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Overview of Theory and Model of Tropical Agricultural Circular Economy in Hainan Province

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Abstract This paper gives a general overview of rationale of tropical agricultural circular economy. On the basis of ecological economic theory, circular economy is a new model of economic development which aims at realizing reducing of resources use, reuse of products and recycling of wastes, conforming to the principle of 4R. It is to make economic system melt into the process of cycle of material of natural ecological system harmoniously. This paper introduces the advantages of developing tropical agriculture in Hainan Province, the main problems existing in the development and two main models of sustainable tropical agricultural development in Hainan Province at present. 9 typical models of tropical agricultural circular economy in Hainan Province are listed in particular, including compound ecological project of forestry and animal husbandry, three-dimensional planting model of plantation, multilayered structure of eucalyptuses, sustainable agricultural model of sightseeing, the model of using animal manure, precision tropical agricultural model, clean production model of tropical agriculture, deep processing model of tropical agricultural products, and the model of ecological agricultural industrialization. Corresponding countermeasures and suggestions are put forward to promote development of tropical agricultural circular economy in Hainan Province as follows: take actions that suit local circumstances, exert advantage and exploit potential; give full play to advantage of integration of production, teaching and research, and promote agriculture by applying scientific and technological advances; the whole staff participate and strengthen construction of soft environment and hard environment.

Key words Circular economy, Tropical agriculture, Sustainable development, Hainan, China

Circular economy has a close relationship with the development of agriculture. Implementing circular economy has great significance to the realization of sustainable development of agriculture, and even to the sustainable development of whole society. In the recent years, the research on circular economy and sustainable development becomes a hotspot^[1–3]. Circular economy has an early start in developed countries, while in China, it still stay at the level of concept. Currently, in the process of constructing ecological province, Hainan Province quickens the pace of transition from traditional agriculture and modern agriculture to agricultural circular economy. Hainan international tourism island has been elevated to national strategy. Tropical agricultural development is an important part of construction of international tourism island, which holds sway over economic development of Hainan. The sustainable development of tropical agriculture is significant to promoting development of Hainan and ensuring agricultural production security and quality of regional environment. We give a general overview of rationale of tropical agricultural circular economy. On the basis of ecological economic theory, circular economy is a

new model of economic development which aims at realizing reducing of resources use, reuse of products and recycling of wastes, conforming to the principle of 4R. It is to make economic system melt into the process of cycle of material of natural ecological system harmoniously. This paper introduces the advantages of developing tropical agriculture in Hainan Province, the main problems existing in the development and two main models of sustainable tropical agricultural development in Hainan Province at present. 9 typical models of tropical agricultural circular economy in Hainan Province are listed in particular, including compound ecological project of forestry and animal husbandry, three-dimensional planting model of plantation, multilayered structure of eucalyptuses, sustainable agricultural model of sightseeing, the model of using animal manure, precision tropical agricultural model, clean production model of tropical agriculture, deep processing model of tropical agricultural products, and the model of ecological agricultural industrialization. Corresponding countermeasures and suggestions are put forward to promote development of tropical agricultural circular economy in Hainan Province.

1 Basic concept of tropical agricultural circular economy

1.1 The formation of tropical sustainable agricultural development concept Sustainable development has become the common concern of human society nowadays^[4]. Sustainable tropical agriculture is derived from the extension of sustainable developing and sustainable agriculture into tropical agricul-

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ture and rural economy in tropical regions. The tropical region is the geographical unit with the characteristics of unique climate and geographical features. It has the sustainable development system for tropical agriculture, integrating agricultural economy, rural society, agricultural resources and environment, agricultural production, agricultural technology and other factors with the characteristics of tropical zones. It also has particularity.

Sustainable development of tropical agriculture will mainly focus on the following three basic objectives: first, further improve the output and quality of agriculture, forestry, animal husbandry, fishery and other industries, spare no efforts to promote productivity and promote the development of agricultural production; second, improve farmers' net income per capita, alleviate poverty, control population, and propel sustainable and coordinated development of agro-ecological economy; third, maintain and improve agricultural ecological environment, especially pay attention to the conservation of the tropical rain forest and biodiversity, strengthen governance of environmental pollution and soil erosion, improve and optimize agricultural natural resources and promote the utilization rate of agricultural resources.

