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Advancement of the Qianyanzhou Mode in the New Period

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Abstract: In the early 1980s, to control soil and water loss in the rainy season and problems of water shortages in the dry season in the red soil hilly region of central Jiangxi, the academician team of Li Wenhua from Qianyanzhou Station of the Chinese Academy of Sciences proposed a comprehensive muti-dimensional agriculture development mode known as the "Qianyanzhou Mode". Since then, models for the forest-livestock-food ecosystem, forest-fruit-economy ecosystem, and land-water compound muti-dimensional system and others have been tested, demonstrated, promoted and used to solve major issues in ecological restoration and agricultural production. With the dawn of the new era, the Qianyanzhou Mode is being given new connotations. In order to reduce the use of pesticides and eliminate the use of antibiotics for improving the quality of agricultural products, increasing farmers' income, and assisting in strategies for rural vitalization, Qianyanzhou Station is currently focusing on the development of experiments and demonstrations of green agricultural development modes, such as forest-fruit-fowl, hybrid paper mulberry-pig-fruit, grass-sheep(cattle)-fertilizer-fruit, hybrid paper mulberry-fish-goose, paddy-shrimp, and others. The goal of this new effort is to apply the wisdom of Qianyanzhou to the construction of the ecological civilization, including ecological environment protection and the prosperity of farmers in the old revolutionary base areas in central Jiangxi Province.

Key words: hills in central Jiangxi; Qianyanzhou New Mode; green development; eco-civilization

1 Introduction

Located in a humid subtropical climate zone, Jiangxi is an area rich in water, heat and biological resources. In November 2014, Jiangxi became one of the first demonstration areas of ecological civilization in the country, since it occupied a pivotal position in green development and was also an important agricultural production area in China.

In the 1980s, the famous Qianyanzhou Mode solved the problems of comprehensive ecological and environmental management, comprehensive and efficient development and utilization of agricultural resources and rural food shortage at that time, achieving the win-win goal of increasing farmers' income while maintaining a good ecological environment. Despite the unique advantages of Jiangxi in terms of geographical location, resource endowment and national attention, the problems of industrial structure and layout, comprehensive environmental improvement, red soil land integrity decline and rural surface source pollution in recent years have led to farmland abandonment and labor loss, which have restricted the implementation of China's sustainable agricultural development and rural revitalization strategy.

In 2007, the former Ministry of Agriculture of China proposed the "Circular Agriculture Promotion Initiative" and carried out pilot projects nationwide to advocate the promotion of circular agriculture. The massive use of chemical fertilizers of China (about 54.03 million tons in 2019) (Huang et al., 2020) has also become a major burden of environmental pollution. Insisting on green agricultural

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development and cultivating a green agricultural industry chain (creating green production, green processing and green marketing as one chain), is the basic way to solidify the cornerstone of rural revitalization. From the perspective of agricultural innovation and development, it is necessary to explore the paradigm of combining the green agricultural industry chain with new technologies and new systems to enhance agricultural production efficiency. Therefore, under the new ecological construction situation and social demand conditions, the "Qianyanzhou Mode" is being given new connotations in order to provide technical support for the construction of ecological civilization and the implementation of the rural revitalization strategy in Jiangxi.

2 The origin and development of the Qianyanzhou Mode

The red soil hills in China are widely distributed across 18°–32°N and 96°–120°E, with a total area of 1.13×10^6 km^2, accounting for 11.8% of China's total territory in which nearly 30% of the Chinese population lives (Ma et al., 2015), but it has a soil erosion area of about 3.4×10^5 km^2 (Zhang and Cheng, 2014). There is a red soil area of 9.31×10^4 km^2, representing about 56% of total land area of Jiangxi Province. The soil-forming parent materials of Jiangxi red soil are mainly quaternary red clay, red sandstone, granite, metamorphic rock and other weathered materials. Among them, red clay derived red soil has the widest area of distribution and the greatest quantity, and this part of the land is mostly distributed among the low hills below 50 m in elevation, mainly on both banks of the Ganjiang River and Fuhe River, Jitai Basin and the shore of Poyang Lake, with a gentle slope and continuous concentration.

