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Study on eco-compensation and financial support for environment-friendly development in China

Zhang Keqiang

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About the author

Mr. Zhang Keqiang is a renowned researcher and Vice director of Agro-Environmental Protection Institute (AEPI) at Ministry of Agriculture and Rural Affairs (MARA) in China. His main research focus is the resource utilization of livestock and poultry breeding waste and the coordinated prevention and control of pollution. He has carried out systematic scientific and technological innovation, and has made outstanding contributions in the theory and technology of pollution prevention throughout the entire process of livestock and poultry farming.

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Sino-German Agricultural Centre (DCZ)
Room 201, Foreign Economic Cooperation Centre (FECC) of MARA
55 Nongzhan Beilu, Chaoyang District
100125 Beijing, China

T +86 (0) 10 6500 0958

E info-dcz@iakleipzig.de

W www.dcz-china.org

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EXECUTIVE SUMMARY

China and the European Union (EU) have long maintained close cooperation in the field of agro-ecological compensation and environment-friendly development. 2009-2014, Agro-Environmental Protection Institute (AEPI) of the Ministry of Agriculture took the lead in implementing four projects on sustainable development and eco-compensation in agriculture in the framework of the China-EU Policy Dialogue Support Facility (PDSF), which resulted in the landmark publication "Sustainable Agricultural Development and Eco- Compensation - Theory and Practice of China-EU Agricultural Eco-Compensation". The results have had a positive and far-reaching impact on the establishment of agro-ecological compensation mechanisms and the development of environment-friendly technologies in China.

Commissioned by the **Sino-German Agricultural Centre (DCZ)**, we have systematically analyzed the series of initiatives undertaken by China since the conclusion of the China-EU Policy Dialogue Support Facility. These initiatives aim to promote the establishment of an agro-ecological compensation mechanism and the adoption of environmentally friendly technologies. This study, titled ***China's Eco-Compensation and Financial Support for Environmentally Friendly Development***, covers five key areas: the planning framework, project implementation, typical case studies, and the challenges and corresponding solutions. This study includes six development plans, eleven action plans, and two technical standards related to eco-compensation and environmentally friendly technologies at the government level since 2014. Additionally, it covers seven national projects led and implemented by the central government. The study uses Shiyan in Hubei Province as a typical case study and proposes drawing on Europe's advanced experiences to strengthen the agricultural eco-compensation mechanism in a locally adapted manner, while ensuring food security. The promotion of the industrialization of innovative technologies, along with the incentive mechanism encouraging young farmers to return to their hometowns and start their own businesses, has been proposed to support research on the green transformation of agriculture. This approach is conducive to the sustainable development of agriculture by drawing on the experiences and lessons learned from both China and Europe. It aims to further enhance policy dialogues and exchanges between China and Europe in this field.

Project Background

China and the EU have long maintained close cooperation in the field of agro-ecological compensation and environment-friendly development. From May 2009 to July 2014, Agro-Environmental Protection Institute (AEPI) of the Ministry of Agriculture and Rural Affairs took the lead in implementing four projects in the area of sustainable agricultural development and eco-compensation in the framework of the China-EU Policy Dialogue Support Facility (PDSFI-A8/A25, PDSFII-A2/A10). Experts from China and Europe carried out exchanges and cooperation on scientific application of fertilizers and pesticides, resource utilization of livestock and poultry manure and crop straw, and prevention and control of agricultural non-point source pollution in watersheds, etc. Six demonstration sites were set up in Baodi of Tianjin, Suzhou of Jiangsu Province, Tongcheng of Anhui Province, Dali of Yunnan Province, Changzhou of Jiangsu Province and Xianning of Hubei Province, and experimental demonstrations of environment-friendly technologies and eco-compensation policies have been carried out. Through the joint efforts of experts from China and Europe, a landmark publication "Sustainable Agricultural Development and Eco-compensation - Theory and Practice of China-EU Agro-ecological Compensation" has been published, which has positively influenced the promotion of the establishing eco-compensation mechanism and environment-friendly development.

1. Relevant development plans, action plans and technical standards

From 2014 to the present, the Chinese Government has introduced policies related to fertilizer and pesticide reduction and scientific application, livestock and poultry manure and straw utilization, mulching film pollution prevention and control, and watershed-scale management of agricultural non-point source pollution, including six development plans, eleven action programs and two technical standards.

1.1 Relevant 6 development plans

(1) National Plan for Sustainable Agricultural Development (2015-2030)

Expected goal: By 2020, the sustainable development of agriculture would have achieved initial results, with obvious economic, social and ecological benefits. By 2030, sustainable agricultural development will have achieved remarkable results. A new pattern of sustainable agricultural development with strong security of supply, efficient utilization of resources, good environment of origin, stable ecosystem, affluent farmers' lives and beautiful rural scenery will be basically established.

Key tasks: optimizing the development layout, stabilizing and improving agricultural production capacity; protecting arable land resources and promoting the sustainable use of farmland; conserving and efficiently using water and ensuring agricultural water security; managing environmental pollution and improving the agricultural and rural environment; and restoring agro-ecology and upgrading ecological functions.

Major projects: soil and water resources protection projects, agricultural and rural environmental governance projects, agro-ecological protection and restoration projects, and experimental demonstration projects.

(2) Demonstration Project: Construction Plan for Comprehensive Treatment of Agricultural Non-point Source Pollution in Key Watersheds (2016-2020)

Planning target: By 2020, a number of demonstration zones for the comprehensive prevention and control of agricultural non-point source pollution in key watersheds and regions will be built, and a number of replicable and generalizable technologies and models will be explored, so as to provide demo samples and experiences for the comprehensive implementation of agricultural non-point source pollution treatment. In the demonstration areas, chemical fertilizers and pesticides will be reduced by more than 20%, the comprehensive utilization rate of mixed sewage and animal waste in village areas will reach more than 90%, the comprehensive utilization rate of straw will reach more than 85%, and chemical oxygen demand, total nitrogen and total phosphorus emissions will be reduced by more than 40%, 30% and 30% respectively; and the thickness of mulch film of 0.01 mm and above will be fully popularized, and the recycling rate of mulch film for the current season will reach more than 80%.

Key projects: comprehensive prevention and control of farmland non-point source pollution, pollution control in animal husbandry, pollution prevention and control in aquaculture, and agricultural waste recycling.

