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Multi-Stakeholder Game Relationships in Promoting the Development of the Non-Timber Forest Product Industry by State-Owned Forest Farms

Qin Qiao [1], Zhenyu Lin [1], Zhongrui Sun [2], Wenting Zhang [1], Meijuan Zhang [1], Yong Sun [3,*] and Xinting Gao [1,*]

[1] State Key Laboratory of Environmental Criteria and Risk Assessment, Chinese Research Academy of Environmental Sciences, Beijing 100012, China; qiao.qin@craes.org.cn (Q.Q.); 220220932171@lzu.edu.cn (Z.L.); zhangwenting@mail.bnu.edu.cn (W.Z.); zhangmeijuan23@mails.ucas.ac.cn (M.Z.)

[2] Yangtze Delta Region Academy (Jiaxing), Beijing Institute of Technology, Jiaxing 314001, China; sunzhongrui@casisd.cn

[3] School of Public Administration, Guangzhou University, Guangzhou 510006, China

* Correspondence: sunyong@gzhu.edu.cn (Y.S.); gao.xinting@craes.org.cn (X.G.)

Abstract: State-owned forest farms are key players in managing forestry resources worldwide, playing a pivotal role in advancing the development of the non-timber forest product industry. This paper constructs a tripartite evolutionary game model involving "government–state-owned forest farms–farmer households" to delve into how state-owned forest farms collaborate with governments and farmer households to propel the growth of the non-timber forest product industry. Additionally, it explores the interactive relationships among multiple stakeholders and their asymptotic stability. The findings reveal that (1) under certain conditions, the game model can achieve four stable equilibrium strategies: (0,0,0), (0,1,0), (0,1,1), and (1,1,1). (2) Key factors influencing the tripartite game include the political performance and administrative costs of local governments involved in the industry's development, assessment performance and reduced management and protection expenses of state-owned forest farms, and sales revenue and planting costs of farmers' under-forest products. (3) The market development costs shared by state-owned forest farms and government subsidies for under-forest planting should be within a reasonable range. This ensures effective promotion of farmers' participation in under-forest planting while maintaining the willingness of state-owned forest farms and governments to actively engage. These findings provide concrete guidelines that policymakers can use to spur sustainable growth in the NTFP sector.

Keywords: forest policy; non-timber forest products (NTFPs); state-owned forest farms; local governments; farmers; evolutionary game theory

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1. Introduction

Non-timber forest products (NTFPs) are any products or services produced in forests other than timber, and their industrial models include under-forest planting, under-forest farming, and forest tourism [1–3]. The development of the NTFP industry is of great significance to forestry ecological environmental protection, regional economic development, and poverty reduction in rural areas [4–6]. Firstly, promoting the orderly development of the NTFP industry can reduce illegal logging and forest-destruction behaviors, facilitate the rational utilization of forest land, aid in forest restoration, and enhance the diversity and functionality of ecosystems [7]. Secondly, by carrying out activities such as agriculture, forestry, and tourism in forests, it can stimulate the rural economy, while simultaneously improving farmers' income levels and enhancing their quality of life [8–10].

However, the development of the non-timber forest product industry also faces a series of difficult challenges, including unstable economic benefits, farmers' lack of technical and management experience, and difficulties in marketing [11,12]. Non-timber forest products are mostly specialty agricultural products that are greatly influenced by factors such as policies and market demand. There is a need to develop and enhance the market competitiveness of these products [13], but their profitability logic and sustainability may be unstable [14,15]. Furthermore, non-timber forest product farmers and some enterprises lack advanced technology and management experience, resulting in low production efficiency and difficulty in ensuring product quality. Policy support and assistance are necessary to address these issues [16]. Studies have shown that good synergy among stakeholders, including government regulation, forest land owners, and farmers, is a key factor influencing the development of the non-timber forest product industry [17–19]. On one hand, strong relationships with stakeholders can enable farmers to gain a better understanding of policies and market demands, allowing them to promptly adjust their strategies for the cultivation or breeding of understory products. This helps to mitigate the adverse effects of market demand fluctuations on farmers [20]. At the same time, robust stakeholder relationships allow state-owned forest farms or other enterprises to share cultivation experiences with farmers, thereby enhancing production efficiency and ensuring product quality. Therefore, studying the relationships among stakeholders in the non-timber forest product industry is of great significance and can promote its effective development [21].

Existing research on non-timber forest product stakeholders mainly focuses on three aspects: the roles of stakeholders, their impact on industry development, and the influencing factors of internal cooperation among stakeholders. Firstly, regarding stakeholder roles, studies have indicated that non-timber forest product stakeholders include governments, forest land owners, farmers, enterprises, consumers, and environmental protection organizations [22–24]. They are involved in various links of the industry chain, such as production, manufacturing, marketing, and sales [25]. Effective policy intervention can increase the benefits of stakeholders [26]. The government's management and protection of forests contribute to the sustainability of the industry [27,28]. State-owned forest farms can enhance their social effectiveness through improved forest and ecological cultural development, as well as stakeholder involvement [29]. Among them, the three particularly important stakeholders in promoting the development of the non-timber forest product industry by state-owned forest farms are the government, state-owned forest farms, and farmers. Effective communication and collaboration among these three stakeholders are crucial for state-owned forest farms to promote sustainable and healthy development of the non-timber forest product industry.

Secondly, regarding the impact of stakeholders on industry development, relevant studies point out that farmers, as beneficiaries of the non-timber forest product industry, can improve their household income levels. Providing farmers with ample farmland and employment opportunities can reduce their reliance on non-timber forest products [9]. However, factors such as the lack of industry organization, poor market information channels, and inadequate storage and drying measures constrain their profitability [24]. Increased levels of off-farm employment, external financial support, and skill training are crucial factors in promoting farmer participation in understory planting projects [30,31]. Government departments, as important participants, play a significant role in enhancing the transparency of industry licensing and combating corruption, providing a favorable business environment for industry development and ensuring that all stakeholders can play their roles under favorable policies and institutional arrangements [19,32]. Consumers are also important stakeholders who pay more attention to the green, organic, and safety aspects of products [33]. Innovative policies focusing on food safety and governance models can help promote and revitalize the non-timber forest product industry [34]. Forest land owners, including both public and private entities, will face different interests and demands in developing the non-timber forest product industry [35,36].

Thirdly, regarding the influencing factors of stakeholder cooperation. Relevant studies indicate that managers need to balance multiple and potentially conflicting goals among different stakeholder groups to promote non-timber forest product development [25]. Lack of industry standards and poor resource management are major factors hindering the sustainability of the non-timber forest product industry [37]. Miina et al. investigated the views of different stakeholders on the cultivation of specialty mushrooms under forests in Finland. The results showed that a lack of information on cultivation success rates, yields, costs, and profitability analysis was the biggest obstacle to stakeholder cooperative production [38]. Ndeinoma et al. studied the cooperation mechanisms among different stakeholders in the non-timber forest product industry in Namibia. The results indicated the need for further cooperation and information-sharing mechanisms to guide the cooperative relationships among different stakeholders [39].

In summary, existing research on stakeholder relationships in the non-timber forest product industry has primarily focused on identifying stakeholder roles, their impact on industry development, and the influencing factors of stakeholder cooperation. However, there has been limited exploration of the interaction mechanisms among stakeholders. Evolutionary game theory, as a mathematical tool for analyzing strategy selection and evolution among multiple boundedly rational individuals in repeated games, is suitable for analyzing the inherent mechanisms of stakeholders [40]. It has been widely applied in green development fields such as forestry management and ecological protection [3,41]. For instance, in forest management, numerous studies have discussed different conflicts of interest among various stakeholders in the forestry economy and the factors influencing their game behaviors [42,43]. Evolutionary game methods have been employed to construct dynamic game models and analyze the evolutionarily stable strategies among key stakeholders like governments, enterprises, and communities [44].

State-owned forests, as crucial stakeholders in the non-timber forest product industry, are significant entities and stakeholders for many governments worldwide in managing forestry resources. Promoting the development of the under-forest economy with state-owned forests as the focal point has a broad practical foundation [45–47]. In China, there are 4855 state-owned forests, which are the backbone of forest resource cultivation. These forests not only undertake the function of protecting forest resources but also engage in economic activities such as wood production and the development of NTFPs to achieve a balance between ecological and economic benefits [48]. Thus, focusing on the development of non-timber forest product industries by state-owned forest farms holds considerable typification and representativeness. Clarifying the internal mechanisms of key stakeholders in the industry is conducive to the optimization and dissemination of policies.

In this context, this paper selects a typical under-forest cultivation model in state-owned forests to study the evolutionary game relationships among stakeholders, including local governments, state-owned forests, and farmers. The main scientific questions addressed are as follows: First, what kind of stable equilibrium state can be achieved through the collaborative participation of local governments, state-owned forests, and farmers in developing the non-timber forest product industry? What are the boundary conditions? Second, what factors influence the collaboration among local governments, state-owned forests, and farmers? This study deepens the theoretical understanding of the internal mechanisms of stakeholder game in non-timber forest products, thereby extending the theoretical frontier of non-timber forest product research to some extent. Operationally, by dissecting successful cases and operational models of state-owned forest farms in enhancing the value of non-timber products, the study aids in optimizing the development models of non-timber forest product industries and offers valuable experience for the promotion and development of non-timber products in similar regions.

