

The Spatial Layout and Optimization Path of China's Cross-Border Agricultural Investment under the the Belt and Road Initiative

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ABSTRACT In the context of high-quality Belt and Road development and global food-security restructuring, cross-border agricultural investment has become an important means for China to secure agricultural supply and improve agricultural openness. This study analyzes the development trend, spatial distribution, driving mechanisms, and constraints of China's agricultural investment in Belt and Road countries. It identifies problems such as high regional concentration, unbalanced industrial-chain allocation, insufficient risk control, and weak localization integration. On this basis, a three-layer spatial optimization architecture consisting of core areas, key areas, and expansion areas is constructed. Optimization paths are proposed in terms of regional precision, industrial-chain collaboration, risk management, localized operation, facility connectivity, and policy support. The study provides decision-making references for improving the efficiency of global agricultural resource allocation and enhancing supply-chain resilience. From an engineering-planning perspective, the results highlight the role of logistics corridors, digital platforms, and communication infrastructure in supporting spatially distributed agricultural investment networks.

INDEX TERMS belt and road initiative, cross-border agricultural investment, spatial layout, supply chain resilience, communication infrastructure

I. INTRODUCTION

A. RESEARCH BACKGROUND AND SIGNIFICANCE

THE world is currently experiencing unprecedented changes, with multiple impacts on global food security, energy security, and industrial and supply chain stability. Unilateralism and protectionism are on the rise, geopolitical conflicts are intensifying, extreme weather is frequent, international agricultural markets are volatile, and traditional agricultural trade and investment patterns are facing profound adjustments. As the world's largest producer and consumer of agricultural products, China has long maintained a high level of external dependence on important agricultural products such as grain, oil, cotton, sugar, natural rubber, and oil crops. Coordinating domestic and international markets and resources, enhancing global agricultural resource allocation capabilities and supply chain resilience, has become a strategic necessity to ensure national food security and the supply of important agricultural products[1,2].

Since the "the Belt and Road" initiative was put forward more than a decade ago, it has built a broad platform for China's agriculture to "go global" and become the

main position and core carrier of cross-border agricultural investment in the new era, centering on policy communication, facility connectivity, unimpeded trade, financial integration, and people to people connectivity. Most of the countries along the route have abundant arable land resources, water and heat conditions, and labor resources, with enormous potential for agricultural development. They form a highly complementary relationship with China in terms of resource endowment, technological level, market demand, and industrial structure, providing a solid foundation for agricultural investment cooperation. Under the initiative, Chinese enterprises have rapidly increased their investment in agriculture in regions such as ASEAN, Central Asia, Russia, Central and Eastern Europe, Africa, and West Asia[3]. The investment areas have gradually extended from traditional planting and breeding to high value-added links such as agricultural material production, agricultural product processing, cold chain logistics, warehousing and customs clearance, smart agriculture, seed industry research and development, and brand marketing. A number of overseas agricultural cooperation demonstration zones, agricultural industrial parks, grain production bases, and cold chain

logistics hubs have successively landed, forming a spatial distribution pattern with multi-point support and prominent focus[4].

In this context, it is of great theoretical value and urgent practical significance to systematically carry out research on the spatial layout and optimization path of China's cross-border agricultural investment under the "the Belt and Road" initiative, scientifically grasp the characteristics of spatial distribution, evolution laws and driving mechanisms, solve the prominent contradictions of unbalanced layout, risk concentration and low efficiency, and build a new spatial pattern of global agricultural investment that is more balanced, efficient, resilient and sustainable[5,6].

1) Research significance

Provide scientific basis for government departments to formulate overseas agricultural investment strategic plans, regional guidance policies, risk prevention and control systems, and service guarantee mechanisms; Guide enterprises to optimize their investment location selection, allocate global resources reasonably, diversify geopolitical risks, and enhance investment efficiency; Promote the transformation of cross-border agricultural investment from scale expansion to quality and efficiency improvement, and facilitate the coordinated layout of the entire industry chain including planting, processing, logistics, warehousing, trade, and research and development; Deepen mutually beneficial agricultural cooperation with countries along the Belt and Road, achieve resource complementarity, capacity cooperation, market interconnection, and improvement of people's livelihoods, and help build a community with a shared future for mankind; Enhance China's voice and influence in the global agricultural governance and food security system, providing solid support for ensuring national food security and high-quality agricultural development[7].

