Enhancing Rural Collective Action Capacity to Accelerate Agricultural Science and Technology Advancement Postprint

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Abstract

Technological progress is of significant importance for promoting agricultural supply-side reform. This article adopts a collective action perspective to provide insights for scientifically understanding and promoting agricultural technological progress. The declining capacity for collective action in China' s rural public affairs governance and public goods provision is an important constraint on agricultural technological progress, particularly the diffusion of collaborative technologies. The dilemmas confronting rural collective action can be attributed to ten major factors. Concurrently, there also exist four factors conducive to rural collective action. To resolve the dilemmas of rural collective action and accelerate agricultural technological progress, it is necessary to adopt a holistic view of rural governance and comprehensively enhance rural collective action capacity. Specific policy orientations include: strengthening grassroots governance capacity and public service system construction; actively developing specialized services and diversified rural cooperative governance; vigorously developing rural e-commerce and rural e-government services; emphasizing and strengthening rural cultural construction and democratic and legal construction; deepening the reform of the rural collective property rights system and promoting institutional innovation according to local conditions.

Full Text

Enhancing Rural Collective Action Capacity to Accelerate Agricultural Technological Progress

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Abstract: Scientific and technological progress is crucial for promoting agricultural supply-side structural reform. This paper introduces a collective action perspective to provide insights for scientifically understanding and facilitating agricultural technological advancement. The declining capacity for collective action in rural public resource governance and public goods provision represents a significant constraint on agricultural technological progress, particularly the diffusion of collaborative technologies. The dilemma facing rural collective action can be attributed to ten major factors. Simultaneously, four favorable factors exist that can promote rural collective action. To overcome this collective action dilemma and accelerate agricultural technological progress, it is necessary to adopt a holistic perspective on rural governance and comprehensively enhance rural collective action capacity. Specific policy orientations include: strengthening grassroots governance capacity and public service system construction; actively developing specialized services and diversified rural cooperative governance; vigorously developing rural e-commerce and rural e-government services; emphasizing and strengthening rural cultural construction and democratic legal system development; and deepening rural collective property rights system reform while advancing institutional innovation tailored to local conditions.

Keywords: collective action, rural commons, technological progress, institutional innovation, rural governance

Introduction

Scientific and technological progress constitutes a fundamental force driving agriculture' s transition from traditional to modern modes. Vigorously promoting modern technological innovation and diffusion is key to realizing China' s agricultural modernization. The 2017 Central No. 1 Document emphasized strengthening innovation-driven development and enhancing agricultural technology extension. Accelerating modern technological progress and developing modern agriculture to improve land productivity, resource utilization efficiency, and labor productivity holds great significance for agricultural supply-side structural reform. In practice, we can observe that modern technology diffuses significantly faster in urban areas than in rural areas, and that technological progress in modern services and industry outpaces that in agriculture. Reflecting on how to accelerate the diffusion of modern technology in rural and agricultural domains represents a valuable academic question.

Theoretical research demonstrates that agricultural technology diffusion and adoption are primarily influenced by extension agents, technological characteristics, and farmer attributes, with the nature of the technology itself having a particularly important impact on diffusion speed [1]. Many modern agricultural technologies possess large-scale collaborative characteristics—such as dryland

farming ecological technologies, agricultural water-saving technologies, ecological technologies for preventing soil erosion, integrated pest management technologies, comprehensive ecological engineering technologies, and rural energy development technologies—and can therefore be termed "collaborative technologies." Collaborative technologies have public goods attributes and can be analyzed within the framework of commons governance. Their diffusion depends on multi-stakeholder joint collective action but requires overcoming the "free-rider" dilemma in cooperation. Since the 21st century, the decline in China's rural collective action capacity has created a dilemma that has become an important constraint on agricultural technological progress, particularly the diffusion of collaborative technologies.

The Decline in Rural Collective Action Capacity: Current Situation and Consequences

Government administration, market regulation, and social autonomy represent three fundamental approaches to enhancing collective action. As China's economy and society have transformed and rural social structures have changed, the mobilization capacity of rural grassroots organizations has declined, market mechanisms have limited effectiveness in supplying rural public resources and goods, and farmers'self-governance capabilities have failed to develop adequately. This has created a governance predicament characterized by simultaneous "government failure," "market failure," and "social failure" in rural public governance, leading to a widespread rural collective action dilemma [3]. Because collaborative technologies depend on large-scale collective action, they are more likely to face "market failure," "government failure," and "social failure" simultaneously, resulting in relatively slow diffusion and placing higher demands on rural collective action capacity. Therefore, deeply reflecting on the reasons for the decline in China's rural collective action capacity and systematically diagnosing the factors affecting this capacity holds important policy value for further accelerating agricultural technological progress and promoting agricultural supply-side structural reform.

