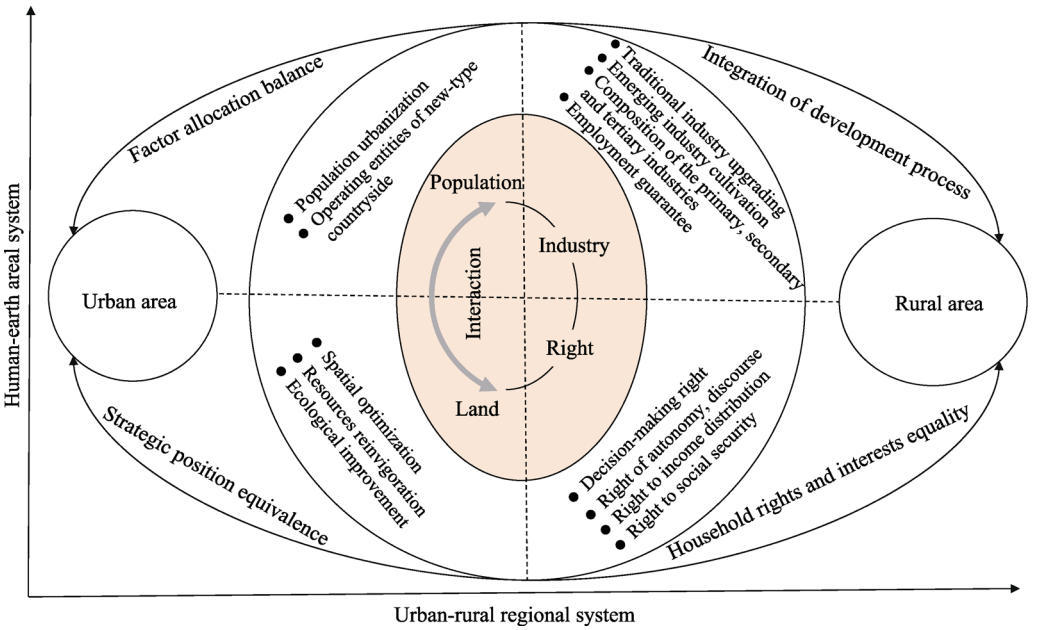

Figure 4 Theoretical framework of the urban-rural integration

scattering and fragmentation of small-scale cultivated land and the lack of adequate farmland infrastructure have resulted in a low utilization rate of cultivated land. Existing rural problems related to people's well-being, ecology, industry, and facilities can all be attributed to the problem of land use. Rational land use provides a valid foundation for reinvigorating land resources, optimizing spatial pattern, improving the eco-environment, and supporting industrial development, which constitute the highlights of the urban-rural integration.

The focus of rural revitalization is industrial prosperity and rural industrial development is a motivational guarantee and inner mechanism of rural revitalization. On the one hand, traditional rural industries must be protected while modern agriculture must be developed; on the other hand, efforts should be made to cultivate both emerging and strategic industries as well as to promote the integration of primary, secondary, and tertiary industries in rural areas. For instance, unique tourism resources can be relied upon for the development of the rural tourism industry, the sightseeing industry, the leisure agriculture and service industry, and the rural new energy and new material industries (including e-commerce, informatization, and other industries). To develop rural industries, an overall consideration should be focused on the regional differences of rural areas, the bearing capacity and property rights of land, and the related rights enjoyed by peasants. The operating entities of the new-type countryside constitute a major force for rural revitalization, and by developing new techniques, new modes, and new commercial forms of rural industries, urban-rural factor flows can be promoted (such as labor flow, the flow of funds, technology flow, information flow, and product flow).

The right of peasants to make their own decisions is important in rural revitalization, and their rights of discourse, to autonomous development, to income distribution over

collective land, and to social assistance and social security must all be safeguarded. In the process of coordinated urban-rural allocation and the equal exchange of urban-rural factors, the key lies in guaranteeing equal rights and interests to both urban and rural residents. During the assets-oriented innovation of land, the property rights of peasants must be safeguarded, such as their rights and interests over land assets both before and after land consolidation as well as their right to income. At present, many regions have explored the possibilities of implementing a joint-stock land consolidation mode, with the purpose of safeguarding peasants' rights to income and their right of participation after land consolidation.

