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The Basic Model of Green Farming Cycle Agriculture Comparison and Optimization Study

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Abstract

Agricultural green sustainable development has become an important strategy in every country, and whether this strategy can be realized depends on the development and popularization of the model of planting and breeding combined circular agriculture. Based on the related theories, a three-dimensional structure analysis model including the types of participants, project operation mode, planting and breeding structure and benefit is established in this paper. And by examining the typical case of green agriculture in China, in this study, three green farming models, namely, the animal-plant cycle model dominated by two agents, the three-dimensional cycle model with multi agents, and the three-stage cycle model dominated by individual investors, were summarized. Finally, through the comparison and induction of the models, the existing problems and optimization direction of the current basic models of planting and breeding cycle agriculture were put forward.

Keywords

Breeding Cycle Model; Green Agriculture; Breeding Body; Breeding Structure

1 Introduction

In 2017, the Chinese government proposed to "establish a sound economic system of green, low-carbon and cyclic development", making the green and high-quality development of agriculture an important strategic task for the country. In 2017, the Chinese government formulated the plan of "establishing a sound economic system of green, low-carbon and cyclic development". The overall trend of the national economy is shifting from high-speed growth to high-quality growth. Agriculture, as the foundation of the country, must be developed to green, recyclable, efficient and high-quality as soon as possible. However, there are many restrictive factors in the process of promoting high-quality agricultural development. In agricultural development, there are not only problems of environmental protection and resource shortage, but also problems of unsustainability of existing agricultural models.

In order to solve the above problems, relevant departments of Chinese agriculture have promulgated corresponding policy documents. The national agriculture department promulgated a policy document on building

integrated breeding and recycling agriculture, while jointly with other departments, it continued to issue the Notice on Pilot Work of Green Breeding and Recycling Agriculture in April 2021. All of the above policy documents require localities to implement policy directives to strengthen the combination of breeding and raising and promote the development of the agricultural circular economy. The first of these documents mentions the importance and urgency of building and developing green breeding and recycling agriculture, and sets out a plan for the construction of pilot projects. Chinese governments at all levels actively carry out the pilot project of integrated farming and recycling agriculture, and strive to cultivate a number of specialized service subjects of integrated farming and recycling agriculture within five years, and form a replicable and replicable model of green recycling agriculture development in which farming households, service organizations and planting subjects are closely connected.

In order to solve the existing problems of the planting and breeding cycle agriculture and explore the realization mode of the green planting and breeding cycle agriculture, this paper, based on the establishment of the analysis dimension of the planting and breeding cycle, combined with a number of case studies, the basic model of green farming and breeding cycle agriculture was refined. At the same time, the suitable environment, implementation cost, advantages and disadvantages of green farming and breeding cycle agriculture are compared and analyzed, and the optimization direction of each basic model is further studied.

2 Review of the Literature

The breeding cycle model is an innovative development and transformation of the ecological cycle, which has unique advantages over traditional agriculture, such as sustainability and efficiency. The research on ecological cycle agriculture in China started later than that in western developed countries. According to Li Jingshui (2002), ecological recycling agriculture is a new model of agricultural development that combines traditional agriculture with modern technology and considers agricultural production, rural economic development and rural environmental management as one. Li Jincai et al. (2008) defined ecological circular agriculture as a modern agricultural model that integrates economic, social and ecological benefits by optimizing the structure of traditional agricultural models through the application of effective methods. Chen Haiqiu et al. (2010) argue that as the Chinese government attaches importance to the protection of the natural environment and the concept of green development takes root in people's hearts, this sustainable and high performance ecological circular agriculture model will gradually gain attention. Wang Huiming et al. (2019) argue that the introduction of third-party forces through the government's purchase of rural governance services provided by third-party organizations is an effective way to solve problems that arise during rural agricultural production, such as the treatment of farm manure. Liu Penghu (2020) et al. argue that to carry out rural revitalization and achieve green and sustainable agricultural development in the new era, attention must be paid to the development of ecological recycling agriculture.