Taking farmland irrigation as an example, under the people's commune system in the planned economy era, political mobilization organized farmers for large-scale water conservancy construction. Since the rural tax-and-fee reforms of the early 21st century, an increasing number of farmers have opted for solutions like well-drilling, pond excavation, and purchasing pumping equipment to meet irrigation needs. According to survey data from the China Institute for Rural Studies at Tsinghua University, the proportions of rural households using machine pumping, well-drilling, and canal irrigation are each approximately one-third, with machine pumping and well-drilling having become the main irrigation methods. In contrast, only 1.1% of households use new water-saving irrigation technologies such as sprinkler, drip, or film irrigation [2]. Over the past half-century, the basic unit of rural collective action in China has shrunk from people's communes to village communities, and further to several house-

holds or even single households today, reflecting the decline of China' s rural collective action capacity from one perspective [3].

This decline in collective action capacity significantly affects the diffusion of collaborative technologies. Again using farmland irrigation as an example, rice is China' s largest water-consuming crop, accounting for approximately 50% of national water consumption, making rice water-saving irrigation technology strategically important for improving water resource efficiency [4]. Controlled irrigation technology for rice has proven suitable for southern China and was widely applied in Yancheng City during the 1990s. Compared with conventional shallow-water irrigation, controlled irrigation can save 30-45% of irrigation water while increasing yields by 5-10% [5]. This technology was incorporated into national policy documents for promotion, and at its peak, the national 推广 area reached 200 million mu. However, its sustainability and recent promotion effects have been unsatisfactory, primarily due to inadequate water conservancy infrastructure and an unsound agricultural water management organizational system. This explains from a technological progress perspective the phenomenon of "gradual deterioration of public infrastructure alongside proliferation of small-scale water projects." The decline in rural collective action capacity is the root cause behind the difficulty in effectively promoting many collaborative technologies such as rice controlled irrigation technology, as well as the crux hidden beneath surface phenomena like government inability to promote and farmer unwillingness to participate.

Factors Affecting Rural Collective Action

Many factors influence rural collective action, which can be broadly categorized into natural geographical conditions, socioeconomic attributes, institutional rules, and farmer characteristics [6]. Through a series of empirical studies on factors affecting collective irrigation in rural China [7-10], our research team has identified both numerous unfavorable factors and some favorable factors, which are briefly summarized here. Although these insights are primarily based on research on collective irrigation action, as a microcosm and typical case of rural collective action, they provide valuable reference for understanding the logic of rural collective action in China.

Unfavorable Factors for Rural Collective Action (1) Deterioration of Resource Conditions. Natural resource conditions profoundly affect rural collective action. Both excessively scarce and excessively abundant natural resource conditions are unfavorable for collective action, while moderate resource conditions are most conducive [11,12]. China has a large population with relatively limited land, and per capita possession of various natural resources is relatively scarce, which itself is unfavorable for collective action. Additionally, deteriorating water and soil resource conditions and frequent natural disasters further exacerbate the difficulties of rural collective action.

(2) Changes in Economic Geography. The closer farmers are to markets

and the more non-agricultural income opportunities they have, the less motivated they are to participate in rural collective action [13,14]. Our research finds that collective irrigation development in non-suburban villages is significantly better than in suburban villages, because non-suburban villages are farther from urban centers and local farmers attach greater importance to their village' s public affairs [7]. As China' s urbanization has developed rapidly, numerous villages have been quickly urbanized or suburbanized, while transportation infrastructure development has made connections between farmers and markets increasingly convenient. These trends may weaken the motivation for rural organizations to undertake collective action.

(3) Large-Scale Labor Outflow. Urbanization has been accompanied by massive rural labor outflow. By the end of 2015, China had 277 million rural migrants to urban areas, accounting for 20% of the total population, with this number projected to grow to 350 million by 2050 [15]. Labor outflow reduces rural collective action capacity through at least three mechanisms: Loss of leadership, as outflow removes elite talent who could play organizational and coordinating roles in rural governance; Loss of social capital, as outflow weakens existing interpersonal networks within villages, making collective action based on trust, credible commitments, and mutual monitoring more difficult; and Reduced sense of belonging, as farmers' local attachment declines, weakening their willingness and motivation to participate in public affairs [7].

