

# A Case Study on the Development and Application of Low-altitude Economy in Agriculture in China: Based on Demand-Supply-Environment Perspective

Jingye Yang\*

International College Beijing, China Agriculture University, Beijing, China

\*Corresponding author: jingeyang520@gmail.com

**Abstract:** With the development of science and technology, China's low-altitude economy has been increasingly widely used in agriculture and has become an important force in promoting the modernization of agriculture. Based on the theory of innovation economics, this paper puts forward the three dimensions of demand, supply, environment, and selects specific typical cases such as XAG and SINO-AGRI Leading Biosciences Co., Ltd. to research the development of China's low-altitude economy in the field of agriculture. The study concludes that the demand side of China's low-altitude agricultural economy, farmers and farms, are increasingly in need of facilities, technology, talents, and environment. In such a context, the supply-side technology enterprises provide elemental resources such as technology, facilities, talents, and programs for industrial development, while the environment side provides policies and regulations, relevant mechanisms, and sustainable development conditions. These three dimensions work together to create great potential for the development of low-altitude agricultural economy in China. Based on the current situation of the development of low-altitude agricultural economy in China, this paper proposes strategies such as strengthening the construction of the supply side and the environment side in order to meet the development needs of low-altitude agricultural economy and to promote the sustainable development of new quality productive forces.

**Keywords:** Low altitude economy; Low altitude agricultural economy; Agriculture; Plant protection UAVs

## 1. Introduction

Low-altitude economy is a comprehensive economy that takes many kinds of unmanned and manned vehicles as the main body, carries out low-altitude flight activities in the range of less than 1,000 meters in true altitude and up to 3,000 meters according to specific conditions, and drives the development of upstream and downstream related industries. This concept was first put forward in 2010 in China, which is an emerging economic concept based on the further derivation of the traditional general aviation economy, highlighting the innovation of technology, application, mode, and other aspects. It is also a typical representative of the new quality productive forces. Low-altitude economy has significant three-dimensionality, with low-altitude airspace as the main place of activity, but inseparable from the ground industry, which is a typical three-dimensional economy with the close air-ground connection<sup>[1]</sup>. Low-altitude economy covers a wide range of primary, secondary, and tertiary industries, mainly consisting of four aspects: low-altitude flight, low-altitude security, low-altitude manufacturing, and comprehensive services. The "low-altitude economy +" model is the application of low-altitude economy in different scenarios. Low-altitude agricultural economy, also known as "low-altitude economy + agriculture", is the application of low-altitude economy for plant protection UAVs in agricultural field.

In developed countries, such as the United States, low-altitude operations led by UAVs have long been more mature applications in the agricultural field, but the concept of "low-altitude economy" has not been directly put forward. The term "low-altitude agricultural economy" currently exists only in China. In terms of the actual meaning of low-altitude agricultural economy, compared with developed countries, China's development in this field started later, but in the field of technology has been at the forefront of the world, which creates the possibility of further exploring the application of the "low-altitude economy + agriculture" model. Low-altitude agricultural economy takes various kinds of agricultural UAVs activities as the major activities. In recent years, China has retained a large amount of agricultural UAVs. UAVs are currently categorized in a variety of ways. For examples, based on aerodynamic characteristics, it can be divided into fixed-wing, rotary-wing, and composite-wing. Based

on the degree of autonomy, it can be divided into autonomous control, semi-autonomous control, and command control. Besides, it can also be divided based on the types of power supply or based on the sizes and quality<sup>[2]</sup>. In recent years, the application of domestic agricultural UAVs mostly adopts advanced technologies such as one-key takeoff, RTK positioning, three-dimensional route planning, ground-like flight, variable spraying, and autonomous obstacle avoidance, which are characterized by automation and intelligence. Agricultural UAV technology has a wide range of applications, among which the most common applications are the precise monitoring and the spraying<sup>[3]</sup>. In terms of policy, a series of relevant documents released by the state in recent years have also provided strong supports for the development of low-altitude agricultural economy. In 2022, The Chinese Ministry of Agriculture and other departments released the *14th Five-Year Plan for the development of the national pesticide industry*, which explicitly focused on the promotion of plant protection UAVs and other highly efficient drug application equipment. Encouraged by the national policy, social capital has rushed into the field of low-altitude agricultural economy. For instances, the high-tech enterprises led by DJI and XAG, and the agricultural companies led by SINO-AGRI have started the construction of low-altitude agricultural projects one after another.