Western scholars have mainly studied the application of the circular economy model in various industries. For example, in the 1930s and 1960s, Rudolf Steniner (1924) argued that organic farming was the future of agriculture and put forward the idea of organic farming. Boulding put forward the concept of "circular economy", believing that human beings need to use the limited resources on earth rationally and create more useful resources on the basis of these limited resources. In recent years, based on the research of circular economy

model, there are many fruitful results for green and circular development of agriculture in foreign countries. Guido (2020) believes that green development of agriculture will be a goal for both developed and developing countries, and proposes that green development of agriculture should achieve eight sustainable agricultural goals such as no poverty, no hunger, clean water and sanitation. Oene (2020) argue that there is now a general consensus that agriculture should be "sustainable" and that for developing countries to truly implement this goal, a combination of intellectual, technological, and institutional efforts is needed. Davies et al. (2020) argue that the functioning of the global food system puts great pressure on the ecosystem and that the challenge of changing current food production and farming practices must be prioritized in order to limit the further development of climate emergencies and related challenges. This requires the development of green cycle agriculture to ultimately achieve a win-win situation for both food security and ecological conservation.

In summary, Chinese scholars' research on circular agriculture is relatively late, and is mainly focused on the discussion of ecological agriculture development model due to the policy influence, mostly using literature collection and field survey to focus on a certain region for in-depth research (Kong, 2019). Western scholars have studied the circular economy model earlier, and gradually combined the model with agricultural development based on the study of circular economy model, and mainly focused on the goal of achieving green agricultural development. However, the research of Chinese and foreign scholars has not paid much attention to the green breeding cycle, which is a model of agriculture, but it is a model of agriculture that can achieve high quality development. The research in this paper can fill this gap. Based on the latest policies and measures on agricultural development in China, this paper makes a comparative analysis of three typical cases by means of literature collection. This paper analyzes the typical cases from the following aspects: the participants, the production and operation mode, the structure of planting and breeding and the benefit it brings. On this basis, the optimization direction of planting and breeding cycle agriculture model in the future was put forward.

3 Analysis Dimension

3.1 Types of Participating Subjects

In the model of combined breeding and feeding cycle agriculture, it involves the participation of multiple subjects, which play their respective roles to promote the conversion of materials and energy among plants and animals, and finally realize the breeding cycle. In terms of the types of participating parties, the model can be generally divided into growers, farmers and third parties. The farmers consume the feed provided by the growers and hand over the livestock manure to the third-party entities, which transform the livestock manure into electricity and organic fertilizer for the growers after processing, thus realizing the recycling of agricultural resources. The third-party entities include leading enterprises, cooperatives, social service organizations and other new entities, which have experience in the development mode of mature combined farming and recycling agriculture.

3.2 Production Operation Mode

Production operation mode is the way of combining various production organizations. From the perspective

of production and operation mode, the analysis of recycling agriculture model can be divided into the production and operation mode of "leading enterprises (cooperative organizations) + parks + bases + farmers", i.e. leading enterprises or cooperative organizations establish standardized livestock breeding parks and planting bases, drive farmers to plant corn, vegetables, forage and other crops, and provide manure from the breeding parks to the planting bases in the form of organic fertilizer after treatment; "farms + joint household biogas projects + villages + agricultural parks + organic fertilizer processing plants". The model of "farm + household biogas project + village + agricultural park + organic fertilizer processing plant" means that the household biogas project treats livestock and poultry manure from the farm, and the biogas produced is transported to the rural community, and the digestate is transported to the surrounding agricultural park or processed into organic fertilizer after solid-liquid separation. The model of "leading enterprise + farm + planters" is that the technology and energy company collects livestock and poultry excrement from farms regularly and transports organic fertilizer to planters for consumption through technical treatment, realizing the cycle of breeding.

3.3 Planting and Breeding Structure

The integration of planting and farming is the expression of green farming cycle agriculture in the structure of planting and farming. The livestock manure produced by farming pigs, cattle, sheep, etc. is treated through technology, biogas is used for power generation, digestate solids produce organic fertilizer, and methane is turned into fertilizer for watering crops. Both biogas residue and biogas slurry can flow to the planting industry, making it grow food, cash crops and fodder. The feed such as forage corn, silage corn, alfalfa and other high quality forage can be directly provided to the farming industry, and the straw produced from the harvest of food and cash crops such as wheat, rice, corn and cotton can be returned to the farming industry through straw feed utilization.

