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Research on the coupling and coordinated development of forest economic and ecological environment systems in Heilongjiang Province

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ABSTRACT

The coupling coordination degree model is used to analyze the change law of the inherent coupling relationship between the forest economy and the ecological environment system in Heilongjiang Province from 2006 to 2018 and its causes. The results show that by combining the coupling relationship with the relative priority of under-forest economic development, the coupling relationship change can be divided into three stages, the coupling coordination degree from 2006 to 2009 is mainly on the verge of imbalance, and the under-forest economic development lags behind the development of the ecological environment. From 2010 to 2012, the coupling coordination degree changed from the reluctant coupling stage to the stage on the verge of imbalance, and the forest economy was ahead of the ecological environment development. From 2013 to 2018, the degree of coupling and coordination was in the reluctant coupling stage, and the under-forest economy and the ecological environment continued to develop in synchronize and in harmony. Therefore, according to the research results, it is proposed to establish the principle of ecological priority, adhere to the development of characteristics, improve the level of science and technology, and rationally develop the under-forest economic industry, so as to promote the coupling and coordinated development of the under-forest economy and ecological environment system in Heilongjiang Province.

Keywords: Understory Economy; Ecological Environment; Coupling Relationship; Relative Priority

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1. Introduction

Due to the rapid deterioration of the ecological environment, since 1998, the state has decided to implement the natural forest protection project, and the forest area of Heilongjiang Province is as one of the key areas implemented project, the commercial logging of natural forests was completely stopped in 2014. With the implementation of the natural forest protection project, the forest area of Heilongjiang Province urgently needs to change the development mode that traditionally relies on timber production and gradually realize economic transformation. The development of the under-forest economy is in line with the urgent need for the economic transformation and development of the forest area of Heilongjiang Province. There are many research results on the economic development and ecological environment under the forest at home and abroad. Of course, there is no concept of "under-forest economy" in foreign countries, and the similar concept is social forestry and agroforestry composite economy, which mainly defines the development area and content of social forestry, and

systematically analyzes the economic benefits of agricultural and forestry complex ecosystems[1,2]. Scholars in China have discussed the prominent problems in enterprises and people's livelihood caused by the comprehensive cessation of logging[3,4]. The researches are carried out on: the diversified business models of the under-forest economy[5,6], the development efficiency of the under-forest economy and the selection of advantageous industries[7,8], the strategic countermeasures for the development of the under-forest economy[9], the efficiency of different business entities of the under-forest economy[10], and the influencing factors of the economic behavior of farmers under the forest[11]. Foreign scholars have discussed the issues of environmental protection from different perspectives[12,13], and the analysis of the relationship between economic development and ecological environment has become a research hotspot[14,15]. Domestic scholars mainly evaluate ecosystem functions[16,17], ecological vulnerability[18], ecological security[19] and ecological compensation[20-22]. The coupling coordination degree model is used to study the mutual coupling and coordination relationship between ecological environment and economic development[23], urbanization construction[24-26] and tourism industry[27,28]. In summary, the research of domestic and foreign scholars on the under-forest economy and ecological environment mainly focuses on the analysis within the under-forest economic system or focuses more on the relationship between the ecological environment and the economy, tourism industry and urbanization from the macro perspective. While there are still relatively few research results on the in-depth analysis of the coupling and coordination relationship between the under-forest economy and the ecological environment from the micro perspective. On the one hand, a good ecological environment can provide suitable basic conditions for under-forest production and operation activities, which is conducive to promoting the development of under-forest economy and the innovation of under-forest industry. On the other hand, in the context of forestry protection policy, the development of the forest industry will have a substitution effect on the mining and transportation industry and the wood processing industry, reduce the deforestation activities, and help promote the growth of forest resources and the protection of the ecological environment. Therefore, during the construction of the index system of the under-forest economic and ecological environment system, the coupling coordination model is used to find the change law of the coordinated development between the under-forest economy and the ecological environment system in Heilongjiang Province from 2006 to 2018, and put forward corresponding suggestions to promote the coupling and coordinated development.

