# The Strategic Value and Technological Support of Urban Modern Agriculture Development: Post-print

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## Abstract

The rapid advancement of urbanization has profoundly transformed China' s socio-economic structure, which in turn has exerted comprehensive influences on agricultural development, with urban agriculture positioned at the forefront of urbanization being the most significantly impacted. Owing to its unique geographical location, modern urban agriculture exhibits important characteristics in social functions, production structures, and cultivation-breeding models that distinguish it from rural agriculture. It is precisely based on these regional features and advantages that urban agriculture holds significant strategic value in serving urban residents' needs, increasing incomes for suburban farmers, and driving the development of rural agriculture. To realize the strategic value of modern urban agriculture, it is necessary to focus on ecological civilization construction to promote major breakthroughs in resource-saving and clean production technologies; concentrate on agricultural product quality and safety to advance the widespread application of habitat control and information traceability technologies; emphasize core capability enhancement to vigorously develop germplasm and smart agriculture technologies; and center on optimizing the production-marketing system to achieve systematic integration of e-commerce and logistics technologies.

## Full Text

### Strategic Value and Technology Support for the Development of Urban Modern Agriculture

The rapid advancement of urbanization has profoundly transformed China' s socio-economic structure, which in turn has comprehensively impacted agricultural development. Urban agriculture, positioned at the forefront of urbanization, has experienced the most significant effects. Due to its unique location,

urban modern agriculture exhibits distinct characteristics in social function, production structure, and farming models that differentiate it from rural agriculture. Leveraging regional features and advantages, urban modern agriculture holds critical strategic value in serving urban residents' needs, increasing incomes for suburban farmers, and driving agricultural development in rural areas. To realize this strategic value, development efforts must focus on: achieving major breakthroughs in resource-saving and clean production technologies centered on ecological civilization construction; promoting widespread application of habitat control and information traceability technologies to ensure agricultural product quality and safety; advancing seed source technology and smart agriculture to enhance core capabilities; and integrating e-commerce and logistics technologies to optimize production-marketing systems.

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Urban modern agriculture has become an integral component of metropolitan socio-economic systems. On one hand, urbanization comprehensively influences the development of urban agriculture; on the other, urban agriculture is fully integrated into urban life. However, the concept of urban agriculture has long suffered from unclear boundaries and ambiguous characteristics, which has somewhat hindered its scientific and rational development. For such a historically vague concept, we should first understand it as agriculture in urban areas, then analyze it across four dimensions—development space, social function, production structure, and farming models—to obtain a systematic and clear development framework.

## Urban Modern Agriculture as the Product of Urbanization' s Profound Impact

**Pre-Urbanization Era: Widespread Subsistence Agriculture Within Cities** In ancient times, subsistence agriculture was common within cities—to the extent that urban residents were essentially part-time farmers. Fernand Braudel, a representative of the French Annales School, wrote in his seminal work *Civilization and Capitalism, 15th-18th Century*: "In the Middle Ages, the cities of Ulm, Augsburg, or Nuremberg resounded with the sound of flails; pigs were raised freely in the streets, which became muddy and filthy, forcing pedestrians to cross on stilts or planks laid from one side to the other" [1]. During China' s Song Dynasty, rice fields were distributed within Luoyang City, while Huangzhou City even featured "rice cultivation beside official streets" [2]. Vegetables were the most widely grown crops in ancient cities. During the Han Dynasty, "the Imperial Gardens grew winter onions, leeks, and vegetables under covered walkways with fires burning day and night to provide warmth"[3]. In the Northern Song period, "generally near the capital (Kaifeng), all land consisted of gardens and vegetable plots, with no idle land within a hundred miles" [4], a prosperity reflected in Zhang Zeduan' s famous painting *Along the River During*

*the Qingming Festival.*

In the early 1930s, economist Feng Rui observed: "In a broad sense, every Chinese is a farmer, because even in a busy metropolis like Guangzhou with a population of 900,000, chickens are raised everywhere" [5].