3.4 Breeding Cycle Benefits

The recycling of waste from the breeding industry through the breeding cycle can yield economic benefits and has a greater contribution to social development and ecological protection (Zhang, 2017). In terms of economic benefits, biogas, biogas residue and biogas slurry are produced after livestock and poultry excreta are treated. Biogas can be used to generate electricity, saving coal and other energy use. The sale of biogas residue and biogas slurry as organic fertilizer can bring economic benefits to the processing unit, and the free supply of biogas residue and biogas slurry to farmers can reduce the planting cost and increase crop yield. In terms of social benefits, the use of pesticides and chemical fertilizers can be reduced by improving the production and living conditions of farmers and reusing the wastes from farming and breeding, in order to avoid farmland fertilization, pesticides or livestock breeding caused by non-point source pollution. In terms of ecological benefit, the crop straw and the excrement of livestock and poultry are reused to avoid the problems of burning straw to pollute the atmosphere and discharging livestock and poultry excrement to pollute the soil and water source, thus effectively improving the agricultural ecological environment, promoting sustainable development of agriculture.

The following table shows the comprehensive analysis structure of the four aspects of the type of participating subjects, production and operation mode, planting and breeding structure, and the benefits of the breeding cycle.

Table 1. Analytical dimensions of the basic model of green breeding and recycling agriculture

Analysis Dimension	Basic Content
Types of Participating Subjects	Growers, farmers, third-party subjects (leading enterprises, cooperatives, third-party subjects) Leading enterprises (cooperative organizations) + park + base + farmers
Production operation mode	Farms + joint household biogas projects + villages + agricultural parks + organic fertilizer processing plants Leading enterprises + farms + growers
Planting and breeding structure	Planting: food, cash crops, forage crops Farming: cattle, sheep, pigs, donkeys, etc. Cycle method: planting crops to feed - livestock excrement processing - methane returned to planting base
Benefits of the seed-feeding cycle	Economic benefits: save electricity and fertilizer costs, increase revenue from organic fertilizer sales, improve crop yields Social benefits: improve farmers' production and living conditions, achieve resource conservation Ecological benefits: avoiding pollution of the atmosphere, reducing surface pollution and protecting the agricultural ecological environment

4 Case Study

As China is a vast country, there are large differences between different regions in terms of natural resources and climatic conditions. By carefully considering all factors, this study selects three typical cases from a number of demonstration counties that have carried out integrated farming model in recent years, and analyzes them in order according to the four analytical dimensions constructed above.

4.1 Northwest Region—Inner Mongolia Tumed Left Banner

Tumed Left Banner is located on the Inner Mongolia Plateau, with a temperate continental monsoon climate and a relatively arid climate. The total land area of the region is over 4 million Mu, of which the agricultural area accounts for almost 80% or more, which makes it gradually become the core of Inner Mongolia's agriculture and animal husbandry industry. Both planting and farming are the leading industries in the area, and it is the first dairy flag in China, as well as the largest corn production base and vegetable planting base in the city. In accordance with the idea of "interdependent combination of farming and breeding and mutual promotion", the place relies on the advantages of farming and vigorously develops supporting forage planting, forming a new circular farming structure with the core of planting grain and forage.

In the process of developing circular agriculture and other processes, the main body of breeders includes agricultural cooperatives and family farms. According to statistics, in 2020 there have been a number of family

farms and ranches in the area have reached the district and municipal level and received the honorary title. Family farms and professional cooperatives are also booming, the current number of family farms and professional farmers' cooperatives in the flag has exceeded 100, including the number of cooperatives up to more than 1,400. The development of the leading enterprises is good, the flag leading enterprises at the national, regional and municipal levels are distributed.

According to the relevant policy documents, the local government will continue to develop and grow leading enterprises in the industrialization of agriculture and animal husbandry, continue to strengthen the leading enterprises and base construction, the interests of farmers linkage mechanism. In the development of animal husbandry, relying on leading industries such as dairy cattle and beef cattle, the main model of "large enterprises + breeding areas + professional bases + breeding individual farmers" will be used to build a technically economical and efficient green animal husbandry. In the breeding industry, through the construction of relevant forage planting base to specialize in the planting of high-quality forage, the establishment of "large enterprises + forage base + planting individual farmers" mode of operation, the formation of a reasonable "grain crop, economy crops, feed crops" ternary structure.