In the early days of the founding of New China, the phenomenon of farming on steep slopes and destroying forests to reclaim farmland prevailed for historical, natural (disasters), and social (development stages) reasons. At the same time, environmental pollution caused by the rapid development of industry caused the province's ecological environment to suffer further destruction. After the Great Leap Forward (1958–1960), three years of natural disasters (1959–1961) and the Cultural Revolution (1966–1976), the Ministry of Agriculture of China and the Chinese Academy of Sciences held a meeting in Jiangxi to discuss the situations on the utilization and improvement of the southern red soil in the face of severe soil erosion of barren mountains and the frequent natural disasters leading to food shortages. Jiangxi Province undertook the key project of "high-yield test for improvement and utilization of red soil" issued by the State Scientific and Technological Commission, established 11 improved utilization and high-yield demonstration sites in different soil types, and worked to improve the production levels in regions with grain development as the main focus, as well as the complementary use of agriculture, forestry and livestock, and the comprehensive management of mountains, rivers, forests, farmlands and roads.

From 1980 to 1982, the South Team (Comprehensive Scientific Expedition Team of Southern Mountain Area, Chinese Academy of Sciences) conducted large-scale scientific research projects in Jitai Basin, Jiangxi Province. Through further demonstration, analysis, and examination of the scientific data, the older generation of scientists, such as Li Wenhua and Cheng Tong, proposed to use water as a breakthrough point for development and governance. Through commercial production activities, the well-known "Qianyanzhou Mode" was created in the Qianyanzhou area of Taihe County, which made important contributions to local economic development.

The Qianyanzhou Mode of that period included three typical agroforestry complex management systems, namely "forest-livestock-food", "forest-fruit-economy" and "Land and water compound muti-dimensional management". Among them, the "forest-livestock-food" mode of a circular ecosystem was based on forests, with livestock as the mainstay and food as a stabilizing factor. It included planted forests, fields of water, artificial grassland, and poultry and livestock. It realized the organic combination of forestry, animal husbandry and grain production, and solved the problem of food shortage and the management of soil erosion at that time. The "forest-fruit-economic" model was designed to make up for the shortcomings of the long growth cycle and low economic benefits of forest trees, and according to different slopes, the "timber forest-chestnut-economic crop" and "slash pine-Chinese medicines" models were carried out to realize the integration of long-based, short-supporting and long-medium-short cycles. The "land and water compound muti-dimensional management" mode was a complex management system focused on the development of the aquaculture industry and supplemented by the development of land cultivation. Plantations were planted in the hills of the upper and middle reaches on both of the Songtang Reservoir-centered sides in Qianyanzhou, and included artificial forests in the upper hills, orange groves in the middle and developing rice fields in the lower part; and this mode also included planting pastures by the ponds, building pig pens and poultry houses, raising aquatic products in the reservoir, and forming a hybrid production business model of using livestock manure to produce biogas as clean energy (Cheng et al., 2015), returning biogas residue to the field, and putting biogas slurry into the orange orchard (Zou et al., 2018), see Fig. 1.

3 Historical contributions of the Qianyanzhou Mode

3.1 Ecological benefits

During the period from 1982 to 1988, the area of woodland in Qianyanzhou increased by 119.8 ha, orchards increased from 0 to 27.3 ha, artificial grassland increased by