(3) Construction Planning for the Demonstration Project of Circular Agriculture with Integrated Planting and Animal Husbandry (2017-2020)

Construction goal: By 2020, 300 demonstration counties for circular agriculture combining planting and animal husbandry will be established. The layout of planting and animal farming in these counties will become more rational, with the comprehensive utilization of crop stalks and livestock and poultry manure largely realized. The utilization rate of comprehensive animal manure treatment will exceed 75%, and the comprehensive utilization rate of straw will exceed 90%. Efforts will also focus on exploring typical models of circular agriculture, combining planting and animal farming, in different regions, with varying scales and varieties.

Construction projects: standardized forage base project, standardized animal farm renovation project, standardized slaughterhouse waste recycling project, animal manure recycling project, crop straw comprehensive utilization project.

(4) "Fourteenth Five-Year Plan" for Comprehensive Treatment of Agricultural Non-point Source Pollution in Key Watersheds (2021-2025)

Planning target: By 2025, several key project counties for comprehensive treatment of watershed agricultural non-point source pollution will be established, driving the prevention and control of agricultural non-point source pollution in key watersheds. Agro-chemical inputs in the Yangtze River, Yellow River, and other major watersheds will be reduced, and their efficiency will be improved. The level of waste utilization will be significantly enhanced, and agricultural green development will show substantial progress. The comprehensive management model and effective mechanisms for addressing agricultural non-point source pollution will be initially established, significantly strengthening the capacity to manage such pollution.

Key tasks: promoting the reduction and efficiency of fertilizers and pesticides use, promoting the resourceful utilization of livestock and poultry manure, promoting the treatment of pond aquaculture waste water, promoting the comprehensive utilization of straw, promoting the recycling of agricultural mulch films, and strengthening the construction of the monitoring and evaluation support system.

Key projects: farmland non-point source pollution prevention and control project, livestock and poultry manure resourceful utilization project, aquaculture waste water treatment project, comprehensive utilization of crop straw project.

(5) National Agricultural Green Development Plan for the 14th Five-Year Plan (2021-2035)

Expected goals: By 2025, resource utilization will be significantly improved, environmental quality in key areas will be notably enhanced, agricultural ecosystems will be substantially strengthened, the supply of green products will be greatly increased, and the capacity for emission reduction and carbon sequestration will be significantly enhanced. By 2035, the green development of agriculture will achieve remarkable results, the rural ecological environment will be fundamentally improved, and a green approach to production and life will be widely adopted. Agricultural production will align with the carrying capacity of resources and the environment, and a development model where production and life are in harmony with ecology will be largely established. Additionally, a new socialist countryside, characterized by beautiful, livable surroundings, prosperous industries, and thriving communities, will be well on its way to being fully realized.

Main tasks: strengthen the protection and utilization of agricultural resources, enhance the capacity for sustainable development, strengthen the prevention and control of agricultural non-point source pollution, enhance environmental protection in the place of production; strengthen

the protection and restoration of agroecology, enhance the function of ecological nourishment; to create a green and low-carbon agricultural industry chain, enhance the quality, efficiency and competitiveness of agriculture; and improve the green technological innovation system, strengthen the scientific and technological support for green development of agriculture.

(6) The "14th Five-Year Plan" National Plan for the Use of Animal Manure in Combined Planting and Animal Raising (2021-2035)

Construction Objective: By 2025, the level of resource utilization of livestock and poultry manure will be significantly improved. Progress will have been made in returning manure to farmland, and a circular development model combining cropping and animal husbandry, with manure return to farmland as a key link, will have taken shape. By 2035, the country will have largely achieved the resource utilization of livestock and poultry manure, with facilities and equipment reaching the standards of developed countries. A fully integrated circular development model combining cropping and animal husbandry will be established.

Key tasks: promote the use of manure, promote the quality of arable land; enhance the level of facilities and equipment, improve the efficiency of manure utilization; strengthen the scientific and technological innovation capacity, enhance the level of supporting services; improve the market operation mechanism, enhance the ability of sustainable development.

Key projects: The resource utilization of livestock and poultry manure are promoted throughout the counties, and the resource utilization capacity of livestock and poultry manure is improved.

1.2 Relevant 11 action programs

(1) Action Program for Zero Growth of Fertilizer Use by 2020 (2015-2020)

Expected goal: By 2020, a scientific fertilization management and technology system will be initially established, and the level of scientific fertilization will be significantly improved.

Key tasks: promoting soil testing and formula fertilization, promoting the transformation of fertilization methods, promoting the application of new fertilizers and new technologies, promoting the resourceful use of organic fertilizer and improving the quality of arable land.

(2) Action Program for Zero Growth in Pesticide Use by 2020 (2015-2020)

Expected goal: to establish a preliminary resource-saving and environment-friendly sustainable pest management technology system, significantly improve the level of scientific use of pesticides, control the use of pesticides per unit of control area below the average level of the last three years, and strive to achieve zero growth in the total use of pesticides.

Priority tasks: building a monitoring and early warning system for pests and diseases, promoting the scientific use of pesticide, green prevention and control, and unified control and management.

(3) Guidance on the Preparation of the Implementation Plan for Comprehensive Utilization of Straw in the 13th Five-Year Plan (2016-2020)

Expected goal: Straw will be largely utilized in a resource-efficient manner, and the issues of resource waste and environmental pollution caused by straw waste and burning will be addressed. By 2020, efforts will be made to establish a more effective socialized service system for straw return to the field, including collection, storage, and transportation. A comprehensive utilization model with a rational layout, diversified uses,

and sustainable operation will be formed, with the comprehensive utilization rate of straw exceeding 85%.

Focus areas: straw used as fertilizer, straw as feed, straw as energy, straw as base material, straw as raw material.

Key projects: project for straw returning to field, project for straw collection, storage and transportation system, technology system project for production, learning and research, straw for soil improvement demonstration project, straw for combined planting and animal farming demonstration project, straw for clean energy demonstration townships (parks) construction, straw for compound utilization demonstration project of industry and agriculture.

(4) Action Program on Resource Utilization of Livestock and Poultry Manure (2017-2020)

Expected goal: By 2020, a scientific and standardized livestock and poultry waste resource system with clear rights, responsibilities, and strong utilization constraints will be established. A circular development mechanism combining cropping and animal farming will be built, significantly improving manure resource utilization capacity. The national comprehensive utilization rate of livestock and poultry manure will exceed 75%, and more than 95% of large-scale farms will be equipped with manure treatment facilities. Large-scale farms with manure treatment facilities and equipment will achieve 100% coverage one year ahead of schedule. Large livestock counties, national modern agricultural demonstration zones, agricultural sustainable development pilot zones, and modern agricultural industrial parks will take the lead in achieving these goals.