Local mainly relies on livestock and poultry manure recycling project, through large dairy farm "excrement bedding reuse + manure and water return to the field" utilization model, for large scale farms, to carry out comprehensive waste treatment and utilization. After the efficient use of waste in the production process of planting and breeding, the development of organic fertilizer processing industry based on the deep processing of regional characteristics of agricultural products, not only to realize the resource utilization of organic waste, but also to extend the industrial chain to improve the added value. The final formation of the breeding park, agricultural and livestock products processing and waste recycling synergistic supporting the construction model.

In terms of economic and social benefits, the local area has gradually formed a good development momentum of "one township, one industry, one village, one product" through the creation of special agricultural and livestock products, pulling rural revitalization through the development of special industries and improving the quality of production and life of local people; in terms of ecological benefits, the area has replaced organic fertilizers with organic fertilizers through the development of breeding and recycling agriculture to further improve the safety of agricultural products. In terms of ecological benefits, the area has been developed through the development of breeding cycle agriculture, replacing chemical fertilizers with organic fertilizers to further enhance the safety of agricultural products. In addition, the reduction of waste gas emission also improves the local agricultural and rural environment, helping to form a clean and orderly, ecological and livable rural environment.

4.2 Southwest China—Shehong County, Sichuan Province

Shehong County, a county-level city in Sichuan Province, is located in the middle of the Sichuan Basin, with a mild climate and four distinct seasons, and is one of the major counties in the region for planting and farming. It is one of the largest counties in the region in terms of planting and breeding. It mainly develops recycling agriculture according to the mechanism of "government encouragement, market-led and multi-body participation".

In terms of participating subjects, Shehong County mainly relies on the PPP (Public - Private - Partnership) model in developing breeding cycle agriculture. The government, professional and technical enterprises and individual farmers combine to build a complete cycle chain of farming.

In terms of production and operation mode, in the development of circular agriculture in Shehong County, the "three biogas (biogas, biogas slurry and biogas residue) clever use" is used as a breakthrough to support the development of the entire circular agriculture. For the surrounding farms, the focus is on biogas construction to lay a complete infrastructure for the subsequent use of the three biogas; livestock and poultry manure is turned into fertilizer through biogas treatment to irrigate farmland, realizing the secondary efficient use of waste, turning waste into treasure (Zhang, Xu, Chen, & et al., 2012). For large farms, the PPP model is mainly used to promote recycling. By the third-party comprehensive utilization of farm manure company to carry out related waste collection and transportation, storage and processing and utilization of "one-stop" professional services to achieve the scientific and efficient disposal of waste resources.

In terms of planting and breeding structure, based on the development of "three biogas", the local establishment of "pig - biogas - fruit (vegetable / medicine / grain)" planting and breeding cycle agriculture model, the county has established a standardized There are more than 50 farms in the county, accounting for more than 40% of the total number of farms. The supporting projects such as field manure pipeline network, biogas fertilizer transportation cooperatives and processing plants have been carried out in an orderly manner and achieved effective results.

In terms of the benefits of the breeding cycle, the "pig - biogas - fruit" breeding cycle model relying on the "three biogas" has effectively improved the local soil quality in ecological terms, increasing the organic matter content of the soil by more than 0.25%. At the same time, the use of organic fertilizer has also increased the yield of crops, and the cost saving and efficiency of the relevant planting base is more than RMB 100 Yuan per Mu. The biogas project provides centralized gas supply for 3,600 local households, and the annual direct income reaches 135,000 RMB. All the above-mentioned agricultural development helps to improve the income level of local residents and also lays a solid foundation for the construction of ecological agriculture.

4.3 Southeast Region—Longyou County, Zhejiang Province

Longyou County is a large county of livestock and poultry breeding, in carrying out the breeding cycle is mainly led by the village committee, and individual farms, relevant technology professional companies and other signed service agreement, to achieve a win-win situation for multiple subjects.