1.2 Theoretical basis of tropical agricultural circular economy On the basis of ecological economic theory, circular economy is a new model of economic development which aims at realizing reducing of resources use, reuse of products and recycling of wastes, conforming to the principle of 4R. It is to make economic system melt into the process of cycle of material of natural ecological system harmoniously. Tropical agricultural circular economy is to apply the concept of circular economy in tropical agricultural systems, reduce the inputs of resources and materials in the process of tropical agricultural production and life cycle of products, reduce the emission of wastes, and achieve "win-win" of tropical agricultural economic development and ecological environment benefits. The theory is based on theory of tropical agro-ecological economic system. The tropical agro-ecological economic system is composed of agro-ecosystem, agricultural economic system and rural social system. The agro-ecosystem, agricultural economic system and rural social system are integrated through material recycling, energy flow and information exchange. In this system, the substance can be recycled incessantly through the physical process, chemical process, and biological process.

1.3 Principles and main content of tropical agricultural circular economy Developing tropical agricultural circular economy must conform to principle of reduction, principle of reuse, principle of recycle and principle of recovery. In addition, developing tropical agricultural circular economy must also adhere to the principle of taking actions that suit local circumstances, the principle of systematicity, participation, innovation and combination of use, maintenance and protection of land resources, the principle of rational resources flow and optimal allocation of resources, the principle of rationalization of economic structure, the principle of linking eco-industries and the principle of "win-win" of socio-economic benefits and ecological environmental benefits^[4].

Tropical agricultural industrial system is the system coupling tropical farming system, tropical forestry system, tropical fisheries system, tropical animal husbandry system, and the extended system of production and processing industries of tropical agricultural products, the system of trade and service industries of tropical agricultural products, and the system of consumption of tropical agricultural products. These systems are interdependent, interrelated closely and synergistic. The integration feature of this agricultural industry determines that we must implement coordinated development of agricultural industry. We need to establish and strengthen the agricultural industry through circular economy, in order to obtain the best economic benefits and environmental benefits. In addition, each subsystem should vigorously promote clean production, in order to minimize pollution; subsystems should exchange wastes fully, in order to recycle them into resources.

2 Overview of tropical agricultural development in Hainan Province

2.1 The advantage of developing tropical agriculture in Hainan Province Hainan Province, located in southernmost China, surrounded by the sea, with the low latitude, has a tropical monsoon climate. Hainan is rich in land resources, with diverse land types and extensive land suitability. Most of the land in Hainan has the characteristics of being concentrated into a wide expanse and being easily reclaimed. The land is suitable for reclamation by machinery, with high use rate and prodigious potential of development. In addition, high coverage rate of forestry keeps the soil and water in a good state. Compared with the inland, Hainan Island has strong complementary characteristic in terms of climate, crop resources, fruits, vegetables varieties and harvest time. Because of geographical particularity, many cash crops, such as rubber, coffee, cashew nuts, coconut, pepper, betel nuts, sisal and so on, are of great scarcity. These have become potentials and advantages for the sustainable development of tropical agricultural economy in Hainan Province, and have brought great space for sustainable development of tropical agriculture in Hainan Province.

2.2 The main problems existing in the agricultural development of Hainan Province The overall intensification degree, modernization level, resources use rate and productivity level of tropical agriculture in Hainan Province are all relatively low. The special climatic conditions in tropical regions make fertility of agricultural land decline, and soil erosion and land desertification serious. Excessive use of pesticides and fertilizers exerts adverse impact on the quality of tropical agricultural products, tropical agricultural ecosystem and human health.

In addition, Hainan farmers are generally with low quality and poor educational background, and there is a critical shortage of personnel who promote agricultural technology, restricting the promotion and application of modern advanced agricultural technology and influencing improvement of the agricultural ecological environment and development of high-efficiency tropical agriculture.