Key tasks: establishing a sound system for resource utilization, optimizing the regional layout of the livestock industry, accelerating the transformation and upgrading of the livestock industry, promoting the resource utilization of livestock and poultry manure, upgrading the level of combined planting and livestock farming, and improving the efficiency of methane and biogas utilization.

(5) Action Program for Agricultural Mulch Film Recycling (2017-2020)

Expected goal: In 2017, the initiative to launch 100 demonstration counties for mulching film management in Gansu, Xinjiang, and Inner Mongolia began. Within 2-3 years, the comprehensive promotion and use of thick films in these counties will be realized, with the recycling and processing system largely established. The film recycling rate will reach 80% or more during the season, achieving the basic resource utilization of mulch films. By 2020, the national agricultural film recycling network will be continuously improved, resource utilization levels will be enhanced, the agricultural film recycling rate will exceed 80%, and "white pollution" will be effectively prevented and controlled.

Key tasks: promoting the reduction of mulching film use, promoting the standardization of film products, promoting the mechanization of film pick-up, and promoting the specialization of film recycling.

Priorities: building recycling demonstration counties, exploring the extended producer responsibility system, strengthening scientific and technological innovation, and promoting the development of policy system.

(6) National work program for the project of promoting the utilization of livestock and poultry manure throughout the county (2018-2020)

Objective: From 2018 to 2020, the National Development and Reform Commission and

the Ministry of Agriculture will focus on selecting more than 200 large livestock counties to develop manure treatment and resource utilization facilities. Upon completion of the project, the comprehensive utilization rate of manure in these counties will exceed 90%, and the rate of manure treatment facilities and equipment in large-scale farms will reach 100%. This will establish a robust model for promoting the resourceful utilization of livestock and poultry manure across counties and help achieve the nationwide goal of comprehensive agricultural waste utilization in a gradual and orderly manner. The policy system for manure resource utilization in these counties will be continuously improved, with clear policies for manure collection, storage, transportation, resource utilization, and relevant support policies and end-product subsidies. The layout of livestock and poultry farming in these counties will become more rational, establishing a sustainable agricultural development mechanism combining agriculture and animal husbandry. The proportion of organic fertilizer replacing chemical fertilizers will steadily increase. In national modern agricultural demonstration zones, sustainable agricultural development experimental zones, and modern agricultural industrial parks, the proportion of organic fertilizers replacing chemical fertilizers will exceed 20%.

Key content: infrastructure construction for livestock and poultry manure collection, storage, treatment and utilization, covering large-scale farms (upgrading of manure treatment and utilization facilities and supporting facilities), regional centralized manure treatment centers, and large-scale biogas projects.

(7) Opinions on Accelerating the Prevention and Control of Agricultural Mulching Film Pollution (2019-2025)

Main objectives: by 2020, a working mechanism will be established, the main responsibility will be clarified, the recycling system will be basically established, the recycling rate of agricultural film will reach more than 80%, and the national film coverage area will basically realize zero growth. By 2025, all agricultural films will be basically recycled, the amount of film residue nationwide will be realized negative growth, and white pollution in farmland will be effectively prevented and controlled.

Prevention and control work: regulate enterprise production behavior, strengthen market supervision, promote reduction and efficiency, and strengthen recycling.

(8) Guidance on the Comprehensive Utilization of Bulk Solid Waste in the 14th Five-Year Plan (2021-2025)

Main objectives: By 2025, the comprehensive utilization capacity of crop straw and other bulk solid waste will be significantly enhanced, with the scale of utilization continuously expanding. The comprehensive utilization rate of new bulk solid waste will reach 60%, and the stock of bulk solid waste will be reduced in an orderly manner. The overall level of comprehensive utilization will continue to improve, and the industrial system for bulk solid waste utilization will be strengthened. Key bottleneck technologies will experience breakthroughs, and a comprehensive technological innovation system for bulk solid waste utilization will gradually be established. Policies, regulations, standards, and the statistical system will be continuously improved, creating a near-perfect comprehensive utilization system. Inter-industry integration and regional synergistic development will continue to foster innovation. The demonstration and leadership role of intensive and efficient industrial bases and key enterprises will be significantly enhanced, and a new pattern for high-quality development in the comprehensive utilization of bulk solid waste will have largely taken shape.

Key tasks: Adhere to the priority of agricultural use and continue promoting the utilization of straw for fertilizer, feed, and substrates. Expand the scale of clean energy utilization of straw and encourage the application of biomass natural gas in industry. Continuously expand the use of straw as a raw material, promoting its use in the production of environmentally friendly panels, charcoal-based products, polylactic acid, pulp, and more. This will support the transformation of straw resources into high-value, green products. Establish and improve the straw collection, storage, and transportation system, providing specialized and efficient transportation and management services.

(9) Action Program for Fertilizer Reduction by 2025 (2022-2025)

Expected goals: By 2025, the total amount of fertilizer applied to agriculture nationwide will steadily decline. The amount of organic fertilizer returned to the field will be further increased, and the coverage rate of soil testing and formula fertilization technology for major crops will be stabilized at over 90%. Additionally, the coverage of soil testing and formula fertilization will continue to expand, further improving fertilizer utilization rates. As a result, the utilization rate of chemical fertilizers for the country's three major food crops will reach 43% by 2025.

Key tasks: soil testing and formula fertilization enhancement action, "three new" integration and supporting action, multiple substitution of chemical fertilizer promotion action, fertilizer efficiency monitoring and evaluation action, publicity and training to the household action.

(10) Action Program for the Reduction of Chemical Pesticides by 2025 (2022-2025)

Expected goal: By 2025, an environment-friendly and ecologically inclusive integrated technological system for crop pest control will be established and improved. The structure of pesticide varieties will be rationalized, and the level of scientific and safe pesticide use technology will be comprehensively enhanced. Efforts will be made to maintain a sustained decline in the total use of chemical pesticides.

Key Tasks: Actions will be taken to enhance the monitoring and forecasting capacity for diseases and pests, strengthen green prevention and control measures, and promote professional pest and disease management. Additionally, efforts will focus on monitoring and evaluating pesticide use, promoting the safe and responsible application of pesticides, and strengthening supervision and regulatory management of pesticide usage.

