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Enhancing agricultural producer resilience to systemic shocks through a dual strategy: integrating product certification and e-commerce

Jinkai LI[1,2], Yadong QIU (✉)[1], Xining LI[1], Wei SI[1,2]

1 College of Economics and Management, China Agricultural University, Beijing 100083, China.
2 Academy of Global Food Economics and Policy, China Agricultural University, Beijing 100083, China.

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Correspondence: qiuyadong1999@163.com

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Global agricultural production is facing mounting systemic risks driven by climate change, extreme weather events, supply chain disruptions and volatile commodity markets. These interconnected risks threaten the stability and sustainability of agrifood systems, particularly for small-scale producers who are often more vulnerable to sudden impacts from economic and environmental problems and who have fewer resources to cope with such shocks. Recent crises, including the COVID-19 pandemic, geopolitical conflicts and climate extremes, have exposed the fragility of existing agricultural value chains and underscored the urgent need for resilience-building strategies that enable producers to absorb shocks, adapt to rapidly changing conditions and recover swiftly. Strengthening producer resilience is therefore fundamental to enhancing the resilience of broader agrifood systems under growing uncertainty.

In this commentary, agricultural producer resilience refers to the capacity of producers to absorb shocks, adapt to changing conditions and recover from disruptions without long-term loss of productive capacity. Product certification refers to formal verification of production standards that facilitates market recognition and access to premium markets, and e-commerce adoption refers to the use of digital platforms and online channels to market and sell agricultural products. Resilient agricultural systems maintain core functions under stress, reorganize in response to disruptions, and continue providing food, income and ecosystem services[1]. In this context, two complementary strategies, viz., product certification and e-commerce adoption, have emerged as promising pathways for enhancing producer resilience. Although each strategy has been widely examined, limited attention has been given to whether their combined adoption provides synergistic benefits. Schneider et al.[2] emphasize that governance and resilience indicators are highly interconnected within food systems, with synergies and trade-offs varying across contexts. This perspective suggests that integrating product certification with e-commerce may create mutually reinforcing pathways that strengthen producer resilience to systemic shocks and contribute to more resilient agrifood systems.

The resilience-enhancing effects of the dual strategy arise from the complementary mechanisms through which product certification and e-commerce operate. Product certification can improve income stability by strengthening quality signaling, facilitating access to premium markets and reducing exposure to price volatility. E-commerce can enhance market diversification by expanding sales channels and reducing dependence on vulnerable intermediaries. When adopted

jointly, these strategies further strengthen resilience by providing producers with multiple market options during disruptions and reducing reliance on any single marketing channel. They also reinforce institutional linkages by connecting producers more closely with cooperatives, agribusiness firms, certification bodies and digital platforms, thereby improving access to information, services and market opportunities. In combination, income stability, market diversification, risk buffering and institutional linkages strengthen producer absorptive capacity to withstand immediate shocks, adaptive capacity to respond to changing market conditions, and transformative capacity to pursue longer-term upgrading and development. Through these interconnected pathways, the dual strategy can enhance agricultural producer resilience to systemic shocks (Fig. 1).

Recent empirical evidence provides support for this conceptual framework. Using a nationally representative survey from China, Liu et al.[3] examined how different combinations of product certification and e-commerce adoption affect producer outcomes. Three important patterns emerged. First, producers who adopted both strategies experienced clear synergistic effects, with joint adoption yielding greater gains than either strategy alone. Second, despite the additional compliance and production costs involved, dual adopters benefited from higher product prices, increased sales and improved profitability.