In terms of participation, the place focuses on creating "small, medium and large three cycles". Individual farmers as the main body to focus on the combination of farming construction of the main small cycle; the region through the village committee to cooperate with third-party enterprises, to farming supporting the comprehensive utilization of waste as the focus of the park in the cycle; the county through the docking with enterprises, agricultural waste recycling as the focus of the county's large cycle. Each cycle has its own focus, and works with village collectives, individual farmers and growers, and third-party companies to build a unique breeding cycle model.

In terms of the production and operation model, within the agricultural production and operation, we promote the self-digestion model of "livestock - biogas - crops" to achieve complementary farming and improve the separation of farming and breeding; within the region, the village committee signs a contract with a third-party professional treatment team to closely In the region, the village committee signs a contract with a third-party professional treatment team to closely connect the planting and farming industries, and the professional team is responsible for the transportation of the digestate. And through the construction of digestate ponds and other construction to achieve the effective use of fertilizer in the planting and breeding park, to build a three-way win-win cycle for farmers, growers and village collectives; in the whole county, by promoting the model of "manure recycling - supplying biogas to produce electricity - producing organic fertilizer - benefiting crops", the village committee has been able to improve the separation of planting and breeding. In the whole county, by promoting the model of "manure recycling - supplying biogas to produce electricity - producing organic fertilizer - benefiting crops", we rely on professional companies to collect and treat the excrement of farms in the county on a regular basis, and the biogas formed is used to supply electricity. The biogas residue is used for planting base and farming base through solid-liquid separation to realize the big cycle in the county.

As far as the planting and breeding structure is concerned, the main small cycle is carried out in accordance with the guiding concept of "combining planting and breeding, consistent pacing and local recycling of manure". The planting area is mainly planted with fruits and pasture, and there is a matching animal manure recycling pond next to it. On the one hand, it helps alleviate pollution from farming, on the other hand, it can reduce fertilizer input and labor cost, and ease the burden of farmers; in the middle cycle of the region, although the planting structure of each household is different, the high cost of planting makes the local collective economic development sluggish. Through the contract signed between the village collective and the methane treatment company, the effective treatment and irrigation of methane can generate more than 100,000 RMB per year for the village collective economy; in the county wide cycle, the recycling of livestock manure waste and irrigation of local crops such as fruit trees and pasture by a professional company has successfully achieved increased production and income.

In terms of the benefits of the breeding cycle, through the development of recycling agriculture, it helps to optimize the structure of the agricultural industry and solve the problem of local separation of breeding and raising (Smith, 2020). In terms of ecology, through the development of breeding and raising circular agriculture, the discharge of waste such as manure is further reduced, which effectively improves the problem of water pollution. In addition, the resource utilization of waste has improved the comprehensive treatment capacity of local pollutants and relieved the pressure on the natural environment. In terms of economic and social development, social forces have been introduced to help agricultural development in the area, which has led to the development of the collective economy of villages and the improvement of farmers' income levels, and promoted agriculture in the direction of specialization, efficiency and intensification

5 Comparison and Analysis of Models of Green Breeding and Recycling Agriculture

Through analyzing the above cases, the basic models of green farming and recycling agriculture are extract-

ed, and the characteristics of each model are analyzed in terms of the applicable natural environment, industrial conditions and technical conditions.

5.1 Dual Subject-led Dynamic Plant Cycle Model

This model is mainly applicable to areas with vast grasslands and arid climate such as Inner Mongolia, Shaanxi and Ningxia in China. These areas mainly raise livestock through grazing, which is not easy to collect livestock excrement; as pasture areas with large pastures, they rely on natural pastures and are prone to shortage of forage when it is not the green grass growing season; due to the more arid climate, the utilization rate of farmland is low and the utilization of crop straw needs to be enhanced.

This model is suitable for areas where the leading industries are corn, vegetables, pasture and other planting industries and dairy cattle, beef cattle, meat sheep and other farming industries. Such areas have many large-scale farms in the region, which can efficiently implement standardized circular farming and have a high potential for farming development. Large-scale farms need to have a vast area for planting and breeding as well as supporting treatment facilities that can ensure adequate supply of forage, animal disease prevention and control, and ecological protection of the area.