4 Land engineering for land capacity building as technical support

Land capacity is an umbrella term for land potential, productivity and functions, and a comprehensive embodiment of the natural potential, economic values, ecological functions, social security, and technical contributions of the land of a specific region (Liu, 2018b). Here, land capacity differs from what we used to call land potential or productivity, as it is a systematic and comprehensive supporting service and guarantees capacity. The fundamental goal of land capacity building is to introduce land engineering technique, create high-standard farmlands, guarantee sustainable land use, and promote agricultural security as well as sustainable rural development. Relying on agricultural land engineering, the primary approach of land capacity building is to explore the techniques of cultivating and meliorating organic soil, and to make clear the coupling process of water-soil-climate-biology and the occurrence theory of "three-micro elements" (i.e., microstructure, micromorphology, and micro-mechanism) by conducting field observations and scientific tests of research bases. It also aims to put forward a coordinated strategy of the agricultural ternary structure with food crop, economic crop and forage crop, and an agricultural mode of production-living-ecological integration, thus offering a scientific basis for the planning and decision-making of land use and rural sustainable development in typical cases and major regions and at both national and global scales (Liu, 2017; Yang *et al.*, 2018). Land consolidation provides a critical means of realizing land capacity building and it is an indispensable way of spatial restructuring in rural China, which will establish a platform for revitalizing the countryside and realizing urban-rural integrated development (Long, 2014; Wu *et al.*, 2019; Zhou *et al.*, 2020). With regard to the problems of inefficient land use and spatial scattering and to achieve the goals of efficient land resource utilization and orderly land space utilization, efforts must be made to scientifically promote the comprehensive consolidation of rural land; to facilitate the integration of organizations, industry and space in rural areas; and to effectively shape the new driving forces and new mechanisms of rural revitalization and urban-rural integrated development in China. Land consolidation aims to raise the efficiency of land use, strengthen production capacity of agriculture and highlight the value of modern agriculture and rural areas. These factors help to enhance multi-functional and high-quality agriculture, while simultaneously promoting intensive and ecological rural development. The resources, assets, and capital attributes of land dictate that land has the following features which reveals that the process of land consolidation should also focus on

these aspects: (1) Economy—Land is the most fundamental means of production. Its economic characteristics mainly include the scarcity of land supply, the dispersion of land use patterns, the difficulty of land use type change and diminishing marginal returns. (2) Ecology—Land requires conservation to solve ecological problems. In accordance with the requirements of ecological civilization construction, the land ecological consolidation is advocated to thoroughly implement integrated ecological protection, restoration for mountains, rivers, forests, fields, lakes, and strongly build ecological land. (3) Sociality—Land use has the sociality and externality, and land is the key to securing people's well-being. (4) Policy and strategy—Land is the spatial carrier of human main economic and social activities. It is a strategic resource. The core of ecological civilization construction, land spatial optimization and the transformation of economic development mode, is the intensive and economical use of land which is featured by policy-orientation. In 2018, the Ministry of Land and Resources and the Ministry of Finance signaled continuous support would be offered for the in-depth promotion of regional major project construction according to national land consolidation planning in impoverished areas, old revolutionary base areas, major grain-producing areas, border areas, minority areas, and other areas with abundant cultivated land reserves. This support had the purpose of pushing forward the targeted poverty alleviation strategy and conducting the rural revitalization strategy as well as other national strategies.