### 1.3.1 Urbanization' s Rapid Advancement Transforming Agricultural Demand Quantity and Structure

(1) Rural populations becoming urban residents increased the number of people needing to obtain food from markets, directly raising agricultural marketization levels; (2) Population transfer driven by rising income levels elevated overall societal income, thereby increasing agricultural consumption and upgrading consumption structures; (3) Inter-regional population migration altered the regional structure of agricultural supply and demand, increasing the difficulty of market balance; (4) Expanding city scales continuously reduced suburban farmland, making food supply security for urban residents more challenging. For urban agriculture in large city suburbs, these changes also created opportunities for developing non-storable, high-quality agricultural products [6].

### 1.3.2 Urbanization's Demand for Traditional Agricultural Production Factors Raising Urban Agricultural Production Costs

As centers of population and industry aggregation, cities compete with agriculture for traditional production factors—land and labor. Regarding land, as cities expand, land demand increases and non-agricultural returns on land continuously rise. However, after substantial land conversion to non-agricultural uses, non-agricultural returns begin to decline (due to falling real estate prices reducing land marginal productivity), while agricultural land returns gradually increase (rising agricultural prices increase farmland marginal productivity). Eventually, when non-agricultural and agricultural land returns converge (Point B in [Figure 1: see original paper]), farmland ceases further conversion. Labor remuneration follows a similar trend. During rapid urbanization, both land and labor in large city suburbs face increasing non-agricultural returns, continuously raising urban agricultural production and operation costs.

### 1.3.3 Urbanization' s Advanced Production Factors Providing Conditions for Urban Agricultural Modernization

The development of urban non-agricultural industries has generated abundant capital, technology, and management resources. As these advanced production factors accumulate, intensified market competition drives down their returns in non-agricultural sectors, creating opportunities for agriculture to attract these elements—presenting favorable conditions for agricultural modernization. Urban agriculture in large city suburbs enjoys locational advantages in accessing these advanced factors, making such opportunities more readily available.

The evolution of agricultural modernization is illustrated in [Figure 2: see original paper]: In the early urbanization stage (Point A), scarce capital yields far higher non-agricultural returns than agricultural returns, resulting in limited agricultural investment. As industrialization and urbanization advance, urban capital rapidly accumulates and returns decline. When non-agricultural returns fall below agricultural returns (Point B), capital begins flowing into agriculture, accelerating modernization. However, limited by agricultural product market size, agricultural development easily becomes saturated. When capital inflow reaches a certain point (Point C), agricultural returns drop sharply, eventually converging with non-agricultural returns (Point D), after which total agricultural investment stabilizes and modernization is essentially complete.

## Four-Dimensional Characteristics of Urban Modern Agriculture

### Development Space: Urban and Extended Areas

Determining the regional scope of urban modern agriculture should be based on three criteria: (1) The area' s agriculture primarily serves the needs of a specific central city; (2) The area' s agricultural production factors (including capital, technology, and talent) mainly originate from the specific central city; (3) The area has formed or needs to form an agricultural production structure closely related to and distinct from that central city [7].

### Market and Production Factors Driving Structure Toward Urban Demand-Oriented and Capital-Intensive Optimization

Agricultural production is heavily influenced by natural resource conditions. Production arrangements based on natural conditions entail relatively low costs, while artificially constructed production environments (facility agriculture) inevitably increase costs. Due to limited farmland in urban and extended areas, even when following natural conditions, production costs remain constrained by scale and cannot compete with rural agriculture. Therefore, urban agriculture selectively produces market-demanded products, while rural agriculture prioritizes products suited to natural resource conditions.

In terms of resource consumption types, urban modern agriculture should focus on developing capital-intensive products, while rural agriculture should prioritize land-intensive products. Based on whether increased capital investment can effectively raise per-unit land area yields, agriculture can be divided into capital-intensive and land-intensive types. If capital investment increases yield (Q) or improves product quality, it constitutes capital-intensive agriculture ([Figure 3: see original paper]). If capital investment cannot increase per-unit yields, requiring land area expansion for higher total output, it is land-intensive agriculture ([Figure 4: see original paper]).

