

The Influencing Factors of High-Yield Unsalable Fruit in Guangxi based on System Dynamics

Jianwei Qiu^{1,2}, Jie Xu^{2,*}

¹Research Center of Modern Enterprise Management of Guilin University of Technology, Guilin Guangxi 541004, China

²School of Business, Guilin University of Technology, Guilin Guangxi 541004, China

Abstract

According to statistics, in recent years, the frequent occurrence of unsalable fresh fruits in Guangxi has had a great impact on the income of fruit farmers in remote mountainous areas, especially since the outbreak of Coronavirus disease 2019 (COVID-19). Based on the theory of deep poverty alleviation, this paper uses the method of system dynamics to clarify the four-dimensional causality of fruit farmers' production, fruit merchants' sales, logistics transportation, and government's support. This paper analyzes the mechanism of influencing fresh fruit production and marketing, constructs a four-dimensional dynamic model of fresh fruit production and marketing system, and simulates the model with Vensim software. The results show that: fruit farmers' production, fruit merchants' sales and logistics transportation have a great impact on fresh fruit production and marketing, while government support has a positive impact on fresh fruit production and marketing, but its impact is not significant.

Keywords

Unsalable Deep Poverty Alleviation; Coronavirus Disease; High-Yield but Unsalable Fruit; System Dynamics; Four-Dimensional Dynamic.

1. Introduction

The fresh fruit industry has become one of the pillar industries of Guangxi's economy with the characteristics of many varieties and large output. However, the phenomenon of unsalable fresh fruits has seriously damaged the income of fruit farmers in remote mountainous areas, especially since the outbreak of Coronavirus disease 2019 (COVID-19). Due to the insufficient and untimely access to supply and marketing information and the simplification of fresh fruit sales ways, small-scale fruit farmers are hard to keep up with the changes of market supply and demand, and often fall into the dilemma of high-yield but unsalable fruit. Therefore, in the face of the current situation, existing problems and development trend of Guangxi's fresh fruit industry, how to make Guangxi's fresh fruit industry high-yield and best-selling, promote the healthy development of Guangxi's fresh fruit industry economy, and help the deep poverty alleviation, become the urgent problems to be solved.

In recent years, domestic and foreign scholars have carried out research on unsalable problems, and the main objects are agricultural products. Renko, N., Nikolasevic, S. and Pavicic, J. (2002) [1] proposed the government's support for Croatian agricultural product market mechanism and the effective application of agricultural product information system, which realized the effective prevention of agricultural product market failure. Nakandala, D., Lau, H. and Zhang, J. (2016) [2] used genetic algorithm and fuzzy genetic algorithm to analyze, and proposed that logistics managers in the upstream of fresh food supply chain make cost optimization decisions in the logistics transportation process in order to minimize the total cost and ensure that the food quality is higher than a certain level. J.P. Wei, J.B. Zhang and P. Li(2013) [3] carried out

logistic regression analysis on the influencing factor model of agricultural products unsalable from the perspective of farmers; J.H. Liu, Q. Cai and Q. Chang(2013) [4] and others proposed that the main factors of unsalable agricultural products were market saturation in sales links, blocked sales channels and blind production in production links. J.Chen and X.Y. Chen(2018) [5] suggested that by accelerating the construction of logistics service function of agricultural products wholesale market, the degree of vegetable unsalable and the frequency of vegetable unsalable could be reduced.

For the unsalable problem, scholars analyze the reasons for the frequent occurrence of unsalable events from different angles, and put forward different measures and suggestions [6-7], but there are few studies on the key subjects of unsalable events. In addition, the existing research ignores the relationship between the main subject of fresh fruit production and marketing and the elements in the system, so it is difficult to reflect the evolution trend of fresh fruit production and marketing. Therefore, based on the principle of system dynamics, this paper analyzes the causality of fresh fruit production and marketing system from four dimensions: fruit farmers' production, fruit merchants' sales, government support and logistics transportation, and then constructs a four-dimensional dynamic model of fresh fruit production and marketing system. The system is simulated from 2018 to 2030 with the fresh fruit industry data of Guangxi agricultural and rural department and the relevant data of Guangxi statistical yearbook. At the same time, the influence law of some key parameters such as the capital input intensity of the main object is studied.