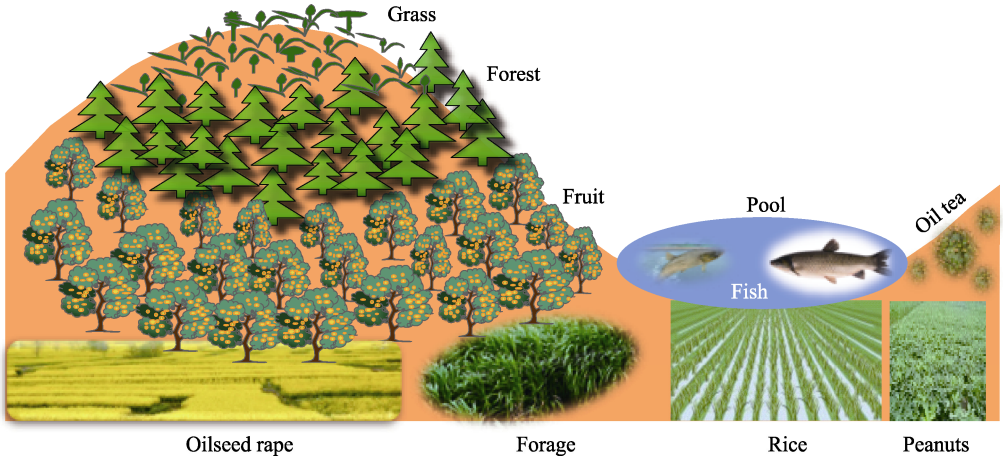

Fig. 1 Schematic diagram of the Qianyanzhou Mode

7.0 ha, and the aquaculture water area increased by 5.9 ha. In contrast, the area of wasteland and hills decreased by 156.9 ha (Table 1). The forest coverage rate increased from 0.43% to more than 80%, which effectively controlled soil erosion. The amount of soil erosion decreased from 2.82 kg m^{-2} in 1984 to 0.16 kg m^{-2} in 1992, and the surface runoff decreased from 7.463×10^3 m^3 ha^{-1} yr^{-1} in 1983 to 3.303×10^3 m^3 ha^{-1} yr^{-1} in 1997 (Fig. 2).

Table 1 Comparison of the main indicators before and after the development of Qianyanzhou (Unit: ha)

Year	Arable land	Woodland	Orchard	Artificial grassland	Aquaculture water area	Wasteland and hills
1982	21.7	0.9	0	0.1	0.1	175.2
1988	17.8	120.7	27.3	7.1	6.0	18.3

Note: Source of information: Ni and Deng (1990).

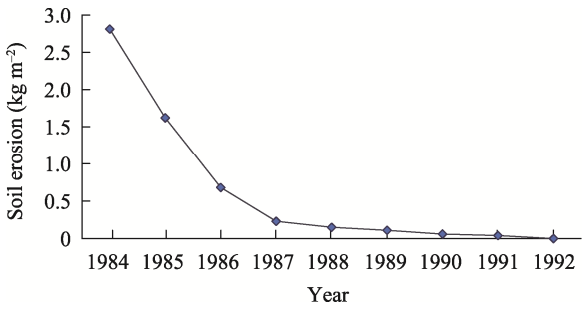

Fig. 2 Effect of controlling soil erosion in the land-water compound mode

3.2 Economic benefits

Before the transition, the social and economic development of Qianyanzhou was relatively backward. In 1982, the net income per capita was only USD 18.78, which was lower than the average levels of Taihe County and Jiangxi Province. During the three years from 1983 to 1986, the land utilization rate of Qianyanzhou increased from 10.9% to 75.4%. Of which, orchard, woodland, and aquaculture water-area bodies increased from less than 1% to 13.2%, 68.42%, and 2.4%, respectively. The proportion of barren hills and sloped land decreased from 85.83% to 4.26% (Table 1). This change in land use pattern directly drove the rapid economic growth of the pilot area, with many farmers moving in. The population of the area increased from 31 to 156. Per capita net income in 1993 was nearly 20 times that of 1982 at USD 2374, far surpassing the averages of Taihe County and Jiangxi, producing a dozen of the first batch "10000 yuan households" (deposit or income up to USD 1581) in Jiangxi Province. A comprehensive analysis showed that total agricultural production values of the experimental areas grew rapidly, from USD 817 in 1982 to USD 71273 in 1989 (The data in 1989 were used to highlight the contribution of the Qianyanzhou model at that time), for an increase of about 87-fold (Fig. 3).