2. Methods

As mentioned earlier, the evolutionary game model, starting from the premise of bounded rationality, can examine the dynamic evolution processes of different stakeholders and also takes into account the influence of external factors on the stakeholders involved in the game. It has now become a powerful tool for analyzing stakeholder relationships [3,40,41]. In this paper, we employ the evolutionary game approach to derive the evolutionarily stable strategies for the government, state-owned forest farms, and farmers, and further analyze the stability of the system. Additionally, dynamic evolutionary simulations of the game system are conducted to further validate the correctness of the model.

2.1. Analytical Framework

The development of the non-timber forest product industry is conducive to promoting sustainable economic, ecological, and social development in rural areas rich in forest resources. Relevant theories involved include anti-poverty theory [49] and household livelihood theory [50]. Simultaneously, the effective operation of the under-forest economy can enhance the diversity and stability of local forest ecosystems. Governments should provide certain economic compensation to forest guardians, involving the theory of ecological compensation [51]. Furthermore, this paper investigates the stakeholder relationships in the non-timber forest product industry, encompassing stakeholder theory [52]. The concept of "stakeholder" emerged in the 1960s during economists' exploration of corporate governance models and was widely introduced into the field of natural resource management in the 1990s [53]. In 2018, Raum reviewed stakeholder research in the ecological environment field, defining it as "any organization, group, or individual interested in or influential on ecosystem services" [54]. According to Raum's definition, stakeholders in NTFP industry development include governments, forestland owners, farmers, environmental organizations, downstream supply chains, and consumers of under-forest products, covering a wide range of entities. Taking the under-forest mushroom economy of Wangyedian Experimental Forest Farm in China as an example, this paper analyzes from the perspective of incentive mechanism setting for stakeholders. It aims to achieve efficient operation of the under-forest economy, reduce poverty, and promote regional sustainable development. It explores a scientific and efficient decision-making-management model as a guideline to construct a multi-stakeholder research framework involving "government (policy implementer and administrator)–state-owned forest farm (forest manager)–farmers (under-forest cultivators)".

In the tripartite game relationship of "government–state-owned forest farm–farmers" in the non-timber forest product industry, the government plays a crucial role. It needs to monitor the safety and stability of forest ecosystems and guide state-owned forest farms and farmers to participate in the development of the non-timber forest product industry. This approach aims to achieve multiple goals such as forest protection, increasing farmers' employment, and promoting regional poverty reduction within limited fiscal expenditure constraints. As one of the main participants in the development of the non-timber forest product industry, state-owned forest farms bear the responsibility of forest management and protection as well as the sustainable operation of the farms. They can provide under-forest cultivation spaces for farmers, offer technical guidance and sales support, and guide farmers to participate in under-forest cultivation. Simultaneously, they guide farmers to provide services for forest management and protection, ultimately achieving the goals of improving forest management and enhancing the overall benefits of the farms. Farmers, as participants and beneficiaries of the under-forest economy, can realize economic benefits from cultivating under-forest economic products by participating in technical training and under-forest crop cultivation, thereby achieving employment and income growth (Figure 1).

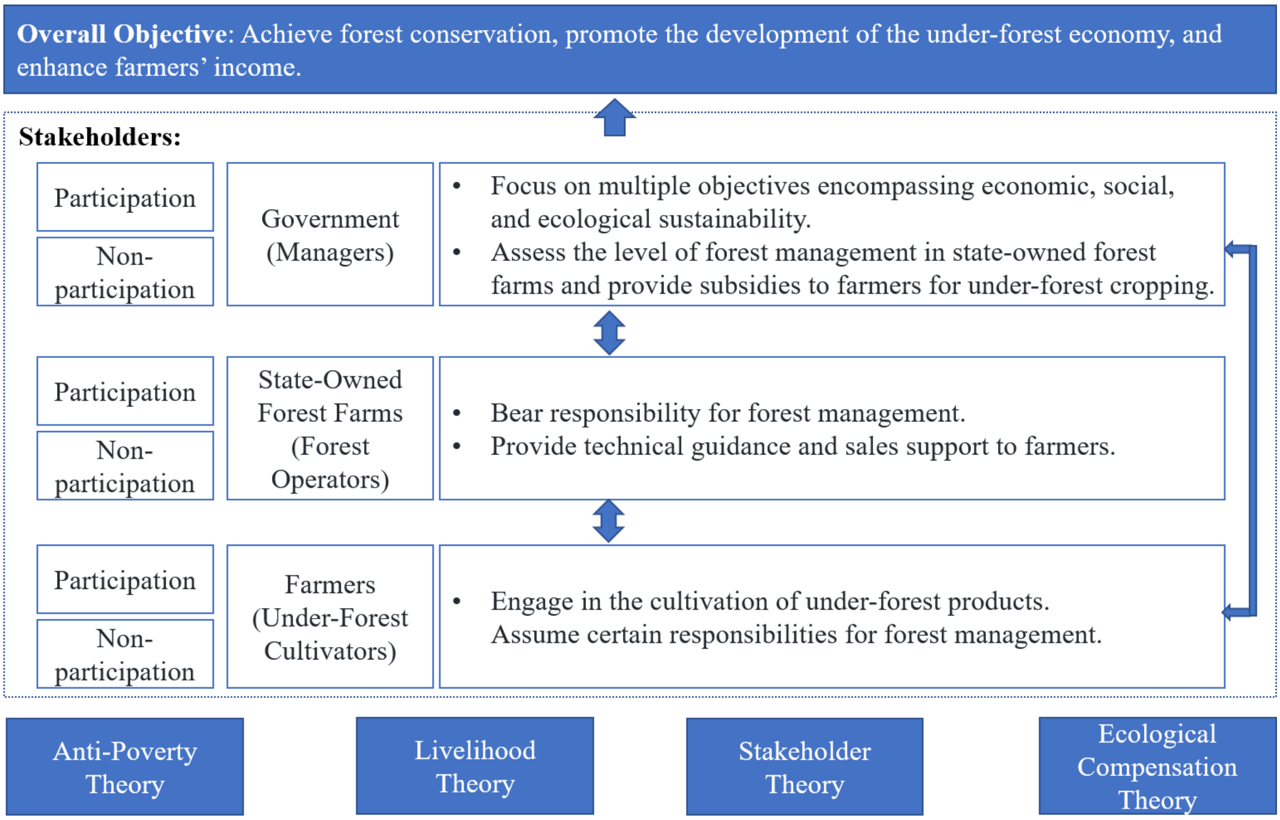

Figure 1. Research framework for the game among three parties.

2.2. Model Assumptions

To analyze the strategic behavior of the tripartite game in the non-timber forest product industry, it is necessary to make assumptions about key influencing factors such as under-forest space rental, costs, demand for under-forest products, sales prices of under-forest products, subsidies, and so on. Based on theoretical analysis and referring to the experience of under-forest mushroom cultivation at Wangyedian Experimental Forest Farm in China, this paper proposes the following assumptions (Table 1).

Table 1. Definitions of parameters in the evolutionary game.

Parameter	Definition
P_s	Annual sales revenue from non-timber forest products for farmers
C_f	Costs incurred by farmers participating in under-planting
A	Subsidies provided by the government for farmers participating in under-planting
R_n	Other net income for farmers not participating in under-planting
R_v	Annual rent for the under-planting space provided by state-owned forests
L	Opportunity cost of state-owned forests for not developing non-timber forest product industries
D_f	Cost savings from reduced manual maintenance for state-owned forests actively developing non-timber forest product industries
D_c	Costs associated with research and development, as well as market expansion for state-owned forests actively promoting non-timber forest product industries
U_h	Assessment performance of state-owned forests participating in non-timber forest product industry development

Table 1. *Cont.*

Parameter	Definition
R_g	Political performance of government initiatives to promote the non-timber forest product industry
C_g	Administrative costs associated with government initiatives in promoting the non-timber forest product industry
x	Proportion of government initiatives to promote the non-timber forest product industry
y	Proportion of state-owned forests actively developing non-timber forest product industries
z	Proportion of farmers participating in under-planting

Assumption 1. ***Game participants and strategies***

In the evolutionary game model of non-timber forest product industry activities, the parameters can be divided into three aspects, namely, local government, state-owned forest farm, and farmers. Referring to similar studies [3,55], these three participants are assumed to have bounded rationality, meaning they are not completely rational in the decision-making process but gradually adjust their strategies through trial and error and learning. This setting aligns with the behavioral characteristics of decision-makers in the real world. The strategy set of the local government is assumed to be S_1 = *{promote, no farm} is* S_2 = *{actively develop, passively develop}, with the proportion of choosing the active development strategy being y and the proportion of choosing the passive development strategy being* $1 - y$*. The strategy set of farmers is* S_3 = *{participate, not participate}, with the proportion of choosing the participation strategy being z and the proportion of choosing the non-participation strategy being* $1 - z$*.*