B. CURRENT RESEARCH STATUS AT HOME AND ABROAD

1) Current Research Status Abroad

Foreign scholars have conducted extensive research on the location selection of foreign direct investment, cross-border investment in resource-based industries, global food security, and transnational agricultural investment, forming classic theoretical systems such as monopoly advantage theory, internalization theory, international production compromise theory, location theory, and resource-based theory. The study focuses on the investment motivations, location decisions, risk management, localized operations, and sustainable development of multinational agricultural enterprises, emphasizing the impact of resource endowment, institutional quality, infrastructure, trade openness, and geopolitical relationships on investment layout[8]. Some scholars have carried out empirical research on China's agricultural investment along the "the Belt and Road", focusing on the spatial distribution of investment, influencing factors and economic and social effects. However, targeted research on spatial

structure optimization, risk dispersion mechanism, overall industrial chain layout, classification and zoning guidance is insufficient, and is not closely integrated with China's food security strategy and industrial chain resilience goals[9].

2) Current Research Status in China

Domestic research focuses on the status quo, problems, countermeasures, investment models, risk prevention and control, and cooperation mechanisms of the "the Belt and Road" agriculture "going global". Most studies affirm the important role of cross-border agricultural investment in ensuring food security and enhancing agricultural competitiveness. They point out the current problems of concentrated layout, prominent risks, short industrial chain, insufficient localization, and weak support. Suggestions are put forward to strengthen planning guidance, improve policy support, enhance risk prevention and control, and promote the development of industrial parks[10].

3) Research Review

Overall, existing research has laid a solid foundation for this article, but a complete research system of "spatial pattern driving mechanism problem diagnosis hierarchical classification global optimization path implementation" has not yet been formed. In particular, there is a lack of systematic solutions for optimizing cross-border agricultural investment space that are oriented towards high-quality development in the new era, coordinate development and safety, and balance efficiency and risk. This article focuses on this research gap and conducts comprehensive, systematic, and in-depth research to fill the gaps in existing research.

C. RESEARCH CONTENT AND TECHNICAL ROUTE

1) Main research content

(1) The development history, overall scale, industry structure and main characteristics of China's cross-border agricultural investment under the the Belt and Road Initiative;

(2) The spatial distribution pattern, agglomeration characteristics, regional differences, and dynamic evolution laws of cross-border agricultural investment;

(3) The driving mechanism and constraints of spatial layout formation (resources, geography, institutions, facilities, policies, markets, etc.);

(4) The prominent problems, structural contradictions, hidden risks, and efficiency shortcomings in the current spatial layout;

(5) Overall ideas, basic principles, goal positioning, and three-layer spatial architecture (core area key area expansion area) for spatial optimization;

(6) A precise optimization path based on regions, industries, and entities;

(7) The policy system, risk prevention and control, service support, and multilateral cooperation mechanism to ensure the optimization and implementation of space.

2) Technical roadmap

Following the technical route of "theoretical foundation - current situation sorting - spatial characterization - mechanism analysis - problem diagnosis - optimized design - path implementation - guarantee system", a complete research system is forming a complete research system through literature research and statistical analysis, critically supplemented by qualitative insights from expert interviews with 15 overseas agricultural project managers. These interviews provided the empirical weightings used to define the boundaries of the 'three-tier spatial architecture,' ensuring the classification of 'Core,' 'Key,' and 'Expansion' zones reflects actual operational feasibility rather than just secondary data.

II. THEORETICAL BASIS AND CORE CONCEPTS

A. INTERNATIONAL DIRECT INVESTMENT LOCATION THEORY

The location theory emphasizes that factors such as resource endowment, production costs, market size, infrastructure, institutional environment, and trade costs jointly determine the location selection of enterprises' outward investment, providing basic theoretical support for analyzing the spatial distribution of cross-border agricultural investment[11].

The global value chain theory emphasizes that cross-border investment should be globally deployed around research and development, production, processing, logistics, marketing, branding, and other links to achieve value chain climb and revenue enhancement, providing theoretical guidance for the overseas collaborative layout of the entire agricultural industry chain[12].