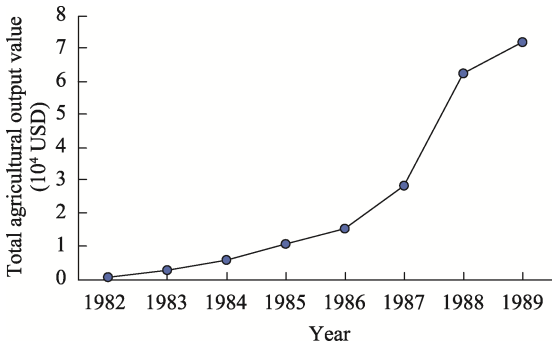

Fig. 3 The total agricultural output value before and after the development of Qianyanzhou
Note: Source: Kang, 1993.

3.3 Social benefits

According to published statistics, during "the Ninth Five-Year Plan" period, 38 demonstration and extension sites with a total area of 866.67 ha were established in the Jitai Basin, which had a huge social impact. The successful establishment and promotion of the Qianyanzhou Mode

aroused much attention in China, and it was fully acknowledged by many leaders and experts, and widely reported by more than 30 media outlets including China Central Television and People's Daily. Its achievements were included in the "Exhibition of Agricultural Achievements in the 50th Anniversary of the Founding of the People's Republic of China" and in the "Geography" textbooks of ordinary high schools. The red soil development achievements of the Qianyanzhou Mode were selected as one of Rio de Janeiro's international models, and awarded the title of "Top 100" for global ecological restoration by the United Nations.

4 New ideas, problems and advantages

4.1 New forms need new ideas to develop

In November 2012, the 18th Party Congress made the strategic deployment of "vigorously promoting the construction of ecological civilization" a priority, and since then China has successively put forward a series of development strategies, such as "two mountains theory" referring to clear waters and green mountains as invaluable assets, "the community of life of mountains, rivers, forests, fields, lakes and grasses", and "rural revitalization strategy and green development". In 2016, policy maker emphasized that "green ecology is Jiangxi's greatest wealth, advantage, and brand" during his survey in Jiangxi, and put forward the requirements for creating a "Jiangxi mode of beautiful China". The Jiangxi Provincial Party Committee and the Provincial Government thoroughly implemented ecological civilization construction and required all relevant departments in Jiangxi Province to strengthen the protection and restoration of ecosystems and to vigorously develop green ecology agriculture (recycling and high-efficiency agriculture), thus improving the ecological environment management system from the perspective of political responsibility on the path of "ecology priority and green development".

4.2 Modernization needs to solve new problems

Since the founding of New China, Jiangxi has always been an important food production area in the country and a major livestock and poultry breeding province (Jiang et al., 2016). Liang (2011) analyzed the practical path of modern agricultural development in China and pointed out the inevitability of agricultural industrialization theory and multifunctional agricultural development theory to realize the integration of the agricultural industry, and on this basis, proposed the "horizontal widening and vertical elongation" as the new framework of agricultural industry integration which embodies the concept of circular economy. The Qianyanzhou Mode has relatively complete industrial categories horizontally, including vegetables, seafood (rice and shrimp), fruits (Jinggang tangerines, honey pomelo), livestock and poultry (live pigs, black-bone chicken), staple foods (potato, rice) and a series of industries, but the vertical integration between sub-industries is not sufficient.