2. Data and methods

2.1 Overview of the study area

Heilongjiang Province is the northernmost and easternmost provincial administrative region in China, located in the Heilongjiang River basin composed of four major river systems: Heilongjiang, Songhua, Ussuri, and Suifenhe. According to the "2018 Heilongjiang Provincial Ecological Environment Status Communiqué": In 2018, the province's ecological environment system pattern was stable and the overall condition was good. The water quality in the province is slightly polluted by the Songhua River, Heilongjiang, etc., the Suifen River system with good water quality conditions, and the annual average concentration of various pollutants in the province has reached the secondary standard.

As a large forestry province, Heilongjiang Province has rich forest resources. According to the results of the Ninth National Inventory of Forest Resources, the forest area of Heilongjiang province is 19.9046 million hm^2, ranking 3rd in the country, the forest coverage rate of 43.78%. Heilongjiang Sengong Forestry District has jurisdiction over four forestry management bureaus, 40 forestry bureaus, 625 forest farms (institutes), and the forest area has a population of 1.67 million people. There are also more than 460 species of wild fields in the forest area, including bears and sika deer. There are more than 2,200 kinds of higher wild plants, including more than 120 kinds of medicinal plants, including Ginseng, Astragalus, and Schisandra and other val-

uable Chinese herbal medicines and a variety of edible mushrooms. Relying on the vast forest resources of the forest area, the under-forest planting, aquaculture, gathering industry, and under-forest tourism have developed vigorously. As of 2018, the gross economic output of the forest industry in the forest area of Heilongjiang Province was 187.8399 billion yuan, an increase of 14.9%. Forest medicinal materials produced in forest areas 9.1116 million tons, edible mushrooms 13.9424 million tons, wild vegetables 6.4391 million tons, as well as the production of large livestock stocks 35.95 million and poultry stocks 649.53 million, the number of tourists under the forest reached 1,313.73 million visitors. As the implementation area of comprehensively stopping logging, Heilongjiang Province shoulders many responsibilities, such as protecting the ecological environment, restoring natural forest resources, developing the economy of forest areas, and improving the lives of people in forest areas. Although Heilongjiang Province is rich in forest resources, its distribution is uneven, the forest coverage rate in the western region is low, and the ecological environment is fragile. The implementation of returning farmland to forests can fundamentally maintain water and soil and improve the ecological environment. Returning farmland to forests involves a large number of peasant households, and the implementation areas are often ecologically weak, and they are also economically impoverished areas. Therefore, Heilongjiang Province was selected as the research area to analyze the coupling relationship between the understory economy and the ecological environment.

2.2 Sources of data

The original data used in the study are the relevant statistics of Heilongjiang Province from 2006 to 2018, and the data are derived from the 2007–2019 China Forestry and Grassland Statistical Yearbook, the China Energy Statistics Yearbook, the Heilongjiang Statistical Yearbook, and the internal statistics of Longjiang Sengong Group. In terms of carbon emissions, since Heilongjiang Province does not have a unified and authoritative carbon emission data, the terminal energy consumption method is used to calculate regional dioxide Carbon emissions[29].

2.3 Construction of indicator system

The evaluation index system of the understory economy and ecological environment is shown in **Table 1**.

Table 1. Evaluation index system of under-forest economy and ecological environment

Primary class	Second class	Third class	Index character	Entropy weight
Under-forest economic index	Input index	Professionals (person)	Positive	0.3210
		Number of employees (person)	Positive	0.1429
		Average annual on-the-job salary (RMB)	Positive	0.2428
		Accumulated investment since the beginning of the year (10,000 RMB)	Positive	0.2130
	Output index	Total economic output value under forest (10,000 RMB)	Positive	0.0803
Eco-environmental index	Stress index	Waste water discharge amount (10,000 ton)	Negative	0.1153
		CO_2 emissions (ton)	Negative	0.0778
		Output of industrial solid waste (10,000 ton)	Negative	0.1133
	State index	Amount of water resources per capita (m^3/person)	Positive	0.3170
		Total afforestation area (10,000 hm^2)	Positive	0.0443
	Impact index	Area of forest pests and rats (10,000 hm^2)	Negative	0.1371
		CO_2 emissions (10,000 ton)	Negative	0.1111
	Response index	Completed investment in industrial pollution control (10,000 RMB)	Positive	0.0841