System dynamics was established in 1956 by Professor Forrester of Massachusetts Institute of technology. System dynamics model is based on qualitative and quantitative research method, which simulates the function of the system, and is suitable for solving complex social and economic problems. According to the viewpoint of the system, the behavior mode and main characteristics of the system mainly depend on its internal mechanism and feedback mechanism. It is emphasized to establish a structural model for simulation analysis based on the system structure, behavior, and causality [8-10]. The fresh fruit production and marketing system is affected by the factors of different subject object activities (fruit farmers' production activities, fruit merchants' sales activities, logistics and transportation activities, etc.). For example, the capital input intensity of the main object affects the capital input of the fresh fruit industry, and then leads to the fluctuation of the production technology level, deep processing level and preservation level. The fluctuation of the ability level makes the production and sales of fresh fruits change. This change realizes the rise and fall of the annual output value of fresh fruits by changing the economic loss, and the annual output value of fresh fruits in turn will affect the capital input intensity of the main object. Based on this, this paper takes the annual output value of fresh fruit as a comprehensive performance of the overall function. The research of unsalable fresh fruit is a process of multi-agent, multi variable and multi factor interaction. Therefore, the construction of system dynamics model has become an effective way to find the key subject objects and their constraints.

2. Methodology

2.1. Dynamic Model Construction of Four-Dimensional Fresh Fruit Production and Marketing System

Based on the principle of system dynamics, this paper takes fruit farmers, fruit merchants, government and logistics as the main objects, takes the annual output value of fresh fruit as the main index of fresh fruit production and marketing, analyzes the interaction among variables in the fresh fruit production and marketing system, and draws the causal relationship diagram of influencing factors of fresh fruit production and marketing, as shown in Figure 1.

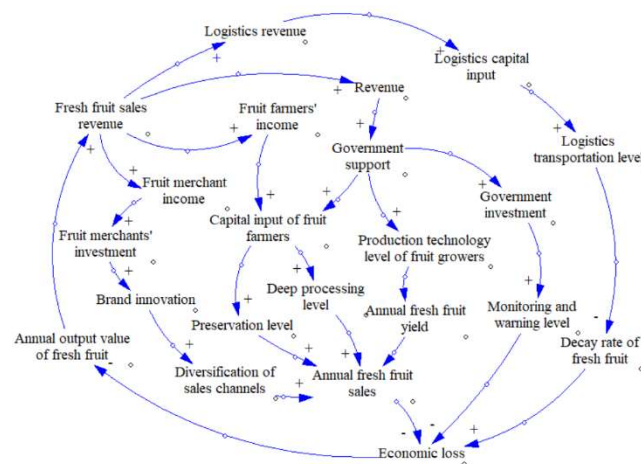


Figure 1. Causality diagram of influencing factors of fresh fruit production and marketing system

Comprehensive analysis of causality diagram shows that fresh fruit sales revenue has a direct impact on fruit farmers' income, fruit merchant's income, financial revenue and logistics income.

In fruit farmers' production activities, the income obtained by fruit farmers and government subsidies determine the amount of capital investment in the production of fresh fruit industry, and then have an impact on the deep processing and fresh-keeping treatment of fresh fruits. The ability of deep processing and preservation is the premise of giving high added value to fresh fruit, which can greatly reduce the rate of fresh fruit damage in picking, transportation and sales, and effectively reduce the economic loss of fresh fruit industry.

In the fruit merchant's sales activities, the amount of capital investment for the fresh fruit industry depends on the income of the fruit merchant. In recent years, many high-quality and low-price fruits from ASEAN countries have impacted the local fresh fruit industry in Guangxi. The imported products have occupied the high profit market and compressed the profit space of local products. In the face of fierce market competition, brand innovation of fresh fruit industry can increase the publicity of local fresh fruit products, help to broaden the sales channels of fresh fruits, promote sales and increase revenue.

In government support activities, the government reduces economic losses by organizing production technology training meetings and giving fruit growers a certain amount of policy subsidies, and the degree of support is mainly affected by financial revenue. Through participating in production technology training, fruit farmers can strengthen the planting management of fresh fruits, realize the standardization and standardization of production, ensure the quality of fresh fruits meet the industrial standards, and then improve the production and sales of fresh fruits and annual output value.