Therefore, while the agricultural and rural economic development momentum of Jiangxi Province is improving, we must clearly understand the shortcomings in the development of Qianyanzhou's agriculture, which can be grouped into five main themes. First, the agricultural industry chain system is not sound, and the lack of chain linkage has led to low value-added benefits. For example, Taihe County's "nine major projects" (vegetable industry, fruit industry, aquaculture and other industries) have not formed a linkage system, and the yield of converting manure produced by the aquaculture industry into organic fertilizer is not high. The main reason may be the lack of key processing technology and equipment. Second, it is difficult for the circular economy to play a role (Tian et al., 2018); that is, the spatial distribution of various industries is relatively fragmented, and certain policy support from the government is required (Peng et al., 2019) to make the overall plans for the industrial layout in order to accelerate the development of circular green agriculture. The third shortcoming is the serious loss of the rural labor force, the low income of farmers, and the low cultural quality. Fourth is the low degree of urban-rural integration, the mechanism of factor flow has not been established, and the new business forms of service industries such as rural tourism, leisure agriculture, and homestay economy have just started (Planning Office, 2020); Fifth, while promoting the combination of planting and breeding, it is necessary to increase the research and development of core technologies, so that technology can drive the integration of various elements and better serve the new model of Qianyanzhou.

4.3 New development requires new advantages

In light of the major strategic opportunities of domestic economic quality development in the new era, the Qianyanzhou Mode has the foundation, conditions and strength to upgrade the overall situation of quality development, and it is innovation-driven to help create a beautiful "Jiangxi mode" of China, which is mainly manifested in the following advantages.

First, historical and policy advantages. National strategies such as the "Belt and Road" initiative and the "Yangtze River Economic Belt" overlap in Jiangxi. The new era supports the revitalization and development of the old revolutionary areas, the Poyang Lake National Independent Innovation Demonstration Zone, the Jiangxi Inland Open Economy Pilot Zone, in addition to the major historical opportunities such as the revitalization and development of the Central Soviet Area and the strategic upgrading of the Jitai Corridor. The No. 1 document of the Central Government in 2020 also mentions the promotion of the combined farming model and the promotion of green agricultural development. In the future, the development trend will be to link the farming and breeding industries through the medium of "industrial chain" (Tang et al., 2021). Therefore, Taihe County is facing

an unprecedented opportunity.

Second, socio-economic advantages. The successful creation and promotion of the Qianyanzhou Mode has already benefited villagers continuously, boosted per capita income, eased employment pressure, and put into practice the "three-life integration" of ecology, production and life. In 2019, Taihe County's GDP reached USD 3052.8 million, ranking second in the Ji'an City, with a steadily improving economy. The products of the Qianyanzhou Mode, namely the implementation of the Taihe Black-bone Chicken Action Plan (output value reached USD 156.3 million in 2017), the integrated development of multiple industries such as green food and big health industries (e.g., green rice), are building new economic growth poles (Taihe Government, 2020).

Third, ecological and resource advantages. The forest coverage rate increased to 62.69% in 2017. After the construction project of the community of life in mountain, water, forest, lake and grass in Qianyanzhou was included in the province's pilot project in 2019, the water quality of Taihe section of Ganjiang River was maintained above Class II, and the water quality of the national examination section was excellent at 100%. In terms of air quality, the average concentration of $PM_{2.5}$ was reduced to 32 μg m^{-3}, and the ratio of good air days was 97.5%, higher than the city average by 6.5 percentage points. The urban and rural environment is better, the green color is more adequate, and the appearance is new (Taihe Government, 2020).

5 Exploration of Qianyanzhou New Modes

5.1 Forest-fruit-fowl mode

Jiangxi has an advantageous geographical location that is rich in water, heat, land, and forests, which is currently producing agricultural and economic crops such as rice, fruits, and camellia, and is the birthplace of Taihe silky fowl. Under the social and economic situation of pursuing green, ecological and "no antibiotics" foods, the Qianyanzhou Experimental Station, with the help of the advantageous resources of Jiangxi, has carried out a "forest-fruit-fowl mode" experimental demonstration suitable for subtropical regions (Wang et al., 2019), that is, breeding Taihe silky fowl under the canopy of Masson pine, Moso bamboo, Jinggang honey pomelo, Oil tea, etc (Fig. 4).