Assumption 2. ***Costs and benefits for government***

When formulating policies for non-timber forest product industry activities, the government considers multiple factors such as the sales price of under-forest products, the cost of under-forest cultivation for farmers, forest management and protection costs, budgetary constraints, political performance, and credibility [56,57]. The goal is to promote the active participation of state-owned forest farms and farmers to achieve sustainable development. To incentivize farmers to engage in under-forest economic activities, the government provides subsidies for under-forest cultivation [3], denoted as A. Furthermore, government decision-making is essentially driven by officials' considerations of political performance. Consequently, the government's non-timber forest product industry development policy focuses on its political performance, including the ecological protection and poverty-reduction benefits achieved through the development of the non-timber forest product industry. Following the relevant research [40], this political performance is represented by R_g*. The administrative costs incurred by the government in implementing the non-timber forest product industry development system are denoted by* C_g*.*

Assumption 3. ***Costs and benefits for state-owned forest farms***

When considering under-forest economic activities, state-owned forest farms base their decisions on various factors such as actual forest management and protection needs, the level of under-forest economic cultivation technology they possess, market conditions for under-forest products, and expected returns [3,58]. Their primary need is forest fire prevention, pest control, and routine management and protection, followed by achieving a certain level of economic benefits [59,60]. The costs incurred by state-owned forest farms for technology research and development and expanding under-forest product sales channels when actively developing non-timber forest product industry activities are denoted by D_c*. The economic benefits obtained from providing under-forest space are represented by* R_v*. The reduction in forest manual management and protection expenses due to non-timber forest product industry activities is denoted by* D_f*. When state-owned forest farms actively develop non-timber forest product industry activities and contribute to regional rural economic development, the performance evaluated by the government is represented by* U_h*. Furthermore, when state-owned forest farms choose to passively approach under-forest economic development, they may miss out on potential development opportunities and economic benefits, such as inadequate* *utilization of land resources or missing peak market demand periods, which can put them at a disadvantage in the long run. These opportunity costs are denoted by L.*

Assumption 4. ***Costs and benefits for farmers***

When considering whether to participate in non-timber forest product industry activities, farmers comprehensively weigh various factors such as their own costs, government incentives, and the sales price of under-forest products. Based on these considerations, they decide whether to engage in the cultivation of under-forest economic crops [61,62]. A higher level of participation can bring more substantial economic benefits to farmers and create more development opportunities for their communities [58]. It is assumed that the sales revenue per mu (a unit of area in China, equivalent to 0.0667 hectares) of under-forest products is represented by P_s*, and the cost of cultivating under-forest products per mu for farmers, including under-forest space rental, seedling care, labor costs, and other expenses, is denoted by* C_f*. The subsidy provided by the government to encourage farmers to participate in under-forest economic projects is represented by A, which constitutes a fiscal policy of subsidies for forest farmers. If farmers choose not to participate in under-forest cultivation, they may pursue other occupations, and the net income obtained from these alternatives is denoted by* R_n*.*

2.3. Payment Matrix

The payment matrix for the triadic evolutionary game involving government, state-owned forests, and farmers in the development of the non-timber forest product industry is represented as a three-dimensional matrix, as shown in Table 2. When the government chooses to promote, state-owned forests may choose to actively develop or passively develop, and farmers may choose to participate or not participate. Similarly, when the government chooses not to promote, these same choices are available for state-owned forests and farmers. Consequently, this results in eight possible strategy combinations, each with its own set of payoffs for the three stakeholders. Based on our assumptions about the behavior and payoff structures of each stakeholder, we can fill in the payment matrix as follows:

Table 2. Payment matrix of the evolutionary game.

	Government Promotes (x)		**Government Does Not Promote ($1-x$)**	
	State-Owned Forests Actively Develop (y)	**State-Owned Forests Passively Develop ($1-y$)**	**State-Owned Forests Actively Develop (y)**	**State-Owned Forests Passively Develop ($1-y$)**
Farmers participate (z)	$R_g - C_g - A$ $U_h + R_v + D_f - D_c$ $P_s + A - C_f + D_c$	$-C_g$ $-L$ 0	0 $R_v + D_f - D_c$ $P_s - C_f + D_c$	0 $-L$ 0
Farmers do not participate ($1-z$)	$-C_g$ $U_h - D_c$ R_n	$-C_g$ $-L$ R_n	0 $-D_c$ R_n	0 $-L$ R_n

2.4. Numerical Solution

To further validate the correctness of the model derivation and the rationality of the discussion, Python was used to conduct dynamic evolution simulation of the game system. This simulation aimed to explore the impacts of factors such as government incentives and participation costs of the non-timber forest product industry on the tripartite game. Following the practices of similar studies [63], to better reflect the real situation of the development of the non-timber forest product industry, we investigated the staff of the Harqin Banner Forestry and Grassland Bureau, the staff of Wangyedian Experimental Forest Farm, and local farmers in Chifeng City, Inner Mongolia Autonomous Region, China. This is a project promoted by the Harqin Banner government, with the participation of Wangyedian Experimental Forest Farm and local farmers, aiming to support local farmers' employment and income increase, transforming green mountains into golden mountains (Appendix A). We collected and analyzed relevant policy documents, academic papers, media reports, and field research data to understand the background, objectives, operational mechanisms, and implementation effects of the understory mushroom system. This process yielded various types of structured and unstructured data, including policy documents, media reports, and interview records.

Harqin Banner is located in the eastern part of Inner Mongolia Autonomous Region, China, with a forest coverage rate of 57.8%, which is 34 percentage points higher than the national average. The eastern part of the Banner is characterized by river valley plains with thick soil layers and relatively abundant water resources, suitable for the growth of grains, traditional Chinese and Mongolian medicinal herbs, greenhouse vegetables, and forestry economic crops. In 2022, the GDP of the Banner reached 10.86 billion yuan, ranking low among all districts and counties in the city, with the primary sector contributing the most to the economy. However, the per capita disposable income of local farmers and herders is lower than the average level of Inner Mongolia Autonomous Region, necessitating the exploration of diversified income methods to improve income levels. The investigation found that the cultivation of understory mushrooms has been effectively promoted and implemented in Harqin Banner, improving the income level of local farmers and promoting the protection of forest resources. The operational effectiveness of this system is complexly influenced by the collaborative participation of stakeholders and affected by multiple factors such as policy support, market demand, farmer participation, and cultivation techniques. This provides a solid realistic foundation for the analysis in this paper. Based on field interviews, multi-source data, and expert experience, we set the initial values of the model parameters as follows: $R_n = 5 \times 10^4$ yuan, $P_s = 6.5 \times 10^4$ yuan, $C_f = 3.5 \times 10^4$ yuan, $A = 2 \times 10^4$ yuan, $D_f = 2 \times 10^3$ yuan, $D_c = 8 \times 10^3$ yuan, $C_g = 5 \times 10^4$ yuan, $U_h = 5 \times 10^4$ yuan, $R_g = 10 \times 10^4$ yuan, $R_v = 2.5 \times 10^4$ yuan, $L = 4 \times 10^4$ yuan, $x = 0.5$, $y = 0.5$, $z = 0.5$. The simulation period t was set to 5 years.

3. Results

3.1. The Replication Dynamic Equation for Government

In this study, the expected payoff for the government when choosing the promotion strategy is defined as E_{11}. The expected payoff when choosing the non-promotion strategy is defined as E_{12}. Therefore, the average expected payoff for the government is E_1, which can be calculated using Equation (1).

$$\begin{cases} E_{11} = (1-y)\left(-C_g(1-z) - C_g z\right) + y\left(-C_g(1-z) + \left(-A - C_g + R_g\right)z\right) \\ E_{12} = 0 \\ E_1 = xE_{11} + (1-x)E_{12} \end{cases} \tag{1}$$

The replication dynamic equation for the government can be expressed as Equation (2).

$$F(x) = \frac{dx}{dt} = x(E_{11} - E_1) = (-1+x)x\left(C_g + \left(A - R_g\right)yz\right) \tag{2}$$

3.2. The Replication Dynamic Equation for State-Owned Forests

This paper defines the expected payoff for state-owned forests when choosing the strategy of actively developing the non-timber forest product industry as E_{21}, and the expected payoff when choosing the strategy of passively developing the non-timber forest product industry as E_{22}. The average expected payoff for state-owned forests is denoted as E_2, which can be calculated using Equation (3).

$$\begin{cases} E_{21} = (1-x)\Big(-D_c(1-z) + \Big(-D_c + D_f + R_v\Big)z\Big) + \\ \quad x\Big((-D_c + U_h)(1-z) + \Big(-D_c + D_f + R_v + U_h\Big)z\Big) \\ E_{22} = (1-x)(-L(1-z) - Lz) + x(-L(1-z) - Lz) \\ E_2 = yE_{21} + (1-y)E_{22} \end{cases} \tag{3}$$