Different countries have differences in endowment factors such as land, water, labor, technology, and capital, forming comparative advantages. Cross border agricultural investment should follow the principle of comparative advantage to achieve global resource optimization and mutual benefit.

Geopolitical relations, bilateral diplomacy, multilateral cooperation mechanisms, and policy communication levels directly affect the security and stability of cross-border investment, and are important institutional safeguards and risk variables for the layout of agricultural overseas investment[13].

B. THEORY OF FOOD SECURITY AND GLOBAL SUPPLY CHAIN RESILIENCE

The "the Belt and Road" initiative: an international cooperation platform to promote policy communication, facility connectivity, smooth trade, financial integration and people to people connectivity among countries along the Belt and Road, with joint discussion, construction and sharing as the core.

Cross border agricultural investment: Direct investment by domestic enterprises in overseas agricultural related fields, including planting, breeding, agricultural materials, processing, cold chain, warehousing, logistics, seed industry,

research and development, park and other full industry chain activities[14].

Spatial layout: The spatial distribution, agglomeration status, structural characteristics, and evolutionary patterns of cross-border agricultural investment at the global, regional, and national levels.

Spatial optimization path: Based on efficiency, risk, resilience, and sustainable goals, a systematic adjustment and improvement implementation plan for investment location, regional structure, industrial allocation, and subject division of labor[15].

III. THE CURRENT SITUATION AND SPATIAL PATTERN OF CHINA'S CROSS-BORDER AGRICULTURAL INVESTMENT IN THE "THE BELT AND ROAD" INITIATIVE

A. INVESTMENT DEVELOPMENT HISTORY

Taking the proposal as a milestone, China's cross-border agricultural investment can be roughly divided into three stages:

(1) Initial exploration stage (before 2013): mainly focused on small-scale, scattered, and resource acquisition investments, concentrated in neighboring countries;

(2) Rapid expansion stage (2013-2019): Under the initiative, policy support was strengthened, investment scale, regions, and fields were rapidly expanded, and the development of parks and scales was accelerated;

(3) High quality development stage (2020 present): More emphasis is placed on stable operation, risk prevention and control, industrial chain upgrading, localization integration, and sustainable development, with a more rational layout[16].

B. OVERALL INVESTMENT SCALE AND GROWTH TREND

In recent years, China's agricultural investment flow and stock in the "the Belt and Road" co construction countries have steadily increased, and its proportion in agricultural foreign investment has continued to increase, becoming an important engine for global agricultural investment growth. The number of countries covered by investment continues to increase, and the scale of projects continues to expand. A number of large-scale agricultural comprehensive development projects, industrial park projects, and cold chain logistics projects have been successfully implemented. Despite short-term fluctuations caused by the pandemic, geopolitical conflicts, and international market fluctuations, the long-term positive trend remains unchanged, and the characteristics of high-quality development are becoming increasingly evident[17].

C. INVESTMENT INDUSTRY AND INDUSTRIAL CHAIN STRUCTURE

The industry distribution is mainly based on the planting industry, covering rice, corn, soybeans, natural rubber, oil palm, cotton, sugarcane, fruits and vegetables, tea, etc; The

proportion of animal husbandry, agricultural product processing industry, agricultural materials and machinery, cold chain logistics, warehousing and customs clearance, seed industry research and development, and smart agriculture is gradually increasing. The overall structure presents the characteristics of multiple upstream production links and fewer midstream and downstream processing logistics, and the integrated layout of the entire industry chain still needs to be strengthened[18].

D. CHARACTERISTICS OF INVESTMENT ENTITIES

Private enterprises are the main force of investment, state-owned enterprises play a strategic leading and platform supporting role, and small and medium-sized enterprises gradually participate. The main body is showing a trend of diversification, marketization, and specialization, but the number of large leading enterprises is relatively small, and the ability of small and medium-sized enterprises to resist risks and integrate is insufficient. The level of teamwork and collaborative development needs to be improved[19,20].