To analyze the coupling and coordination relationship between the under-forest economy and the ecological environment in Heilongjiang Province, the research objects include two parts: the sub-system of the under-forest economy and the subsystem of the ecological environment, which respectively reflect the current situation of economic and ecological environment development

under the forest in Heilongjiang Province. To study the coupling relationship between the two, the scientificity, representation, rationality, and feasibility of the index system are followed. Then, in conjunction with relevant forestry economic research[30,31], the indicators of understory economic development are determined from the angle of input and output. In terms of economic input under the forest, the number of employees, the cumulative investment completed since the beginning of the year, the professional and technical personnel, and the average annual wage of the in-service are selected: in terms of output, the total output value of the understory economy is selected. In terms of ecological environment, combined with relevant research[32-34], ecological environment indicators are established from the perspective of pressure-state-impact response. In terms of ecological and environmental pressure, the three indicators of total wastewater discharge, sulfur dioxide discharge, and industrial solid waste generation are selected. In terms of ecological environment status, the two indicators of per capita water resources and total afforestation area were selected, and the two indicators of forest diseases, insects, rats and rodents and the area of occurrence and carbon emissions were selected. In terms of ecological environmental impact. In terms of ecological environmental response, industrial pollution control is selected to complete investment indicators.

2.4 Data processing methods

The coupling coordination degree model is used to calculate the coupling coordination degree between the forest economic system and the ecological environment system in Heilongjiang Province. After standardizing the original data of Heilongjiang Province from 2006 to 2018[35], each indicator is empowered according to the Entropy Rights Law[36] to obtain the weight of the under-forest economic indicator and the weight of the ecological environment index. And then calculate the coupling degree index (C), the comprehensive co-adjustment index (T) and the coupling co-adjustment index (D)[37] and the relative priority of the under-forest economic development (z)[38] from 2006 to 2018 based on the weight. At the same time, the under-forest economic development index (x) and the ecological environment development index (y) are calculated. In order to judge the degree of coupling of the coordinated development of the understory economic and ecological environment system, the coupling coordination degree is classified by reference to relevant studies[39], which is specifically divided into 3 categories and 10 sub-categories. And then each sub-category is subdivided into 3 types according to the comparative results of the under-forest economic and ecological environment evaluation function, and then 30 basic types are formed (**Table 2**).

May wish to set: when $z > 1.5$, the level of economic development under the forest was higher than that of ecological environment development, which indicated that the economic development under the forest was relatively advanced. When $1.1 \leq z \leq 1.5$ hours, the level of economic development under the forest was synchronized with the level of ecological environment development. When $z < 1.1$, the level of under-forest economic development was lower than the level of ecological environment development, it indicated that the development of under-forest economy is relatively lagging behind.

Table 2. Coupling and coordinated development and evaluation criteria

Type	D value	Subclass
Coupling coordination class	0.90–1.00	Excellent coupling coordination class
	0.80–0.89	Good coupling coordination class
	0.70–0.79	Intermediate coupled coordination class
	0.60–0.69	Primary coupling coordination class
Reluctant coupling coordination class	0.50–0.59	Grudgingly couple coordination class
Endangered disorder decline category	0.40–0.49	Endangered disorder decline category
	0.30–0.39	Mild disorder recession category
	0.20–0.29	Moderate disorder decline category
	0.10–0.19	Severe disorder recession category
	0.00–0.09	Extreme disorder recession category

2. Results and analysis

2.1 The degree of coupling and coordination between the forest economy and the ecological environment in Heilongjiang Province continues to rise

The comprehensive coordination index and coupling coordination degree of the understory economy and ecological environment are shown in **Table 3**. Although the degree of coupling and coordination between the forest economy and the ecological environment system in Heilongjiang Province fluctuated during 2006–2018, it showed a good upward trend overall. Coupling Association 2006 Lower scheduling, only 0.458, after 13 years of development. In 2018, the degree of coupling coordination rose to 0. 587. In the first stage (2006–2009), the degree of coupling developed from the near-out phase to the reluctant coupling phase. Coupling coordination degree from 2006 to 0.458 grew to 2009's 0.515. During this period, the economy under the forest gradually developed, but the overall scale was small. With the implementation of banning logging policy in an all-round way, forest resources have gradually recovered, the ecological environment has improved and the degree of coupling of the economic environment under the forest in Heilongjiang Province has developed from the stage of being on the verge of dysregulation to the stage of barely coupling.