(11) Notice on the Comprehensive Utilization of Crop Straw in 2023 (2023)

Expected goals: In 2023, approximately 400 key counties and 1,600 straw comprehensive utilization demonstration bases will be established, ensuring that the nationwide comprehensive utilization rate of straw remains above 86%. Sub-regional and crop-specific straw return-to-field models will be developed, improving the standardization and normalization of straw return practices. Additionally, the straw collection, storage, and transportation system will be enhanced to increase specialization and market efficiency. Efforts will also focus on fostering market participants in straw processing by promoting the adoption of advanced technology and suitable equipment, thereby strengthening the industrialization of straw utilization.

Key tasks: Promote the scientific return of straw to the field, standardize straw collection and storage operations, enhance off-field utilization of straw, strengthen the development of straw resource accounting systems, and reinforce the role of demonstration projects as models for best practices.

1.3 Two relevant technical standards

(1) Technical Guidelines for Green Agricultural Development (2018-2030)

Development objectives: Accelerate the development of green inputs, significantly enhance the supply capacity of green technologies, establish a foundational system for green development and a low-carbon model, develop a comprehensive green standards framework, and substantially improve the monitoring and early warning mechanisms for agricultural resources, the environment, and ecology.

Main tasks: Development of green inputs, research and development of green production technologies, development of green post-production value-added technologies, innovation of green and low-carbon farming structures and technology models, technology and model of comprehensive development of green countryside, strengthening of basic research on green development in agriculture, and improvement of the green standard system.

(2) Guiding Opinions on Promoting the Development of a Standard System for the Resourceful Utilization of Animal Manure (2023)

Development objective: to implement the decision and deployment of the Party Central Committee and the State Council to accelerate the utilization of livestock and poultry waste, give full play to the standardization and leading role of standards in the resource utilization of livestock and poultry manure.

Main content: to systematically build a standard system for the whole chain of resource utilization such as collection, treatment, application and testing of livestock and poultry manure, covering five sub-systems such as comprehensive and general, hazard-free treatment, manure fertilizer utilization, gas control and testing methods, and further subdivided in accordance with terminology, technology, process, equipment, methods, safety and so on, to form fifteen sub-systems.

Priority tasks: In the comprehensive and general aspect, it mainly includes basic common standards such as management terminology, the amount of livestock and poultry manure generated, manure characteristics, and the evaluation of comprehensive utilization of manure. In terms of hazard-free treatment, it primarily includes standards such as technical specifications for manure treatment, design requirements for facilities and equipment, and requirements for safe production. Regarding manure utilization, it mainly includes standards on limiting indicators, technical parameters, and application techniques. In terms of gas control, it primarily includes standards such as technical specifications for the reduction of greenhouse gases and malodorous gases, as well as standards for accounting and certification. In terms of testing methods, it mainly includes standards for the sampling and measurement methods of livestock and poultry manure.

2. After 2014, government-level national special projects related to eco-compensation and environment-friendly technology development

In support of the above development plans, action programs and technical standards, the Chinese Government has taken the lead in implementing seven national-level special projects, the main contents of which are as follows:

2.1 Special project on "Research and development of comprehensive technology for reducing chemical fertilizers and pesticides application and increasing efficiency" (2016-2020)

In 2016, the State launched a pilot special project of the Key Research and Development Program "research and development of comprehensive technology for reducing the application of chemical fertilizers and pesticides and increasing the efficiency". The focus is primarily on research into efficient utilization mechanisms and standards for chemical fertilizers and pesticides, innovation in fertilizer and pesticide technologies, and the development of related equipment. This includes the integration and demonstration of technologies that enhance fertilizer and pesticide efficiency. The goal is to establish a comprehensive theoretical, methodological, and technological system for reducing the application of fertilizers and pesticides while improving their efficiency. The project aims to achieve a 20% reduction in fertilizer use and a 30% reduction in pesticide use within the target area, reduce labor costs by 50%, and address the problems of excessive fertilizer and pesticide application as well as the lack of viable alternatives in China.

2.2 Special project "Comprehensive prevention, treatment and restoration of farmland polluted by agricultural non-point sources and heavy metal " (2016-2020)

In 2016, China has launched the key special project of "research and development of comprehensive prevention, treatment and restoration technologies for farmland contaminated by agricultural non-point sources and heavy metals". Breakthroughs have been achieved in the theoretical understanding of the migration and transformation mechanisms of agricultural nitrogen, phosphorus, and heavy metals, as well as in the relationship between pollution load, regional environmental quality, and the quality of agricultural products. Basic theoretical research has been strengthened, and China's capacity for the standardization and industrialization of key technologies for the prevention and control of agricultural nitrogen, phosphorus, pesticides, heavy metals, and agricultural organic waste has been significantly enhanced. A total of 109 demonstration zones for the management of agricultural non-point source pollution and 110 demonstration projects for waste treatment will be established, covering a total demonstration area of 220,000 hectares. Within these zones, the pollution load will be reduced by 30%, the bioavailability of heavy metals in arable land will be decreased by 50%, and the utilization rate of hazard-free treatment for agricultural organic waste will reach 95%.

2.3 Countywide Project for Livestock and Poultry Manure Resource Utilization (2017-present)

In 2017, the county-wide promotion project for livestock and poultry manure resource utilization was launched to support the improvement and enhancement of manure treatment facilities and equipment, to summarize and promote the technology model of combined planting and animal husbandry, explore and build the market operation mechanism, promote the local use of county manure, and promote the circular development of agriculture and animal husbandry.

During the "13th Five-Year Plan" period, 585 livestock counties have achieved full coverage of livestock and poultry manure treatment, and the comprehensive utilization rate of livestock and poultry manure nationwide will reach 76% by 2020. 133,000 large-scale farms will all be equipped with manure treatment facilities and equipment, and the national annual production of livestock and poultry manure will drop to 3.05 billion tons, a 19.7% decrease compared with 2015. The manure utilization system has basically been completed, and the pattern of green development is accelerating.

During the "Fourteenth Five-Year Plan" period, support will be provided to more than 250 project counties for upgrading manure treatment facilities and constructing demonstration bases for the return-to-field of manure.

2.4 Comprehensive utilization of crop straw project

In 2016, China has launched the project for crop straw comprehensive utilization, adhering to the priority of agricultural use, multiple measures, industry-oriented, in-depth implementation of straw comprehensive utilization action, continue to enhance the effectiveness of straw comprehensive utilization across the country, and promote the formation of fertilizer and feed based multi-purpose utilization pattern in accordance with local conditions, taking into account the use of straw as energy, substrates and raw materials.