According to the goals of land consolidation and the benefits generated by it, land consolidation plays a "five-guarantee" role for promoting rural revitalization: (1) Resources guarantee—Land consolidation in China is mainly marked by the construction of high-standard farmlands. Relying on land consolidation as well as other projects and techniques, land resources can be effectively integrated, thus raising the quantity and quality of cultivated land, while guaranteeing food security. (2) Engineering support—Land consolidation is a systematic engineering construction activity which adopts engineering, technical, biological and other measures to conduct the comprehensive consolidation of disused or degraded land. It could increase the area of effective arable land and the efficiency of land use, and promotes the integration of the production, living and ecological spaces. This project is not merely technical; it is also a social project aiming to benefit peasant households through land consolidation. (3) Technical support—Land consolidation adopts the technical means of remote sensing or unmanned aerial vehicles to conduct dynamic monitoring and all-round surveys in project areas, to acquire basic data through rapid remote sensing interpretation and investigation, and to use a big data platform to provide scientific decision-making for rural revitalization. (4) Industry guarantee—Agriculture is multi-functional. Promoting the integrated development of the primary, secondary, and tertiary industries would constitute a basis for rural revitalization. Based on the increase of cultivated land resources via land consolidation and the development of modern agriculture and emerging industries through cultivation technical system of agricultural experiment or land circulation, the aim is to increase the income and employment of peasants and to realize a sustainable development of rural areas. (5) Institutional guarantee—Measures are taken to guide the consolidated land through land transfer and ownership adjustments, to determine land-use rights (instead of land itself), to allocate the rights

and interests over newly increased cultivated land. It is important to entitle peasants to more property rights through land consolidation, and to increase the asset income of peasants. The breakthrough of rural land consolidation lies in innovating the rural land system, i.e., in introducing a new-type mechanism to promote the development of land consolidation (Wang, 2012). The roadmap for promoting rural revitalization through land consolidation is shown in Figure 5.