In 1987, Freeman applied innovation economics to study the impact of technological innovation on economic activities<sup>[4]</sup>. As an emerging economy, the development of low-altitude agricultural economy is also inseparable from the innovation of low-altitude agricultural technology, and technological innovation is affected by the comprehensive impact of demand, supply, and environment. Based on the perspective of innovation economics, this paper will analyze the application cases of "low-altitude economy + agriculture" in China from three dimensions of demand, supply, and environment, sort out the current development status of China's low-altitude agricultural economy, look forward to the development prospect of low-altitude agricultural economy, and put forward feasible suggestions for the combination of low-altitude economy and agriculture.

## 2. Literature review

As an emerging concept proposed for the first time in China, the directly related research on low-altitude agricultural economy mainly focuses on summarizing and discussing the concept of itself and the exploration of its combination mode with agriculture. Qin Rui et al. (2011) early summarized the concept of low-altitude economy and proposed that its industrial composition and industrial activities form can be associated with agriculture and forestry<sup>[5]</sup>. In the field of technology development and application of agricultural UAVs, the main carrier of low-altitude agricultural economy, international scholars have carried out many researches and achieved remarkable results. Messina et al. (2020) studied in depth the application of thermal imaging of UAVs in precision agriculture, elaborated on the role of remote sensing technology and the operation mechanism in low-altitude farming, and made an outlook on the future of this field<sup>[6]</sup>. Bouguettaya et al. (2022) discussed the classification of UAV agricultural remote sensing image data by deep learning methods, which provides a reference for practical agricultural activities<sup>[7]</sup>. Shahi et al. (2023) reviewed and sorted out the recent advances in the integration of deep learning methods with UAV farming, examining the benefits of the technology in pest control<sup>[8]</sup>. In addition, McEnroe et al. (2022) focused on artificial intelligence in their study and discussed the integration of UAVs with the Internet of Things in precision agriculture.<sup>[9]</sup> Boursianis et al. (2022) reviewed the research on the application of UAV technology combined with IoT in agriculture and noted that these two emerging hot technologies will play an important role in facilitating the transformation of traditional agriculture<sup>[10]</sup>.

By collating research in related fields, we find that there are various ways of applying the low-altitude economy in the agricultural field. Nowadays, there is a variety of supporting mechanisms and related technologies in the world that can be used to assist the work of plant protection UAVs, including but not limited to remote sensing thermal imaging, deep learning method, Internet of Things, artificial intelligence, which opens up space for the development of low-altitude agricultural economy. As a new type of economy with great potential, the development path of low-altitude agricultural economy still deserves further exploration. In this study, we will deeply analyze some specific cases in the current low-altitude agricultural economy in China, hoping to provide new ideas and insights for researchers in this field, as well as to provide strong support for practical applications.

### 3. Analysis of the Development and Application of Low-altitude Agricultural Economy Based on the Theory of Innovation Economics: the Demand-Supply-Environment Dimension

The innovation economics studies technological innovation and its impact on economic development, focusing on the sources and processes of technological innovation and its economic benefits (Freeman, 1987)<sup>[4]</sup>. Technological innovation is the main driver of economic growth, while supply, demand, and environment together influence technological innovation (Dosi et al., 1988)<sup>[11]</sup>. First, innovation economics emphasizes the driving role of technological innovation and knowledge accumulation on economic growth (Schumpeter, 1934)<sup>[12]</sup>. Technological innovation is supplied and driven by the R&D activities of firms and research institutions. Secondly, technological innovation is not only supply-driven but also strongly influenced by market demand (Freeman, 1987)<sup>[4]</sup>. Market demand has also been proposed as an important driver of technological innovation in demand-pull innovation theory (Mowery & Rosenberg, 1979)<sup>[13]</sup>. Finally, institutional economics emphasizes the supportive and constraining role of institutional and policy environments on technological innovation (North, 1990)<sup>[14]</sup>. A favorable institutional and policy environment promotes innovative activities, which is an important concern of innovation economics (Malerba, 2002)<sup>[15]</sup>. Therefore, this paper analyzes the main actors of low-altitude agricultural economy, represented by the government, UAV enterprises, agricultural enterprises, universities and research institutes. We also constructs a three-dimensional analysis framework of "demand-supply-environment" from the perspective of innovation economics to develop the development and application of low-altitude economy in the field of agriculture in China. economy in the field of agriculture in China.

