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# Study on the Development of Under-forest Economy in Guangdong Mountain Areas

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**Abstract** From the origin and connotation of the under-forest economy, this paper analyzed plight of the development of under-forest economy in Guangdong mountain areas. It discussed benefits of under-forest economy, favorable conditions and development path of under-forest economy in Guangdong mountain areas. Results indicate that developing under-forest economy is an essential path for realizing green growth and co-ordinated development of Guangdong mountain areas. However, due to terrain, market, management and technology reasons, the under-forest economy is still not fully developed in Guangdong mountain areas. The development path of under-forest economy suitable for Guangdong mountain areas should be based on ecological protection and oriented towards maximizing ecological, economic and social benefits. Guangdong mountain areas have in-born natural and resource advantages, economic pull of development mode and market demand change, and favorable condition of policy encouragement for development of under-forest economy. Finally, it came up with recommendations for development of under-forest economy in Guangdong mountain areas from development mode, industrial distribution and development direction.

**Key words** Guangdong mountain areas, Under-forest economy, Development path

## 1 Introduction

Guangdong Province plays an important role in national economy. By 2013, general financial revenue of Guangdong Province has ranked in the first place of the whole country for 23 consecutive years<sup>[1]</sup>. However, the socio-economic development is extremely unbalanced in Guangdong mountain areas and plain areas. Therefore, promoting rapid and sound development of Guangdong mountain areas is the key for realizing regional coordinated and sustainable development of Guangdong Province. In recent years, the under-forest economy receives more and more attention in China and remains the stage of vigorous development<sup>[2]</sup>. In Guangdong mountain areas, the development scale of under-forest economy is still very small and relatively backward for following reasons: (i) Terrain is complex, so it is difficult to conduct large-scale under-forest planting and implement mechanized operation, and difficult to manage the under-forest breeding. (ii) The development of under-forest economy involves many departments. Breeding industry and planting industry of some counties and regions are under jurisdiction of different departments. For example, in Lianping County of Heyuan City, planting industry is managed by bureau of agriculture, breeding industry is managed by bureau of animal husbandry, veterinary medicine and fishery. Thus, government functions may overlap or be vacant in development and extension of under-forest economy. (iii) The under-forest economy lacks guidance of industrial associations and leading enterprises and it lacks vitality. (iv) Sci-tech input is insufficient and there are few researches

about under-forest planting and breeding in subtropical mountain areas. Therefore, it is necessary to summarize origin and connotation of concept of the under-forest economy, analyze feasibility of extending the under-forest economy and favorable conditions for developing under-forest economy in Guangdong mountain areas, discuss development mode, spatial distribution and development direction of the under-forest economy in Guangdong mountain areas, seek suitable development path, and accordingly come up with pertinent recommendations for promoting development of under-forest economy in Guangdong mountain areas, economic transformation of mountain areas, and scientific and effective use of forest resources.

## 2 Connotation and benefits of the under-forest economy

**2.1 The under-forest economy and agroforestry** The concept of agroforestry is a basis of generation of the under-forest economy, while the under-forest economy is a specific manifestation of agroforestry. As a type of land use, agroforestry has a long history, especially in tropical zone and subtropical zone. Taking Guangdong Province as an example, the famous mulberry tree based fishpond model (mulberry tree - silkworm - fishpond) in the Delta of the Pearl River has a long history. Since publication of *Tree Crops: A permanent Agriculture* by Russell Smith in 1950, the agroforestry has gradually become an independent discipline, but its practical significance and theoretical value are still not valued for a long time. As a new agricultural production mode and economic phenomenon, the under-forest economy receives close attention of State Bureau of Forestry in recent years. Since 2010, the State Bureau of Forestry held many times of meetings to promote development of the under-forest economy. In August 2012, General Office of State Council issued *Opinions about Accelerating Development of the Under-forest Economy*.

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opment of Under-forest Economy (No. 2012: 42). Although the under-forest economy has been lifted to strategically important position, scientific theoretical researches and practical experience about the under-forest economy are still quite insufficient. Relevant survey shows that there are more than 500 types of compound agroforestry ecosystem, including agriculture - forestry system, forestry - animal husbandry system, agriculture - forestry - animal husbandry system, forestry - fishery system, forestry - agriculture - animal husbandry - fishery system, forestry - agriculture - insect system and sightseeing agroforestry system, etc<sup>[3]</sup>. These systems value suiting measures to local conditions and different times, to optimize combination of resources and production elements. The under-forestry economy stresses developing planting, breeding and other suitable industries using under-forest resources such as ecological public welfare forest and commercial forest, to realize high-efficient use of forest resources, mutual promotion of agriculture, forestry and animal husbandry, and realize ecological, social and economic benefits of forest land and forest resources.