In the logistics transportation activities, in view of the fresh fruit has the characteristics of freshness and perishability, the sales of fresh fruits have great limitations, and the effective large-scale outward transportation cannot be realized under the condition of lack of cold chain logistics infrastructure. The construction of cold chain logistics infrastructure has become a key factor affecting the rate of fresh fruit loss and decay, and a key factor affecting the transportation cost and efficiency.

2.2. Model Checking

According to the above causal analysis, this paper takes the fruit industry data of Guangxi agricultural and rural department and the relevant data of Guangxi statistical yearbook as the initial data, and uses the system dynamics special software Vensim to draw the flow chart of the four-dimensional linkage fresh fruit production and marketing system, as shown in Figure 2.

In the logistics transportation activities, in view of the fresh fruit has the chain the system dynamics model, the annual output value of fresh fruit is a comprehensive performance of the overall function.

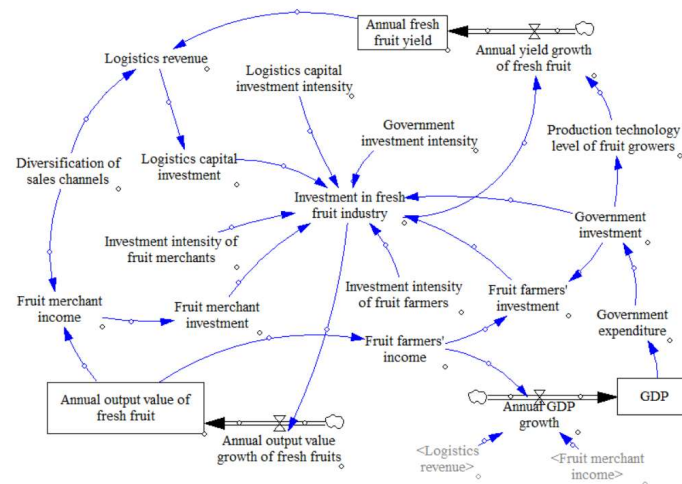


Figure 2. Flow chart of dynamic model of four-dimensional linkage fresh fruit production and marketing system

Therefore, this paper selects the annual output value of fresh fruit as the main output value of the model to reflect the production and marketing situation of fresh fruit industry, and selects Guangxi GDP as the second output value of the model to indirectly reflect the economic effect. In order to verify the consistency between the model and the real system, the validity of the model is ensured by comparing the simulation results with the actual system historical data. Figures 3- Figure 4 show the simulation results output of the two output variables from 2016 to 2020, and Table 1 shows the comparison between the simulated output value and the real value.

Table 1. Error rate of model output

Year	Annual output value (100 million yuan)			GDP (100 million yuan)		
	Fitted value	Actual value	Error rate	Fitted value	Actual value	Error rate
2016	248	248	0.00%	15673	15673	0.00%
2017	334	337	0.89%	16264	16803	3.21%
2018	437	450	2.89%	17018	18318	7.10%
2019	561	549	2.19%	17964	18523	3.02%
2020	708	738	4.07%	19136	20353	5.98%