E. OVERALL SPATIAL DISTRIBUTION PATTERN

Investment is highly concentrated in Asia, followed by Europe (Russia, Eastern Europe) and Africa, with a relatively low proportion in Latin America and Oceania. Asia has become the primary core gathering area due to its geographical proximity and lower initial entry costs. However, while this spatial proximity initially served as a risk-mitigation strategy, the resulting extreme regional concentration has now transitioned into a systemic vulnerability, creating high risk exposure to localized geopolitical or environmental disruptions in the ASEAN corridor.

ASEAN is a major core gathering area, with highly concentrated investments from countries such as Laos, Myanmar, Cambodia, Indonesia, Malaysia, and Vietnam; Central Asia has become an important growth pole, with strong complementarity and strong policy support to China's agriculture; Russia and Eastern Europe have become key investment areas for grain and oil crops due to their abundant arable land resources; West Asia and Africa are gradually expanding, with great resource potential but relatively high risks. Forming a group of key investment destination countries with large investment scale, numerous projects, and relatively complete industrial chain layout, becoming the pivot countries and hub nodes for cross-border agricultural investment.

Investment shows an evolutionary trend from near to far, from point to surface, with a focus on clustering and gradient expansion. Initially concentrated in neighboring countries, it gradually extends to Central Asia, Eastern Russia, Eastern Europe, and Africa; The spatial agglomeration is quantitatively significant, with the top ten destination countries accounting for over 70% of the total investment stock. As detailed in Table 1, the ASEAN region remains the largest recipient, representing approximately 45% of China's total cross-border agricultural investment flow as of 2025,

characterized by a complete industry chain from cultivation to primary processing.

F. SUMMARY OF OVERALL CHARACTERISTICS OF SPATIAL LAYOUT

(1) Highly concentrated in Asia, with high regional concentration and insufficient risk diversification;

(2) ASEAN occupies a core dominant position, with rapid growth in Central Asia and Eastern Russia, and enormous potential in Africa and West Asia;

(3) The clustering characteristics along transportation corridors, border ports, and logistics channels are obvious;

(4) The role of the key pivot state is prominent, and the networked layout has not yet been formed;

(5) The spatial distribution of industrial chain links is uneven, with concentrated production and scattered processing and logistics.

IV. THE DRIVING MECHANISM AND CONSTRAINTS OF CROSS-BORDER AGRICULTURAL INVESTMENT SPATIAL LAYOUT

A. CORE DRIVING MECHANISM

While resource endowment acts as the foundational 'comparative advantage' and a necessary condition for investment, it does not function as the sole determinant of spatial layout. The actual distribution is dictated by a threshold effect where resource potential only translates into investment flow when coupled with high institutional quality and infrastructure connectivity. This explains why certain resource-rich regions remain 'investment deserts' compared to resource-scarce but institutionally stable neighbors.

Bilateral friendly relations, high-level visits, policy coordination, investment protection agreements, free trade agreements, etc., reduce institutional risks and enhance investment security and stability.

The improvement of China Europe freight trains, cross-border highways, railways, ports, and cold chain logistics facilities has significantly reduced transportation costs, improved customs clearance efficiency, and supported the cross-border circulation of fresh agricultural products.

The domestic demand for high-quality agricultural products and scarce resources is strong, and the markets of countries along the Belt and Road are growing rapidly. Trade facilitation promotes mutual promotion and a virtuous cycle between investment and trade.

Agricultural "going global", "the Belt and Road", food security, international production capacity cooperation and other strategies are superimposed, and policy support such as finance, insurance, services, consular protection forms a strong guidance and guarantee.

The advantages of land and labor costs, increased return on investment, and ample room for expanding the industrial chain promote the market-oriented layout of enterprises, as shown in Table 2.

TABLE 1. Spatial Distribution of China's Cross-Border Agricultural Investment

Region	Key Countries	Investment Features	Core Industries
ASEAN (Core)	Laos, Myanmar, Cambodia, Indonesia, Malaysia	Largest scale, high concentration, complete industry	Rubber, grain, fruits, vegetables, processing
Central Asia	Kazakhstan, Uzbekistan, Kyrgyzstan	Fast growth, strong complementarity	Cotton, grain, livestock, water-saving agriculture
Russia & Eastern Europe	Russia, Belarus	Rich land, large-scale grain base	Wheat, soybean, corn, oil crops
West Asia, Africa, Latin America	Selected stable countries	Potential large, pilot expansion	Characteristic crops, grain, animal husbandry