**2.2 Connotation of the under-forest economy** There are few theoretical researches about the under-forest economy. The earliest literature found in CNKI is in 2003, while 4/5 literature appear after 2010<sup>[4]</sup>. In limited researches, there is still no uniform definition of the under-forest economy. Li Ronghe *et al* stated that the under-forest economy is a compound operating mode taking full advantage of land resources under forest to develop planting and breeding industries and realize share of agriculture, forestry and animal husbandry resources and economic win-win<sup>[5]</sup>. Gu Xiaojun *et al* stated that the under-forest economy is a compound operating mode of carrying out forestry, agriculture and animal husbandry with the aid of under-forest ecological environment and resources<sup>[6]</sup>. Zhan Chenxiang *et al* believed that the under-forest economy is a vertical compound production and operation taking full advantage of under-forest resources to develop planting and breeding industries, so as to realize resource sharing, mutual supplement with each other's advantages, and coordinated development<sup>[7]</sup>. Zhang Dongsheng *et al* extracted five key elements of the under-forest economy: (i) taking forest land as major scope of activities, including related ecological cultural resources; (ii) taking ecology, ecological economics, system engineering as basic theories; (iii) taking maximization of economic, ecological and social benefits as direct objective; (iv) taking reasonable distribution and fully use of under-forest resources to develop circular economy as basic idea; (v) taking sustainable development as guiding principle<sup>[8]</sup>. From the above opinions and combining actual situations of Guangdong mountain areas, the under-forest economy of Guangdong mountain areas can be defined as compound operating mode of scientific and reasonable use of under-forest resources on the basis of protecting ecology. The purpose is to ensure maximal ecological, economic and social benefits, promote socio-economic development and ecological protection of Guangdong mountain areas, and narrow the gap between rich and poor.

### 2.3 Benefits of the under-forest economy

**2.3.1** Ecological and economic benefits of the under-forest economy. According to most existing researches, compound operation of agriculture and forestry has higher ecological and economic benefits than simple crop planting and breeding. Under-forest intercropping can generate water and soil conservation effect, soil fertility effect, hydrology effect, wind prevention effect, thermal power effect, CO<sub>2</sub> regulation function, and dust prevention function<sup>[9]</sup>. In ecological benefit, experts and scholars generally think that the agriculture-compound mode with local characteristics can obtain higher ecological benefits. For example, "forest - grass - poultry" system can effectively combine ecological and economic benefits and is an under-forest economic development mode with sustainable development characteristics suitable for Chongming Island<sup>[10]</sup>. The typical rubber - tea - chicken mode in Wenchang City of Hainan Province can significantly improve physical properties of soil, improve soil fertility and increase yield of rubber and tea, improve chicken quality, having higher ecological benefits<sup>[11]</sup>. *Alnus formosana* forest - grass compound mode has huge potential of increasing content of organic carbon and soil fertility<sup>[12]</sup>. The ecological type economic forest compound mode for slope farmland in Three Gorges Reservoir Region has high comprehensive benefit and excellent effect<sup>[13]</sup>. In economic benefit, there are few individual researches. Most scholars stress experimental statistics of economic benefit on the basis of ecological benefit, to obtain gain of economic benefit. According to previous researches, the under-forest economy uses forest land from multiple targets, multiple levels and multiple perspectives, undertakes forestry, agriculture, breeding industry or even tourism, to realize high-efficient use and intensive operation of forest land, which is favorable for increasing farmers' income and stimulating labor enthusiasm.