2.3 Models of sustainable tropical agricultural development in Hainan Province

Currently, there are mainly two models of sustainable tropical agricultural development. One is the ecological agriculture, the practice of which starts from construction of eco-farmers and eco-villages, and extends to the construction of ecological town, ecological county, ecological city, and even ecological province. Ecological agriculture is three-dimensional netlike rural ecological economic system^[5], which uses principles of ecology and ecological economics to guide rural production and reproduction, and uses the energy conversion law among human, biology and environment, and the law of symbiosis among organism in order to promote repeated use and recycling of material. Ecological agriculture fully and rationally uses local natural resources and modern technical achievements, implements non-waste production and pollution-free production, and establishes a virtuous circular system, integrating many industries, so that it achieves comprehensive development. As can be seen from the definition of ecological agriculture, it has a broad meaning, and actually embodies the content of organic agriculture. The other is intensive sustainable agriculture, which emphasizes high efficiency, high yield, and coordinated development of food security and sustainability. The intensive sustainable agriculture is to realize sustainable use in terms of resources, ecology and environment, and to realize high input, high output and high benefits in terms of economy and production. In the light of practice of sustainable development of tropical agriculture in Hainan Province, the ecological agriculture develops extensively, and has formed a number of specific models, technologies and operating methods. Therefore, the ecological agriculture now is the main model of sustainable development of tropical agriculture in Hainan Province.

3 Typical models of developing tropical agricultural circular economy in Hainan Province

3.1 Compound ecological project of forestry and animal husbandry Compound ecological project of forestry and animal husbandry means that the byproducts of forestry, such as certain types of leaves, can be directly used as livestock feed, or we feed livestock and poultry directly in the forest. For example, by using resources condition that there are many rubber producing bases in local areas, "rubber-tea-chicken model" in Wenchang City and other places, is to grow tea plant within semi-canopy rubber plants, implement intensive operation and breed Wenchang Chicken on a large scale, which can get better economic and ecological benefits.

3.2 Three-dimensional planting model of plantation By using the unique rubber resources in tropical regions and imitating multi-level structure of forest ecosystem, some three-dimensional structure models are established, such as "banana-tea plant", "rubber-pepper" and "rubber-Chinese herbal medicine". The three-dimensional structure model can effectively improve micro-climate of forestry and provide good habitat for the growth of rubber and other crops. In addition, as the com-

plex group structure is built, it increases the coverage rate of vegetation and strengthens the capacity of storing precipitation of vegetation. Composite structure rubber plantations also can effectively use environmental resources, and promote bio-yield. A large amount of withered foliage forms mulch, and a great deal of organic matter continuously supplies soil nutrients and improves soil structure, which continuously improves the soil fertility in forest and creates the conditions for continuous improvement of productivity of plant community.

3.3 Multilayered structure of eucalyptuses In recent years, with the implementation of integration program of forest, pulp and paper in Hainan Province, the area of eucalyptus forests is increased significantly. Therefore, we can plant pineapple and other tropical crops within eucalyptus forest, and use physiological characteristics of different plants to learn from strong points to offset weakness. If we conduct rational planning, we can also promote economic benefits and ecological benefits.

3.4 Sustainable agricultural model of sightseeing It is to use abundant tropical resources to develop tourism in order to combine tropical agriculture and tourism closely and promote development mutually. On the basis of developing ecology-oriented tropical agriculture, we should develop tourism and sightseeing agriculture in tropical areas moderately, and exert existing advantages of resources, in order to create greater benefits and promote sustainable development of ecology-oriented tropical sightseeing agriculture.

3.5 The model of using animal manure The model is to transform the excrement of poultry and livestock into resources through certain technical processing, and to realize recycling among cultivation, breeding and so on. The existing low use rate of animal manure in chicken farms and pig farms of Hainan Province affects the surrounding environment. If we transform the excrement of poultry and livestock into energy, manure and feed, it either can improve the environment, and or can achieve certain economic benefits.

3.6 Precision tropical agricultural model According to the growth habits of tropical crops and external environmental factors, by relying on technological means of information, we should vigorously promote the precision balanced fertilization, and establish and perfect modern agricultural operating technology and management system, so that we use the least inputs to obtain the most outputs.