Table 3. Coupling degree of under-forest economy and ecological environment

Year	*x*	*y*	*C*	*T*	*D*	Coupling degree
2006	0.4067	0.4283	0.4998	0.4197	0.4580	Verge disorder
2007	0.4481	0.4210	0.4998	0.4318	0.4646	Verge disorder
2008	0.4379	0.4527	0.4999	0.4468	0.4726	Verge disorder
2009	0.5062	0.5480	0.4996	0.5313	0.5152	Barely coupled
2010	0.5828	0.4741	0.4974	0.5176	0.5074	Barely coupled
2011	0.7443	0.3664	0.4702	0.5176	0.4933	Verge disorder
2012	0.7490	0.3369	0.4626	0.5018	0.4818	Verge disorder
2013	0.6903	0.5197	0.4950	0.5880	0.5395	Barely coupled
2014	0.6385	0.4791	0.4949	0.5429	0.5183	Barely coupled
2015	0.6932	0.4912	0.4927	0.5720	0.5309	Barely coupled
2016	0.7230	0.6284	0.4988	0.6662	0.5764	Barely coupled
2017	0.7970	0.6104	0.4956	0.6850	0.5827	Barely coupled
2018	0.7952	0.6264	0.4955	0.6939	0.5870	Barely coupled

In the second stage (2010–2012), the coupling degree decreased from grudging coupling to the near-out phase. Coupling coordination degree from 0.507 (2010) dropped to 0.482 (2012). During this period, the under-forest economy has developed rapidly. There are some reasons, which include the one-sided pursuit of economic benefits by various stakeholders in the forest area, large-scale over-exploitation, the development of planting and aquaculture, and the lack of strategic consideration for the local ecological capacity. They have led to relatively serious environmental pollution of the air and water, the ecological environment has not advanced and retreated, and the degree of coupling between the under-forest economy and the ecological environment has dropped from barely coupling to the verge of imbalance.

In the third stage (2013–2018), the coupling degree returned to the reluctant coupling stage. Coupling coordination degree from 0.539 increased to 0.587, close to the primary coupling phase. Compared with the previous two periods, on the one hand, the scale of economic development under the forest has gradually expanded, and the income of rural households has increased by a large margin. On the other hand, the farmers have enhanced the ecological awareness, forest resources have been rationally developed and utilized to develop the under-forest economy, and the ecological environment has been further protected. The government and farmers have also increased their investment in pollution control, the water and air pollution have been greatly reduced. Therefore, the degree of coupling between the under-forest economy and the ecological environment has increased steadily during this period, but the increase is not large, and it is still in the stage of reluctant coupling.

In summary, from 2006 to 2018, Heilongjiang

Province has made great achievements in the coordinated development of the under-forest economy and ecological environment, but the coupling coordination degree is still in the reluctant coupling stage, and it is still far from the well-coupled coordinated development of the under-forest economy and ecological environment or even the high-quality coupling coordinated development.

2.2 The priorities of under-forest economic development have undergone tortuous changes

Relative priority (z) and coupling type of coordinated development of understory economic and ecological environment coupling in Heilongjiang Province, 2006–2018 It is shown in **Table 4**. In order to more specifically understand the changes and the main reasons in the coordinated development of coupling between the economic and ecological environment systems under the forest in Heilongjiang Province, the priority model of the understory economic development of the forest is further used to coordinate the changes in coupling It is subdivided into 3 stages for analysis. In the first stage (2006–2009), the under-forest economy lagged behind the stage of ecological environment development. The degree of coupling coordination between the economic and ecological environment systems under the forest in Heilongjiang Province is from 0.458 grows to 0.515, up 12.44% grew from near-dysregulation to reluctance Strong coupling (**Table 3**). The relative priority of the understory economy fluctuates up and down around 1, and neither exceeds 1.1, at this time, the development index of the ecological environment is slightly lower than the under-forest economic development index in 2007, and the rest are greater than the under-forest economic development index. The coupling type is the under-forest economic lagging type (**Table 4**) with the beginning of the "promotion stage" of the construction of Heilongjiang Ecological Province in 2006[40].