The replication dynamic equation for state-owned forests can be expressed as Equation (4).

$$F(y) = \frac{dy}{dt} = y(E_{21} - E_2) = -(-1+y)y\Big(-D_c + L + U_h x + \Big(D_f + R_v\Big)z\Big) \tag{4}$$

3.3. The Replication Dynamic Equation for Farmers

In this study, the expected payoff for farmers when choosing the strategy of participating in under-forest planting is defined as E_{31}. The expected payoff when choosing not to participate in under-forest planting is defined as E_{32}. The average expected payoff for farmers is denoted as E_3, which can be calculated using Equation (5).

$$\begin{cases} E_{31} = \Big(\Big(-C_f + D_c + P_s\Big)(1-x) + \Big(A - C_f + D_c + P_s\Big)x\Big)y \\ E_{32} = (R_n(1-x) + R_n x)(1-y) + (R_n(1-x) + R_n x)y \\ E_3 = zE_{31} + (1-z)E_{32} \end{cases} \tag{5}$$

The replication dynamic equation for farmers can be expressed as Equation (6).

$$F(z) = \frac{dz}{dt} = z(E_{31} - E_3) = \Big(R_n + \Big(C_f - D_c - P_s - Ax\Big)y\Big)(-1+z)z \tag{6}$$

3.4. Analysis of System Stability

Based on Equations (2), (4) and (6), a three-dimensional replication dynamic equation can be obtained, as expressed in Equation (7).

$$\begin{cases} F(x) = \frac{dx}{dt} = (-1+x)x\big(C_g + \big(A - R_g\big)yz\big) \\ F(y) = \frac{dy}{dt} = -(-1+y)y\Big(-D_c + L + U_h x + \Big(D_f + R_v\Big)z\Big) \\ F(z) = \frac{dz}{dt} = (-1+z)z\Big(R_n + \Big(C_f - D_c - P_s - Ax\Big)y\Big) \end{cases} \tag{7}$$

Letting ($F(x) = F(y) = F(z) = 0$) allows us to derive nine stable equilibrium strategies: $E_1(0,0,0)$, $E_2(0,0,1)$, $E_3(0,1,0)$, $E_4(1,0,0)$, $E_5(1,1,0)$, $E_6(1,0,1)$, $E_7(0,1,1)$, $E_8(1,1,1)$, and $E_9(x^*,y^*,z^*)$. In asymmetric games, if the equilibrium of the evolutionary game is an evolutionarily stable strategy, then this game must also be a strict Nash equilibrium. Moreover, a strict Nash equilibrium is a pure strategy equilibrium; thus, the dynamic mixed strategy equilibrium of an asymmetric game cannot be evolutionarily stable. Therefore, for the triadic evolutionary game involving "government–state-owned forests–farmers" in non-timber forest products, it is unnecessary to consider $E_9(x^*,y^*,z^*)$.

The remaining eight equilibrium strategies from E_1 to E_8 are not necessarily all stable equilibrium strategies. Utilizing the method proposed by Friedman, the analysis of the system's evolutionarily stable strategies can be conducted through the Jacobian matrix of the replication dynamic equations. According to Lyapunov's First Method [64], the stability of the replication dynamic system at the equilibrium points can be determined by the eigenvalues λ of the Jacobian matrix (A) of the dynamic game model. First, if all eigenvalues of the Jacobian matrix have negative real parts, this point is asymptotically stable; if any of the eigenvalues have positive real parts, the equilibrium point is unstable; if the eigenvalues λ include some with zero real parts and none with positive real parts, the stability of the equilibrium point cannot be determined. By taking the first-order partial derivatives with respect to x, y, and z, the following Jacobian matrix, Equation (8), can be obtained.

$$J = \begin{bmatrix} F_x(x) & F_y(x) & F_z(x) \\ F_y(y) & F_y(y) & F_y(y) \\ F_z(z) & F_z(z) & F_z(z) \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \tag{8}$$

Therefore, the asymptotic stability of the equilibrium strategies can be analyzed based on the eigenvalues (Table 3).

Table 3. Eigenvalues of equilibrium points and conditions for stability.

Equilibrium	Eigenvalues	Stability
(0,0,0)	$\lambda_1 = -C_g$ $\lambda_2 = -D_c + L$ $\lambda_3 = -R_n$	The point (0,0,0) is asymptotically stable if $-C_g < 0$, $-D_c + L < 0$, and $-R_n < 0$; otherwise, it is a saddle point or unstable.
(0,0,1)	$\lambda_1 = -C_g$ $\lambda_2 = -D_c + D_f + L + R_v$ $\lambda_3 = R_n$	The point (0,0,1) is a saddle point.
(0,1,0)	$\lambda_1 = -C_g$ $\lambda_2 = D_c - L$ $\lambda_3 = -C_f + D_c + P_s - R_n$	The point (0,1,0) is asymptotically stable if $-C_g < 0$, $D_c - L < 0$, and $-C_f + D_c + P_s - R_n < 0$; otherwise, it is a saddle point or unstable.
(1,0,0)	$\lambda_1 = C_g$ $\lambda_2 = -D_c + L + U_h$ $\lambda_3 = -R_n$	The point (1,0,0) is a saddle point.
(1,1,0)	$\lambda_1 = C_g$ $\lambda_2 = D_c - L - U_h$ $\lambda_3 = A - C_f + D_c + P_s - R_n$	The point (1,1,0) is unstable if $D_c - L - U_h > 0$, $A - C_f + D_c + P_s - R_n > 0$; otherwise, it is a saddle point.
(1,0,1)	$\lambda_1 = C_g$ $\lambda_2 = -D_c + D_f + L + R_v + U_h$ $\lambda_3 = R_n$	The point (1,0,1) is unstable if $-D_c + D_f + L + R_v + U_h > 0$; otherwise, it is a saddle point
(0,1,1)	$\lambda_1 = -A - C_g + R_g$ $\lambda_2 = D_c - D_f - L - R_v$ $\lambda_3 = C_f - D_c - P_s + R_n$	The point (0,1,1) is asymptotically stable if $-A - C_g + R_g < 0$, $D_c - D_f - L - R_v < 0$, and $C_f - D_c - P_s + R_n < 0$; otherwise, it is a saddle point or unstable.
(1,1,1)	$\lambda_1 = A + C_g - R_g$ $\lambda_2 = D_c - D_f - L - R_v - U_h$ $\lambda_3 = -A + C_f - D_c - P_s + R_n$	The point (1,1,1) is asymptotically stable if $A + C_g - R_g < 0$, $D_c - D_f - L - R_v - U_h < 0$, and $-A + C_f - D_c - P_s + R_n < 0$; otherwise, it is a saddle point or unstable.

In summary, evolutionary game theory under specific conditions identifies four stable equilibrium points. To provide better management implications, we reference relevant studies [65] to analyze the conditions for achieving asymptotically stable equilibrium strategies and their corresponding real-world scenarios:

Scenario 1: When $-C_g < 0$, $-D_c + L < 0$, and $-R_n < 0$, (0,0,0) is the asymptotically stable point, meaning that local governments do not promote, state-owned forestry farms develop passively, and farmers do not participate. High promotion costs may lead local governments to choose not to promote non-timber forest product industry-development policies, which could occur in situations of tight finances or when policy priorities are elsewhere. If state-owned forestry farms face high costs for actively developing the non-timber forest product industry, they may choose passive development, possibly due to lack of technical support, insufficient market demand, or high management costs. When farmers' planting costs (including land rental, seedling care, and labor costs) exceed the sum of sales revenue and government subsidies for under-forest products, and also exceed their other net income from not participating, farmers will choose not to participate.

Scenario 2: When $-C_g < 0$, $D_c - L < 0$, and $-C_f + D_c + P_s - R_n < 0$, (0,1,0) is the asymptotically stable point, meaning that local governments do not promote, state-owned forestry farms develop actively, and farmers do not participate. High administrative costs may be the reason local governments do not promote non-timber forest product industry development, such as when resources are limited, policy priorities lean towards other fields, or the potential benefits of non-timber forest product industry development are not fully recognized. For state-owned forestry farms, even without local government promotion, effectively reducing technical development and market-exploration costs and avoiding the opportunity costs of passive development make active development a more profitable choice. However, despite state-owned forestry farms' active development, high farmer participation costs and the sum of under-forest product sales revenue and state-owned forestry farm support costs still do not outweigh farmers' other net income from not participating, making participation risky. Alternatively, if farmers already have stable and high income sources in other agricultural fields, the appeal of participating in under-forest planting is insufficient, leading farmers to choose not to participate.

Scenario 3: When $-A - C_g + R_g < 0$, $D_c - D_f - L - R_v < 0$, and $C_f - D_c - P_s + R_n < 0$, (0,1,1) is the asymptotically stable point, meaning that local governments do not promote, state-owned forestry farms develop actively, and farmers participate. The total cost of promotion and subsidies by local governments exceeds the political performance gains from the promotion policy. This indicates that while the policy may bring certain political performance gains, the overall costs are higher, leading local governments to choose not to promote. The cost for state-owned forestry farms to actively develop the non-timber forest product industry is less than the total benefits from reducing labor costs and avoiding losses from passive development. Therefore, the net benefit of active development is positive, incentivizing state-owned forestry farms to choose active development. The total of farmers' planting costs and other net income from not participating in under-forest planting is less than the benefits from planting (including state-owned forestry farms' support costs and product sales revenue). This indicates that farmers' participation in under-forest planting is profitable, thus incentivizing farmers to participate.