By 2020, an improved service system for straw return-to-field, collection, storage and transportation will be established throughout the country, and a comprehensive utilization pattern with reasonable layout, diversified utilization and sustainable operation will basically be formed, with the comprehensive utilization rate of straw reaching more than 85%.

By 2021, the amount of straw returned to the field would have reached 400 million tons, the utilization rate of straw off the field will reach 33.4%, the utilization rate as fodder will reach 18%, and the national straw utilization market players will be 34,000, with the proportion of fodder utilization players reaching 76.9%, and the proportion of fertilizer, fuel, substrate, and raw material utilization players would be at 7.8%, 8.9%, 3.8%, and 2.6% respectively.

2.5 Project on scientific use and recycling of mulching film

In 2022, China has launched the "Scientific Use and Recycling of Mulching Film" program, focusing on key film-using areas, key crops and key links, and selecting counties with a large amount of film, a good working foundation and a high degree of motivation to carry out pilot projects, and making concerted efforts in the two directions of substituting all-biodegradable film and using thicker and higher-strength film to carry out the work of scientific use and recycling of mulching film. It will promote the use of fully biodegradable mulching film for 333,000 hectares

and thickened high-strength film for 3.3 million hectare, stabilizing the film recycling rate in the project area at more than 80%, systematically solving the difficulty in recycling the traditional film and high cost of substitution, and effectively improving the level of scientific use and recycling of film, so as to promote the high-quality and green development of agriculture and revitalization of the countryside.

2.6 Pilot project on green and circular planting-animal farming

In 2021, China launched a pilot project on green planting-animal farming circular agriculture. The core objective is to establish a mechanism that fosters model creation, market expansion, and smooth circulation between crop cultivation and animal farming. The project aims to eliminate bottlenecks, promote the return of manure to fields, accelerate the resource utilization of livestock and poultry waste, and advance the green and high-quality development of agriculture.

Since its launch, the project has been implemented in 299 counties (or farms) across 22 provinces and municipalities nationwide. In the pilot areas, the average utilization rate of livestock and poultry manure resources has reached 93.5%, representing a 5-percentage-point increase compared to pre-project levels. Cumulatively, chemical fertilizer use has been reduced by 320,000 tons (pure substance). The number of service entities engaged in the green farming cycle has grown to 2,501—an increase of nearly 1,000 compared to before the project began—employing nearly 30,000 people.

2.7 Prevention and control project of non-point source pollution in key watersheds

In 2017, the Chinese government officially launched the "Pilot Project for Comprehensive Treatment of Agricultural Non-point Source Pollution in Typical Watersheds." This initiative targeted key agricultural sub-watersheds located within important water source protection zones and environmentally sensitive areas—such as Dongting Lake, Poyang Lake, Lake Taihu, the Haihe River Basin, the Songhua River, the Huaihe River, the Three Gorges Reservoir, the Danjiangkou Reservoir Area, Chaohu Lake, and the Erhai Sea. The pilot sites were required to have clearly defined watershed or catchment and drainage boundaries, with at least 20,000 mu of farmland and livestock waste generation equivalent to no less than 20,000 hogs.

In 2019, building on the foundation of this pilot, China expanded the initiative into the "Comprehensive Treatment Project for Agricultural Non-point Source Pollution in the Yangtze River Economic Zone." The focus shifted to controlling pollution from crop cultivation, sub-scale livestock and poultry farming, and aquaculture. The project also established a technology bank for agricultural non-point source pollution prevention and control, categorized by pollution types and sources across different sub-regions. Through pilot demonstrations and the synthesis of best practices nationwide, multiple pollution treatment models were developed to drive industrialization and achieve economies of scale.

During the 13th Five-Year Plan period, 118 agricultural non-point source pollution treatment projects were implemented in environmentally sensitive areas of the Yangtze River Economic Belt. These projects significantly reduced nitrogen and phosphorus emissions and produced effective management results. Several technical models were developed for different geographical

conditions, including the Yixing model for plains with water networks, the Xingshan model for hilly regions, and the Dali model for the Yunnan-Guizhou Plateau—each representing a strategy for synergistic prevention and control.

In 2021, China officially launched the "Program for Comprehensive Management of Agricultural Non-point Source Pollution in Key Watersheds," focusing primarily on the Yangtze River and Yellow River basins. The program aims to mitigate the impact of agricultural non-point source pollution on water quality through a governance approach that addresses the entire chain, all elements, and the full system. The program targets sensitive water environments along main rivers, major tributaries, irrigation zones, lake and reservoir catchments, and drinking water sources. A total of 200 counties with high levels of agricultural pollution were selected. Within each county, 2–3 typical agricultural sub-watersheds—each with well-defined watershed boundaries—were chosen as demonstration areas. A menu-based approach was used to select treatment technologies, and integrated support was provided to scale up these models countywide, aiming to systematically address agricultural non-point source pollution in these watersheds.

2.8 Financial Support

To address the excessive use of chemical fertilizers and pesticides, the Chinese government launched a key R&D project on comprehensive technologies for reduction and efficiency improvement, with a total investment of 2.39 billion Yuan.

During the 13th Five-Year Plan period, the government has allocated 623 million Yuan for a major R&D project focused on comprehensive prevention and remediation technologies for agricultural non-point source pollution and farmland contaminated by heavy metals.

Also, during the 13th Five-Year Plan, the central government allocated 29.6 billion Yuan to support 723 project counties in promoting the utilization of livestock and poultry manure, improving infrastructure, and exploring effective treatment mechanisms. This initiative covered all 585 major livestock and poultry counties across the country.

Since 2021, pilot projects on green circular agriculture integrating crop cultivation and animal farming have been implemented in 299 counties (or farms) across 22 provinces (municipalities) and the Northern Wilderness. Over the past three years, the central government allocated 7.402 billion Yuan to support these county-wide pilots, focusing on areas with strong foundational conditions and highly motivated local governments—particularly in animal husbandry provinces, major grain and vegetable production areas, and key ecological zones.

From 2019 to 2020, the National Development and Reform Commission and the Ministry of Agriculture and Rural Affairs launched the Yangtze River Economic Belt Agricultural Non-Point Source Pollution Control Project, with a total investment of 2.2 billion yuan from the central budget. In 2021, the scope of support was extended to the Yellow River Basin, with an additional 1.5 billion Yuan allocated to address agricultural non-point source pollution in relevant provinces along both major river basins.