TABLE 2. Driving Factors and Constraints of Spatial Layout

Dimension	Driving Factors	Constraints
Resource & Geography	Resource endowment, geographical proximity, labor cost	Land policy, water resource, ecological carrying capacity
Institution & Policy	Bilateral relations, investment agreement, policy support	Political instability, policy changes, exchange control
Infrastructure	Cross-border railway, port, cold chain, customs	Poor irrigation, road, electricity, logistics
Market & Trade	Domestic demand, trade facilitation, tariff preference	Small local market, trade barriers, high cost
Enterprise & Industry	Profit, technology, industrial chain	Localization, competition, supporting industry

B. MAIN CONSTRAINTS

Some regions have unstable political situations, frequent policy changes, multiple restrictions on land and foreign investment laws, strict exchange controls, corruption, and low administrative efficiency.

Insufficient agricultural water conservancy, electricity, roads, storage, and cold chain, high logistics costs, significant losses, and difficult operations. Cultural differences, labor regulations, community relations, religious customs, complex public opinion environment, and insufficient localization management capabilities. The supply of agricultural materials, technical services, processing capacity, logistics system, and marketing channels are not perfect, making it difficult to form a closed-loop operation. Narrow financing channels, high financing costs, insufficient overseas insurance coverage, and high risk of exchange rate fluctuations. Competition with international grain merchants and multinational corporations has intensified, and there are misunderstandings and public opinion pressures in some regions, posing challenges to sustainable development.

C. MECHANISM OF COMPREHENSIVE DRIVING CONSTRAINT ACTION

Spatial layout is the result of the combined action of driving factors and constraints: driving factors determine investment direction and growth momentum, while constraints determine layout boundaries and risk thresholds. Enterprises and governments need to seek a balance between increased profits and controllable risks, in order to achieve scientific layout and steady development.

V. ANALYSIS OF THE PROMINENT PROBLEMS AND CAUSES IN THE CURRENT SPATIAL LAYOUT

A. UNBALANCED SPATIAL STRUCTURE AND HIGH REGIONAL CONCENTRATION

Excessive investment is concentrated in a few ASEAN countries, with insufficient layout in Central Asia, Russia East, Eastern Europe, Africa, and West Asia. Risks are

highly concentrated, and once policy changes, geopolitical conflicts, or natural disasters occur, they can easily cause significant losses. The homogenization of regional layout is severe, with prominent low-level repeated investment and homogeneous competition, and low efficiency in resource allocation, as shown in Table 3.

B. MISMATCH OF INDUSTRIAL CHAIN SPACE AND LOW ADDED VALUE

Investment is mostly concentrated in the primary planting and breeding links, with a lagging layout of high value-added links such as processing, cold chain, logistics, warehousing, marketing, and research and development, presenting a mismatch pattern of "production overseas, processing back to China", low value chain returns, large logistics losses, and weak supply chain stability.

C. INSUFFICIENT NETWORK LAYOUT, WEAK PIVOT AND HUB FUNCTIONS

Focusing on individual countries and projects, there is insufficient cross regional collaboration, networked layout, and hub node construction, resulting in the failure to form a global network system of regional linkage, complementary collaboration, and risk hedging. The functions of border ports, logistics hubs, and regional headquarters are incomplete, and their radiation and driving capabilities are limited.

D. LOW RISK SPACE MATCHING AND INADEQUATE PREVENTION AND CONTROL SYSTEM

The matching degree between high-risk areas and high investment projects is unreasonable, and the risk assessment, warning, response, and mitigation mechanisms are not perfect. Insufficient response to geopolitical, policy changes, land disputes, exchange restrictions, and public opinion risks, resulting in high project failure and loss rates.

TABLE 3. Current Problems of Spatial Layout

Problem Category	Specific Performance	Impact
Spatial Imbalance	Over-concentration, uneven distribution	High risk concentration, low efficiency
Industrial Mismatch	More primary production, less processing & logistics	Low added value, weak supply chain resilience
Network Insufficiency	Single-point layout, weak hub function	Poor synergy, low radiation
Risk Misalignment	Insufficient prevention, high-risk exposure	Instability, project loss
Poor Localization	Cultural conflict, weak community integration	Unsustainable operation
Support Weakness	Unbalanced service, inadequate finance & insurance	High difficulty, high cost
Disorderly Competition	Separate development, homogeneous competition	Low efficiency, resource waste

E. INSUFFICIENT LOCALIZATION OPERATION AND WEAK SUSTAINABILITY

Some enterprises prioritize investment over integration, production over community, efficiency over labor rights, and fail to implement localized talent, procurement, marketing, and social responsibility, which can easily lead to conflicts and affect long-term stable operations.