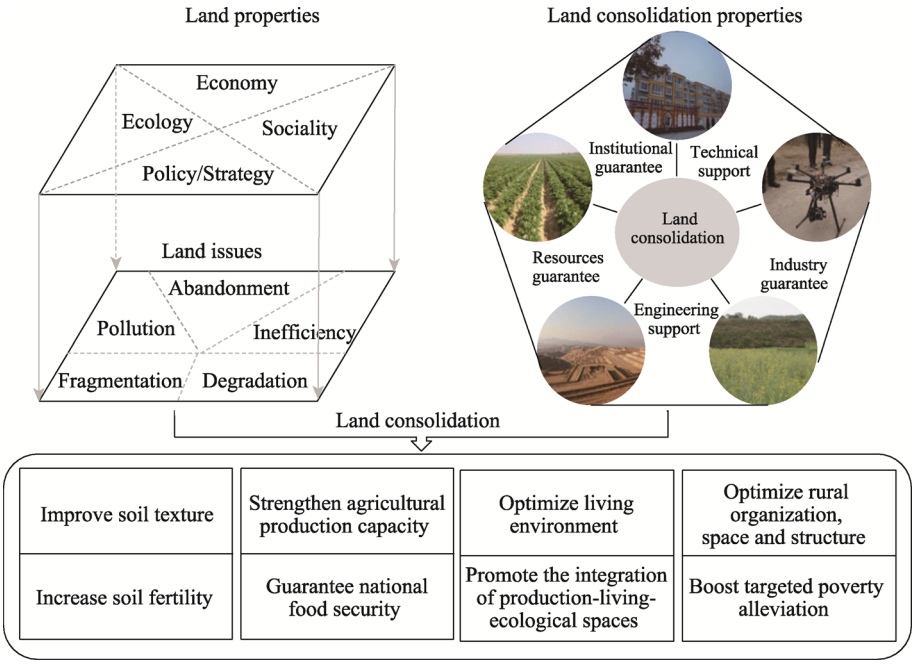

Figure 5 Roadmap for promoting rural revitalization through land consolidation

A diversified range of land consolidation projects has been proposed, such as sandy soil regulation, flood-damaged land governance, barren hilly land consolidation, hollowed village consolidation, and polluted land remediation, etc. The essence of land consolidation is to use engineering technique to convert degraded land into productive cultivated land; to transform fragmented and inefficient cultivated land into high-standard farmlands; and to increase peasants' livelihoods resources, assets, and capital. To further protect the cultivated land and to implement the national strategy of requisition-compensation balance, with quantity increase and quality guarantee, China has systematically launched engineering applications of key techniques related to the comprehensive consolidation of disused or degraded land. The following four main types have been identified in typical areas: (1) *Hollowed village consolidation project: consolidation of disused land in the villages of Yucheng, Shandong Province*—By revealing the evolvement course of rural hollowing, this project establishes a technical system of information acquisition, identification survey, potential assessment, and decision-making for disused land of rural villages. The potential of hollowed village consolidation in China was measured at 114 million mu (7.6 million ha) for the first time (Liu *et al.*, 2013). It proposes a "three-integration" mode (i.e., rural spatial restructuring, organizational reconstruction, and industrial reshaping) that can adapt to the development rules of rural transformation and build a spatial restructuring hierarchy for a city-town-

central village (community) composition. With regard to the different needs of the government, peasant households, enterprises, and other concerned parties, this project supports to return disused land to farmland and forest after consolidation; it also constructs residential and industrial areas to achieve community-based residence, clustered employment and socialized service. By developing the construction technology of healthy soil related with land cultivation, soil layer compounding, and soil improvement, the problems faced by newly increased cultivated land during village reclamation (such as instable structure and poor fertility) have been solved. Currently, land consolidation in hollowed villages has become one of the most important measures taken by the state towards rural sustainability (Li *et al.*, 2018). (2) *Gully land consolidation project in Yan'an*—The "Grain for Green" project in this Loess Plateau has achieved a significant ecological construction effect, meanwhile, it has also affected the local household livelihood and food security. Therefore, gully consolidation became a key for strengthening the agricultural production capacity of gullies. Relying on the gully consolidation mode of "grain for green up the hill and gully consolidation down the hill", this project has contributed to the optimization of land use structure and landscape pattern, and help to guarantee the eco-security of watershed (Li *et al.*, 2019). In the gullies of Yan'an, the main cropping pattern is the single cropping of corn at present which does not conform to the macro strategy of China's agricultural structural adjustment. By innovating the modern gully agricultural development pattern based on the production-living-ecology integration, the land consolidation project has introduced forage rape into the agricultural production chain after gully consolidation and promoted the multi-functional agriculture of "planting + breeding + processing + sightseeing". This innovation laid a foundation for realizing the multi-functional gully agriculture pattern from single cropping (corn) into double cropping (corn + rape) (Liu *et al.*, 2019b), and from one industry into three industries in the gully regions of the Loess Plateau, while simultaneously promoting the cooperative and professional construction of agricultural bases (Liu *et al.*, 2017; Liu and Wang, 2019). (3) *Barren hilly land consolidation project: the land consolidation and circulation project in Fuping County of Hebei Province*—The development of mountainous areas of Fuping County is mainly based on a requisition-compensation balance. Damaged construction land and unused land with a slope of less than 25° is developed into cultivated land which is used for a requisition-compensation balance; furthermore, the surplus index of construction land is transferred within the province. The intra-provincial transfer of the land-use index is a market transaction of the land development right and a transaction between the rural and urban land development rights (Liu and Wang, 2019). This transaction not only promotes the bilateral flow and efficient integration of urban-rural resources while increasing the supply of urban construction land but also effectively increases peasants' income from the assets-oriented conversion of land by promoting the capitalization of land resources (Zhou *et al.*, 2019). Furthermore, taking the opportunities of land consolidation and migration relocation and implementing land transfer, the land management right is converted into shares by area and circulated to the village committee. Then, on behalf of peasant households, the village committee contributes in the form of land and engages with agricultural companies in cooperative development and management. As a result, land consolidation creates employment opportunities and widens the employment channels for local farmers to increase their income in the three forms of "share capital, dividend, and wage" (Wu *et al.*, 2019). At the same time, the land consolidation project consolidates geological disaster-stricken land into