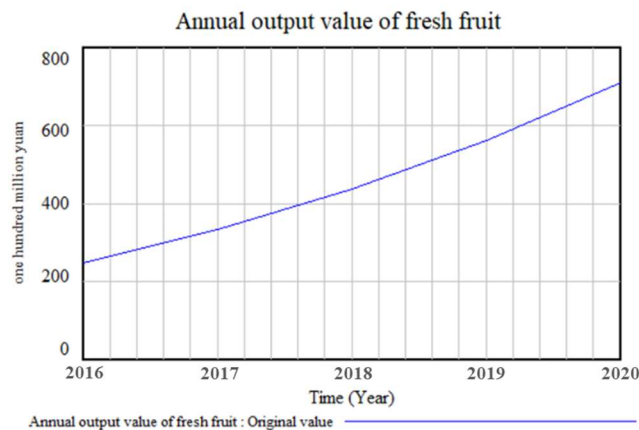


Figure 3. Output chart of annual output value of fresh fruit

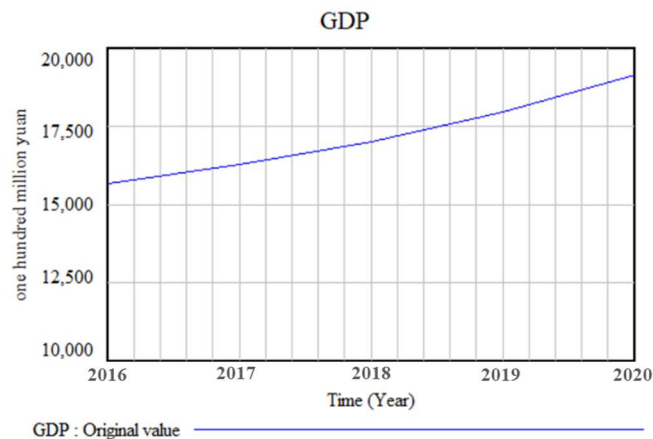


Figure 4. Output chart of GDP

According to the chart, the error rate of annual output value of fresh fruit is within 5%, and the maximum error rate is 4.07%; the error rate of GDP is within 10%, and the maximum error rate is 7.10%. The fitting degree between the predicted value and the actual value is good, which indicates that the model can objectively reflect the production and marketing situation of Guangxi fresh fruit industry, and the rationality and accuracy of the model.

3. Results and Discussion

By changing the key objects such as the capital input intensity of the main object, and taking the annual output value of fresh fruit as the main output value, this paper explores the influence law of fresh fruit production and marketing. The main objects of fresh fruit production and marketing system include fruit farmers, fruit merchants, government and logistics. At the same time, the investment of fresh fruit industry is also affected by the investment intensity of different main objects. Under the condition that other state variables remain unchanged, it is assumed that the capital input intensity of fruit growers, fruit merchants, government and logistics funds will increase by 10% respectively. The output results of the model simulation are shown in Figure 5- Figure 8.

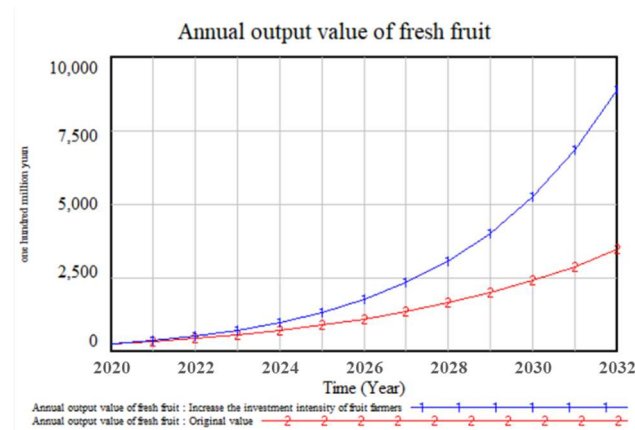


Figure 5. Output chart of increasing fruit farmers' capital input intensity

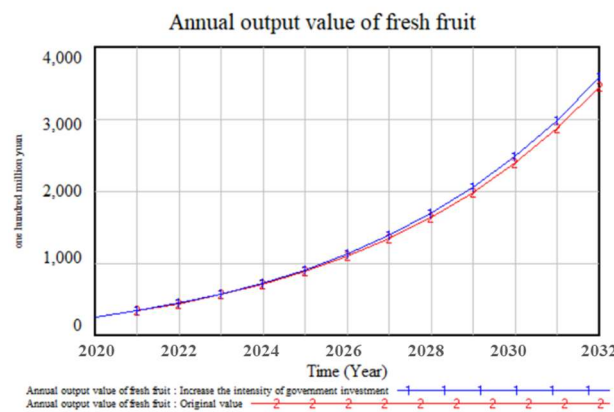


Figure 6. Output chart of increasing government investment intensity

The analysis shows that the increase of fruit farmer's capital input intensity, fruit merchant's capital input intensity and logistics capital input intensity have a significant impact on the annual output value of fresh fruit, among which the fruit farmer's capital input intensity has the greatest impact. As the main participants in the fresh fruit production and marketing system, fruit farmers not only improve their own technology and capital investment, but also have a great impact on other subjects, thus promoting the production and marketing of fresh fruits and increasing the annual output value of fresh fruits. The quality of fresh fruit is an important.