Scenario 4: When $A + C_g - R_g < 0$, $D_c - D_f - L - R_v - U_h < 0$, and $-A + C_f - D_c - P_s + R_n < 0$, (1,1,1) is the asymptotically stable point, meaning that local governments promote, state-owned forestry farms develop actively, and farmers participate. When the total cost of promotion and subsidies by local governments is less than the political performance gains, local governments are motivated to promote non-timber forest product industry development. This may be because local governments aim to achieve ecological protection, economic development, poverty alleviation, and other goals through the non-timber forest product industry, thereby enhancing political performance and public credibility. The cost for state-owned forestry farms to actively develop the non-timber forest product industry is less than the total benefits from reducing labor costs, avoiding losses from passive development, and achieving performance assessments. Therefore, the net benefit of active development is positive, incentivizing state-owned forestry farms to choose active development. The total of government subsidies and under-forest product sales revenue exceeds the total of farmers' planting costs, state-owned forestry farms' support costs, and other net income from not participating in the non-timber forest product industry. This indicates that farmers' participation in under-forest planting is profitable, thus incentivizing farmers to actively participate.

3.5. Numerical Simulation

3.5.1. Impact of Local Government Behavioral Parameters on Evolutionary Games

Local governments' political performance R_g in promoting the development of non-timber forest product industries has a significant impact on the enthusiasm of local governments. As seen in Figure 2a, when R_g is relatively small, the political returns obtained by local governments are limited, resulting in insufficient motivation to promote the development of this industry. However, as R_g increases, local governments can obtain more political benefits from this action, such as higher performance evaluations and broader social recognition, greatly stimulating their enthusiasm to promote the industry's development. Inspired by the active promotion of local governments, state-owned forest farms also recognize the broad prospects and potential benefits of the industry, thereby enhancing their willingness to develop. Simultaneously, farmers are more willing to participate due to the government's positive attitude and potential policy preferences, which create a favorable environment and conditions for their involvement.

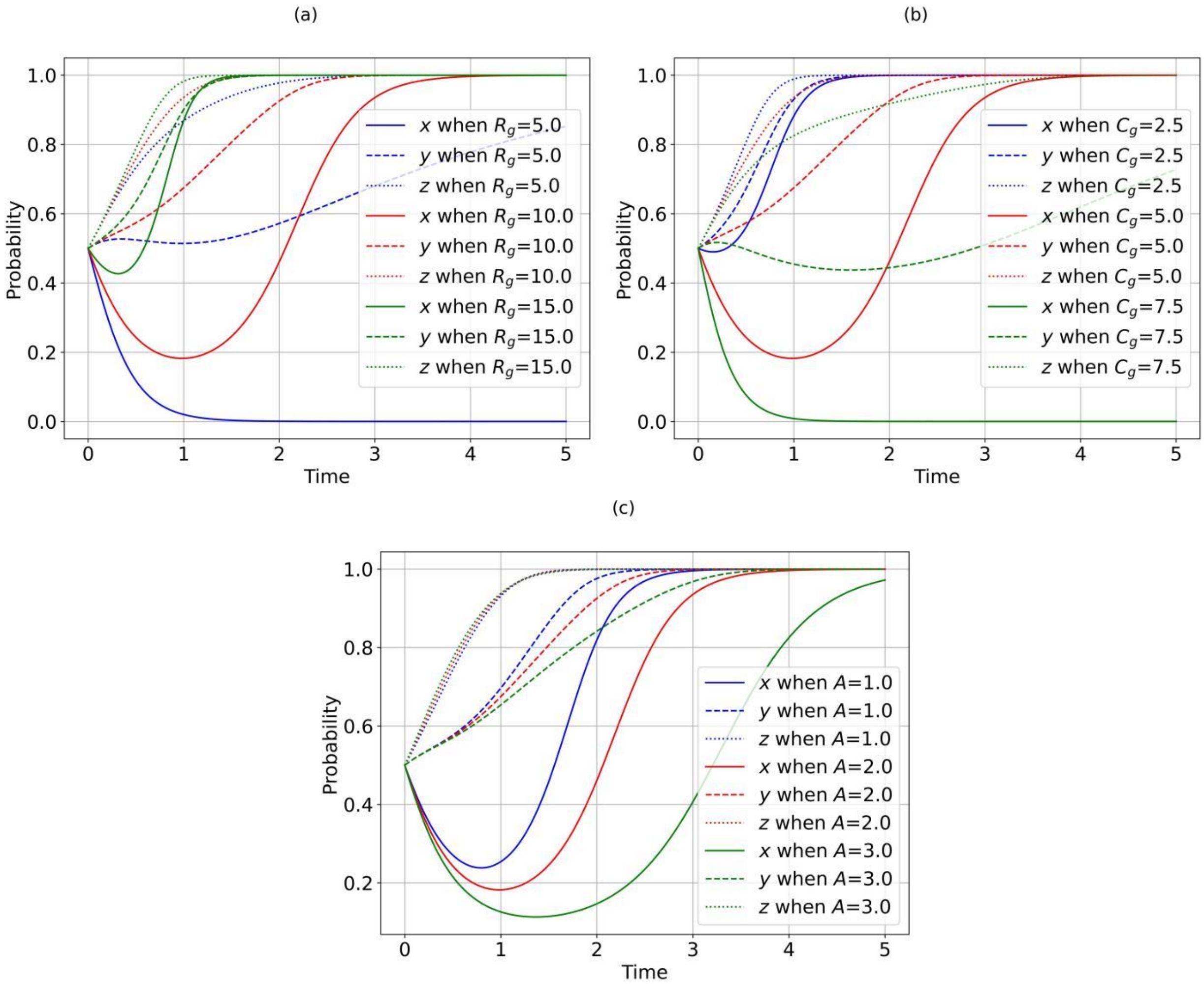

Figure 2. Impact of government behavioral parameters on evolutionary games. (**a**) Impact of R_g; (**b**) Impact of C_g; (**c**) Impact of A.

Local governments' administrative costs C_g in promoting the non-timber forest product industries exhibit an inverse relationship with their enthusiasm. As shown in Figure 2b, when C_g is high, it indicates that the government needs to invest significant human, material, and financial resources to promote the industry's development, increasing the burden and pressure on local governments and dampening their enthusiasm. Conversely, as administrative costs decrease, local governments can achieve the same development goals at lower costs. The efficient use of resources makes it easier for governments to promote the industry's development, naturally increasing their enthusiasm. This enhanced enthusiasm is transmitted to state-owned forest farms and farmers. State-owned forest farms intensify their development efforts due to increased government support, while farmers gain more confidence to participate due to smooth government promotion.

The subsidy A provided by local governments for farmers' participation in understory planting needs to be within a reasonable range. As depicted in Figure 2c, when local governments increase subsidies A for farmers to participate in understory cultivation, it significantly promotes farmer participation. However, it may reduce the government's enthusiasm for promotion. This is because higher subsidies mean more financial expenditure for the government, which may affect the government's resource allocation and work focus in the short term. Nevertheless, in the long run, the active participation of farmers lays a solid foundation for the industry's development, driving its scale and professionalization and ultimately enhancing the value of ecological products, which can repay the government's investment. Although the government's enthusiasm may be affected in the short term, a reasonable subsidy policy plays a crucial role in promoting the industry's development from an overall and long-term perspective.

3.5.2. Impact of State-Owned Forest Farm Behavioral Parameters on Evolutionary Games

The increase in the rent R_v for the understory space provided by state-owned forest farms has a positive effect on the enthusiasm of multiple stakeholders. As shown in Figure 3a, when rent R_v rises, state-owned forest farms generate greater economic returns from leasing understory land, which directly enhances their motivation to actively develop the non-timber forest product industry. The increased participation of state-owned forest farms creates more favorable conditions for the development of this industry and bolsters local governments' confidence in promoting non-timber forest products. In response, local governments intensify policy support and resource investment, further optimizing the development environment. Additionally, farmers become more enthusiastic about participation due to the favorable conditions fostered by the proactive stance of state-owned forest farms and strong support from local governments, which heightens their expectations for growth and benefits.

The increase in the assessment performance U_h of state-owned forest farms participating in the development of non-timber forest product industries also has a positive effect on the enthusiasm of multiple stakeholders. As indicated in Figure 3b, when U_h increases, it signifies that the state-owned forest farms' achievements in developing non-timber forest product industries are more fully recognized and rewarded. This not only motivates state-owned forest farms to pursue higher performance metrics but also sends a positive signal to local governments, encouraging them to more firmly advocate for the development of non-timber forest products to achieve better regional economic and ecological outcomes. Farmers, witnessing the active engagement of both state-owned forest farms and local governments, gain confidence in the industry's future and are thus more inclined to participate actively in its advancement.