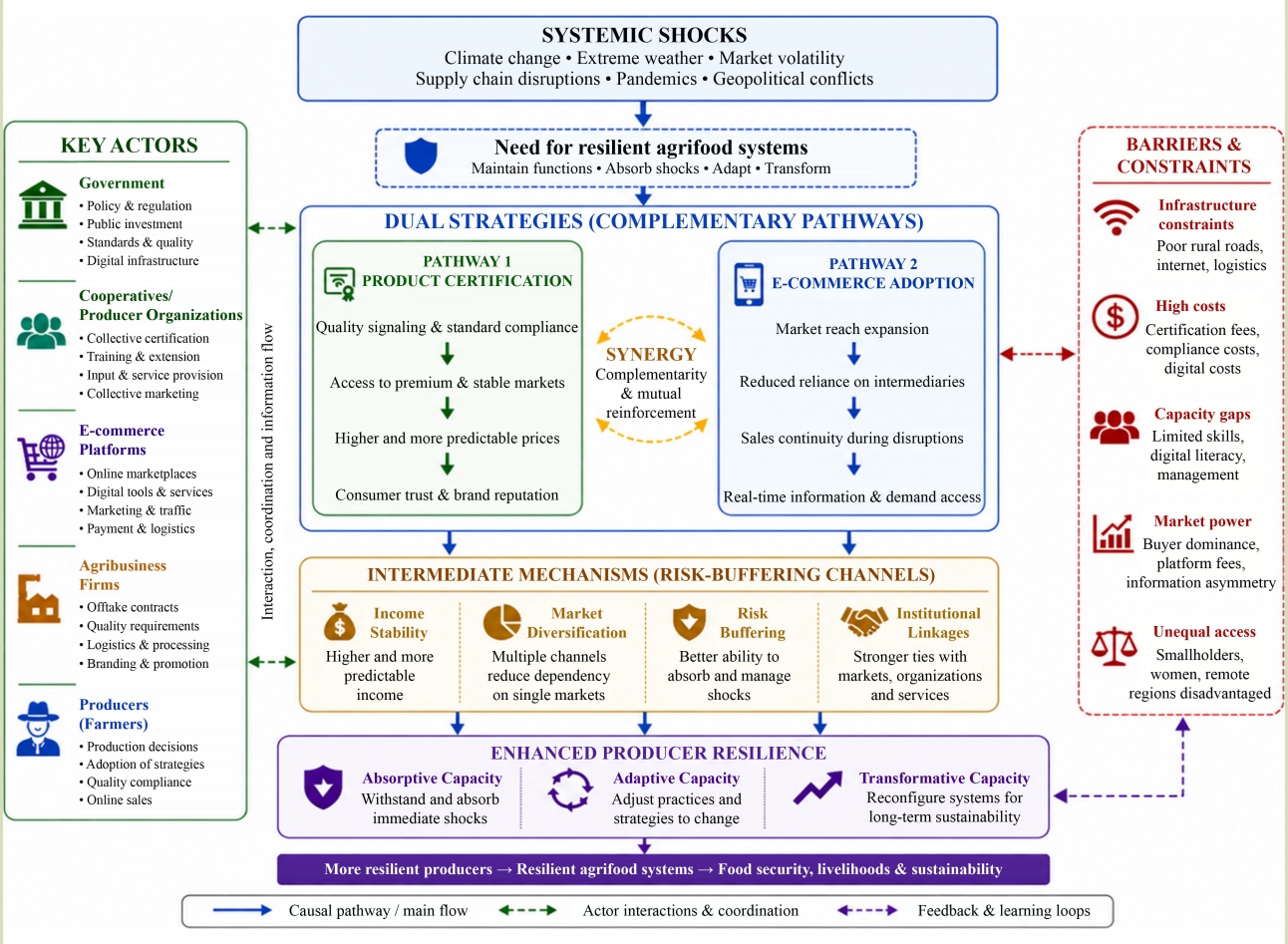


Fig. 1 Conceptual framework of the dual strategy for enhancing agricultural producer resilience. This framework illustrates how systemic shocks create the need for resilience and how product certification and e-commerce operate as complementary strategies. Through income stability, market diversification, risk buffering and institutional linkages, the dual strategy strengthens producer absorptive, adaptive and transformative capacities. It also highlights the roles of key actors and the constraints that may limit resilience outcomes.

Third, these advantages were unevenly distributed: cash crop and larger-scale producers captured most of the benefits, whereas grain and small-scale producers continued to face persistent barriers, including limited access to certification services, inadequate digital infrastructure and insufficient technical support. These findings underscore both the resilience-enhancing potential of integrated strategies and the need to ensure that resilience gains are more broadly shared across different categories of producers.

These findings indicate that realizing the resilience benefits of the dual strategy requires supportive institutions that can reduce barriers to adoption and broaden participation. Accordingly, we outline actor-specific pathways, targeting governments, cooperatives and producers, for leveraging product certification and e-commerce to enhance resilience.

First, governments should take the lead in designing and implementing enabling policies that expand agricultural producer access to both product certification and e-commerce. Public intervention is essential, as market mechanisms alone cannot overcome the structural barriers faced by small-scale producers[4]. To lower entry costs and administrative burdens, governments can subsidize certification fees, streamline regulatory procedures, and provide targeted training on quality standards and compliance, particularly for small-scale producers who face disproportionately high barriers[5]. As of 2022, China had 7780 so-called Taobao villages (engaged in e-commerce through the e-commerce via the Taobao online retail platform) in 28 provinces and 180 cities, involving about 1.2 million rural households. However, these villages are concentrated primarily in economically developed eastern coastal regions, where digital infrastructure, logistics networks and market accessibility are relatively advanced. Nevertheless, the growth momentum of Taobao villages has gradually shifted to central and western China, and rural digital economy keeps expanding to less developed areas. The applicability of this experience to central and western grain-producing regions remains less certain and warrants further investigation. In addition, public investment in regional branding initiatives and consumer awareness campaigns can further strengthen the market recognition of certified products and encourage broader participation in certification programs.