(4) Changes in Village Demographic Characteristics. Urbanization has profoundly changed rural population structures, with hollowing-out and aging becoming prominent features. Large-scale urbanization has created increasingly numerous hollow villages, causing many villages' populations to continuously shrink, which negatively affects rural collective action [7]. The population migrating from rural to urban areas consists overwhelmingly of young and middle-aged people, further accelerating rural population aging. The loss of younger rural populations and the aging of the remaining population adversely affect collective action. Additionally, the declining cultural quality and labor skills of the older rural population also negatively impact collective action.

(5) Declining Dependence on Agriculture. With large-scale rural labor outflow, both village and household populations are shrinking, the proportion of part-time farmers is increasing, and the share of household income derived from agricultural operations is continuously declining. On average, agricultural income now accounts for less than one-quarter of total household income. Reduced dependence on agriculture leads to decreased willingness to participate in rural public affairs [7,16].

(6) Increasing Heterogeneity Among Villagers. The growth in farmers working outside villages and the increase in part-time households raise economic heterogeneity within villages. Greater social openness and mobility also increase socio-cultural heterogeneity among villagers. Increased heterogeneity leads to divergent demands for rural public affairs [17]. For example, regarding farmland irrigation, better-off households prefer to drill wells or purchase their own

pumping equipment, making it difficult for farmers to reach consensus on a larger scale and contributing to the proliferation of small-scale water projects.

(7) Weak Rural Grassroots Governance. Following rural tax-and-fee reforms, the institutional authority of rural grassroots political organizations has weakened. In many villages, the "one matter, one discussion" system operates poorly, with difficulties in "organizing meetings, discussing resolutions, and implementing decisions." The institutional supply problem underlying effective collective action is prominent. Survey data from the China Institute for Rural Studies at Tsinghua University shows that approximately 90% of surveyed households have never or rarely participated in discussions about village irrigation affairs [2].

(8) Low Level of Self-Governance. Due to declining mobilization capacity of rural grassroots political organizations and deepening "atomization" of rural society, farmers' enthusiasm for participating in public affairs is low, and they often play passive roles. Although various types of rural cooperative organizations have developed rapidly, playing a positive role in reversing this trend, many farmers' cooperative organizations have not achieved satisfactory results for various reasons. For example, after 20 years of development, nearly 100,000 water user associations have been established nationwide. However, our research shows that water user associations in many regions operate inefficiently or become mere formalities, demonstrating no institutional advantage over traditional village collective management [10]. This reflects that improving rural self-governance remains a formidable task.

(9) Inadequate Monitoring and Reward-Punishment Mechanisms. Effective institutional operation depends on mutual monitoring and credible commitments, necessitating corresponding sanction and punishment mechanisms, which are crucial for achieving effective collective action [16]. Currently, in rural grassroots social operation, on the one hand, the informal institutional effectiveness of traditional customs and village regulations is declining, while on the other hand, the formal institutional operation system based on modern rule of law has not been fully established, resulting in generally absent or weakly enforced sanction and punishment mechanisms. According to survey data from the China Institute for Rural Studies at Tsinghua University, in grassroots irrigation management, only about one-quarter of surveyed villages have taken punitive measures against behaviors such as unauthorized canal digging for water theft or water fee arrears [2,7]. The low cost of violating institutions further encourages widespread social non-compliance at the grassroots level, reducing the likelihood of successful rural collective action.

(10) Rural Collective Property Rights Reform. China's natural resources are primarily under a collective property rights system, whose operation and benefit distribution highly depend on effective collective action. Due to the difficulty of collective action, collective property rights operation has generally been ineffective, prompting "titling" reforms of rural natural resources in practice, involving land resources, forest resources, grassland resources, and water

resources. These include the "household responsibility system" for farmland property rights following the initial reforms, the recent nationwide "farmland titling" reform, the "forest allocation to households" collective forest rights reform implemented in multiple southern provinces, the "grassland allocation to households" pasture system reform carried out in northwestern provinces, and the recently launched nationwide "water rights allocation to households" pilot reform. While these reforms create property rights incentives for farmers, they also cause fragmentation of public resources, making it more difficult for farmers to form effective and large-scale cooperation for commons governance and exacerbating the rural collective action dilemma [3].