**2.3.2** Mode selection and comprehensive benefit of the under-forest economy. The ecological benefit of under-forest economy can be understood as turning "one-dimensional" agricultural ecosystem into "multi-dimensional" agriculture-forestry ecosystem, increasing diversity of system in space and time, and making ecosystem more complex and more stable, and have higher ecological benefit. However, introduction of different species generates different ecological and ecological benefits, and different population density has different influence on ecosystem. Thus, improper development of the under-forest economy may bring about negative influence or even affect ecosystem balance. Selecting a suitable under-forest economic mode can increase economic benefit on the basis of ensuring ecological benefit. Research of other scholars on intercropping several economic crops under bamboo woods in three counties of Anhui Province<sup>[14]</sup> and research of several types of timber under China fir woods show that excellent vegetation coverage under forest can effectively reduce water and soil loss; different plants under forest can exert different influence on river water characteristics, loss of silt, and loss of nitrogen. Thus, it is required to select optimum crops or plants for under-forest planting. Research of intercropping under rubber artificial forest in Hain-

an<sup>[16]</sup> and different under-forest operating mode of poplar woods in Heze City of Shandong Province indicate that different operating mode has different influence on economic benefit, so it is necessary to select higher value under-forest economic mode through comparative experiment. According to previous researches, increase of comprehensive benefit involves geographical position, types of animals and plants, distribution density, and growth stage. Selection of under-forest economic mode for a certain area exerts an important influence on comprehensive benefit of under-forest economy.

### 3 Development conditions for the under-forest economy of Guangdong mountain areas

**3.1 Resource condition: inborn natural environment and resource advantage** Natural resource advantages for developing under-forest economy in Guangdong mountain areas are mainly manifested in two aspects. Firstly, mountain areas are rich in forest land resources. In 2010, forest area of 51 mountain counties in Guangdong Province reached 80521 km<sup>2</sup> accounting for 73.3% of the whole Guangdong Province, and the forest coverage was up to 68.8%. Secondly, mountain areas have warm and moist habitat conditions. Under influence of southeast monsoon and typhoon, Guangdong Province has plentiful rainfall. Besides, Guangdong Province has a lot of rivers, so the water resource is abundant. In addition to subtropical location, Guangdong Province has warm and moist habitat for distribution and growth of plant vegetation in mountain areas. Besides, it also provides rich water, heat and sunshine resources for development of under-forest economy, especially subtropical plants. The development and use of forest land and forest resources are still concentrated on traditional forestry economy, and products are mainly timber, bamboo, tung tree seed, tea oil tree seed, and rosin. The implementation of under-forest economy can provide rich under-forest economic products, increase added value and utilization efficiency of forest land, and promote transformation of forest land resources from extensive to comprehensive use type. Inborn natural environment and resource advantages are breeding ground of the under-forest economy. With the development of under-forest economy, advantages and potential of ecological environment and natural resources of Guangdong mountain areas will receive better performance.

**3.2 Economic conditions: change of development mode and market demand** On the one hand, as ecological barrier and water source conservation base of the Delta of the Pearl River, mountain areas are faced with pressure of ecological environmental protection and economic development for a long time. In addition to backward economy and inconvenient traffic, Guangdong mountain areas are not suitable for industrial development mode of plain areas. Mountain areas support GDP with resource based industries. Although it can bring certain tax revenue for local government, it can not fundamentally improve living conditions of people in mountain areas. Some resource based industries lack market competitiveness, have low income, and also bring negative influence on ecological environment due to low level of technology.

Therefore, government and scholars are making effort to seek feasible path for realizing transformation of extensive development to ecological development and shaking off poverty and setting out on the road to prosperity. In addition, with advance of ecological compensation policy in the framework of main functional area, Guangdong Province government started implementing incentive financial mechanism with ecological protection as purpose in counties of mountain forest protection, to promote transformation of development mode in these areas. Therefore, the development direction of Guangdong mountain areas should be ecological development oriented towards protecting mountain forest and increasing economic benefit.

On the other hand, with exposure of food security accidents in China, people have increasingly high demand for natural green foods. In addition to constantly improving living conditions, people care more about life care and life quality. Due to backward economy, most areas of mountain areas keep excellent ecological environment, and green mountains and clear water. Rich forest resources are superior conditions that can not be duplicated in plain areas of the Delta Area of the Pearl River. Planting Chinese herbs and crops in forest, breeding livestock and poultry, and conducting sightseeing and life-care tourism meet current market demand. Change of mountain area development mode and market demand provides opportunity for development of the under-forest economy and becomes huge pull for development of the under-forest economy.