#### 3.1. The Case of UAV Companies

At present, China's low-altitude agricultural economic activities are dominated by the application of plant protection UAVs. The supply-side of low-altitude agriculture economy is mainly composed of UAV enterprises, among which, DJI and XAG are the two leading enterprises with the most competitive market. In this paper, XAG, which has the most agricultural cooperation projects and the most typical model, will be selected as the main object of analysis. XAG is a high-performance technology enterprise with the mission of promoting smart agriculture founded in 2007. It combines low-altitude economy and agricultural production, devoting itself to the research and development of UAVs and other high-tech.

XAG has created six major product lines, including agricultural UAVs, remote sensing UAVs, agricultural self-driving instruments, agricultural unmanned vehicles, intelligent agricultural systems, and agricultural Internet of Things. It has launched various products, including the agricultural UAVs led by the P series of, and the M series of surveying and mapping UAVs. At the same time, it has constructed centimeter-accurate PTK navigation networks, realizing the application of low-altitude economy in a wide range of agricultural activities such as cultivation, planting, management, harvesting, as well as ground surveying and mapping.

XAG has established low-altitude agricultural cooperation projects with various parties. In 2021, China's first unmanned cotton farm project, XAG "Super Cotton Field", was launched in Yuli County, Xinjiang. XAG provides technical support for the construction of the "Super Cotton Field" project in Xinjiang, utilizing field inspection UAVs and AI analytics to achieve more accurate monitoring of growth, disaster prediction, pesticide spraying, and identification of diseases. The practice of low-altitude agriculture has significantly reduced the amount of chemical fertilizer application, irrigation water usage, and labor cost inputs in the process of cotton planting, improved the yield and quality of cotton, liberated the potential productivity of local farmers, and provided samples for large cotton growers in Xinjiang to learn from. In addition, XAG also cooperates with farms in Shenyang, Jiangsu, and other local farms.

In terms of personnel management, XAG adopts a combination of offline and online modes, with offline field training for staff on agricultural UAV operation specifications, and online dissemination of technical knowledge related to low-altitude agricultural economy through short-video platforms such as Douyin and Kuaishou. In addition, XAG has also created the "XAG Academy", which is dedicated to cultivating outstanding talents in this field.

#### 3.2. The Case of Agribusiness

As an important part of the low-altitude agricultural economy, agriculture-related enterprises also involves in the supply side, building a bridge between technology and practical applications. In this paper, we have selected SINO-AGRI as an example, which is one of the leading agriculture-related enterprises

in China and has the most comprehensive application of low-altitude economy in agriculture. SINO-AGRI is a leading pesticide distribution enterprise in China with a wide sales network and strong influence, committed to combining plant protection technology services and information technology to build an information-based modern agricultural service platform. SINO-AGRI has established a professional service team and an integrated service network. Through its subsidiaries, SINO-AGRI carries out the operation of plant protection machinery, constructing a dual main business consisting of plant protection service and plant protection machinery, which realizes a stable growth in turnover.

In the field of low-altitude economy, SINO-AGRI has formed a comprehensive plant protection product system of "ground and air", which includes two modes of "self-production + cooperation" and "leasing + service". The "self-production + cooperation" mode refers to the fact that SINO-AGRI entered the plant protection UAV market in 2017 by launching the "Little Wasp" series of plant protection UAVs through its holding subsidiary Sprayer China, realizing the "self-production" mode. Then it cooperates with high-tech UAV enterprises led by XAG to introduce other brands of agricultural UAVs to realize "cooperation" mode. The "Lease + Service" model is that SINO-AGRI provides UAV leasing services by cooperating with other UAV companies, which provides farmers with professional technology, reduces their initial investment costs, and improves the efficiency of agricultural production.

In 2019, SINO-AGRI carried out the project of "Emergency Prevention and Control of Grass Moth" in Hengxian County, Guangxi province. Hengxian County in Guangxi is an important production area of sweet corn, which is known as the "Hometown of Sweet Corn". In order to deal with the impacts of the grass moth on the sweet corn harvest, China LINONG launched a prevention and control program centered on protecting crops and protecting bracts, distributed relevant medicines, held training meetings, and used UAVs to carry out flight prevention activities, which successfully dispersed the grass moths.