Favorable Factors for Rural Collective Action (1) Rapid Rural Economic Development. Rising economic development levels help improve rural infrastructure, creating favorable conditions for enhancing rural public goods supply capacity and improving commons governance. Our research shows that in relatively economically developed rural areas, irrigation infrastructure conditions are better, farmers' irrigation canal maintenance costs are lower, and public governance performance is relatively higher [9]. Since the 21st century, China' s rural economy has developed rapidly, with farmers' income continuing to grow at a relatively fast pace. Particularly since 2009, the urban-rural income gap has begun to narrow, farmers' consumption and expenditure structures have accelerated upgrading, and this has directly promoted the accelerated diffusion of modern technology in agriculture and rural areas. With further rural economic development, if the favorable conditions created by economic growth can be utilized to improve rural governance and institutional construction, it may be possible to reverse the unfavorable situation of declining collective action capacity.

(2) Deepening Rural Marketization. The continuous expansion of market mechanisms in rural areas has directly promoted the commercialization, mechanization, and informatization of agricultural production, accelerating the diffusion of modern technology in rural areas and the process of agricultural modernization. This is the fundamental driving force behind the earth-shaking changes in China' s rural areas since the reform and opening-up. Market mechanisms can provide effective supply for goods and technologies with private goods characteristics. As marketization continues to expand, some goods and technologies originally belonging to the public goods category can be provided through markets or with partial market introduction. For example, land trusteeship emerging in some rural areas can provide specialized services for various production stages including pesticide application, weeding, irrigation, pest control, harvesting, and transportation. This represents an innovation in agricultural production and management methods born from deepening markets promoting agricultural production specialization.

(3) Accelerating Rural Informatization. In recent years, China' s rural internet user base has continuously grown, rural e-commerce has developed

rapidly, and rural informatization has achieved breakthrough progress. By the end of 2015, China' s rural internet user population reached 195 million, with an annual growth rate of 9.5%; rural online shopping users numbered 92.39 million, with an annual growth rate of 19.8% [15]. Informatization can accelerate the diffusion of modern agricultural technology in rural areas, facilitate agricultural supply-side structural reform, and promote the integrated development of primary, secondary, and tertiary industries. Meanwhile, the rapid development of village WeChat groups and e-commerce is profoundly changing China' s rural governance structure. Village WeChat groups have become platforms for information exchange between village cadres and villagers, as well as among villagers themselves, providing great convenience for gathering public opinion, village affairs transparency, and democratic supervision. E-commerce partners in rural areas may become coordinators for villagers' discussions of public affairs, and e-commerce service points may become important venues for such discussions. These new development trends help enhance rural collective action capacity.

(4) Advancement of Rural Land Transfer. China' s small per capita farmland area and land fragmentation constitute fundamental constraints on rural collective action. Rural land transfer will alleviate this situation to some extent. By the end of June 2016, the area of contracted farmland transferred nationwide had reached 460 million mu, exceeding one-third of the total contracted area, with the transfer ratio exceeding one-half in some eastern coastal regions [15]. Orderly rural land transfer and the gradual formation of appropriately scaled farm operations can enhance rural collective action capacity in two ways: Scaled operations increase the relative returns of agricultural production activities, raise farmers' dependence on agriculture, and thereby increase farmers' willingness to participate in collective action such as agricultural infrastructure construction and maintenance; and Changes in human-land relationships reshape cooperation among farmers, offsetting to some extent the adverse effects of labor outflow such as leadership loss and social capital drain, thereby enhancing collective action capacity. With the continuous advancement of the "separation of three rights" reform for agricultural land, a large number of "middle farmer" households with appropriately scaled operations and ordinary agricultural elite households are expected to become the backbone of rural collective action, as this group is the most enthusiastic, least likely to "free-ride," and most actively organizes, maintains, and participates in rural public affairs [18].

Policy Orientations for Breaking the Rural Collective Action Dilemma

Breaking the rural collective action dilemma requires adopting appropriate public policies that suppress unfavorable factors and leverage favorable factors for rural collective action. This analysis yields five specific policy implications.

(1) Strengthen Grassroots Governance Capacity and Public Service System Construction. Using grassroots Party building as the lever, enhance the leadership, credibility, and mobilization capacity of grassroots cadres. In-

crease fiscal transfers to township governments, improve their public service capabilities, and strengthen the construction of grassroots public service institutions such as township agricultural technology extension agencies, enriching the grassroots professional talent pool through multiple channels. Strengthen the autonomous functions of villagers' committees, give full play to the role of village regulations, and truly implement villagers' self-governance. Enhance the organizational capacity of villager groups so they can play a role in organizing farmers to improve technology extension and application systems, solving the "last mile" problem in agricultural technology extension.