From the perspective of resource type consumption, higher organic composition represents more advanced technology, which can be termed technology-intensive production methods ([Figure 5: see original paper]). Conversely, lower organic

composition, relying more on labor, represents labor-intensive production methods ([Figure 6: see original paper]). Typically, labor costs are high while material capital costs are relatively low in urban and surrounding areas, leading urban modern agriculture to adopt technology-intensive methods (Point A in [Figure 5: see original paper] as equilibrium), while rural agriculture tends toward labor-intensive methods (Point B in [Figure 6: see original paper] as equilibrium).

**Resource and Environmental Constraints Driving Farming Models Toward Environmentally Friendly and Technology-Intensive Optimization**

Urban ecosystems are fragile due to non-agricultural industry and population concentration. While crop cultivation possesses ecological maintenance functions similar to green spaces or wetlands, agriculture does not inherently provide ecological benefits—inappropriate farming methods may cause environmental pollution. However, as an industry utilizing the growth and development patterns of animals and plants through artificial cultivation, agriculture retains ecological maintenance potential. Realizing this function in urban modern agriculture is difficult through market mechanisms alone and requires government intervention, regulation, and guidance.

**Strategic Value of China' s Urban Modern Agriculture**

Although urban modern agriculture accounts for only a negligible share of urban economies and a small proportion of overall agriculture, this does not diminish its pivotal importance. Compared with urban secondary and tertiary industries, agriculture is a vital industry; compared with rural agriculture, urban agriculture is closer to modern advanced factors.

**Serving Urban Residents' Needs**

As an important component of urban socio-economic systems, urban modern agriculture primarily serves urban needs, including production supply security, ecological environment maintenance, and quality of life improvement [8].

(1) **Production Supply Security**: This includes sharing responsibility for food security, stabilizing the "vegetable basket" product market, and ensuring agricultural product quality and safety. Grain production requires minimal labor, while large city suburbs lack labor resources, making grain production stability essential. "Vegetable basket" products must be continuously produced and consumed for urban residents' livelihoods. Whether production's temporal and spatial structures match consumption patterns affects market and social stability. In the context of large markets and circulation, agricultural product price fluctuations are transmissible and easily amplified. Enhancing local production capacity helps stabilize local markets and, by extension, national markets. Highly socialized division of labor and marketization create severe information asymmetry across

supply chain segments, posing high safety risks for agricultural quality. Effectively preventing quality safety incidents and incentivizing producers to enhance safety levels are crucial supply security components. Urban modern agriculture plays key regulatory and safeguarding roles in stabilizing "vegetable basket" markets and ensuring quality safety.

(2) **Ecological Environment Maintenance**: Environmental issues represent major social challenges brought by industrialization and urbanization. Due to high population and industry concentration, urban ecosystems are extremely vulnerable. Agriculture possesses potential ecological maintenance functions, and urban modern agriculture, located at the urban forefront, provides far greater environmental benefits than rural agriculture. Positive ecological functions include crop purification and carbon sequestration, as well as agricultural participation in urban waste cycling. Environmental maintenance functions largely cannot rely on market mechanisms and require policy regulation, guidance, and support.

(3) **Quality of Life Improvement**: Urban residents' daily work and lives are increasingly distant from natural environments. Urban modern agriculture can provide more opportunities for nature contact, enriching daily life. Rising income levels and monotonous urban living create demand for leisure and sightseeing agriculture. Developing urban agriculture to enrich residents' spiritual and cultural lives requires transcending traditional product concepts and fully exploring how agricultural production processes can provide spiritual pleasure and stress relief.

**Increasing Suburban Farmers' Income**

Although agriculture generally represents a low share of large city economies, and urban residents have increasingly diverse non-agricultural income sources, urban modern agriculture development remains crucial for safeguarding suburban farmers' interests. On one hand, farmers require considerable time to adapt and fully integrate into urban work and life, and market economies inevitably experience cyclical fluctuations, making long-term stable urban employment difficult. On the other hand, as urban industrial structures upgrade, non-agricultural industries' employment absorption capacity will relatively decline, meaning urban agriculture will continue playing an important role in increasing suburban farmers' incomes for a considerable period. Specific channels include: guiding farmer cooperation to stabilize agricultural income; supporting family farms to increase agricultural income; and introducing social capital to increase wage income.