productive land; effectively reduces landslides, debris flows, and other natural disasters; and efficiently achieves poverty alleviation and disaster reduction. (4) *Sandy soil consolidation: the* "*double-optimal*" *project* (*i.e.*, *optimal formulation of soil layers and optimal selection of improved varieties*) *for degraded land in Yulin*—By analyzing the component structure and evolutionary process of the sandy soil in the Mu Us Sandy Land of Yulin and by relying on the physical complementarity of local sandy soil and red clay, this project experimentally proposed a structural consolidation theory to rehabilitate sandy land into farmland by soil body building, soil layer reconstruction, and soil quality improvement (Wang *et al.*, 2020). An innovative "double-optimal" matching mode was introduced for sandy soil consolidation, whose objective is to understand how to grow optimal crops in particular soils, i.e., how the growth of different crops influences and improves the land, and how different land components affect the growth of crops. Consequently, land suitability and biological fitness are perfectly combined. When applied to sandy soil regulation projects, the composite land-forming technique efficiently transforms sandy soil in wind-blown sand regions into high-productivity farmlands. Land consolidation also increases the quality of degraded land and improves its ecological environment.

5 Rural land system reform and reconstruction for management

Rural land system reform is an important support for rural revitalization. Implementing the rural revitalization strategy requires adhering to the priority development of agriculture and rural areas and establishing a sound policy system for the integrated urban-rural development. Optimization of the rural land system not only provides the premise to effectively solve the "three rural problems" but also constitutes the key toward a thorough implementation of the rural revitalization strategy. Based on the proposed framework of the land-use policy in China (Liu *et al.*, 2014), we constructed a framework of the rural land-use policy reform in China (Figure 6), which consists of one overall goal, two basic systems, five core systems, and multiple basic guarantee systems. Specifically, the two basic systems are the cultivated land-protection system and the intensive land-use system. In the context of rural

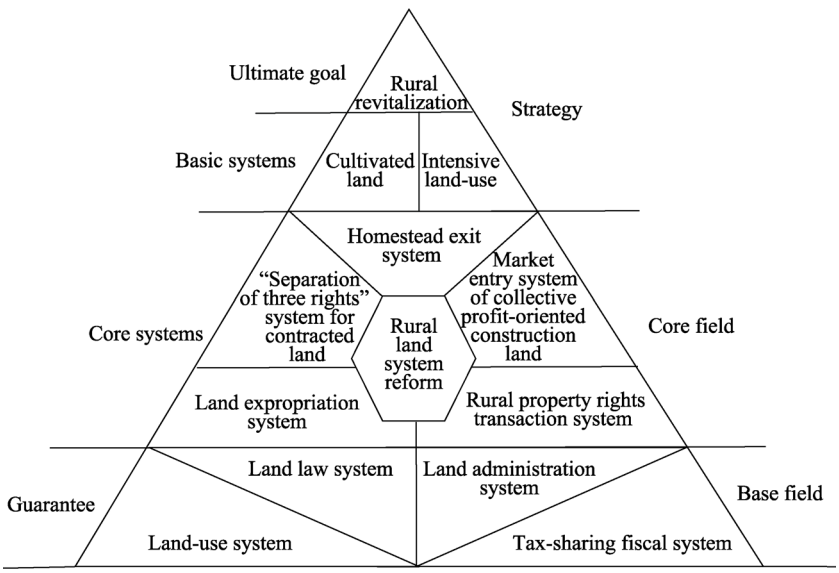

Figure 6 Framework of the rural land-use policy reform in China

revitalization, the rural land system reform mainly covers three fields: the rural contracted land, the homestead, and the collective construction land. Its five core systems include the "separation of three rights" (i.e., collective ownership, contractual right for peasant households, and management right for operators) system, the homestead exit system, the market entry system of a collective profit-oriented construction land, the land expropriation system, and the rural property rights transaction system.