The increase in the reduction of artificial care costs D_f due to the active development of non-timber forest product industries by state-owned forest farms also has a positive effect on the enthusiasm of multiple stakeholders. As illustrated in Figure 3c, when D_f increases, it signifies that state-owned forest farms can secure more development opportunities while reducing costs. This cost-saving and efficiency enhancement makes state-owned forest farms more willing to engage in the development of the non-timber forest product industry. Local governments are quick to recognize this change and, through further guidance and support, intensify their efforts to promote the industry. Observing the proactive actions of state-owned forest farms and local governments, farmers are also drawn to participate, collectively contributing to the growth of the non-timber forest product industry.

The increase in the opportunity cost L when state-owned forest farms are less active in developing non-timber forest product industries also has a positive effect on the enthusiasm for participation among multiple stakeholders. As revealed in Figure 3d, with the increase in L, state-owned forest farms become more acutely aware of the importance of actively developing non-timber forest product industries. To avoid missing developmental opportunities, state-owned forest farms proactively engage in the advancement of non-timber forest products. This positive shift encourages local governments to strengthen their support, refine accompanying policies and services, and create superior conditions for the industry's growth. Consequently, farmers, inspired by the progressive attitudes of both state-owned forest farms and local governments, are more resolute in their participation, fostering a collaborative effort to promote the development of the non-timber forest product industry.

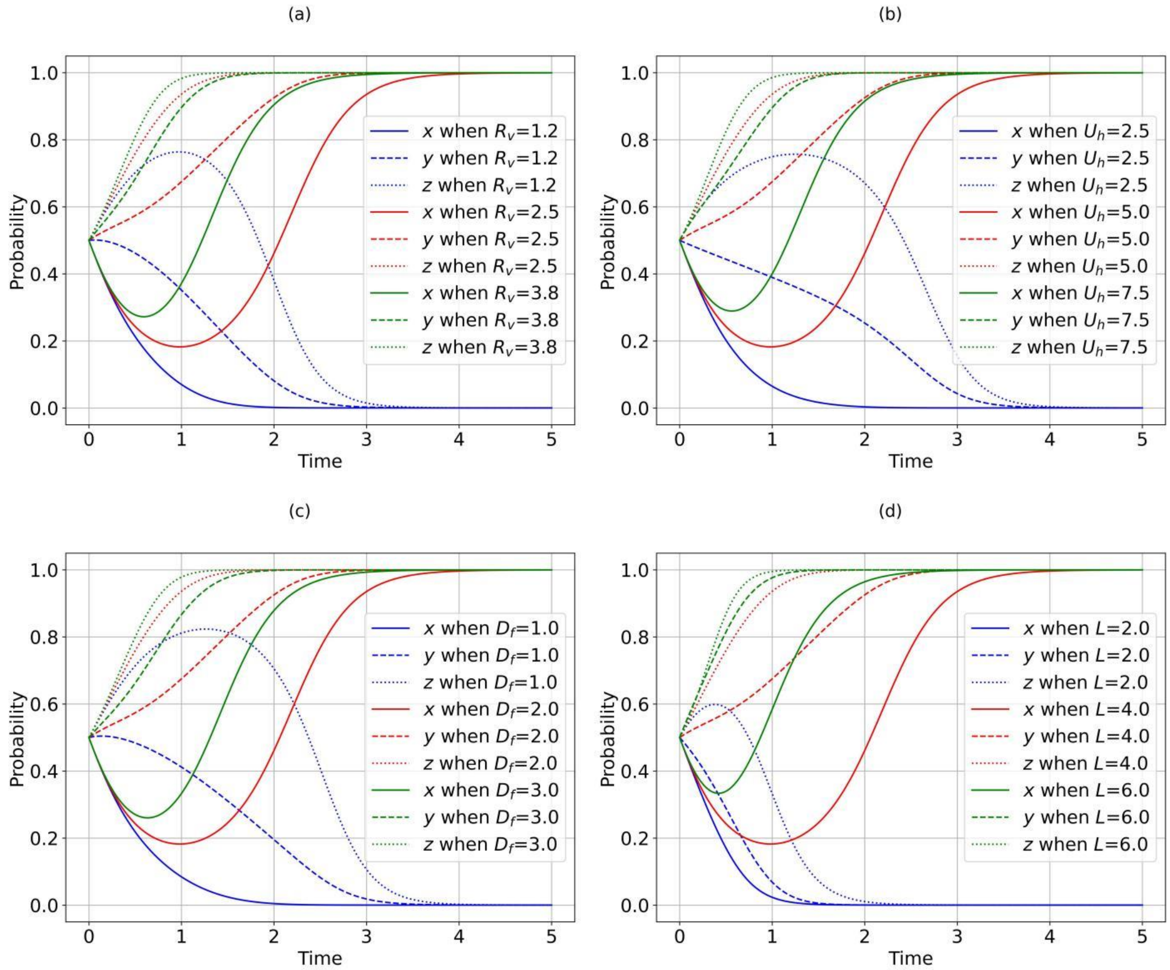

Figure 3. Impact of state-owned forest farm behavioral parameters on evolutionary games. (**a**) Impact of R_v; (**b**) Impact of U_h; (**c**) Impact of D_f; (**d**) Impact of L.

3.5.3. Impact of Farmers' Behavioral Parameters on Evolutionary Games

The net income R_n of farmers who do not participate in understory planting and instead engage in other work exerts a negative effect on the enthusiasm for participation among multiple stakeholders. As shown in Figure 4a, as R_n increases, it indicates that farmers can earn relatively high and stable returns from other work. In this scenario, farmers tend to favor other work over understory planting due to the income comparison, thus reducing their enthusiasm for participation. The decreased motivation of farmers creates a challenge for local governments in promoting the non-timber forest product industry, as it weakens the government's confidence in the push. State-owned forest farms also face difficulties in achieving scalable development due to reduced farmer participation, thereby lowering their willingness to actively develop the non-timber forest product industry.

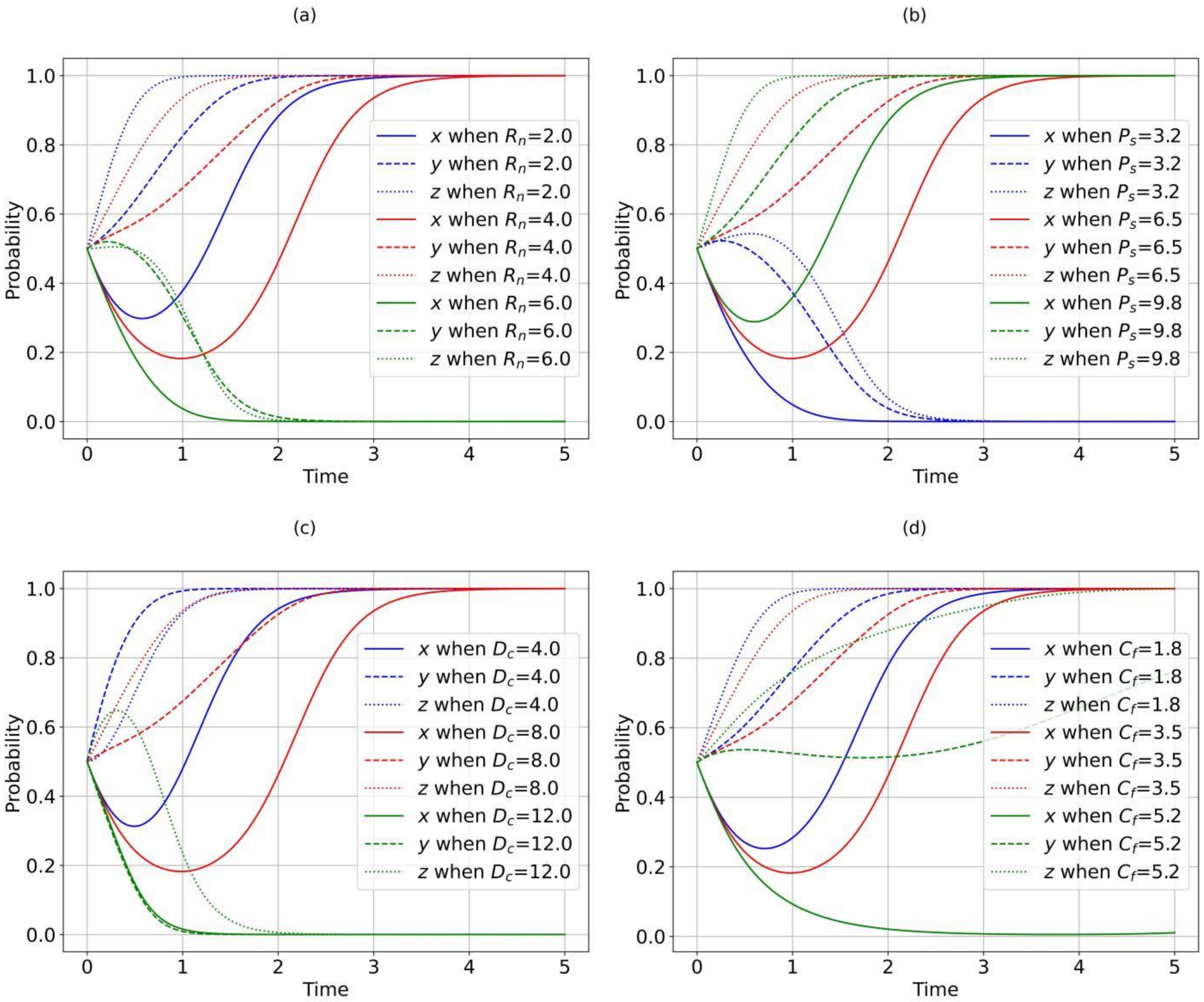

Figure 4. Impact of farmers' behavioral parameters on evolutionary games. (**a**) Impact of R_n; (**b**) Impact of P_s; (**c**) Impact of D_c; (**d**) Impact of C_f.