In 2023, the project "Pillar of Prosperity, Abundant Harvest" was carried out in Huaxian County, Henan Province. In cooperation with XAG, through the mode of "pesticide product supply + technical service + aerial spraying service", SINO-AGRI realized large-scale and efficient aerial spraying, effectively dealt with the high incidence of diseases and pests during the period of maize tasseling, and improved the efficiency of farming and maize yield.

### ***3.3. Needs analysis of low-altitude agriculture economy: based on multiple cases***

The demand element provides the internal drive for innovative economic activities. The subjects on the demand side of the low-altitude agricultural economy include large-scale or specialized farms, agricultural demonstration parks, integrated parks, agricultural cooperatives, and so on. For these subjects, the demands for the development of low-altitude agricultural economy cover several aspects, such as the demands for facilities, equipment, technology, human resources, programs, policies, and sustainable development.

In order to meet the development needs, the demand-side main bodies led by specialized farms and supply-side enterprises have carried out a series of cooperation, introducing the advanced technology, equipment, and system from supply-side enterprises to improve the productivity and to promote the sustainable development of low-altitude agriculture. Some farms in Hengxian County of Guangxi and Huaxian County of Henan Province have successively established partnerships with SINO-AGRI, successively launching two low-altitude agricultural economic projects, namely "Emergency Prevention and Control of Grass Moths" and "Pillar of Prosperity, Abundant Harvest". In Xinjiang, local farmers joined hands with XAG to introduce plant protection UAV technology and build unmanned "super cotton fields". These cases provide models for the application of low-altitude economy in farmers' farms.

### ***3.4. Supply analysis of low-altitude agricultural economy: based on multiple cases***

Supply elements provide feasibility for innovative economic activities. Supply-side enterprises provide the necessary infrastructure, technical support, high-performance aircraft, personnel training, and customized strategy to carry out low-altitude agricultural construction, making the vertical development of the low-altitude agricultural economy practical and feasible.

The supply of infrastructure and technology for low-altitude agriculture is mainly reflected in three aspects: the construction of an operational network, a navigation network for the positioning of UAVs, and geographic information technology for processing operational data. In terms of infrastructure, XAG has developed the I-series agricultural Internet of Things and built a high-precision RTK cloud network based on the BeiDou system, laying the cornerstone of navigation and positioning for agricultural UAV

operations. Many supply-side enterprises have also combined remote sensing technology with deep-learning mapping methods to equip agricultural UAVs with the ability to collect geographic information in low-altitude farming operations. On the supply side of the equipment, XAG has launched the P series of agricultural UAVs and the M series of mapping UAVs, which can be used for a variety of tasks such as irrigation, medicine applications, and monitoring. Agricultural enterprises, led by Zhonghua Linong, have launched the "Little Wasp" series of plant protection UAVs to enrich the supply of plant protection equipment. In terms of personnel training, XAG has created the "XAG Academy", which combines online and offline lectures to strengthen the professionalism of agricultural authors. In addition, a suitable operation program can guarantee the normal operation of low-altitude agriculture. XAG has formed a set of intelligent agricultural ecosystems with plowing, planting, management, and harvesting as the main links, while SINO-AGRI has adopted two modes, namely, "self-production+cooperation" and "leasing+service", forming the "self-manufacturing" and "leasing+service" system, a comprehensive plant protection system of "both ground and air".

### 3.5. Environment analysis of low-altitude agricultural economy: based on multiple cases

Environment elements provide internal and external conditions for innovative economic activities. As an important part of the new productive forces development, the development of the low-altitude agricultural economy must be supported by a sound environment, including the environment of policy systems, the environment of guarantee mechanisms, and the environment of sustainable development (Table 1).