3. Typical cases of agricultural eco-compensation and environment-friendly development in China

Shiyan City in Hubei Province, as one of the demonstration sites under the China-EU Policy Dialogue Support Facility, has emerged as a widely recognized model of success. Its achievements have attracted significant attention, prompting the Hubei Provincial Department of Agriculture and Rural Affairs to promote Shiyan's effective practices and experiences across the province. As a result, Shiyan has been established as a demonstration site for green agricultural development, showing clear progress in both industrial growth and environmental protection, as summarized below:

3.1 Basic Overview

Shiyan City, located in northwestern Hubei Province, lies in the heart of the Qinba Mountain region and the upper and middle reaches of the Han River. It is situated at the intersection of Hubei, Henan, Shaanxi, and Chongqing. The city has jurisdiction over four counties, one county-level city, and three districts, and is recognized as a National Garden City, a national ecological civilization demonstration city, and a national "Two Mountains" practice and innovation base.

Shiyan is home to the Danjiangkou Reservoir, the core water source for the South-to-North Water Diversion Project. As a key national ecological function zone, the area is known as the "green lung of Central China" and the "northern water well." Since the project officially began delivering water in 2014, a cumulative 68 billion cubic meters had been transferred by October 31, 2024, benefiting 26 large and medium-sized cities along the route and directly serving nearly 114 million people. Shiyan has taken on the political responsibility of ensuring a continuous supply of clean water to the north, making sustained efforts to protect water quality and strengthen ecological conservation. Thanks to these efforts, the water quality of the Danjiangkou Reservoir has consistently remained at or above Class II standards throughout the year.

3.2 Specialized actions

Faced with the limitations in traditional industrial development, the Shiyan Municipal Government has shifted its strategic approach. With a strong focus on building a green and low-carbon development demonstration zone, the city has prioritized the modernization of agriculture and rural areas, developed locally adapted leading industries, and actively fostered new forms of agro-ecological industries. Over the years, Shiyan has promoted sustainable agricultural development through the following seven key actions:

- **Strengthening Fertilizer and Pesticide Reduction**

Since 2015, Shiyan has steadily advanced soil testing and formula fertilization, conducted fertilization surveys among farmers, and issued scientific fertilization guidelines, including 24 large-scale fertilization formulas for major crops. The city has promoted green planting techniques such as side-deep fertilization for rice, seed-fertilizer co-sowing, water-fertilizer integration, slow- and controlled-release fertilizers, and the use of organic fertilizers (e.g., commercial organic fertilizers, return of livestock and poultry manure, straw incorporation, and green manure planting). Green pest control methods and drone-based spraying technologies have also been widely adopted.

- **Deepening Straw Resource Utilization**

The agricultural department actively promotes the efficient recycling of summer harvest rapeseed and wheat straw, introducing composting and mechanized deep plowing on small-scale plots. Straw is also being converted into high-value forage through techniques such as ensiling, compression, and bulking, thereby advancing the industrial and value chain use of straw and turning an ecological “burden” into green asset.

- **Improving Livestock and Poultry Manure Management**

Strict ecological red lines have been drawn for large-scale livestock farms to ensure timely collection, storage, transportation, and treatment of manure. The city promotes green circular farming, encouraging the nearby return of manure to fields, and has established centralized manure treatment centers in Yunyang, Yunxi, and Zhushan. Shiyan is also fostering regional green industry alliances, aiming to develop a model of livestock production that integrates agriculture, animal husbandry, and environmental protection.

- **Promoting Scientific Use and Recycling of Mulching Film**

In 2023 and 2024, Shiyan implemented initiatives for the scientific use and recycling of mulch film, focusing on technical guidance for farmers, appropriate film selection, and residual film collection. Multi-channel recycling mechanisms were introduced to improve the residual film recovery rate in farmland.

- **Encouraging the Transition to Green Agriculture**

The government supports the upgrading of traditional industries into ecological industries. For instance, the high-input yellow ginger industry has transitioned into six key value chains: edible fungi, Chinese medicinal herbs, tea, fruits, rice wine, and woody oilseeds and facility-based fisheries. Efforts are also underway to transition from smallholder, household-based farming to new cooperative models, and from traditional practices to improved land, seeds, machinery, and technologies.

- **Vigorously Developing Circular Agriculture**

Shiyan has introduced circular agriculture models such as “rice+”, “fishery+”, and “pig–biogas–tea” to enhance planting–breeding integration. The edible fungus sector has adopted innovative recycling systems like “agricultural waste–mushroom production–fuel–fertilizer” and “mycorrhiza–fungus–organic fertilizer–mycorrhiza”. The city has also advanced green facility fisheries, including engineered circulating water systems, high-top ponds, zero-emission farming, and land-based seafood farming, contributing to the regional green agricultural economy. These efforts have supported the creation of national-level green food raw material production bases and established Shiyan as a key city for premium agricultural product supply.

- **Promoting Integrated Agricultural Development**

Anchored in agriculture, Shiyan has embedded cultural and tourism elements, leveraging its unique landscapes to drive agriculture–culture–tourism integration. Iconic areas like Wudang Mountain and the Danjiang River serve as platforms for integrated models such as water–tea, water–fish, water–edible fungi, and water–Chinese herbs. Signature rural tourism projects, including “Master’s Mountain” in Wudang Mountain and Peach Blossom Island in Zhuxi, have emerged, along with rural attractions such as the Yunyang Shiitake Mushroom Industrial Park, Oriental Olive Garden, and Wufu Longjing Complex in Zhushan. These developments have

generated local employment, helping residents achieve prosperity at their doorstep, and offer a compelling path for transforming ecological value into economic value.

3.3 Financial Support

in the past ten years since the opening of the middle route of the South-to-North water transfer project, in order to ensure that "clean water goes north sustainably," the Shiyan Municipal Finance Bureau has actively raised funds and invested 35.6 billion Yuan of financial resources in water management, water preservation, and water protection, with an average annual investment of 3.24 billion Yuan.

Shiyan City obtained 384 million Yuan from the central water pollution prevention fund to support the prevention and control of water pollution and the protection and restoration of water ecology in key river basins; it also strived for 2.114 billion Yuan in central and provincial-level forestry transfer payments to support forestry reform and development, such as forest resource management and protection, land greening, and wetland ecological protection.

