A Study on Benefit Distribution in the Supply Chain of Sericulture Industry Based on Shapley's Value Method

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Abstract. At present, there is an imbalance between income and expenditure in the sericulture supply chain, and the income does not cover the expenditure. At the same time, the supply chain of the sericulture industry has a single cooperative relationship among all the subjects and does not form a whole. In this paper, we use the sericulture research institute, sericulture seed farms and sericulture farmers (cooperatives) as the main research objects, and use the shapley value method to measure the profit distribution of one sericulture seed among each subject based on the contribution degree of different subjects, and make suggestions to promote the change of cooperation mode of each subject in the sericulture seed industry supply chain and the stable development of the supply chain. It is hoped that the above problems can be solved by changing the mode of cooperation among the main actors in the sericulture supply chain, integrating resources, sharing the production costs of the main actors in the supply chain and increasing the profits of the supply chain.

Keywords: Silkworm industry supply chain · Supply chain cooperation · Shapley value method

1 Introduction

In the early 21st century, China's sericulture seed production capacity and level of production continued to improve, and a number of seed farms with strong production capacity and good economic efficiency emerged, mainly due to the reform of the system, which led to the upgrading of the sericulture seed industry [1]. According to the author's survey, most state-owned sericulture farms have not been profitable for many years, and the overall economic efficiency of the sericulture industry chain has been declining for a long time [2]. Therefore, the author has constructed a supply chain for the sericulture industry based on the current situation of the sericulture industry, using the idea of a supply chain to link the various business entities of the sericulture industry and analysing each business entity separately [3]. The research objects are sericulture research and development units, sericulture farms and sericulture farmers (co-operatives), and the data on costs and revenues are analysed to study the current situation of benefit distribution

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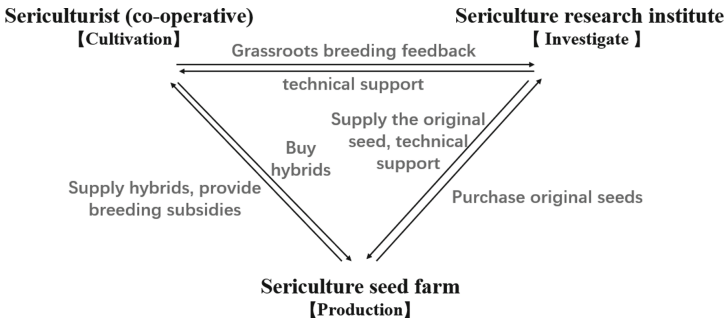

Fig. 1. Cooperation game diagram of the supply chain of the sericulture industry

among the main bodies of the sericulture industry, and according to the results, the degree of contribution of each main body to the sericulture industry is analysed, and give some suggestions [4].

2 Cost-Benefit Analysis Among the Various Subjects of the Sericulture Industry Supply Chain

2.1 Cooperation Game in the Supply Chain of the Sericulture Industry

The supply chain of the sericulture seed industry refers to the process of sericulture seed from research and development to breeding, which is mainly composed of sericulture seed research and development units, sericulture seed production units and sericulture farmers.

Only through close cooperation between the various actors in the sericulture supply chain can the whole supply chain develop steadily in the long term, making the profits of the various actors in the supply chain much higher than if they were working alone [5]. The game diagram of the supply chain cooperation in the sericulture industry is shown in Fig. 1.

2.2 Cost-Benefit Analysis of the Supply Chain in the Sericulture Industry

2.2.1 Stand-Alone Operation

The Sericulture Research Institute acts as the starting point of the supply chain of the sericulture industry, the sericulture farm as the intermediate link and the sericulturist as the final link. See Table 1, when producing one sericulture seed, the cost to the sericulturist is RMB 18.64 and the profit is RMB 6.23; the cost to the seed farm is RMB 36 and the profit is RMB 14; the cost to the sericulture research institute is RMB 58 and the profit is −8. In the current supply chain of the sericulture industry, sericulturists (cooperatives) can obtain 50% of the profit, seed farms can obtain 114% of the profit; sericulture research institutes can obtain −65% of the profit. It can be found that the Sericulture Research Institute is in a state of loss in the current distribution of benefits in the supply chain. Although the Sericulture Research Institute is a non-profit R&D unit,

Table 1. Table of costs and profits for each main body of the sericulture seed industry in a stand-alone state

	Sericulture farmers (co-operatives)	Sericulture seed farms	Sericulture research institutes
Cost value	18.64	36	58
Value of revenue	24.87	50	50
Profit value	6.23	14	−8

its normal operation still needs to solve the problem of balancing expenses, and overall, the current uneven distribution of benefits in the supply chain of the sericulture seed industry is remarkable.

2.2.2 Two-by-Two Cooperation

1. *Sericulture farmers (co-operatives) + sericulture farms.*

After fieldwork, it was found that most sericulture seed farms are producing sericulture in their enterprises by employing specialised staff, but the cost of land and workers' wages are higher for this type of production. The cooperation between sericulturists (co-operatives) and sericulture farms can reasonably share the labour costs of the farms as well as the material costs of the sericulturists (co-operatives) [6].