A sound policy and institutional environment can encourage the development of the low-altitude agricultural economy, regulate its operation, and improve the economic system. With regard to the low-altitude agricultural economy, the Government has issued a series of strategic and guiding policy documents, mobilizing the enthusiasm of builders in the relevant fields. For example, in the *14th Five-Year Plan for the Development of the National Pesticide Industry*, the government clearly highlighted the importance of the promotion of plant protection UAVs and the gradual phasing out of old application equipment. Similarly, a loose and reasonable management policy is an important prerequisite for the development of low-altitude agricultural economy. Simplifying the flight approval process for agricultural UAVs, relaxing the requirements for agricultural UAV maneuvering permits, and lowering the threshold of access to low-altitude agriculture can greatly improve operational efficiency and save time and labor costs. In 2023, Chinese State Council promulgated the *Interim Regulations on the Administration of Flight of Unmanned Aerial Vehicles (UAVs)*, which explicitly put forward the idea that it is not necessary to obtain an operating certificate to engage in routine agricultural UAV operational flight activities in airspace suitable for flight. In the *Interim Regulations on the Administration of Unmanned Aircraft Flight*, the government also established specific low-altitude agricultural flight areas, defining agricultural UAV as piloted aircraft with a maximum flight true height of no more than 30 meters, effectively avoiding conflicts with other airspace activities. Secondly, the successive introduction of laws and regulations has played an important role in improving the low-altitude agricultural economic system. *The Regulations on the Administration of Civil UAV Pilots (2018 Revision)* stipulated that operators of plant protection UAVs should hold a pilot's license with a V classification level or pass the operational training test stipulated by the relevant departments, which guaranteed the professionalism of the operators. In addition, in 2022, the central government successively promulgated the *Quality of Plant Protection UAV Operations* and the *Operational Procedures for the Control of Wheat Pests and Diseases by Plant Protection UAVs*, which stipulated the industry standards for the main activities in the low-altitude agricultural economy, strengthened the normative nature of the operations of plant protection UAVs, and pushed forward the standardization of the low-altitude agricultural economy operation.

Table 1: A compendium of China's low-altitude agricultural economic policies

timing	policy	content
2013	Opinions of the Ministry of Agriculture on Accelerating the Construction of Modern Plant Protection System	Encourages the development of UAVs, helicopters, and fixed-wing airplanes for pest control in areas where they are available.
2015	Regulations on the Operation of Small and Light UAVs (Trial)	Specific requirements for the operation of plant protection UAVs are described.
2015	Circular of the Ministry of Agriculture on the Issuance of the Action Plan for Zero Growth in Fertilizer Use by 2020 and the Action Plan for Zero Growth in Pesticide Use by 2020	Proposes the promotion of new and efficient plant protection machinery, such as UAVs, to reduce the use of chemical fertilizers.
2016	Civil UAV Pilot Regulations (Revised 2016)	Classifies plant protection UAVs as Class V UAVs.
2016	Circular of the Ministry of Industry and Information Technology, the Ministry of	Proposes the development and production of navigation devices for agricultural UAVs.

	Agriculture and the Development and Reform Commission on the Issuance of <i>the Action Program for the Development of Agricultural Machinery and Equipment (2016-2025)</i>	
2017	Guiding Opinions of the Ministry of Industry and Information Technology on Promoting and Regulating the Development of Civilian UAV Manufacturing Industry	Proposes to promote the innovative application of civil UAVs in agriculture, forestry, plant protection and other industry sectors.
2018	Civil UAV Pilot Regulations (Revised 2018)	Stipulates that plant protection UAV pilots should hold a Class V pilot's license or pass the training examination prescribed by the relevant departments. Clarified the detailed requirements for the Class V license.
2019	Circular of the Ministry of Agriculture and Rural Affairs and the Office of the Central Committee for Cybersecurity and Informatization on the issuance of <i>the Digital Agriculture and Rural Development Plan (2019-2025)</i>	Proposes to strengthen technological research and development of unmanned aircraft, focusing on overcoming key technologies and acquiring advanced unmanned aircraft platforms.
2019	Regulations on the Management of Flight Dynamic Data of Small and Light Civilian UAVs	Requires plant protection UAVs to report flight dynamics data in real time.
2021	2021 National Action Program on "Insects for Food" to ensure a good harvest	Proposes the use of UAVs as application machinery in operational programs.
2022	Quality of plant protection UAV operations	Provides for industry standards for the quality of plant protection UAV operations.
2022	Plant protection unmanned aerial vehicle (UAV) operation protocol for wheat pest control	Provides for industry standards for the operation of plant protection unmanned aircraft for the control of wheat pests and diseases.
2022	Circular of the Ministry of Agriculture and Rural Affairs on the Issuance of <i>the Action Plan for the Reduction of Chemical Fertilizers by 2025 and the Action Plan for the Reduction of Chemical Pesticides by 2025</i>	Proposes the promotion of fertilizer spraying UAVs to reduce fertilizer loss and waste.
2022	National Pesticide Industry Development Plan for the 14th Five-Year Plan	Proposes to focus on the promotion of plant protection UAVs, phasing out of backpack manual sprayers and stretcher spray guns.
2022	Technical Regulations for Safe Application by Plant Protection Unmanned Aerial Vehicles	Provides industry standards for safe application techniques by plant protection unmanned aircraft.
2023	Guidance Catalog for Industrial Structure Adjustment (current year 2024)	Agricultural UAVs (with a load of 20kg or more) and other cultivation and field management machinery are included in the incentive catalog.
2023	Ministry of Agriculture and Rural Development issued seven technical guidance measures for the current fall grain production	Develops technical guidance on issues such as unregulated plant protection UAV application operations.
2023	Circular of the General Station of Agricultural Mechanization of the Ministry of Agriculture and Rural Development on the Issuance of <i>the Technical Guidance on Mechanized Disaster Reduction and Loss Reduction Production in the "Three Autumns" of 2023</i>	Proposes the timely adoption of plant protection UAVs to prevent crops from overwatering and pests breeding.
2023	Provisional Regulations on the Administration of Unmanned Aircraft Flights	Relevant regulations are made on the flight activities of UAVs engaged in agriculture, forestry, animal husbandry, and fishery operations.
2023	Circular of the General Office of the Ministry of Agriculture and Rural Development on the Cultivation of Highly Qualified Farmers in 2023	Proposes to strengthen the training of aerial spraying technicians and to promote the standardization and normalization of agricultural machinery operations.
2024	Guiding Opinions of the State Council on Accelerating Agricultural Mechanization and the Transformation and Upgrading of the Agricultural Machinery and Equipment Industry	Proposes to actively develop agricultural aviation and to regulate the application of plant protection UAVs.
2024	Circular of the General Station of Agricultural Mechanization of the Ministry of Agriculture and Rural Development on the Issuance of <i>Technical Guidelines for Overhauling Agricultural Machines for Spring Agricultural Production in 2024</i>	Emphasizes routine maintenance of plant protection unmanned aircraft.