(2) Actively Develop Specialized Services and Diversified Rural Cooperative Governance. Using agricultural land system reform as an opportunity, further activate various factor markets in rural areas, and encourage various forms of organizational innovation, market innovation, and service innovation. Actively cultivate new types of agricultural business entities, develop various forms of scaled operations, encourage the development of specialized agricultural cooperative organizations, and guide the orderly development of land transfer and land trusteeship. Promote the application of Public-Private Partnership (PPP) models to expand high-quality and efficient supply of rural public goods. Implement government purchase of services to support various social forces in extensively participating in agricultural technology extension. Actively advocate for diversified cooperative governance in rural public affairs, forming a pattern of positive interaction between government governance, social regulation, and resident self-governance.

(3) Vigorously Develop Rural E-Commerce and Rural E-Government Services. Seizing the opportunities of the internet revolution, vigorously develop "Internet + Agriculture" and "Internet + Rural Areas" to promote leapfrog development of the rural economy and society. Accelerate the construction of rural informatization infrastructure, strengthen the summarization and promotion of rural e-commerce development experiences, and accelerate the standardization of rural e-commerce services. Promote the deep integration of rural e-commerce with rural primary, secondary, and tertiary industries to facilitate agricultural transformation, upgrading, and quality and efficiency improvement. Actively use the internet to improve rural social governance, encourage grassroots construction of online platforms for government services and convenience services. Promote the integrated development of rural e-government and e-commerce to drive innovation in rural social governance systems.

(4) Emphasize and Strengthen Rural Cultural Construction and Democratic Legal System Development. Utilize various traditional and modern organizational and cultural resources to maintain rural social capital, enhance village belonging and identity, and strengthen rural social cohesion. Enrich rural public cultural life, improve farmers' moral and cultural quality, and cultivate healthy and uplifting rural social customs. Truly establish villagers' committees as villagers' autonomous organizations, effectively safeguarding farmers' democratic rights to independently manage rural affairs.

Establish rural democratic consultation and public deliberation platforms to enhance communication, mutual trust, and cooperation among farmers, stimulating their enthusiasm for participating in rural public affairs. Enhance farmers' awareness and thinking about the rule of law, improve rural legal service systems, and increase supervision over law enforcement in rural areas.

(5) Deepen Rural Collective Property Rights System Reform and Promote Institutional Innovation Tailored to Local Conditions. Build a rural collective property rights system with clear ownership, complete rights and functions, smooth transfer, and strict protection to promote the development of rural collective economies and continuous increases in farmers' income. Scientifically confirm the membership of rural collective economic organizations, prevent control by internal minorities and encroachment by external capital, and safeguard farmers' collective asset rights and interests. Advance the "separation of three rights"reform for agricultural land. While stabilizing household contract rights and activating land management rights, effectively implement collective ownership rights and fully maintain farmers' collective rights to contract land regarding contracting, adjustment, supervision, and reclamation. Rural system reform must fully leverage farmers' principal role, ensure farmers' rights to information, participation, expression, and supervision, respect farmers' practical innovations and local pilot experiments, and explore locally suitable institutional arrangements according to local conditions.

Conclusion

In the complex coupled natural-economic-social-technological system, technological progress is constrained not only by factors directly related to technology but also by socioeconomic development and institutional environments. This paper introduces a collective action perspective to provide new insights for scientifically understanding and promoting agricultural technological progress. By incorporating the extension of collaborative technologies into the analytical category of rural commons governance and examining the specific factors affecting their collective action, this study expands the cognitive horizon of agricultural technological progress issues. Through identifying unfavorable and favorable factors affecting rural collective action, the paper develops a systematic understanding of the rural collective action dilemma and provides policy implications for overcoming it. Using technological progress to promote agricultural supply-side structural reform requires adopting a holistic perspective on rural governance, comprehensively enhancing rural collective action capacity, and advancing the modernization of rural governance systems and capabilities.

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Note: The term "atomization" (原子化) refers to a social phenomenon where relationships between individuals weaken and groups become estranged, giving rise to social issues such as emotional indifference and moral decline during periods of social transformation.

Note: Figure translations are in progress. See original paper for figures.