Fig. 4 Photographs of the demonstration of the forest-fruit-fowl mode

The test results showed that a density setting of 3 black-bone chicken per ha and free-range rearing in rotation by means of moving chicken houses had no significant impact on vegetation, soil, water quality, etc. According to physiological and ecological habits of Taihe silky fowl, the total cost of breeding chickens for 150–180 days will be USD 16.9 per chicken. The net profit per chicken will be USD 6.57, and the income will be 35.23–44.04 USD ha^{-1} yr^{-1} for two batches a year, which is a considerable improvement of about 3–4 times more than farmland income.

5.2 Hybrid paper mulberry-pig-fruit mode

Qianyanzhou test results showed that the annual output of hybrid paper mulberry in the subtropical red soil hilly area was 74627–119403 kg ha^{-1}. The whole plant was harvested, crushed, sprayed with a specific fermentation broth, packaged in a bag for green storage, and 2–3 weeks later, the fermentation was complete and the product was stored in a

warehouse for later use (with a shelf life up to 1 year). For the pigs, hybrid *Broussonetia papyrifera* was added to the storage feeds starting when the live pigs weighed about 40 kg (from birth to 3 months old), and after fattening them for 4 months, the average weight was 100–110 kg. The technical requirements for the feed ratio were adding about 20%–30% fresh mulberry green storage material (water content 60%–70%) to the ordinary pig fattening feed, mixing it well and feeding it to the pigs. There was no significant weight difference between the pigs raised with different feeds, but the price of feed-improved pork was 1.25 USD kg^{-1} more expensive than ordinary pork. The feed ratio of hybrid paper mulberry fodder to fattening raw pork fodder was 1 to 3. Assuming that the average weight of each pig at slaughter was 100 kg, the weight increase from fattening was 60 kg, and 180 kg of fodder was eaten, of which 45 kg (36 kg–54 kg) was added hybrid paper mulberry feed, and the full price for pig fattening feed was 0.47 USD kg^{-1}, but hybrid paper mulberry fermented feed was 0.24 USD kg^{-1} this would represent a total savings per pig of 10.57 USD in fodder cost. Each pig produced 50 kg of meat, so the net profit increased by USD 62.62 per pig. Excluding the additional cost of USD 15.65 per pig in the process of feeding, the profit of feeding a pig with hybrid paper mulberry could increase by USD 57.53 (Yang et al., 2017).

After pig manure is fermented, the dry and wet components are separated and the solid residue is made into organic fertilizer for use as base fertilizer or organic fertilizer for fruit; while the waste liquid is directly sprayed with a biogas slurry truck or a sewage pump on the paper mulberry or forage planting base, forming a complete planting-breeding-cycle agricultural industry chain.

5.3 Grass-sheep (cattle)-fertilizer-fruit mode

After hybrid paper mulberry (protein feed), giant fungus (energy feed), sweet elephant grass (sugar-containing feed) and other forage grasses are harvested and crushed, they can either be directly fed to cattle and sheep according to a certain proportion, or packaged for green storage to be added to feed after fermentation. Cattle and sheep manure mixed with agricultural waste (or pig or chicken manure) can be fermented to produce special organic fertilizer for specific fruit trees. It can also be used for raising earthworms which can be turned into pharmaceuticals, crushed for addition to feed as animal protein, or directly fed to chickens and fish. Sheep dung can be directly returned to the field after fermentation; while earthworm manure is a good organic fertilizer that can be directly returned to the field or applied around fruit trees.

5.4 Hybrid paper mulberry-fish-goose mode

The goose is a large herbivorous waterfowl characterized as water-loving, alert, cold-tolerant, having regularity in its life cycle, etc. It is favored by farmers and consumers because of its strong disease resistance and low breeding pollution. Grass carp is a typical herbivorous fish that inhabits rivers and lakes, generally preferring to live in the middle and lower layers of water and in coastal watery areas. Grass carp feeds on larvae and algae in its juvenile stage. Adult fish also occasionally eat some invertebrate foods like earthworms and dragonflies.