This model requires large scale farms equipped with manure treatment systems to efficiently treat and utilize livestock and poultry manure through the "excrement bedding reuse + manure and water return to the field" utilization model. In terms of crop straw resource treatment, it is necessary to build green and yellow storage ponds, purchase straw processing machinery, etc. for straw feed utilization, and also to build continuous pyrolysis charcoal furnace, biochar follow-up processing system, charcoal workshop, etc. for straw charcoal return to the field to change the soil.

5.2 Three-dimensional Cycle Model with Multi-body Participation

This model is suitable for southern hilly and rainy areas such as Guangxi, Yunnan, Sichuan and Guizhou in China. The terrain in these areas is mainly mountainous and hilly, with more arable land on the slopes, which is not convenient for the collection and transfer of crop straw; livestock and poultry breeding such as pigs have the problem of random discharge of livestock and poultry excrement, which causes pollution of air, soil and water in the watershed.

This model is suitable for the development of three-dimensional compound planting and farming scale of 500 pigs or more, supporting agricultural parks that match with the digestate and methane return project. The third party main body can also participate in the regional farming cycle, responsible for the construction and maintenance of the storage and transfer facilities for livestock and poultry manure on farms and methane transport pipelines on farmland, and undertake the whole process of manure from collection to processing into organic fertilizer for application.

This model requires companies in the region that have more mature technologies for comprehensive utilization of farm manure. The company collects the livestock manure temporarily stored in the farm, transports it

to the treatment workshop, makes organic fertilizer after the process of stirring and mixing the solid manure, piling and rotting, etc., and carries out solid-liquid separation and biological treatment of the biogas residue and biogas slurry, and processes it into fertilizer water to be transported to farmland for irrigating crops. If some farms are surrounded by farmland or orchards that match the scale of farming, they can carry out the cycle of planting and breeding in close proximity, and need to build biogas treatment facilities, biogas slurry storage and transportation facilities to transport the fertilizer produced after manure treatment to planting land to irrigate crops.

5.3 Retailer-dominated Three-stage Cycle Model

This model is applicable to the southern plain water network areas such as Jiangsu, Zhejiang, Shanghai and Fujian in China. These areas have a small arable land area and high population density; a large water area and a high risk of water pollution from the discharge of sewage with substandard treatment; a large number of pig breeding and a low comprehensive utilization rate of livestock and poultry manure.

The overall county has a reasonable layout of individual, regional and county planting and breeding industries, creating a "small, medium and large three cycles" model, and supporting a professional energy technology company for the collection of livestock and poultry manure in the county, biogas and methane distribution, organic fertilizer processing, etc. Each cycle has its own focus, with individual farmers, growers, village collectives and third-party companies working together to build a breeding cycle model.

This model has high requirements for biogas slurry treatment technology. The comprehensive utilization of supporting biogas slurry for planting and breeding in the area requires the construction of biogas slurry tank and biogas slurry transportation pipe network. The village committee shall sign biogas slurry service agreement with each breeding farm, and the professional service team shall be responsible for the transportation of biogas slurry after transportation and treatment, and repair and maintenance of biogas slurry transportation pipeline on a regular basis. The recycling of agricultural waste in the county requires energy technology companies to regularly collect the excreta of pigs in the county, carry out anaerobic fermentation to produce biogas for power generation, and concentrate biogas liquid to produce liquid organic fertilizer.

The following table shows the comparative analysis of the two-actor-led dynamic plant cycle model, the three-dimensional cycle model with multi-actor participation, and the three-level cycle model with retailer dominance.

Table 2. Comparative analysis of basic models of green farming cycle agriculture

	A dual-activist-led kinetic-planting cycle model	A three-dimensional cycle model with multi-body participation	Retailer-oriented three-tier circulation model
Applicable natural environment	Arid areas; extensive grazing feeding areas	Hilly and rainy areas; arable land mostly on slopes	Plain water network area; less arable land per capita; extensive water area

Applicable industrial conditions	Crop farming and animal breeding; large farms	Stereoscopic compound farming; farming larger scale industries	Rational layout of planting and farming
Applicable technical conditions	Specialized manure treatment system; straw treatment machinery; continuous pyrolysis carbonization furnace, carbonization workshop, etc.	Biogas treatment facilities, biogas slurry storage and transportation facilities; solid organic fertilizer, fertilizer water treatment process	Biogas slurry tank and biogas slurry transportation pipe network; manure anaerobic fermentation treatment technology

6 Problems and Optimization Directions of the Basic Model of Green Breeding and Recycling Agriculture

In terms of the double main body-led dynamic planting cycle model, large and medium-sized farms have a large demand for forage and food cash crop planting area, some even need more than 10,000 Mu, and in some areas there will be a tight land resources. To alleviate the above dilemma, the government should introduce relevant preferential policies in land transfer, infrastructure construction, etc., to encourage enterprises to use land transfer or cooperation with farmers to build breeding pastures and forage bases, to meet the needs of breeding supporting the construction of a large area of feed planting base, to better promote the recycling of breeding industry waste.