By summarizing China's policies and regulations on low-altitude agricultural economy from 2013 to 2014, we found that the relevant policies and regulations were mainly published in the past three years. Generally speaking, as an emerging comprehensive economy in recent years, low-altitude agricultural economy has not yet established a sound legal and regulatory system. It still lacks sufficient targeted insurance and subsidy policies. However, in terms of the development in recent years, China has been

encouraging the application of low-altitude economy to agricultural production, creating a relaxed policy environment conducive to the development of low-altitude agricultural economy.

In addition to the construction of the policy environment, the construction of a suitable safeguard mechanism environment is likewise a great help to the development of low-altitude agricultural economy. Enterprises are one of the main bodies of low-altitude agricultural economic activities. Besides, the establishment of an excellent mode of operation and a good mechanism environment will also help enterprises to developing low-altitude agriculture economy. At present, domestic related enterprises mostly adopt the form of cooperating with universities, establishing the mechanism of collaborative innovation between industry, academia, and research, in order to create an internal environment conducive to the development of the enterprise. Taking XAG as an example, in 2016, XAG Agriculture and South China Agricultural University jointly signed an industry-university-research cooperation agreement to carry out researches on key technologies in the field of low-altitude agricultural economic applications. By 2018, XAG has reached cooperation intentions with several institutions, including South China Agricultural University. In the same year, DJI Agriculture also signed an agreement with China Agricultural University to build a joint laboratory for agricultural UAVs. The synergistic mechanism of joining hands with higher education institutions provides advanced technical supports for UAV enterprises, as well as a favorable mechanism environment for low-altitude agricultural economy.

What's more, the corresponding construction of sustainable development is also one of the environmental constructions that cannot be ignored in the economic development of low-altitude agriculture. Under the environment in China which advocates the all-around construction of sustainable development, the inclusion of low-altitude agriculture in regional agricultural sustainable development planning and the integrated consideration of factors such as land use, water resource protection, and ecological restoration can realize the coordinated development of agricultural production as well as ecological environmental protection. China has now established an ecological monitoring and assessment system in the field of agriculture, which can be used to assess the impact of low-altitude operations on the soil, water quality, vegetation, and biodiversity of arable land. The agricultural monitoring system helps to provide data reference for low-altitude agricultural operations, enabling low-altitude operations to readily adjust operational details such as water and fertilizer application according to the state of the arable land. It also safeguards the integrity of the ecological function of the arable land and promotes the green development of the low-altitude agricultural economy.