Shiyan City actively raised 373 million Yuan of financial funds to implement the "ten-year fishing ban," comprehensively cleaned up cage fish farming facilities in the Danjiangkou Reservoir area, and provided business and basic living security for 50,000 people in the reservoir area who had abandoned fish farming and turned to other production.

Shiyan City invested 1.2 billion Yuan in financial funds to help carry out comprehensive environmental improvement in 1,641 villages across 10 counties (cities and districts), with coverage reaching 87%. It also built 8 provincial-level ecological demonstration counties, 123 ecological townships, and 1,482 ecological villages.

Each year, 33 million Yuan in financial funds are invested to set up horizontal eco-compensation assessment funds for water environment quality, establish and improve the development of horizontal eco-compensation mechanisms for the entire basin, and help the city continue to promote ecological civilization system reforms.

Over the years, Shiyan City has raised a total of more than 30 billion yuan to vigorously support pollution control and ecological restoration. It has built 119 urban sewage treatment plants, 2,577 rural micro-power and non-power domestic sewage treatment facilities, and laid 2,570 kilometers of sewage collection pipeline. The centralized sewage collection rate of Shiyan urban areas has exceeded 90%, ranking first in the province. Additionally, 45 urban and rural waste treatment facilities have been built, 385 small river basins have been restored, 214,000 hectares of land has been afforested, and 181,000 hectares of farmland has been returned to forest. Furthermore, 3700 hectares of exposed mountains have been restored.

3.4 Effect of implementation

Shiyan City has explored a development path of ecological priority, green low-carbon, and sustainable agricultural modernization with mountainous characteristics, achieving remarkable results through the following actions:

The city's fertilizer use intensity dropped from 237 kg/ha in 2015 to 165 kg/ha in 2023. Pesticide application decreased for 11 consecutive years, with fertilizer and pesticide use reduced by 35.1% and 37.1% respectively. The city's comprehensive utilization rate of major crop straw reached more than 90%, and three market players in straw collection, storage, and transportation, with

more than 5,000 tons of annual throughput, were established. 406,500 tons of straw were utilized for fertilizer. The city promoted the resource utilization of manure waste from large-scale livestock and poultry farms, constructing 13 agricultural waste resource treatment centers, and increasing the manure resource utilization rate and facility allocation of large-scale livestock farms from 69.42% and 62.61% in 2018 to 88.99% and 99.75% now. Over 66,600 hectares of thickened, high-strength, and fully biodegradable mulching film was promoted in two years, and 19 waste film recycling outlets were constructed.

Around the six key industrial chains and fishery facilities, Shiyan City developed a total of 11,171 new business cooperation organizations, driving 394,200 farmers, with an output value of 76.15 billion Yuan in 2023. The city promoted 326 hectare of integrated rice field farming, and Shiyan was selected as the first batch of ecological low-carbon tea garden promotion pilots. In 2023, the city's rural tourism attracted 74.4 million trips, with rural tourism income reaching 55.8 billion Yuan, accounting for 46.5% of the annual tourism revenue of Shiyan City. Additionally, 13 provincial-level scientific and technological innovation demonstration bases for rural revitalization have been established, along with 23 national pilot projects for forest health care and recreation.

Shiyan City attaches great importance to the introduction of agricultural science and technology. In 2017, the collaborative innovation task of the Chinese Academy of Agricultural Sciences (CAAS), the "Danjiangkou Water Conservation Area Green and Efficient Agricultural Technology Innovative Integration and Demonstration Project", was launched in Shiyan City, with participation from 14 innovation teams from 10 research institutes of CAAS. The project carried out regional resource and environment background investigations, optimized regional plantation structures, and formed a new model of the planting and animal farming cycle. It researched and developed green and efficient technologies for the entire industrial chain of major agricultural products and distributed domestic pollutants control technologies. The project has served 45 enterprises, trained 5,200 agricultural technicians and new farmers, and applied and promoted the developed technologies in 18 counties (districts) in Hubei and Shaanxi. It has produced significant economic, social, and ecological benefits, providing technical support for promoting the green and efficient development of agriculture in the Danjiangkou water conservation area.

In terms of agro-ecological compensation, Shiyan City actively strives for various types of investment and subsidy policies:

In 2015, under the leadership of the Bureau of Agriculture and Rural Development of Yunyang District and the technical support of the Agro-Environmental Protection Institute (AEPI) of MARA, Shiyan Hongyang Ecological Farming Co., Ltd. and Xinyi Organic Farm of Tanjiawan Town successfully applied for the regional ecological circular agriculture demonstration project. Relying on the project, the enterprises built an ecological circular agriculture model of "eco-cultivation - pig farming - waste treatment - organic return to the field," forming a green circular system for regional agricultural production.

Between 2017 and 2019, six projects on comprehensive treatment of agricultural non-point source pollution in key watersheds were undertaken by the People's Government of Shiyan City, organized by the Agriculture and Rural Affairs Bureaus of six counties. With technical support from AEPI of MARA and Huazhong Agricultural University, the projects covered more than 13,300 hectares of green farmland, treated over 120,000 pig-equivalent livestock and poultry manure, and served more than 40,000 farmers. The project clarified the main factors of agricultural non-

point source pollution in each project county/district of Shiyan City, integrated relevant treatment technologies in a menu style, and completed the comprehensive treatment of agricultural non-point source pollution in six small river basins with the treatment concept of "whole chain and all elements integrated system."

In 2021, Yunyang District of Shiyan City was approved as a pilot project for green circular planting and animal farming. The project is organized and implemented by the Agricultural and Rural Bureau of Yunyang District, with Hubei Woyou Biotechnology Co., Ltd. and Hubei Lvdao Agricultural Development Co., Ltd. as the third-party implementation bodies. The project has returned manure to 6800 hectares of farmland in 11 townships such as Chengguan, Chadian, and Liupi Town, serving more than 1,000 growers and animal farmers. The district consumes more than 150,000 tons of livestock manure, effectively solving the problem of comprehensive manure utilization in Yunyang District.

In 2023, Shiyan City carried out the scientific use and recycling of mulching film. With technical support from Huazhong Agricultural University, more than 500 tons of thickened high-strength mulch film and fully biodegradable mulch film were purchased, and more than 40,000 hectares of farmland was subsidized, effectively enhancing the enthusiasm of farmers to participate in the scientific use and recycling of mulch film. A waste film recycling system has been formed, with agricultural material stations in townships acting as points for unified collection and treatment countywide.