Table 4. Coupling type of under-forest economy and ecological environment

Year	*x*	*y*	*z*	Coupling type
2006	0.4067	0.4283	0.9497	Under-forest economic development lag type
2007	0.4481	0.4210	1.0644	Under-forest economic development lag type
2008	0.4379	0.4527	0.9675	Under-forest economic development lag type
2009	0.5062	0.5480	0.9237	Under-forest economic development lag type
2010	0.5828	0.4741	1.2291	Synchronous development type
2011	0.7443	0.3664	2.0312	Under-forest economic development advanced type
2012	0.7490	0.3369	2.2232	Synchronous development type
2013	0.6903	0.5197	1.3282	Synchronous development type
2014	0.6385	0.4791	1.3325	Synchronous development type
2015	0.6382	0.4912	1.4113	Synchronous development type
2016	0.7230	0.6284	1.1505	Synchronous development type
2017	0.7970	0.6104	1.3057	Synchronous development type
2018	0.7952	0.6264	1.2695	Synchronous development type

After the first phase of the natural forest protection project entered the final stage in 2009, forest resources began to gradually recover, ecological functions continued to improve, the area of forest parks and natural protected areas in Heilongjiang Province grew rapidly during this period, and the ecological environment was greatly improved between 2006 and 2009. In terms of the under-forest economy, due to the lag in the ideological transformation of workers in forest areas, a large number of laid-off workers choose to go out to work. Therefore, at this stage, there are relatively few peasant households engaged in the under-forest economy, and the under-forest economic operation mode is mainly based on the "one household per household" style. The development of the forest economy is limited by factors such as labor force and land circulation funds and has the characteristics of small scale of operation, single variety, low degree of organization, and incomplete sales market. The economic development rate under the forest is relatively slow, a situation of lagging economic lag under the forest is barely coordinated and coupled.

In the second stage (2010–2012), the under-forest economy is ahead of the stage of ecological environment development. The degree of cou-

pling coordination between the forest economy and ecological environment system in Heilongjiang Province is from 0.507 down to 0.482, down 4.93%, and from reluctant coupling to near-out of balance; The under-forest economic development index far exceeds the ecological environment development index, and the relative priority of the under-forest economy has increased from 1.229 to 2.223, an increase of 80.88%. At the beginning of this stage, due to the further development of the under-forest economy, the ecological environment index fell slightly, and the lag of the ecological construction effect led to the coupling type from the previous under-forest economic lag type to the synchronous development type. That became the turning point of the transition from the under-forest economic lag type to the advanced type. Therefore, this stage coupling type is mainly manifested as the advanced type of under-forest economic development. At the end of 2010, the national regional strategic plan "Ecological Protection and Economic Transformation Plan for large and small Xing'anling Forest Areas" was officially introduced, and it pointed out that it is necessary to vigorously develop traditional advantageous industries such as the green food industry, and actively cultivate ecological cultural tourism, Northern medicine industry, and other emerging industries. The implementation and promotion of a series of policies such as planning and forest rights reform have led to a surge in peasant households' enthusiasm for becoming rich in forests, which has greatly promoted the rapid development of the under-forest economy. The scale of under-forest economic development has gradually expanded, and the types of operations have become more diversified. Taking the Chaihe forestry bureau as an example, in 2012, the forest frog farming area was 87,000 hm^2; fungus, slipper mill, and other characteristic edible mushrooms 6,000 bags. Artificial cultivation of Northern Medicine 147 hm^2. However, while the economy under the forest is developing rapidly, on the one hand, some peasant households blindly pursue economic benefits, do not consider the local ecological endurance, and overdevelop planting and aquaculture and forest tourism on a large scale, resulting in soil erosion, serious pollution of water resources, and rapid deterioration of the ecological environment. For example, the wastewater discharge of Heilongjiang Province started at 11.8575 billion t (2010) and surged to 16.2589 billion t (2012), and increased by 37%. On the other hand, because the growth of forest resources requires a long cycle, the growth of the total accumulation of living standing trees and forest coverage is relatively slow, and the ecological subsystem development ability is weak. Therefore, the coupling type changes from the synchronous development type of the forest economy to the advanced development type.