**3.3 Policy condition: forestry economy changing to under-forest economy** In recent years, China has issued many policies and measures to promote development of the under-forest economy, and many leading and pilot cities and areas provide much precious experience. Guangdong Provincial government, especially cities and counties in mountain areas, such as Shaoguan and Zhaoqing, also has taken various measures including government guidance, policy support, and typical model, to promote the development of under-forest economy. In 2010, Guangdong Forestry Bureau issued *Guiding Opinions on Accelerating the Forestry Development* (No. :[2010] 98), to encourage under-forest planting and breeding industries and wild animals and plants cultivation industries. In 2012, Shaoguan Forestry Bureau issued *Opinions about Energetically Promoting Development of Under-forest Economy in Shaoguan City* (No. :[2012] 40) and established the objective of developing to 13 300 hm<sup>2</sup> and realizing annual output value of 500 million yuan in three years. The *Development Plan for Under-forest Economy of Guangdong Province (2010 – 2020)* will provide clear direction for development of under-forest economy of Guangdong Province.

At the same time, by the end of 2011, the Guangdong Province smoothly completed the collective forest tenure reform. Guangdong Province is one of the most important provinces in southern collective forest areas, having collective forest land up to  $1 \times 10^6$  hm<sup>2</sup>, accounting for 91.5% of the total forest land area of the whole province. Before the tenure reform, the ownership is not

clear and operating mechanism is not flexible, forest farmers are not enthusiastic for forestry and under-forest development. The forest tenure reform completed  $9.53 \times 10^6 \text{ hm}^2$  field boundary survey, confirmed  $9.4 \times 10^6 \text{ hm}^2$  forest land ownership, issued 1.081 million forest land use right certificates, the area of certificate issued up to  $9.13 \times 10^6 \text{ hm}^2$ , made clear ownership of mountain forest and established operating subject status of farmers. The completion of collective forest tenure reform is favorable for invigorating forest land resources and forest resources, stimulating farmers' enthusiasm, and laying solid foundation for development of under-forest economy. In the driving action of policies, the forestry economy is gradually taking on the trend of moving to under-forest economy.

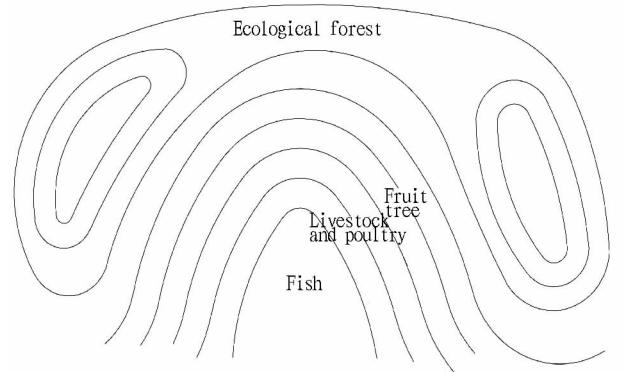
## 4 Development paths for the under-forest economy of Guangdong mountain areas

### 4.1 Selecting development modes according to actual local conditions

Industrial modes of the under-forest economy mainly include forest-grain mode, forest-grass mode, forest-medicinal plant mode, forest-flower mode, forest-fruit mode, forest-edible fungus mode, forest-vegetable mode, forest-oil crop mode, forest-poultry mode, and under-forest special poultry breeding, and under-forest special economic animal breeding, etc<sup>[2]</sup>. Each mode can be subdivided according to vegetation or target objects. For example, forest-grain mode can be subdivided into forest-crop and fruit-crop modes. It also can divide under-forest economy into "company + base + farmer household" and "company + farmer household" according to management methods<sup>[19]</sup>. No matter what kind of division, selecting suitable development mode of under-forest economy is an essential drive for building core competitiveness.