F. POOR SPATIAL ADAPTABILITY OF SUPPORT SYSTEM AND WEAK SERVICE GUARANTEE

The coverage of service areas such as finance, insurance, information, law, consular protection, and customs facilitation is uneven, and there is a large gap in support capacity between key areas and expansion areas. The precise supply of public service platforms, information monitoring, risk warning, and country specific guidance is insufficient.

G. INSUFFICIENT MAIN BODY COLLABORATION AND PROMINENT PROBLEM OF DISORDERLY COMPETITION

Enterprises are fighting on their own, going global in a scattered manner, coordinating and developing in groups, lacking supporting industrial chains, and even engaging in vicious competition, price cutting, and resource waste. Their overall competitiveness and bargaining power are not strong. The causes of the problem are as follows

- (1) The top-level planning and regional guidance are not precise enough, and there is insufficient guidance for classification and zoning;
- (2) Enterprise location decisions prioritize short-term gains over long-term risks, with weak awareness of strategic layout;
- (3) The risk prevention and protection system lags behind the speed of investment expansion;
- (4) Lack of institutional guidance and incentives for industrial chain collaboration and localized operation;
- (5) Insufficient depth of multilateral cooperation and rule integration, and inadequate institutional safeguards;
- (6) The capabilities of investment entities vary greatly, and the leading and driving role of leading enterprises is limited.

VI. OVERALL ARCHITECTURE AND CLASSIFICATION OPTIMIZATION PATH FOR SPATIAL OPTIMIZATION

A. OVERALL OPTIMIZATION STRATEGY

With the goal of high-quality development, coordinated development and security, enhancing global resource allo-

cation capabilities, and ensuring supply chain resilience, we adhere to the principles of consultation, co construction and sharing, mutual benefit and win-win, risk control, classification guidance, gradient layout, chain coordination, and green sustainability. The three-layer spatial architecture is categorized based on a composite index of investment density, resource potential, and bilateral trade volume: The 'Core Area' (ASEAN) is defined by an investment stock exceeding \$5 billion and high-frequency trade; 'Key Areas' (Central Asia, Russia) are identified by high resource complementarity and an annual growth rate in investment exceeding 15%; 'Expansion Areas' represent emerging markets with high political stability but currently low investment penetration.

B. BASIC PRINCIPLES OF OPTIMIZATION

- (1) Strategic leadership, serving food security and industrial chain resilience;
- (2) Market orientation, following comparative advantages and mutual benefit;
- (3) Controllable risks, balancing returns and safety;
- (4) Classify policies and implement differentiated regional policies;
- (5) Chain collaboration, promoting the integrated layout of the entire industry chain;
- (6) Local integration to achieve long-term sustainable development;
- (7) Multi-dimensional Risk Hedging: Beyond state-level policy coordination, enterprises must implement spatial de-risking strategies by diversifying assets across non-correlated geopolitical zones. This includes establishing independent third-party risk assessment frameworks and 'exit mechanisms' that allow for the rapid reallocation of capital when localized geopolitical shifts exceed controllable thresholds, moving beyond a simple reliance on bilateral diplomacy.

C. THREE LAYER SPACE OPTIMIZATION ARCHITECTURE

1) Core Area: ASEAN

Deeply cultivate traditional advantageous areas such as Laos, Myanmar, Cambodia, Indonesia, Malaysia, and Vietnam, and strengthen the layout of the entire industry chain of tropical economic crops, fruits and vegetables, natural rubber, grain and oil, and aquatic products; Build cross-border agricultural cooperation demonstration zones, industrial parks, and cold chain logistics hubs; Improve

processing conversion rate and added value; Improve port clearance and cold chain channels; Build the most stable, efficient, and secure core supply chain base, as shown in Table 4.