For the sake of comparison, an experiment was set up with four treatments (including control). Among them, conventional grass carp feed was used as the control, while 15% (weight ratio) fresh leaves (dry weight, crushed and granulated), 15% fermented hybrid paper mulberry powder, and 15% unfermented hybrid paper mulberry powder were added to the control as experimental groups. The results showed that after 40 days of feeding, adding 15% hybrid paper mulberry to the feed significantly promoted weight gain in the grass carp. Among them, adding 15% unfermented hybrid paper mulberry dry powder increased the weight of grass carp by 19.92%, and that was the best effect compared with conventional feed (Table 2).

5.5 Paddy-shrimp mode

Having a long frost-free period in the subtropical red soil hilly area, double-cropping rice can be planted in most areas, and double cropping rice-rape triple cropping can be achieved in some areas. The paddy-shrimp mode mentioned in this article refers to the cultivation of crayfish (*Procambarus clarkii*) from November to July of the following year in areas where water quality is good and double-cropping rice is planted, with the planting of late rice from August to October. The most significant feature of this model is that crayfish farming and rice planting do not overlap in time. The entire system includes producers, consumers, decomposers and environmental systems in time, and the rice and crayfish have a mutually beneficial and symbiotic relationship (Fig. 5) (Cao et al., 2017; Liu et al., 2017; Yi et al., 2019).

Table 2 Comparison and analysis of the effects of adding hybrid paper mulberry to grass carp feed

Experimental design	Initial weight (g)	40-day weight (g)	Weight gain relative to control (%)
Conventional feed (control)	303.57	524.67	–
Conventional+15% fresh leaves	303.57	588	12.07
Conventional+15% fermented powder	303.57	592.25	12.88
Conventional+15% unfermented powder	303.57	629.21	19.92

Fig. 5 Schematic diagram of the entire industrial chain design of Qianyanzhou's agricultural green development

The paddy-shrimp complex planting and breeding mode has gradually developed, but it has become controversial in recent years, especially standing out in the anti-poverty project. At present, the Ji'an area has model plots of up to 2010 ha. Due to the technical requirements for breeding, the prices of shrimp and rice are affected by market fluctuations, so some farmers are losing money. The results of the investigation and analysis in this paper showed that net income of per unit area of the rice and shrimp farming mode was significantly higher than that of the rice mono culture mode (Table 3). The annual net income of the company-farmer model and the scale business model were 156% and 195% higher than that of rice monoculture model, respectively. Net ecological and economic benefits were 55.56% and 61.79% higher than that of rice monoculture, respectively. In addition, from the perspective of net cash income and net value of ecosystem service functions, the ecological value brought by the paddy shrimp mode was much higher than the economic benefits it brought, indicating that it could ensure food sufficiency and maintain green water and mountains, which is an effective way to promote the green development of agriculture.

5.6 Summary

A recent study of the combinations of planting and breeding has pointed out that many different types can be achieved (Wang et al., 2018), but figuring out how to strengthen the links between the various models requires cooperation and support from local entrepreneurs, governments, science and technology, foreign capital and other parties. New types of agricultural business entities need to be cultivated that are full of vitality, competitiveness and innovation capabilities, such as a few entrepreneurs. At the same time, there is a need to improve the cultural quality of farmers, cultivate knowledge about various modes of planting and breeding, and provide relevant subsidies. There is also a need for the business entities to drive the coordinated development of farmers (Jiang et al., 2014); and for the government to speed up system and policy innovation to promote the implementation of Qianyanzhou New Mode, and to plan the industrial layout from the policy perspective, reduce transportation costs, and strengthen the benefits and connections between industries. In terms of science and technology, there is a need for cooperation with major universities, scientific research institutes, and foreign-funded enterprises, to introduce key technologies, divide laand flexibly use 5G networks to open up the market environment, so as to promote the better functioning of Qianyanzhou New Mode.