The demands of rural revitalization require a further consolidation of the "separation of three rights" system of rural land, thus extending the rural homestead system reform and stimulating the endogenous power of the market entry reform of rural collective profit-oriented construction land. In doing so, the innovation of the land expropriation system can be deepened to provide a decision-making reference for improving the adaptability of rural land system reform, and maximally strengthening the optimal utilization of rural land resources. Details are summarized as follows: (1) *Consolidate the "separation of three rights" system for rural land*—Efforts should be focused on perfecting the "separation of three rights" system for rural land, and keeping the land contractual relationship stable as well as unchanged on a long-term basis. In the case of no change in the subject of rural collective land ownership, it is necessary to protect contractual right of peasant households, accelerate the enlivening of land management right, and introduce a policy allowing the legitimate use of the management right of rural contracted land as a mortgage for financial institutions and as a contribution toward the industrialized management of agriculture (Wang and Zhang, 2017). The current round of land contracts will be extended for a further 30 years upon expiry to provide a long-standing institutional guarantee for rural revitalization. The "separation of three rights" reform of rural land does not affect the collective ownership of rural land but divides the households' contracted management right into two parts, which include nontradable contractual rights of collective members and tradable rural land management rights by land transfer from collective members to agricultural producer (Han, 2016). The differences between land contractual right and land management right include the subject of the right, the content of the right and the nature of the right (Xu *et al.*, 2018). This institutional arrangement aims to active the land transfer mechanism, satisfy the demands of modern agribusiness, and ensure rural residents' rights and social security (Li *et al.*, 2018; Xu *et al.*, 2018; Zhou *et al.*, 2020). (2) *Expanding rural homestead system reform*—According to the requirements of rural revitalization strategy, the rural homestead is a critical index reflecting "ecological livability, rural civilization, and effective governance". Efforts should be made to perfect policies related to peasants' idle homesteads and idle houses. It is also necessary to explore the "separation of three rights", i.e., to implement the collective ownership of homesteads, to guarantee the homestead qualification right of peasant households and the house property rights of peasants, and to moderately enliven peasants' use right over homesteads and houses. With regard to the problems faced by peasant households (such as the difficulty of obtaining a homestead, extensive use, and unsmooth release), the modes of safeguarding and acquiring homestead rights and interests must be perfected. Furthermore, researchers must explore multiple forms of realizing the housing security of peasants in different regions; the possibility of implementing paid use with regard to the "over-standard occupation of the homestead", "one household with multiple homesteads", and other circumstances caused by historical reasons; and the possibility of

implementing a voluntary paid release or transfer of homesteads by peasants who have settled down in cities within their collective economic organization. For example, rural residential land use right is suggested to be acquired at a stepped tariff rather than free of charge, especially for those households with more than one residential plot or with the per capita area beyond the prescribed standard (Gao *et al.*, 2020). In 2018, China established an index of newly-increased cultivated land and a mechanism for cross-provincial regulation of the surplus index for linking the amount of urban and rural construction land. (3) *Stimulating the endogenous power of the market entry reform of rural collective profit-oriented construction land*—The market entry of rural collective profit-oriented construction land becomes the biggest breakthrough for pilot projects in this new round of land system reform. To meet the rural revitalization strategy, the market entry reform of rural collective construction land should focus on stimulating the endogenous power of the system reform, abide by the basic principles of "same price for same right, smooth circulation, and income sharing", and identify the equilibrium point of interests among the state, the collective, and individuals (Du and Huang, 2018). The primary tasks of this reform are to improve the property right system of rural collective construction land, define the scope and way of entering the market, and establish market transaction regulation and service monitoring system (Zhang and Li, 2018; NPCC, 2018). This strategy aims to deepen the rural collective property rights system reform, safeguard the property rights and interests of peasants, and strengthen the collective economy. (4) *Deepening the innovation of the land expropriation system*—The land expropriation system reform aims to realize the "three transformations", i.e., resources into assets, funds into shared capital, and peasants into shareholders. This measure is used to reinvigorate land resources, solve land development problems, and safeguard the rights and interests of peasants during land expropriation. The practice follows the pattern of contribution in the form of land, i.e., peasants contribute in the form of land contracted management rights, while agricultural companies contribute in the form of cash. In this way, peasants can receive an equity dividend from a joint venture they have jointly established. In this practice, land is formally transformed into assets and assumes the credit and debt of the joint venture. This method of land system reform can fully bring into play the resources allocation role of the market, while continuously moving towards the same land, same price and same right for cities and rural areas.