**4.1.1** Selecting the development mode according to natural conditions. According to heat, water, terrain and vegetation conditions, Guangdong Province should select different development modes in different mountain areas. Mountain areas in middle subtropical zone (mainly northern Guangdong mountain areas) have high relief and complex terrain. Some areas are subject to cold wave in winter, so tropical crops have difficulty in passing the winter. It is suitable to develop relatively simple under-forest economic mode. From low to high altitude and from gentle slope to steep slope, it is required to select different under-forest economic mode according to actual local situations, such as forest-poultry, forest-grain, forest-edible fungus, forest-medicinal plant or forest-grass. Mountain areas in southern subtropical zone (mainly western Guangdong and eastern Guangdong mountain areas) have abundant heat and water, and most parts are hilly areas, so it is more suitable for vertical distribution of agriculture and forestry. According to combination of forest, land, water and heat, the under-forest economy may be developed in many modes. A successful compound land use type is "fish - poultry - fruit tree - ecological forest" mode, as shown in Fig. 1. Such mode can protect the entire agroforestry system well. Besides, such vertical distribution

stresses terraced type development, arranges different planting and breeding types according to difference in water in different height, so it more effectively uses land, water and heat resources of southern subtropical mountain areas. This vertical under-forest economic mode is typical in Gaozhou and has excellent development in southern subtropical mountain areas of Guangdong Province, and it is worth popularizing and learning.



**Fig.1** Sketch for distribution of typical agroforestry in southern subtropical mountain areas

### 4.1.2 Selecting development mode according to local characteristics and market preference.

Apart from natural conditions, the development mode of under-forest economy should combine local characteristics, build local characteristic brand, and extend industrial chain. Successful cases of the under-forest economy in Guangdong Province include Five Black Chicken, Black Goat and *Amomum villosum* Lour. of Nanxiong, and Yellow Hair Chicken of Wuchuan. These are local characteristic agricultural products, so they have higher competitiveness and effectively promote local economic development. For example, in Jiangtou Town of Nanxiong City, the black goat breeders have reached nearly 100. The annual increase of income was more than one million yuan (10 000 yuan each breeder). The development of black goat industry also promotes development of other industries, such as catering trade and tourism<sup>[20]</sup>. Situated in tropical and subtropical zone, Guangdong Province is rich in species and suitable for planting various agricultural crops. Guangdong Province should attach great importance to protection and development of traditional southern species. For example, southern medicinal plants have gifted advantages in Guangdong, but due to excessive excavation and no effective protection, they close to extinction. Combining development of the under-forest economy, Guangdong Province should protect diversity of tropical and subtropical species, cultivate local original species, and realize economic benefits and ecological benefits.

### 4.2 Optimizing industrial distribution

Factors influencing optimization of industrial distribution are listed in Table 1.

**4.2.1** Optimizing industrial distribution according to industrial advantages and market demands. Theoretical researches of the under-forest economy focus on development measures on the basis of summarizing practical experience, while few researches touch up-

on industrial distribution. There are two analysis methods of industrial distribution: (i) Location Quotient based method, and (ii) Shift Share Method (SSM). Location quotient based method firstly determines superior industries of agriculture, and then selects suitable industrial distribution for under-forest economy<sup>[21]</sup>; SSM focus on development of under-forest industrial cluster on the basis of strengths and weaknesses of regional economic structure<sup>[22]</sup>. Advantages of these two methods: (i) industrial distribution planning is based on quantitative survey, so it is scientific; (ii)

model data are easy to collect; (iii) industrial distribution planning of under-forest economy has certain guiding significance. But they care little about essential carrier of the under-forest economy: forest vegetation and under-forest land. Apart from advantages of industrial distribution and market demands, the development of under-forest economy is also influenced from natural conditions, such as forest tree species, soil and forest land terrain. Therefore, it is required to consider natural resource conditions when optimizing industrial distribution of the under-forest economy.

**Table 1** Factors influencing optimization of industrial distribution

Types	Influence factors	Influence content
Economic conditions	Industrial advantages and market demands	Influencing selection of planting and breeding species
Natural conditions	Terrain, soil properties, microclimate, vegetation, and water source distribution, etc Land bearing capacity	Influencing suitability of under-forest economy and selection of planting and breeding species Influencing planting and breeding density

**4. 2. 2** Optimizing industrial distribution according to natural conditions. The industrial distribution can be optimized according to natural conditions by following measures. (i) Water source protection zone, nature reserve area, and forest parks should be taken as prohibited development areas. (ii) It is recommended to divide under-forest economic development areas into key development area, conditional development area and reserved development area according to terrain, soil properties, microclimate, vegetation and water source distribution. (iii) It is required to calculate the planting and breeding density according to land bearing capacity of different areas, and then select proper under-forest economic mode according to market preference and industrial advantages. It should be specially noted that the development of under-forest economy in special habitat should attach great importance to ecological benefit. Water and soil loss and stony desertification are major limitations of ecological construction in mountain areas of Guangdong Province. In areas where water and soil loss frequently occurs, it should take special notice of water and soil conservation function of crops. For example, under the oil tea shrubs, it is feasible to plant short-term crops, such as *Amomum villosum* Lour, to increase economic income and prevent water and soil loss. For limestone areas and purple sand shale areas in Guangdong mountain areas, it is required to select proper under-forest economic mode in combination with water and soil conservation and stony desertification measures.