### 3.6. Summary of the analysis

Low-altitude agricultural economy is an emerging comprehensive type of economy that applies low-altitude economy to agriculture. As one of the new quality productive forces, the development of low-altitude agricultural economy has a promising future in China. From the perspective of innovation economics, the relationship between the three elements of demand, supply, and environment in the development of low-altitude agricultural economy is shown in Figure 1:

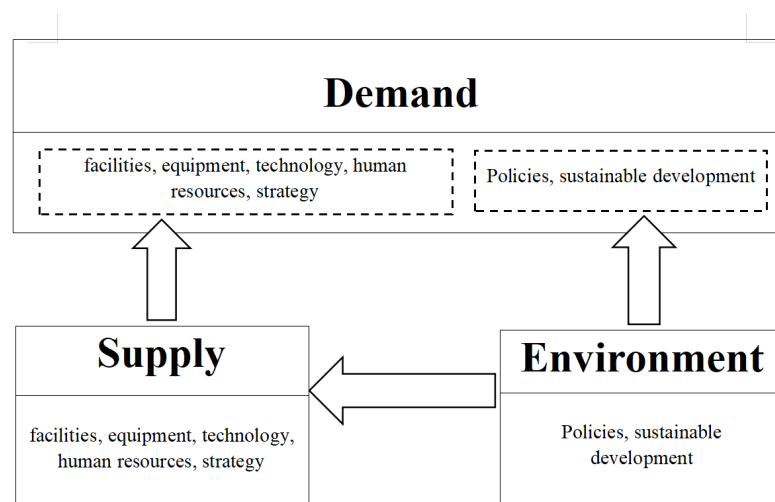


Figure 1: Relationship between demand, supply, and environment in the economic development of low-altitude agriculture

As seen in Figure 1, the supply side and the environment side together support the demand side. Farmers and farms constitute the main demand side of the low-altitude agricultural economy, while enterprises, universities, government, and other institutions satisfy each demand for economic development from the supply side and the environment side respectively. In addition, the environment side also affects the demand side. A relaxed environment can create a suitable external atmosphere for the supply of related enterprises. Nowadays, China has created a beneficial external environment for the development of low-altitude agricultural economy. At the same time, there are corresponding supply and demand at the social level, so the deepening of low-altitude agricultural economy is feasible.

#### 4. Conclusion

To date, the development needs of China's low-altitude agricultural economy have not yet been well met. The development of the field is not yet mature enough. The development of low-altitude agricultural economy cannot be separated from the support of facilities, technology, equipment, talents, programs, policies, and sustainable development. Firstly, in terms of technology and equipment demand, China's low-altitude vehicle research and development started late. Although China has made several remarkable achievements, there is still a certain gap with the developed countries. The current application of low-altitude farming in China is only dominated by UAVs, so it is necessary to increase investment in scientific research and increase the types of low altitude agricultural vehicles, in order to realize diversified low altitude farming functions. Secondly, in terms of mechanism and program demand, the connections between the demand side and scientific research institutions as well as the enterprises on the supply side are still not close enough. The mechanism of innovation and cooperation among industries, universities, and research institutes has not been widely promoted. Many farms also lack mature mechanisms to apply low-altitude economy to farming. Finally, in terms of policy demand, China has not yet established a complete system in the field of low-altitude agricultural economy. Many mechanisms are still to be developed. Rrelevant laws and regulations need to be further improved. Based on the development status and needs of low-altitude agricultural economy in China, this study puts forward some specific suggestions for future development. On the supply side, technology and agricultural enterprises can increase R&D investment, carry out more cooperative projects with universities and research institutions, and further strengthen technological innovation. On the environment side, the government can improve the policy and regulation system, refine the industry standards, introduce subsidy and insurance policies, optimize the industrial layout and synergistic development, as well as build a perfect low-altitude agricultural industry chain. In terms of mechanism construction, relevant organizations should establish and improve the supervision and evaluation system to ensure operational safety and effectiveness. Because low-altitude agriculture has a more mature application mode in developed countries, Chinese builders in this field can also promote international cooperation, strengthen international cooperation, expand the international market, and promote the globalization of low-altitude agriculture economy.

In conclusion, the development of low-altitude agricultural economy requires the joint efforts from all sectors of society. By improving the policy system, strengthening technological innovation, and promoting international cooperation, the healthy development of low-altitude agricultural economy can be further promoted, contributing to the realization of agricultural modernization and sustainable development.

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