6 Discussion

The urban-rural relationship is a basic proposition of applied geography (Serra *et al.*, 2014) and an important field of concern for economics, sociology, and other disciplines. It typically experiences a gradual transformation from separation and opposition toward coordination and integration. The specific contents show China is attaching increasingly greater importance to the issue of unbalanced urban-rural development, and the goal to build a new-type of urban-rural relationship has been constantly raised to a higher level. To realize industrial prosperity, ecological livability, rural civilization, effective governance, and a prosperous life, rural revitalization must focus on the following core contents: the near-term goal is to build a well-off society in an all-round way and to promote urban-rural integration; the long-term goal is to ultimately achieve urban-rural equivalence through realizing the staged process objectives of urban-rural coordination and integration. At the current stage,

the urban-rural integration is the path of first-choice for the realization of rural revitalization.

The rural revitalization strategy aims to solve increasingly serious rural issues. To solve the rural problems caused by the ever-increasing rural decline, efforts should be made to revitalize rural areas based on the urban-rural integration. Urbanization is an inevitable trend of modernization and an effective means for achieving productivity increases. However, China's urbanization cannot solve its problems of rural development. In 2019, China's urbanization rate was 60.60%, exceeding 60% for first time. Eventually, even when it may reach 70% by 2030, almost 500 million people will live in rural areas. Therefore, rural revitalization requires a dual-wheel drive by urbanization and ruralization, both of which apply to special periods and special groups. For instance, one of the biggest problems caused by urbanization is the large-scale elderly people who are being left behind in rural areas, and the development of this group demands ruralization. Ruralization is not the flipside of urbanization; instead, it advocates people-oriented urbanization and aims to realize urban-rural strategic position equivalence and to promote the parallel, integrated, and synergistic development of both cities and rural areas.

The regional system of the human-earth relationship offers a theoretical basis for studies on the urban-rural integration, and the urban-rural integration manifests in factor transfer, strategy change, and mechanism conversion of the urban-rural regional system. Moreover, the synergistic combination of population-land-industry-right constitutes the key to developing the urban-rural integration. The key to rural revitalization lies in the "population", and its focus and root are industrial prosperity and land use, respectively. The land consolidation project provides an important way of realizing land capacity building and is an important engineering means for facilitating rural revitalization. Rural system reform, especially rural land system reform, is an important support and a pivotal issue for rural revitalization. This new strategy should fundamentally solve rural problems and energetically lay the foundation of rural development. Therefore, it should follow the basic rules of problem solving, transformation, development, and revitalization to fully revitalize rural population, land, right and industry.

Ecological revitalization is an important support for rural revitalization. Promoting the construction of ecological civilization and the formation of green development mode and life style are the profound revolution of development concept. Green development is a sustainable mode of economic growth and social development. The essence of green development is to achieve harmony and build a community of life between human and nature. It is essential to establish ecological environment management system and green development system, then to construct three red lines including ecological function guarantee baseline, environmental quality safety baseline and natural resource utilization top-line. In this way, agricultural green, high-quality, characteristic and brand-centered development could offer a guide for rural revitalization. When rural revitalization strategy is combined with green development and targeted poverty alleviation strategies, the theoretical framework constructed in this paper also does work. The people refer to decision makers, practitioners and managers engaged in modern agriculture and green food; the land refers to the territorial space with clear waters and green mountains and the efficient and livable production living space; the industries refer to the modern organic industries which pursue green, low carbon and sustainable development to realize ecological industrialization; the rights refer to ecological compensation, service value and development rights.