The sales income P_s of farmers from understory products has a positive impact on the enthusiasm for participation among multiple stakeholders. As depicted in Figure 4b, when P_s rises, farmers gain more substantial profits from understory planting, directly stimulating their participation. The active engagement of farmers creates broader collaborative opportunities and development prospects for state-owned forest farms, prompting them to strengthen their commitment to the non-timber forest product industry with increased investment and innovation. Local governments, witnessing the enthusiastic response from both farmers and state-owned forest farms, are more motivated to introduce favorable policies and provide supportive services, further propelling the vigorous development of the non-timber forest product industry.

The increase in the marketing development cost D_c borne by state-owned forest farms for farmers has a negative impact on the enthusiasm for participation among multiple stakeholders. Figure 4c reveals that when D_c increase, it raises the operational costs of state-owned forest farms and poses greater economic pressure, inevitably reducing their willingness to actively develop the non-timber forest product industry. The diminished enthusiasm of state-owned forest farms reduces cooperation opportunities and efforts with farmers, who, lacking support and guarantees, also experience decreased participation motivation. Local governments, facing low enthusiasm from both state-owned forest farms and farmers, see their initiative to promote the non-timber forest product industry suppressed.

The increase in the cost C_f of farmers' participation in understory planting also has a negative effect on the enthusiasm for participation among multiple stakeholders. As shown in Figure 4d, when C_f increases, it squeezes the profit margins of farmers and reduces their expected returns. The increased costs with uncertain returns significantly lower farmers' participation motivation. The decreased enthusiasm of farmers poses multiple obstacles for local governments in promoting the non-timber forest product industry, such as greater difficulties in policy implementation and less noticeable development outcomes, further reducing the government's motivation to push. State-owned forest farms also see their willingness to actively develop the non-timber forest product industry wane due to reduced farmer participation and weakened government support, affecting the overall industry progress.

4. Discussion

Previous studies have indicated that the development of non-wood forest product industries faces a series of challenges, and good stakeholder relationships are key influencing factors for promoting the growth of these industries [17–19]. Taking the understory mushroom economy of Wangyedian Experimental Forest Farm in China as an example, this paper analyzes the strategic behavior of the tripartite game between "government–state-owned forest farms–farmers" in non-wood forest products. The results show that there exists a stable equilibrium strategy that can achieve a win–win situation for all three parties, simultaneously promoting the development of non-wood forest product industries, forest protection, economic growth, and increased employment for farmers. This study further deepens the understanding based on existing research.

Practical evidence demonstrates that in 2021, the Wangyedian Experimental Forest Farm successfully conducted experiments on cultivating edible mushrooms, specifically the Tricholoma matsutake, achieving a net income of approximately 20,000 yuan per mu (a unit of area in China, equivalent to 0.0667 hectares). The local government's forestry and grassland bureau strengthened promotion and organized training for farmers, hiring technical experts to teach them cultivation techniques. Driven by the demonstration of the state-owned forest farm, the cultivated area of understory mushrooms expanded rapidly. Currently, Harqin Banner, where the forest farm is located, has become the second largest producer of Tricholoma matsutake in China, with a net profit of 30,000 yuan per mu and an annual output value exceeding 100 million yuan. The case of the understory mushroom economy at Wangyedian Experimental Forest Farm has also been recognized as one of the typical cases of the "Green Water and Green Mountains Are Golden Mountains and Silver Mountains" practical innovation base by the Ministry of Ecology and Environment of China, promoting its successful experience within China and globally. This practical case confirms the reliability of the research presented in this paper.

Similar to previous studies, despite the positive development of the understory mushroom economy at Wangyedian Experimental Forest Farm, there are still challenges to be addressed, including market demand fluctuations and farmers' lack of technical and management experience [14,17]. Simultaneously, the healthy development of the non-timber forest industry must address several critical issues. Firstly, fluctuations in market demand can significantly impact farmers' earnings from understory planting. While growing demand can facilitate product sales, declining demand may expose farmers to the risk of financial loss [66]. Secondly, understory mushroom cultivation requires advanced technical and managerial expertise. Given that most farmers lack such skills and experience, technical training becomes a direct driver of farmer participation in understory planting [3]. Thirdly, during the initial stages of the non-timber forest product industry's development, market expansion is essential. However, individual farmers often find it challenging to bear the high costs associated with market exploration, necessitating the involvement of state-owned forest farms or corporations. Fourthly, fiscal subsidies can boost farmers' enthusiasm for participation and provide a short-term boost to the understory mushroom economy. Still, long-term policy implementation may encounter difficulties due to insufficient financial backing [67]. Additionally, varying impacts from environmental and industry organizations may influence the development of the non-timber forest product industry [68]. Government policymakers must consider the interests of a broader array of stakeholders to ensure the economic, social, and ecological sustainability of the non-timber forest product industry.

To better promote and develop the under-forest mushroom economy, based on the analysis in this paper, the following optimization strategies can be adopted from the perspective of stakeholders: Firstly, state-owned forest farms and farmers should strengthen their benign cooperation and interaction, reinforcing the positive situation of "you help me become rich, and I help you with management and protection". The broad and active participation of farmers enables state-owned forest farms to significantly reduce the cost of management and protection personnel. State-owned forest farms provide farmers with strong technical and sales support, enabling them to actively participate in understory cultivation, obtain income, and achieve employment. To continuously enhance the quality and efficiency of non-timber forest products, it is imperative for state-owned forest farms to provide long-term technical training to farmers. Secondly, state-owned forest farms or large-scale farmers should continuously expand sales channels for understory products, form a stable market sales system, enhance their ability to predict market trends, and mitigate the operational risks of non-wood forest products. Simultaneously, it is advisable for farmers to strengthen their collaboration with major growers or relevant enterprises, exploring the "enterprise + major grower + farmer" cooperative model to mitigate the risks posed by market demand fluctuations. This approach also aids in continuously enhancing their ability to gauge market needs. Additionally, while early government subsidies are necessary for stimulating industry development, later stages of industry growth should primarily rely on effective sectoral management. In this context, the government can gradually reduce financial subsidies and rigid forest protection expenditures to alleviate fiscal pressure. Furthermore, policymakers should consider the interests of various stakeholders, including environmental and industry organizations, to synergize the efforts of different stakeholders in promoting the sustainable development of the non-timber forest product industry across economic, ecological, and social dimensions (Figure 5).

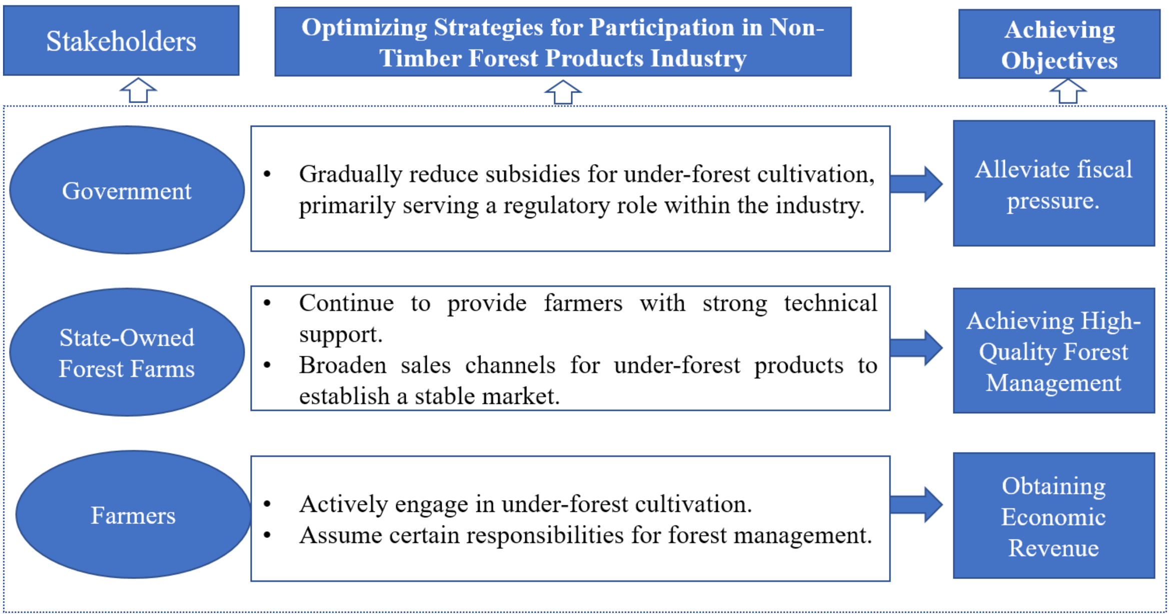

Figure 5. Optimization strategies for stakeholder engagement in non-timber forest product industry.