In terms of the three-dimensional circulation model with the participation of multiple entities, if some farms are surrounded by farmland or orchards that match the scale of farming, they can carry out the cycle in close proximity to the farming, and large farms or intensive farming areas can participate in the PPP off-site cycle, but for small and medium-sized farms without supporting planting areas around them, there may be the problem of random discharge of livestock and poultry manure. Small and medium-sized farms or free-range farmers can centralize the treatment of livestock and poultry manure by village units, and the village committee or other third-party organizations can build a “biogas project” to supply the biogas produced after treatment to the village area for power generation, and the digestate can be processed into organic fertilizer for comprehensive use, or provided to the surrounding farmland and transported to the planting industry through pipelines. The biogas can be processed into organic fertilizer for comprehensive use, or be provided to the surrounding farmland, piped to the plantation etc.

In the case of the three-stage recycling model dominated by retail households, due to the large number of individual farmers in the region, the supporting crop planting area or the possession of construction funds vary, resulting in the low utilization of livestock and poultry manure, and even pollution of air and water. In response to the above problems, the following three aspects can be optimized: first, policy subsidies for participating subjects, such as subsidies for purchasing and building biogas treatment facilities, crop planting subsidies, etc., to reduce the costs borne by farmers; second, technical support for the construction of standardized farms and biogas treatment facilities, and regular assessment and supervision to ensure the safety of the biogas treatment process; third, the inclusion of family farm clusters in the regional cycle, the third-party energy technology company for excreta collection, saving farmers supporting crop area as well as biogas treatment equipment construction costs.

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References

[1] Li, J. S. (2002). Research on the development of ecological agriculture in China. *On Economic Problems*, (8), 31-33.
[2] Li, J. C., Zhang, S. G., Qiu, J. J., & et al. (2008). Ecological agriculture models in China. *Chinese Journal of Eco-Agriculture*, (5), 1275-1278.
[3] Chen, H. K., Xie, D. J. (2010). Modern agriculture in the era of low carbon economy. Economic & Trade Update, (5), 57-58.
[4] Wang, H. M., Zhang, H. Y., & Wang, J. (2019). Third-party governance boosts pollution control and development. Contemporary Jiangxi, (5), 35.
[5] Liu, P. H., Lai, R. L., Liu, T., et al. (2020). Technical measures to promote rural industrial revitalization by developing ecological recycling agriculture. Journal of Subtropical Resources and Environment, (2), 74-80.
[6] Guido, S. T. (2020). The urgency of Agriculture Green Development. Frontiers of Agricultural Science and Engineering, 7(1), 108-109.
[7] Oene, O. (2020). Toward Agriculture Green Development. Frontiers of Agricultural Science and Engineering, 7(1), 110-111.
[8] Davies ,N., & Shen, N. (2020). Reducing the environmental footprint of food and farming with Agriculture Green Development. Frontiers of Agricultural Science and Engineering, 7(1), 1-3.
[9] Kong, W. Y. (2019). Analysis of typical experience of ecological recycling agriculture in Qufu City. Primary Agricultural Technology Extension, 7(8), 61-62.
[10] Zhang, H. Y. (2017). A brief analysis of low carbon agricultural economy and circular agricultural economic development. Knowledge Economy, (17), 56-58.
[11] Zhang, D., Xu, R., Chen, B. & et al. (2012). Treatment technology of livestock manure biogas engineering. Zhejiang Agricultural Science, (2), 223-227.
[12] Smith, N. (2020). Policy options for Agriculture Green Development by farmers in China. Frontiers of Agricultural Science and Engineering, 7(1), 90-93.