The third stage (2013–2018) is the stage of continuous synchronous development of the under-forest economy and ecological environment. The degree of coupling and coordination between the economic and ecological environment system under the forest in Heilongjiang Province increases from 0.5395 rises to 0.5870, an increase by 8.80% (in a state of reluctance coupling). The priority of the economy relative under the forest was first determined by 1.3282 increased to 1.4113 (2015), and then down to 1.2695 (2018), coupling type is always synchronous development type. At this stage, the forest economy and ecological environment show a continuous synchronous development trend. With the accelerated implementation of those, such as the second phase of the project for the protection of natural forest resources and the gradual implementation of the "Twelfth Five-Year Plan" plan for the development of local forestry in Heilongjiang Province, as well as the "Twelfth Five-Year Plan" for the ecological and environmental protection of Heilongjiang Province, great changes have taken place in the ecology, economy, and society of forest areas. It has formed a new pattern of industrial development in which multiple industries such as under-forest breeding, collection and processing, and under-forest tourism are simultaneously adopted. In the past, "one household, one household" type of business entities slowly began to develop into new types of business entities such as large forestry households, forestry cooperatives, and leading forestry enterprises. The moderate development of the under-forest economy has reduced the destructive

production behaviors that cause damage to the ecological environment, enhanced people's attention to the ecological environment, and promoted the protection of the ecological environment. The sustainable development capacity of forest areas has been significantly improved compared with the early implementation of natural forest protection projects, compared with the wastewater emissions of Heilongjiang Province in 2013, the area of forest diseases, insects, and rats have increased from 51.55 million hm^2 (2013) decreased to 414,300 hm^2 (2018), a 20% reduction. The project of returning farmland to forests in Heilongjiang Province has also been further implemented at this stage, playing an important role in maintaining water and soil, conserving water sources, and improving the ecological environment in ecologically weak areas. At the same time, in order to consolidate the results of returning farmland to forests, the government helps farmers choose an under-forest economic model suitable for returning farmland to forests, that vigorously develops the under-forest economy, combines ecological compensation with the sustainable livelihood of farmers. That helps peasant households to get rid of poverty and become rich, and promotes the overall improvement of ecological and economic benefits. In 2018, the quality of the ecological environment in the province is generally in good condition, the sustainable development capacity of the forest area has been significantly improved compared with the early stage of the implementation of the natural forest protection project. The continuous growth of forest resources has laid a material foundation for the sustainable development of the under-forest economy, and the continuous development of the under-forest economy has enhanced the farmers' awareness of the protection of the ecological environment on which they depend, and the under-forest economy and the ecological environment have influenced and blended. Therefore, in the third stage, the under-forest economy and ecological environment of Heilongjiang Province continue to develop synchronously and will enter the primary coupling stage soon.

3 Conclusions and recommendations

3.1 Conclusion

The coupling and coordinated development of the forest economy and ecological environment in Heilongjiang Province has generally shown a steady upward trend, gradually growing from the initial stage of being on the verge of imbalance to the current stage of reluctant coupling. The relative priority of the under-forest economy has successively experienced the lagging type of the under-forest economy, the short-term synchronous development type, the advanced type of the under-forest economy, and finally the continuous stability in the synchronous development type. Studies have shown that a good ecological environment has a driving effect on the development of the under-forest economy, and blindly developing the under-forest economy in violation of local ecological laws will seriously restrict the development of the under-forest economy. Moderate, scientific, and local conditions can effectively reduce production behaviors that are destructive to the ecological environment, raise farmers' awareness of protecting the ecological environment, and promote the growth of forest resources and the construction of the ecological environment.