2. *Sericulturist (cooperative) + sericulture research institute.*

The cooperation between sericulturists (co-operatives) and sericulture research institutes is the same as the cooperation between sericulturists (co-operatives) and sericulture seed farms, which can reasonably share the labour cost of sericulture research institutes and the material cost of sericulture farmers (co-operatives), which also has the effect of reducing costs and increasing profits for sericulture research institutes and sericulture farmers (co-operatives).

3. *Sericulture farms + sericulture research institutes.*

The seed farm and the sericulture research institute cooperate, with the seed farm sharing the research and development costs of the institute and the institute sharing the original seed costs of the seed farm. This will not only allow the seed farm to invest too much money upfront, but also reduce the pressure on the sericulture research institute to invest in research and development and reduce the risk for both parties.

2.2.3 Tripartite Cooperation

Sericulturist (cooperative) + seed farm + sericulture research institute.

When the three parties work together, the sericulturist can share the labour costs for both the sericulture farm and the sericulture research institute, while the cooperation between the sericulture research institute and the sericulture farm is also carried out

simultaneously, which makes the three parties become a community of interests, with shared benefits and shared risks.

3 Benefit Distribution of the Sericulture Supply Chain Based on Modified Shapley

Assume Y is the sericulture research institute; X is the sericulture farm; Z is the sericulture farmer (cooperative). Substitute the above calculation data into the Shapley value method calculation formula [7]. By improving the cooperative relationship between the three actors in the sericulture supply chain, the three actors become a community of interest. The calculation results are shown in Tables 2, 3 and 4.

According to Tables 2, 3 and 4, it can be seen that all segments of the supply chain of the sericulture industry have achieved value-added benefits. Among them, sericulturists (cooperatives) have the most significant increase in profit, sericulture research institutes can keep their income and expenditure in balance and help their sustainable development,

Table 2. Distribution of benefits to sericulturists (co-operatives) under different co-operations

Distribution condition	Cooperation status			
	Z	Z+X	Z+Y	Z+X+Y
V(S)	6.23	29.64	4.36	38.7
V(S-i)	0	14	−8	22.5
V(S)-V(S-i)	6.23	15.64	12.36	16.2
|S|	1	2	2	3
ω(|S|)	1/3	1/6	1/6	1/3
ω (|S|) [V(S)-V(S-i)]	2.07	2.6	2.06	5.4
Gain from cooperation	12.13			

Table 3. Distribution of benefits of sericulture farms under different collaborations

Distribution condition	Cooperation status			
	X	X+Z	X+Y	X+Z+Y
V(S)	14	29.64	22.5	38.7
V(S-i)	0	6.23	−8	4.36
V(S)-V(S-i)	14	23.41	30.5	34.34
|S|	1	2	2	3
ω(|S|)	1/3	1/6	1/6	1/3
ω(|S|) [V(S)-V(S-i)]	4.67	3.9	5.08	11.45
Gain from cooperation	25.1			

Table 4. Distribution of benefits of sericulture research institutes under different collaborations

Distribution condition	Cooperation status			
	Y	Y+Z	Y+X	Y+Z+X
V(S)	−8	4.36	22.5	38.7
V(S-i)	0	6.23	14	29.64
V(S)-V(S-i)	−8	−1.87	8.5	9.06
|S|	1	2	2	3
ω(|S|)	1/3	1/6	1/6	1/3
ω(|S|) [V(S)-V(S-i)]	−2.67	−0.31	1.42	3.02
Gain from cooperation	1.46			

and sericulture farms play a linking role in the supply chain cooperation, linking the various subjects of the sericulture industry closely. The benefits of cooperation between the various actors in the supply chain of the sericulture industry are much greater than the benefits of operating alone, which helps to promote cooperation between the various actors, while enabling risk sharing.

4 Conclusions and Recommendations

4.1 Conclusion

Through a series of studies and analyses, it can be found that the current cooperation model between the various subjects in the sericulture supply chain is relatively simple and difficult to form a good cooperation relationship. Overall, it seems that the traditional sericulture industry supply chain benefit distribution among the three parties is not coordinated, cooperation is weak and unstable, which is not conducive to the healthy development of the sericulture industry supply chain.

4.2 Recommendations

1. Overturn the traditional cooperation model and replace the old cooperation relationship with new ideas and new models. Sericulture research institutes, sericulture farms and sericulture farmers (cooperatives) are closely linked, and the cooperation model given in this paper can be adopted, so that the three subjects can transform from the original each doing their own work, a simple buying and selling relationship to a mutually beneficial supply chain, reducing unnecessary links in the supply chain while making each subject unable to easily abandon the other subjects, so that each individual within the supply chain of the sericulture industry as a whole can achieve benefit sharing The benefits are shared and the risks are shared [8].
2. Changing the mode of cooperation between the main bodies of the supply chain of the sericulture industry is undoubtedly a new opportunity, but it is even more of a great challenge. The cooperation of agricultural enterprises has long been strongly

promoted by the national government [9], therefore, for the cooperation of agricultural enterprises to provide appropriate subsidies and insurance, can promote the cooperation of the main body of the sericulture supply chain, so that the main body is more at ease, more motivated, with the government as the medium to maintain the cooperation of agricultural enterprises, to protect the supply of the two subjects earnings [10].

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