In implementing the rural revitalization strategy, five bottom lines should be maintained: (1) *The security bottom line*—To maintain the security bottom line means to maintain both the cultivated land protection red line and the food security bottom line. (2) *The people's well-being bottom line*—Universal access to health care represents the most important well-being for people and balancing and fairness of interests constitute the most significant institutional innovation. (3) *The ecological bottom line*—Maintaining the ecological bottom line means to adhere to green, ecological, and circular development, ecosystem conservation, and protecting the inner core and inner attributes of rural areas, instead of developing and constructing at the cost of resource exhaustion and environment pollution. (4) *The institutional bottom line*—This concept means the institutional design should be introduced on the basis of adhering to the current collective land ownership and maintaining the social assistance bottom line. Institutions are important platforms guaranteeing efficiency and fairness, and institutional design must pay adequate attention to bottom line demands. (5) *The risk bottom line*—With the exacerbation of landed estate and international problems, financial risks and market risks are being increased. Various types of rural development and construction in the implementation process of targeted poverty alleviation and rural revitalization cannot be promoted on the basis of debt financing. Considering the above five bottom lines, the future rural development of China needs to be planned from the following five aspects: (1) *Maintenance of peasants' subject position*—The subject of rural revitalization is the rural people, who are modern peasants and modern rural subjects. In China, the "three-separation" of urban-rural relationship (i.e., urban-rural segmentation, divided land governance, and human-land separation) has resulted in a decline of agriculture and rural areas as well as an increase in the expansion of the urban-rural gap and many other prominent problems. Without solving these problems, the rural revitalization strategy will inevitably be fruitless. (2) *Consolidation of spatial carriers*—Spatial pattern and spatial organization constitute the basis of factor allocation. Consequently, without rational spaces, efficient factor allocation cannot work. (3) *Enhancement of industrial entities*—Industry constitutes both the motivation and inner core of rural revitalization, and the connotations of industry must be extended. (4) *Strengthening the governance regime*—The regime plays its role mainly through strategy design and implementation control of public governmental services. At present, the government, enterprises, and the common people have different ideas and goals. For instance, for new countryside constructions, the government stresses beauty, wealth, and power. However, peasants choose to work in cities because rural areas cannot provide the resources they need to keep them there. For this reason, grassroots organization and multi-organization synergism must be emphasized, and system and institutional reforms must be deepened. (5) *Protection of vulnerable groups*—Driven by continuous development, the Matthew effect and the Cliff effect become increasingly prominent and highlighted. Therefore, to emphasize the protection of vulnerable poverty groups, efforts should be made from the perspectives of institutional design and mechanism innovation.

7 Conclusions

The urban-rural relationship in China has gradually transited from separation and opposition toward coordination and integration. China has implemented the strategy of rural revitalization for solving rural problems and the urban-rural integration is the path of first choice for

the realization of rural revitalization. As factors determine the characteristics and functions of the system through their interactions, this research constructs the theoretical framework of the urban-rural integration based on the core factor flow between the urban and rural systems. Additionally, this research uses land engineering for land capacity building as the technical support to solve rural issues and constructs a framework of rural land-use policy reform in China for its rural land management. Key findings are as follows: (1) Urban-rural integration should be considered within the territorial rural system for the research of rural revitalization and development based on the human-earth areal system. The synergistic combination of population-land-industry-right constitutes the key to developing the urban-rural integration. A solution-oriented rural revitalization strategy should implement the "four-revitalization" development of rural areas (i.e., revitalization of population, land, industry and rights) to effectively stimulate rural vitality, capacity, motivation, and competitiveness. (2) Land is the root of rural revitalization, and land engineering reinvigorates land resources with land capacity building as the means of technical support. Consolidations of hollowed villages as well as gullied, degraded and sandy land for high-standard farmland have been implemented, providing an important approach in improving land productivity. (3) Rural land system reform is the main line of rural reform and an essential institutional support for rural revitalization. To overcome obstacles of rural development at present and to deepen rural studies, multi-disciplinary crossover and integrated studies of science-engineering-social management must be strengthened, as well as comprehensive studies targeting problematic regions and regional problems. In the meantime, with regard to complex rural systems, efforts should be made to establish big data-based and agent-oriented optimal decision-making, reinforce the construction of a rural scientific method system, and promote the opening of innovative paths at structured, informationized, and technological levels for rural areas.

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