3.2 Recommendations

3.2.1 Clarify the goals and establish the guiding ideology of ecological priority and rational development

Actively promote ecological projects such as natural forest protection, forest care, and nature reserve construction in Heilongjiang Province. According to the basic situation of the under-forest economy and ecological environment in Heilongjiang Province, under the premise of ensuring ecological priority, the development goals of the under-forest economy at different stages are clearly defined, and the economic development under the forest and ecological construction are organically combined through industrial transformation and industrial integration. At the same time, it is necessary to establish a mechanism for the protection and

utilization of under-forest resources, develop the under-forest economy through the comprehensive mode of collecting and deep processing under the forest, breeding and under-forest tourism. To guide forest households that adopt the composite management model to declare in advance, and conduct preliminary examination and assessment through agriculture, environmental protection, and water conservancy departments to ensure that feces and sewage are discharged according to standards and prevent non-point source pollution. Appropriately and appropriately develop the under-forest economy, reduce productive deforestation, enhance the awareness of forest households to protect the ecological environment, and promote the healthy development of the ecological system. So as to achieve the coordinated and sustainable development of the economic transformation and ecological protection of the forest areas of Heilongjiang Province that promote each other and improve together.

3.2.2 Innovate the mechanism and adhere to the basic principles of characteristic development and scientific planning

Characteristic development is an inevitable requirement for the coordinated development of the under-forest economy and ecological environment in Heilongjiang Province, and each forest area should highlight its ecological characteristics and give play to its regional advantages according to its own geography, climate, season and products. Taking Heihe City as an example, we should give full play to the advantages of tourism resources such as Wudalianchi and Jinhe Grand Canyon, increase the publicity of scenic spots, and promote the rapid development of under-forest tourism. All local governments and forest areas should set up special leading institutions such as under-forest economic working groups to conduct research and investigation based on local natural resource endowments, ecological carrying capacity, market demand and the family status of farmers. On the basis of fully grasping the overall situation of the forest area, innovate mechanisms to rationally plan and guide the projects, models and scales of under-forest economic development engaged in by farmers, from dispersion to intensification, from individuals to scale, from workshops to brands. As far as possible, reduce the behaviors that may lead to environmental problems taken by farmers in pursuit of short-term economic benefits, avoid the homogenization and blindness of under-forest economic development projects, and achieve steady and sustained growth of the under-forest economy under the premise of respecting market laws.

3.2.3 Respect ecological laws and regulate the economic operation under the forest

The development of the under-forest economy must on the basis of respecting and maintaining local ecological laws, and actively create and guide the benign interaction between the under-forest economy and the ecological environment. In high-density breeding, animals will over-trample and nibble, damaging the root system and understory vegetation. Planting too densely will affect the soil structure of woodland and the excessive water content of animal excrement cannot be absorbed and cleaned up in time, which will lead to the spread of harmful microorganisms and water pollution, seriously damaging the ecological environment. Therefore, local governments and forest areas should innovate and improve the collective forest rights reform system, standardize the implementation of measures such as subsidy distribution and management responsibilities to improve the awareness of farmers to cultivate forests and protect forests and protect the ecology. Meanwhile, scientifically select varieties and breeding densities suitable for planting and breeding according to the tree species and area of woodland. Small poultry can be raised free-range, and rotational sites and large livestock can be considered to be raised in captivity to reduce the damage to the ecological environment. Finally, the scientific development of the under-forest economy and the systematic improvement of the ecological environment will be realized.

3.2.4 Cultivate the economic and industrial system under the forest, and improve the scientific and technological level of the economic industry under the forest

In modern economic activities, the under-forest economy, as a systematic industrial sys-

tem, is embodied in the organic integration of different industries such as planting, animal husbandry, tourism and service industries and their positive interaction with the local ecosystem. Therefore, local governments and forest areas should pay more attention to the creation of a series of industrial systems from planting and deep processing, feeding, and picking to tourism, experience, and culture, and pay attention to the brand effect and scale advantages of economic products under the forest. Scientifically utilize and strictly protect forest resources, and develop emerging under-forest tourism models such as forest landscape, forest family music, under-forest picking and traditional Chinese and Western medicine. Actively integrate resources through the medium of government organizations, including manpower, funds, land, etc. The high-quality power expands the intensive advantages of the economic development under the forest: to build leading enterprises, promote the construction of demonstration sites, and actively introduce self-harmony Advanced science and technology such as breeding, forest product storage, forest fire prevention and pest control. The improvement of the scientific and technological level of the under-forest economy is an important guarantee for the establishment the under-forest economic system and the protection of the ecological environment.

Conflict of interest

No conflict of interest was reported by the authors.

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