3.7 Clean production model of tropical agriculture Clean production of tropical agriculture means the practical agricultural technologies that not only can meet the need of agricultural production of tropical agriculture, but also can realize rational use of resources and protection of the environment. We will control agricultural pollution in the whole process "from cradle to grave", which is the core of the concept of tropical agricultural circular economy. Through the use of environment-friendly "green" agricultural chemicals, and the improvement of agricultural technology, we are to reduce the risks brought by agricultural production, agricultural products and service process to environment and human.

3.8 Deep processing model of tropical agricultural products

It is to extend the industrial chain of agricultural production; actively advocate that we develop biological agriculture in accordance with the law of food chain; vigorously develop processing industry, packaging industry, preservation industry, storage industry, transportation industry and marketing industry of agricultural products; form supporting industrial chain integrating cultivation or breeding-processing-transportation-marketing; improve the quality and added-value of agricultural products; reduce emission of agricultural production wastes.

3.9 The model of ecological agricultural industrialization

The agricultural industrial ecological development is increasingly promoted in Hainan Province; pollution-free agricultural products and green food production have begun to take shape; it gradually forms a pattern taking market as orientation, and taking technology as means, which is characterized by coordinated development of economic benefits, social benefits and ecological benefits; the agricultural industrial ecological development has supporting system of policy and service; there is guarantee for inputs, there is base for production and there is market for sales. Golden Coconut Plant Eco-industrial Park in Hainan Province is a typical example of ecological agricultural industry, which is a complete closed eco-industrial network integrating "agriculture, sugar, alcohol, methane and agriculture" systematically^[5].

4 Corresponding countermeasures and suggestions of promoting development of tropical agricultural circular economy in Hainan Province

4.1 Take actions that suit local circumstances, exert advantage and exploit potential

Being that the landform type and the economic development level in all regions of Hainan Province are different to much extent, therefore, we should be adapted to local conditions, and conduct rational planning, that is, it is not only to consider the overall layout, but also to consider the regional characteristics. Tropical agricultural circular economy also needs the coordinated development of agriculture, forestry, animal husbandry, fisheries and other industries. We should vigorously develop tropical cash crops, southern medicinal resources, marine biological resources and other advantageous resources; focus on the development of bio-energy industry, rubber processing industry, oil and gas downstream industries, tropical fast-growing plantations, tropical paper industry and so on; highlight the characteristics of "contract agriculture", "green agriculture", and "technology agriculture"; pay close attention to "seasonal difference, famous and high-quality brand, and non-pollution"; quicken the pace of tropical agricultural development.

4.2 Give full play to advantage of integration of production, teaching and research, and promote agriculture by applying scientific and technological advances Promoting agriculture through science and technology can not do without

agricultural talents. Hainan Province must proceed from reality, put greater efforts in agricultural development, foster and introduce a large number of agricultural technological talents with planning and intention, and promote the quality of science and culture of laborers. In the mean time, Hainan Province must strengthen the research and promotion of comprehensive technology of ecological agriculture, rely on advances in technology, and accelerate the development of tropical ecological agricultural construction and ecological province construction of Hainan Province. Chinese Academy of Tropical Agriculture, Hainan University, and other colleges of researching tropical agriculture, as well as the management model of integration of production, learning and research, can provide intellectual support and technical assurance for developing tropical agricultural circular economy in Hainan Province. In addition, we should strengthen the role of National Tropical Agricultural Science and Technology Park which is located in Danzhou City of Hainan Province; guide farmers to conduct ecological demonstration and ecological development; resolve the problems of agricultural technology and management.

4.3 Make whole staff participate and strengthen construction of soft environment and hard environment

Tropical agricultural circular economy is a complicated systematic project integrating economy, technology and society. The government, farmers and all groups of society can promote development of economy, technology and society through joint efforts. Meanwhile, it requires the powerful support of hard environment and soft environment of capital, technology and laws and regulations. Due to the slow development of some areas in Hainan Province and weak consciousness of environment of people, we should strongly advocate green consumption, and scientific cultivation, in order to promote the development of circular economy.

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