**Driving Rural Agricultural Development**

With more convenient access to capital and advanced technology, urban modern agriculture achieves higher modernization levels than rural agriculture. As an important component of urban socio-economic structures, its organizational modernization also exceeds that of rural agriculture. From these fundamental modernization elements, urban modern agriculture leads the nation, fulfilling

important demonstration, radiation, and driving functions for rural agriculture —aligning with the evolutionary law of agricultural modernization development. The driving effects manifest in: aggregating advanced factors to serve as modern agricultural demonstration models; deeply cultivating urban markets to create industrialization driving forces; and pioneering urban-rural integration to assume rural reform vanguard roles.

**Technology Support for Urban Modern Agriculture Development**

Based on the strategic value of urban modern agriculture and important trends in agricultural technology development, efforts should focus on four key aspects:

(1) **Promoting Major Breakthroughs in Resource-Saving and Clean Production Technologies Centered on Ecological Civilization Construction**: Ecological civilization construction represents a major national strategy proposed in response to severe resource and environmental challenges in the new era. Agriculture' s special characteristics determine its particularly important role in ecological civilization construction. Although resource-saving and clean production technologies in agriculture are already abundant, high costs remain the primary bottleneck constraining their application. Without major cost breakthroughs, ecological civilization construction cannot be effectively advanced.

(2) **Promoting Widespread Application of Habitat Control and Information Traceability Technologies for Agricultural Product Quality and Safety**: Agricultural product quality and safety are major livelihood issues, particularly prominent in urban supply systems. For vast and complex urban supply systems, effectively ensuring quality and safety is a massive undertaking, but source safety and process transparency are the two key pillars. While habitat control and information traceability technologies are relatively mature, the critical challenge lies in achieving widespread adoption across large, complex supply systems.

(3) **Promoting Vigorous Development of Seed Source Technology and Smart Agriculture Technology Centered on Core Capability Enhancement**: Seed source technology and smart agriculture technology fundamentally enhance agricultural core capabilities. However, they require substantial R&D investment and face greater intellectual property protection challenges, often receiving insufficient attention in regionally focused urban agriculture. Yet urban agriculture, possessing capital and technological advantages, should assume this responsibility, combining with urban advantageous industries to invest heavily in seed source and smart agriculture technologies to avoid production system parasitism.

(4) **Promoting System Integration of E-Commerce and Logistics Technologies for Production-Marketing System Optimization**: Agricultural products' perishability and complexity make their production-marketing systems far more complicated than general industrial products,

which is why distribution costs account for a much higher price proportion than in industrial products. System optimization can substantially reduce distribution costs and agricultural prices, depending on e-commerce and logistics system applications. While e-commerce and logistics systems are already mature, their integration with agriculture requires system customization based on different agricultural products' supply-demand characteristics.

Rapid urbanization has swiftly expanded China' s city sizes and increased the number of large cities. In 2011, China' s mainland urban population reached 690 million, surpassing the rural population for the first time, with eight cities exceeding five million people and 88 cities between one and five million [9]. By 2025, over 66% of China's population is projected to live in cities, with 221 cities exceeding one million people, 23 cities exceeding five million, and megacities like Beijing and Shanghai surpassing ten million [10].

On April 26–27, 2012, the Ministry of Agriculture convened the National Urban Modern Agriculture Field Exchange Meeting in Shanghai—the first such meeting focused specifically on urban modern agriculture for large and medium-sized cities. On April 27–28, 2016, the Third National Urban Modern Agriculture Field Exchange Meeting was held in Beijing, with Wang Yang, member of the Political Bureau of the CPC Central Committee and Vice Premier of the State Council, emphasizing the strategic importance of accelerating urban modern agriculture development in the new era. Urban modern agriculture is transitioning from theory to practice and will play an extremely important role in China' s urbanization and agricultural modernization. Effectively addressing development challenges while leveraging large cities' special locational advantages and opportunities to serve urban residents, protect farmers' interests, and pioneer agricultural supply-side reform and modernization represents a crucial strategic task for the next 10–20 years.

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The ratio of material capital input to human capital input

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