6 Prospects of Qianyanzhou New Mode

The construction of Qianyanzhou New Mode was based on the idea that "Clear waters and green mountains are invaluable assets". This concept was guided by the theory of the living community of mountains, rivers, forests, farmlands,

Table 3 Costs and benefits of the paddy shrimp farming mode and rice monoculture (Unit: USD ha^{-1})

Project		Company + farmer	Scale business households	Rice monoculture
Cash	Expense	–23.58	–23.83	–14.85
	Income	33.35	35.12	18.67
	Net income	9.77	11.29	3.82
	Cost-benefit ratio	0.01	0.02	0.01
Value of ecosystem service functions	Positive value	36.13	36.32	28.28
	Negative value	–3.29	–3.29	–4.71
	Net value	32.84	33.03	23.57
Net ecological and economic benefits		42.61	44.32	27.39
Comprehensive cost-benefit ratio		0.03	0.03	0.01

lakes, grasses, and sand. Relying on the advantages of the Jiangxi tropical climate zone in resources, location, and policies, it has reconstructed the green industry chain of planting, breeding, comprehensive utilization of resources, agricultural products processing and sales platforms in the red soil hilly area, providing favourable support for the construction of ecological civilization, the implementation of rural vitalization strategy, the construction of a beautiful China, the improvement of people's livelihood and welfare, and the realization of sustainable economic and social development. The main agricultural products of each element which have good development prospects for the new mode of Qianyanzhou's industrial chain fulfill the green production requirements of "no antibiotics, less drugs, and using organic fertilizer", ensuring "safety on the tip of the tongue", meeting the health needs of the public and the laws of market development. The design framework of this new mode of Qianyanzhou—the whole industrial chain of green agricultural development, is shown in Fig. 5.

7 Conclusions

This paper focuses on the achievements and progress of the Qianyanzhou Mode in different time spans. From its introduction in the 1980s, it achieved ecological restoration and an economic leap in Jiangxi's Qianyanzhou, causing great social repercussions and solving the major problems of the environment at the time in which it was launched. Nowadays, under the requirements of a new concept, new problems and new advantages, the Qianyanzhou Mode requires a new connotation, and the "Qianyanzhou New Mode" of "forest-fruit-fowl, hybrid paper mulberry-pig-fruit, grass-sheep (cattle)-fertilizer-fruit, hybrid paper mulberry-fish-goose, paddy-shrimp, etc" is taking shape. It relies on the wisdom of Qianyanzhou to solve the problems of building ecological civilization, promoting people's welfare and achieving sustainable economic and social development in the new era.

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新时期千烟洲模式研究进展

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摘　要：20 世纪 80 年代初期，为了解决赣中红壤丘陵区雨季水土流失、旱季农田缺水等问题，中科院千烟洲站李文华院士研究团队提出了著名的"丘上林草丘间塘，河谷滩地果鱼粮"千烟洲模式，进行林–牧–粮、林–果–经、水–陆复合经营等模式的试验示范和推广，解决了生态修复和农业生产中的主要问题。进入新时期以来，在习近平"两山论、生命共同体、生态兴则文明兴"等生态文明思想的引领下，千烟洲模式正在赋予新的内涵。为了减少农药和杜绝抗生素等使用，提升农产品质量，增加农民收入，助力乡村振兴战略，目前千烟洲站在赣中红壤丘陵区重点开展了"林–果–禽、构树–猪–果、草–羊（牛）–肥–果、构树–鱼–鹅、稻–虾"等农业绿色发展模式试验示范，以期为江西赣中革命老区的生态环境保护和农民富裕等生态文明建设贡献千烟洲智慧。

关键词：赣中丘陵；千烟洲新模式；绿色发展；生态文明