5. Conclusions

The promotion of non-timber forest product industry development by state-owned forest farms has a broad practical foundation and realistic significance. Good stakeholder relationships can drive the development of non-timber forest product industries, forest protection, and employment opportunities for farmers, resulting in positive "social–economic–ecological" benefits. This paper analyzes the main factors influencing the development of non-timber forest product industries from the perspectives of state-owned forest farms, local governments, and farmer stakeholders, and demonstrates the relationships among these factors. The main conclusions are as follows.

(1) In the development of non-timber forest product industries, there are both alignments and conflicts of interests among governments, forest farmers, and state-owned forest farms. It is necessary to adjust various parameter conditions to achieve optimal strategies and equilibrium results. Through the analysis of the evolutionary game model, it can be found that under certain conditions, four stable equilibrium strategies can be achieved, namely (0,0,0), (0,1,0), (0,1,1), and (1,1,1). Among them, the active participation of state-owned forest farms is a necessary condition for promoting the development of non-timber forest product industries, and the active participation of both governments and farmers is the most realistic and ideal scenario.

(2) The main influencing factors for local governments to participate in the development of non-timber forest product industries include political performance, administrative costs, and subsidies for under-forest planting. The main influencing factors for state-owned forest farms to participate in the development of non-timber forest product industries include rental income from under-forest land, assessment performance for participating in industrial development, reduced management and protection costs for participating in industrial development, and opportunity costs when passively developing the industry. The main influencing factors for farmers to participate in under-forest planting include net income from other jobs, sales income from under-forest products, market development costs shared by state-owned forest farms for farmers, and costs for farmers to participate in under-forest planting.

(3) The market development costs shared by state-owned forest farms for farmers and government subsidies for farmers to participate in under-forest planting should be within a reasonable range. On the one hand, it can effectively promote farmers to participate in under-forest planting; on the other hand, the operating costs of state-owned forest farms and government financial subsidies should be controlled within a reasonable range, so that the government and state-owned forest farms still retain a positive willingness to promote industrial development.

The research in this paper reveals the applicability and feasibility of state-owned forest farms promoting the development of non-timber forest product industries under different conditions. However, there are also some limitations and deficiencies in this paper. To focus on studying the game relationship between forest farmers, local governments, and state-owned forest farms, the paper mainly reveals the impact of relevant parameters of local governments, state-owned forest farms, and farmers on the development of non-timber forest product industries. Neglecting the consideration of additional stakeholders, such as the central government, may result in various impacts on the development of the non-timber forest product industry, both positive and negative, or interactions with the factors analyzed in this paper. Secondly, farmers' participation in understory planting is significantly influenced by market factors, which could potentially undermine the long-term stability of the tripartite equilibrium strategy. Furthermore, the selection of parameters for the numerical models in this study is primarily based on field surveys of the understory mushroom economy, and may thus differ somewhat from other types of non-timber forest product industries. Future research could explore stakeholder and farmer participation motives, behavioral strategy impacts on the non-timber forest product industry, as well as their collaborative or competitive relationships between major stakeholders. Moreover, future research could focus on deepening industry studies to continually refine and optimize parameter settings, thereby enabling a more in-depth analysis of the intrinsic game mechanisms among stakeholders.

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Data Availability Statement: The datasets generated during and analyzed during the current study are available from the corresponding author on reasonable request.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Field Research Topic: Development of Understory Mushroom Industry in Wangyedian Experimental Forest Farm

Research Subjects: Staff from the Forestry and Grassland Bureau of Harqin Banner, Chifeng City, Staff from Wangyedian Experimental Forest Farm, Local Farmers

Research Location: Harqin Banner, Chifeng City

Interview Dates: May and July 2023 (conducted in two phases)

Key Research Contents:

(1) Natural and Socio-Economic Conditions for Developing Non-Timber Forest Products (NTFPs) in the Local Area

Kalaqin Banner is located in the eastern part of Inner Mongolia Autonomous Region, China, with a total area of 3050 square kilometers. The forest coverage rate is 57.8%, which is 34 percentage points higher than the national average in China. The Banner falls within the temperate dry-semidry continental monsoon climate zone, with the eastern part being valley plains with thicker soil layers and richer water resources, suitable for the growth of staple crops, traditional Mongolian and Chinese medicinal herbs, greenhouse vegetables, and forestry economic crops. In 2022, the GDP reached 10.86 billion yuan, ranking relatively low in the city. The primary sector contributes the most to the economy. However, the per capita disposable income of local farmers is below the average level of Inner Mongolia Autonomous Region, necessitating the exploration of diversified income methods to improve income levels.

(2) Reasons for the Banner Government's Promotion of NTFP Industry Development

Under the guidance of the central government and the government of Inner Mongolia Autonomous Region, the Banner government has set the goal of developing the NTFP industry to provide local farmers with new economic sources. Since 2021, Kalaqin Banner has been implementing a forestry economy development mechanism characterized by "government promotion, enterprise leadership, base traction, and farmer actions" to promote the development of forestry economy. In 2022, the Banner government released the "Measures for Awarding and Subsidizing Main Industries to Consolidate and Expand Poverty Alleviation Achievements and Effectively Connect with Rural Revitalization in Kalaqin Banner", offering preferential policies for developing forest fungi and medicinal herbs, with subsidies of 2000 yuan per mu for forest fungi and 200 yuan per mu for forest medicinal herbs, effectively enhancing farmers' enthusiasm for planting. Developing the NTFP industry can also increase the assessment performance of the Banner government by higher-level authorities.

(3) Major Reasons for State-Owned Forest Farms to Promote NTFP Industry Development

Wangyedian Experimental Forest Farm, a key state-owned forest farm in Kalaqin Banner, covers an area of 420,000 acres and is administratively subordinate to the People's Government of Kalaqin Banner, while being business-supervised by the Banner's Forestry Bureau. The forest farm staff mainly undertake tasks such as forest fire prevention and pest control, with heavy forest protection tasks and insufficient personnel. Under the guidance of the Banner government, in 2021, the state-owned forest farm successfully experimented with the cultivation of shiitake mushrooms under the forest using abundant forest resources. To promote under-forest cultivation among farmers, the state-owned forest farm employed senior technical experts and dispatched technical backbones to teach farmers skilled cultivation techniques. To ensure product sales, the Forestry and Grassland Bureau and the state-owned forest farm conducted market research in Shandong, Hebei, and other places, connecting with enterprises in need of forest products. To address the lack of storage, quick freezing, sorting, and trading platforms for forest products, the state-owned forest farm cooperated with local enterprises to build a forest product storage, sorting, and packaging workshop, providing free trading places for the public and merchants. In cooperation with farmers, the state-owned forest farm provides forest land for lease and charges rent, offers technical and market support, while farmers provide certain forest protection tasks for the state-owned forest farm, reducing the forest protection costs, creating a situation where "you help me get rich, and I help you protect".

(4) Reasons for Farmers to Participate in NTFP Cultivation

Local farmers have limited sources of economic income apart from agricultural planting and off-farm employment. Under the promotion and advocacy of the banner government and state-owned forest farms, they have gradually begun cultivating non-timber forest products. To mitigate risks, they participate in understory planting training organized by the banner's Forestry and Grassland Bureau and state-owned forest farms on the technical level, and connect with local companies and large farmers to solve the sales issues on the marketing level. Presently, cooperative planting models such as "Company + Base + Farmers" and "Cooperative + Base + Farmers" have been established, covering an area of approximately 8500 mu. With the triple guarantee of technical support, market backing, and government subsidies, participation in understory planting yields favorable economic benefits. Some farmers' annual income from non-timber forest products reaches 50,000 to 70,000 yuan, surpassing the income levels from off-farm employment, thereby incentivizing higher farmer participation in non-timber forest product cultivation.

(5) Current Effectiveness of NTFP Industry Development

In 2023, Kalaqin Banner continued to expand the planting scale, with a total of 3500 mu of shiitake mushrooms developed, yielding an annual output value of over 30,000 yuan per mu and a net income of 20,000 yuan per mu. The annual output value is currently estimated to reach 250 million yuan, with products sold to Beijing, Shanghai, Guangzhou, Fujian, and other places, becoming the largest production base of shiitake mushrooms in the country. This has radiated and driven employment for over 2000 local residents, promoting the sustainable economic and social development of the area.

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