**4. 3 Exploring under-forest potential of ecological public welfare forest** The potential of under-forest economic forest in Guangdong mountain areas lies in ecological public welfare forest. The ecological public welfare forest of Guangdong Province is centralized in mountain areas. After division of ecological public welfare forest, the original owners of mountain forest can not fell trees or do other operating activities in the ecological public welfare forest. The protection of ecological public welfare forest generates huge ecological benefits in the entire society, but it limits production and development rights of people in mountain areas. In 2007, the compensation standard of ecological public welfare forest in

Guangdong Province was 0.53 yuan/ $hm^2$ . By 2012, it increased to 1.2 yuan/ $hm^2$ . According to the field survey, the annual rental rate of forest land in a county of Qingyuan City was 1.33 yuan/ $hm^2$  in 2009, but only 0.9 yuan/ $hm^2$  was compensated to forest farmers, obviously lower than the rental rate. In addition to continual rise of timber price, owners of some better forest land will have the tendency of turning ecological public welfare forest to commercial forest. Besides, the gap between management and protection funds and actual input for ecological public welfare forest is large. Workers of forest management and protection receive low wage. In 2011, the full-time forest management and protection worker only received 8 000 yuan on average annually. In Longchuan County of Heyuan City, the forest management and protection worker only received 350 yuan/month (4 200 yuan/year). As a result, people are unwilling to do such work and it exerts certain influence on management and protection of ecological public welfare forest. For mountain areas with backward economy and rich forest resources, local government fails to provide compensation funds, consequently leading to great pressure of forest land management and protection. Therefore, it is required to change thought, vitalize under-forest land resources, develop under-forest economy, seek self-value creation on the basis of promoting protection of ecological public welfare forest, and to promote change of government subsidy to self-development. This is the essential development direction of under-forest economy in mountain areas. Furthermore, developing planting and breeding industries under ecological public welfare forest should avoid water source, natural reserve zone, and select scientific development mode and proper planting and breeding density without influencing ecological value and ecological safety of ecological public welfare forest.

## 5 Conclusions and discussions

The development of under-forest economy in Guangdong Province is slow, so it is required to actively explore suitable development path to promote development transformation of Guangdong mountain areas. Guangdong mountain areas have in-born natural and

resource advantages, economic pull of development mode and market demand change, and favorable condition of policy encouragement for development of under-forest economy. Development path suitable for under-forest economy in Guangdong mountain areas should be based on ecological protection, to realize maximization of ecological, economic and social benefits. Besides, it should select optimum industrial development mode combining forest, land, water and heat, local characteristics and market preference. In addition, it is recommended to optimize spatial distribution and make proper planning for under-forest economy in accordance with actual local conditions. Also, it is required to encourage development of under-forest economy using the public welfare forest. Developing the under-forest economy is an important path for green growth of economy in Guangdong mountain areas. Government at all levels should organize forces and enhance researches to realize scientific development of the under-forest economy. Government should solve a series of problems, such as how to promote the development of under-forest economy by administrative means, how to make strategic arrangement, how to grasp the development yardstick, how to implement the industrial distribution, how industrial associations guide actions of farmers and enterprises, how leading enterprises lead the industry, how to increase sci-tech input, how to unblock the market information channel, and how to build local under-forest product brand and extend the industrial chain.

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**4.4 Regulating intervening act of local government** It is recommended to bring into full play guidance of agricultural support policies of Hubei provincial government, properly intervene against financial economic act in rural areas, and guide implementation of rural financial policies. Combining local rural economic and financial situations, it is recommended to speed up building rural corporate guarantee system, rural micro business loan risk compensation system, encourage, support and regulate development of specialized intermediaries closely related to rural financial ecology, improve service level and social reputation of intermediaries, promote prosperous development of rural economy and finance, and boost quality of rural financial ecology in Hubei Province.

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