Shiyan has also developed green finance. Hubei Xinlanyuan Olive Technology Co., Ltd. settled in Yunyang District of Shiyan City. With the model of "enterprise + production base + cooperative + farmers," it has driven more than 3300 hectares of olive planting in Yunyang District, accounting for 80% of the province's olive planting area. More than 800 rural households have benefited, with an annual per capita income increase of more than 6,000 Yuan.

Shiyan City has also built a comprehensive treatment system for agricultural non-point source pollution in small watersheds based on sustainable agricultural development and eco-compensation. The system adheres to a small watershed as the overall treatment unit, analyzes the main causes of agricultural non-point source pollution in the watershed, land carrying capacity, and industrial development trends. It integrates green prevention and control technology, focusing on the two aspects of production and life, clarifying the overall layout of agricultural production and rural life in the basin "upstream and downstream, left and right banks," and integrates technologies related to green farmland, planting and breeding cycles, green prevention and control, resource utilization of agricultural waste, rural domestic sewage treatment, and online monitoring of farmland water withdrawal to achieve ecological industrialization and industrialized ecology. The system also innovates long-term working mechanisms, including technical support for scientific research teams, market operation management, and data-based monitoring and evaluation. The comprehensive goal of "four integration" aims to integrate the treatment of agricultural non-point source pollution with new forms of waste utilization, ecological facilities improvement, green industry models, and eco-brand cultivation, thus promoting pollution control, industrial development, and water quality improvement in small watersheds, and fostering the sustainable, green, and high-quality development of regional agriculture.

On July 30, 2024, the Ministry of Agriculture and Rural Affairs (MARA) held a national agro-ecological environmental protection promotion conference in Shiyang City, which played a demonstration role with significant results.

4. Problems and recommendations

In summary, the results of the China-EU Policy Dialogue Support Facility have played a positive role in promoting green and sustainable agricultural development and the establishment of eco-compensation mechanisms in China over the past 10 years. However, compared with advanced experiences such as the European Common Agricultural Policy and good agricultural practices, there are still some shortcomings, and corresponding suggestions are put forward as follows.

4.1 Research and construction of agricultural eco-compensation policy mechanism

In June 2024, the Chinese government promulgated the *Regulations on Ecological Protection Compensation* (hereinafter referred to as the "Regulations"), marking the end of the absence of systematic legislation in China and holding landmark significance. However, there are still some outstanding problems that need to be addressed, such as the limited coverage of compensation, insufficient focus, weak reward and punishment mechanisms, and difficulties in coordinating relevant entities. In particular, the only agricultural area covered is arable land, with livestock, poultry, and aquaculture not yet included. Due to the unique diversity, variability, and complexity of the agricultural ecosystem itself, agriculture requires cross-sectoral cooperation and long-term planning across the fields of environment, resources, and more, and faces many challenges in practical implementation, including how to ensure the effective use of funds and how to assess the value of agro-ecosystem services.

It is proposed that, based on the outcomes of projects supported by the China-EU Policy Dialogue Support Facility and under the premise of ensuring food security, pilot demonstrations of agro-ecological compensation policies and environment-friendly technologies should be carried out in key areas such as reducing fertilizer and pesticide application and increasing efficiency, recycling manure and straw, and preventing and controlling agricultural non-point source pollution in river basins. With Shiyan City and other neighboring areas in Hubei Province as models, and with local governments as the leading actors, China-EU experts as technical support, and willing enterprises as the main drivers of industrial application, joint efforts should be made to promote policy guidance and market-based mechanisms for agricultural eco-compensation, thereby creating an agricultural eco-compensation operational system suited to China's national conditions and conducive to green and high-quality agricultural development.

4.2 Industrialized application of environment-friendly technology

Many environment-friendly agricultural technologies aim to improve the unsustainable pattern of high input and high output in traditional agriculture by reducing the use of agricultural inputs through relevant ecological technologies, improving the efficiency of waste resource utilization, and preventing and controlling non-point source pollution during the agricultural production process, thereby achieving pollution reduction, carbon reduction, and synergistic efficiency gains. However, such technologies either require high initial investment and fail to generate considerable economic returns in the short term, or involve high labor costs, which discourages many practitioners and hinders the industrialization and promotion of the technologies. In addition, many new technologies are not sufficiently integrated with the industry, and there is a lack of adequate training and publicity, making it difficult to implement these technologies in practice.

It is necessary to emphasize both process and end-user evaluation, develop environmentally friendly technologies that are low-cost, highly efficient, and suitable for practical application scenarios, and improve agricultural production efficiency and resource utilization. It is recommended to hold agricultural technology training courses regularly and invite experts to teach on-site, so as to enhance farmers' knowledge and skills in green agriculture, gradually eliminate information barriers, and narrow the gap between theory and practice. Pilot areas should be selected to first implement these technologies and create several environmentally friendly agricultural demonstration zones. Through field visits and exchanges, farmers should be enabled to visualize the economic and social benefits of green agriculture and help improve the user evaluation process and mechanism.

4.3 Incentive mechanism for young farmers to participate in the project

Owing to the disparity in living standards between urban and rural areas, the age of those engaged in front-line agricultural production in rural areas is relatively high, and the large-scale migration of young and middle-aged male farmers to the cities for work, as well as the low receptivity of farmers in many remote rural areas to new environment-friendly concepts and ideas, and their lack of modernized agricultural knowledge and skills, have affected and even constrained, to a certain extent, the green and sustainable development of regional agriculture.

It is recommended to learn from the practice of EU countries, and to include grassroots groups that directly or indirectly benefit from the project—such as young farmers—into the framework of the project, from the initial design to the project implementation and final evaluation and acceptance. These groups should be encouraged to raise actual problems encountered in the practice of agricultural production and in the application of environment-friendly technologies, and the project guidelines and implementation plans should be prepared based on these practical issues and needs. After the project is established, these groups should also be invited to observe and follow up on the experimental demonstration process and the phased implementation results, and finally provide evaluations of the project's implementation outcomes. In this way, young farmers, small and medium-sized enterprise owners, third-party service providers, and other stakeholders can fully participate in the project and witness the entire implementation process and its results. This will promote the enthusiasm of young people to engage in various types of projects and also provide young farmers with a good opportunity to practice and return to their hometowns to start their own businesses, which is conducive to raising the level of environmental protection and supporting the industrialization of regional environment-friendly agricultural technologies.

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