Governments can contribute to enabling producers to adopt e-commerce. Investments in rural broadband infrastructure, logistics networks and digital literacy programs are essential for expanding participation in digital markets[6]. China's investments in rural digital infrastructure, together with initiatives such as Taobao villages, online cooperatives and agricultural live-streaming, demonstrate how public support can facilitate broader market access for rural producers. Priority should be given to underserved regions and producers facing the greatest adoption constraints to ensure that the benefits of digitalization contribute to more inclusive agricultural resilience.

Second, agricultural cooperatives can help small-scale producers overcome barriers to adopting product certification and e-commerce. Cooperatives help in building shared capacity, particularly for producers who lack resources to navigate certification systems and digital markets on their own. They can provide guidance on standards compliance, coordinate group certification applications, and reduce the cost and complexity of certification procedures[7]. Evidence from China shows that among the top 500 farmer cooperatives in 2022, 238 had obtained green or organic certifications. By pooling resources and organizing collective marketing, they help members achieve economies of scale and strengthen bargaining power.

To facilitate digital market participation, cooperatives can offer training and technical assistance to support members in adopting e-commerce tools and developing online sales channels. In 2022, the average e-commerce sales per cooperative reached about 2.40 million yuan, with an average growth rate of about 26% over the previous 2 years. During periods of disruption, cooperatives with established e-commerce infrastructure can act as resilient nodes, maintaining market access and income flows for their members. Cooperatives are therefore essential to ensuring that resilience-building benefits reach small-scale producers rather than bypassing the most vulnerable producers.

Third, agricultural producers should adopt differentiated strategies according to their operational scale, resource endowments and market opportunities. For small-scale producers, particularly those facing severe resource constraints and limited access to services, priority should be placed on strengthening digital connectivity, lowering entry barriers and adopting e-commerce as an initial pathway to market participation. Since the implementation of the Comprehensive E-commerce in Rural Counties Program of China, substantial investments have been made in rural e-commerce

infrastructure and service networks, expanding digital market opportunities for rural producers. As digital and organizational capacity accumulates, certification can subsequently be adopted as a complementary strategy to improve product recognition and access higher-value markets.

For medium- and large-scale producers, particularly those cultivating cash crops, combined adoption of product certification and e-commerce should be encouraged. These producers are generally better positioned to absorb the upfront costs of dual adoption and to capitalize on the complementary benefits of quality premiums and diversified market access. Crop-specific differentiation is also important. Certification may be particularly valuable for producers seeking stable market recognition and longer-term market access, whereas e-commerce can create greater opportunities for producers targeting niche and high-value consumer markets. Such differentiated pathways can help ensure that resilience-building strategies are aligned with producer capacities, production characteristics and market conditions.

International experience reveals context-specific adaptations. In China, the dual strategy has largely been supported through government-led initiatives such as Taobao villages and certification subsidies. In the USA, Organic Valley, a farmer-led cooperative of nearly 1800 members, demonstrates collective certification without direct government support. In Vietnam, small-scale producers using TikTok Shop live-streaming have expanded market reach, but weak logistics systems constrain scalability. These comparisons indicate that while the dual strategy is transferable, its institutional structure must incorporate local digital infrastructure, cooperative maturity and regulatory environments.

The effectiveness of the dual strategy also varies by shock type. Against price volatility, certification provides a strong buffer through price premiums and long-term contracts. Against supply chain disruptions, e-commerce is highly effective through direct-to-consumer channels. Against climate-induced production shocks, such as those caused by drought, flood and pest outbreaks, both strategies offer little protection because there is no surplus to sell. Policymakers should therefore pair the dual strategy with complementary tools such as weather index insurance and emergency reserves. Furthermore, the available evidence is primarily drawn from economically developed regions of eastern China, where certification services, digital infrastructure, logistics systems, and market institutions are relatively well established. The applicability of these findings to central and western grain-producing areas with weaker digital infrastructure and logistics networks requires further investigation.

While this commentary draws on evidence from China, its insights are broadly relevant to global efforts to strengthen agricultural resilience[8]. The effectiveness of the dual strategy depends on supportive institutions, infrastructure and producer capacities. As climate change, market volatility and supply chain fragility intensify, developing more inclusive and context-specific pathways for combining certification and e-commerce will be increasingly important for building resilient agrifood systems worldwide.

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Compliance with ethics guidelines

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