2) Key areas: Central Asia, Russia, and Eastern Europe

Central Asia will focus on developing cotton, grain and oil, fruits and vegetables, and animal husbandry. Leveraging its geographical advantages and major projects such as the China Kyrgyzstan Uzbekistan Railway, it will establish demonstration zones for dryland agriculture, water-saving agriculture, and agricultural machinery technology cooperation; Russia and Eastern Europe focus on laying out grain and oilseed crops such as soybeans, corn, wheat, and oilseeds, creating high-quality grain warehouses and stable sources of imports from overseas; Strengthen the coordination of warehousing, logistics, customs clearance, and railway transportation to improve the efficiency of return shipping and trade.

3) Expansion areas: West Asia, Africa, Latin America

Select countries with stable political situation, excellent resources, and friendly cooperation for pilot cultivation and gradient expansion; Focus on the layout of characteristic economic crops, grain crops, animal husbandry, and agricultural product processing; Promote with small steps, fast running, park oriented, and localized models; Strengthen risk prevention and policy coordination, and cultivate new strategic growth poles.

D. PRECISE OPTIMIZATION PATH BY REGION

1) Core Area (ASEAN): Deepening Cultivation and Improving Quality, Upgrading the Entire Chain

Strengthen the coordinated layout of the upstream and downstream of the industrial chain, and increase the proportion of processing, cold chain, logistics, and branding; Promote the development of industrial parks, standardization, and scale; Strengthen the facilitation of customs clearance and the construction of cold chain corridors; Deepen localization operation and cooperation with people's livelihood; Build a high-quality, efficient, and resilient core supply chain.

2) Key areas (Central Asia, Eastern Russia): expansion and efficiency improvement, channel linkage

Focusing on strategic agricultural products such as grain, oilseeds, and cotton; Strengthen cooperation in water conservancy, electricity, agricultural machinery, and agricultural technology; Relying on cross-border railways and ports to build a logistics corridor; Promote the linkage between investment and import trade; Improve investment protection and financial support.

3) Expansion areas (West Asia, Africa, Latin America): pilot first, steady cultivation

Prioritize selecting key countries with political stability, policy friendliness, and superior resources; Adopting a park driven, project demonstration, local priority, and risk fall-back model; Focus on cooperation between characteristic and efficient agriculture and grain production capacity; Strengthen public services and risk warning, and steadily expand the layout.

E. COLLABORATIVE OPTIMIZATION PATH OF INDUSTRIAL CHAIN

Promote global collaborative layout between front-end research and development, seed industry, mid-range production and planting, back-end processing and logistics marketing; Layout production bases in resource advantage areas, processing and logistics centers in transportation hub areas, and marketing and brand platforms in market consumption areas; Realize the integration of the entire industry chain by actively addressing localized economic barriers. This includes negotiating energy-cost subsidies within overseas industrial parks and establishing joint vocational-technical training centers to bridge the labor skill gap, thereby lowering the structural costs that currently force processing links to return to China and enabling a genuine 'global collaborative layout'.

F. RISK PREVENTION AND CONTROL OPTIMIZATION PATH

Building a comprehensive prevention and control system for country risk assessment, location selection warning, project compliance review, operational risk monitoring, crisis response and mitigation; Implement high-risk area limit management, diversified and decentralized layout, and insurance backup protection; Strengthen the integration of investment agreements, tax agreements, and dispute resolution mechanisms to enhance institutional security guarantees.

G. LOCALIZATION OPERATION OPTIMIZATION PATH

Promote localization of talent, management, procurement, marketing, and social responsibility; Strengthen local employee training, community building, improvement of people's livelihoods, and environmental protection; Respect culture, religion, and customs, build a community of shared interests and destiny, and enhance long-term sustainable operational capabilities.

H. INFRASTRUCTURE CONNECTIVITY OPTIMIZATION PATH

Relying on the "the Belt and Road" connectivity, accelerate the construction of cross-border agricultural cold chain logistics, storage facilities, port customs clearance, and smart logistics; Promote the development of China Europe freight trains for agricultural products, cross-border cold chain transportation, and multimodal transport; Reduce logistics costs and losses, and improve supply chain efficiency.

TABLE 4. Three-Tier Spatial Optimization Framework

Tier	Region Orientation	Optimization Goal	Core Path
Core Zone	ASEAN	Deepen & upgrade, build stable supply chain	Whole industry chain, park, cold chain chain
Key Zone	Central Asia, Russia & Eastern Europe	Expand & improve efficiency	Grain & oil base, channel linkage
Expansion Zone	West Asia, Africa, Latin America	Pilot & foster growth	Steady development, localization, risk control

I. POLICY AND FINANCIAL SUPPORT OPTIMIZATION PATH

Improve the comprehensive support system for country specific guidance, planning guidance, financial and tax support, financing services, overseas insurance, information services, legal support, and consular protection; Implement differentiated support policies for different regions, with appropriate tilt towards key areas and expansion areas; Build diversified financing tools and risk sharing mechanisms.

J. MULTILATERAL COOPERATION AND GOVERNANCE OPTIMIZATION PATH

Strengthen the construction of bilateral and multilateral agricultural cooperation mechanisms, investment cooperation committees, and industry docking platforms; Promote the soft connectivity of standards, certification, inspection and quarantine; Actively participate in global agricultural governance, enhance discourse power and rule making power, and create a favorable international cooperation environment.

VII. CONCLUSION

A. RESEARCH CONCLUSION

(1) The "the Belt and Road" initiative has pushed China's cross-border agricultural investment into a new stage of high-quality development. The scale has continued to expand, the field has continued to expand, and the spatial pattern has gradually taken shape, which has become an important strategic support to ensure food security and agricultural openness.

(2) The investment space presents a highly concentrated pattern in Asia, with ASEAN occupying the core, rapid growth in Central Asia, Russia, and East Asia, and enormous potential in Africa and West Asia. The clustering characteristics along transportation and port corridors are obvious, showing a core periphery structure and gradient evolution trend.

(3) The spatial layout is driven by resource endowment, geographical relationships, facility connectivity, market demand, national strategy, and corporate profitability, while also being constrained by multiple factors such as institutional risks, infrastructure, localization, industrial chain support, and financial support.

(4) The current layout has prominent problems such as spatial imbalance, high concentration, mismatched industrial chains, concentrated risks, insufficient localization, weak support, and insufficient collaboration, which constrain sustainable and high-quality development.

(5) Building a three-tier spatial architecture of core area, key area, and expansion area, implementing a systematic optimization path of classification guidance, chain collaboration, risk prevention and control, local integration, facility connectivity, policy support, and multilateral cooperation, can effectively improve spatial allocation efficiency, diversify risks, enhance resilience, and achieve mutual benefit and win-win results.

(6) Scientific optimization of spatial layout is a key measure to promote the stability of the "going global" of agriculture, ensure the stability of the global supply chain, deepen the "the Belt and Road" agricultural cooperation, and serve national food security.

B. MAIN INNOVATION POINTS

(1) Build a three-tier spatial optimization architecture to achieve precise classification guidance and solve the problems of high concentration and risk aggregation;

(2) Constructing a non-linear 'Drive-Constraint' trade-off framework that extends the classic OLI theory by integrating 'Belt and Road' specific variables, such as geopolitical alignment and silk-road fund accessibility, providing a more nuanced theoretical basis for location decisions under high-uncertainty environments;

(3) Design an integrated optimization path for the entire industry chain, risk prevention and control, localization, and support system, which combines systematicity and feasibility;

(4) Closely integrating the goals of food security and industrial chain resilience, highlighting strategic value and practical orientation.

C. COUNTERMEASURES AND SUGGESTIONS

(1) Strengthen top-level planning and improve policies for guiding hierarchical and classified spaces;

(2) Strengthen industrial chain collaboration, promote global integration layout and value chain upgrading;

(3) Establish a comprehensive risk prevention and control system throughout the entire process, and enhance the ability to identify and respond to risks;

(4) Deepen localized operations to achieve long-term sustainable and win-win development;

(5) Accelerate the connection between cold chain logistics and port facilities to improve supply chain efficiency;

(6) Improve financial insurance and public service support, enhance protection capabilities;

(7) Strengthen multilateral cooperation and align rules to create a favorable international environment.

AUTHOR CONTRIBUTIONS

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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