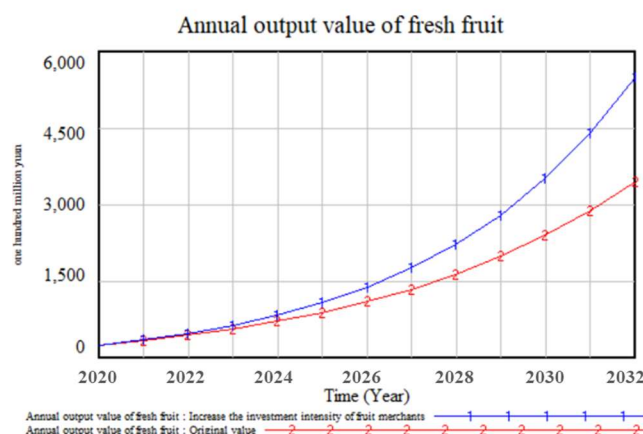


Figure 7. Output chart of increasing fruit merchant's capital input intensity

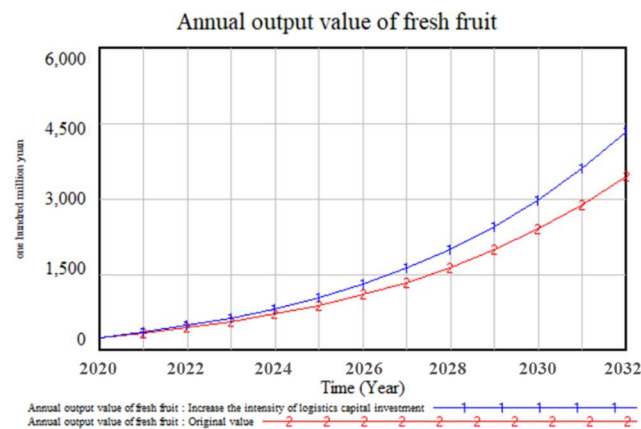


Figure 8. Output chart of increasing logistics capital input intensity

Guarantee to promote the marketing of fresh fruit. The common characteristics of agricultural products that are difficult to sell in the market are common varieties and low technical requirements. The fruit farmers' capital investment directly affects the technical level of the production side, which can realize the standardization and standardization of production, ensure the high quality of fresh fruits, and bring market competitive advantages for the follow-up marketing segment.

The increase of fruit merchant's capital input intensity has a more significant impact on the total output value of fresh fruit than that of logistics capital input. Due to the high proportion of fruit merchants in fresh fruit production and marketing, the main uses of capital investment are fresh fruit processing, brand innovation, Omni channel sales promotion, etc., which can give high added value and competitive advantage to the products, and realize the high output value of fresh fruit industry. At present, the main reason for the frequent unsalable events is that there are great limitations in fresh fruit sales and weak brand awareness of fresh fruits. Therefore, compared with the logistics capital investment, increasing the fruit merchant's capital input intensity can solve the existing unsalable problem of fresh fruit industry more effectively.

The impact of logistics capital input intensity on the annual output value of fresh fruit ranked the third, which showed that the annual output value of fresh fruit was more sensitive to the increase of logistics' capital input intensity. On the one hand, the logistics capital investment can effectively solve the current situation of the overall backwardness of cold chain logistics infrastructure construction by optimizing the logistics infrastructure and improving the level of cold chain logistics, so as to improve the efficiency of fresh fruit storage and transportation process, realize the cost reduction and efficiency increase of fresh fruit industry logistics links, and ultimately improve economic benefits. On the other hand, the logistics capital investment can ensure the quality of fresh fruits to meet the unified safety standards through professional management, reduce the loss rate and non-productive consumption of fresh fruits in transportation and sales, and avoid economic losses to a certain extent.

Finally, it is concluded that increasing the intensity of government investment has little effect on the growth of the total output value of fresh fruits. The government's capital input is mainly in the form of agricultural subsidies, but this part of subsidies accounts for a relatively small proportion of the whole fresh fruit production and marketing funds. In addition, the current increase of agricultural subsidies within the scope of existing objects has been unable to solve many problems faced by agricultural development in the current new era. Therefore, government support has little impact on the overall value of fresh fruit industry.

4. Conclusion

Based on the principle of system dynamics, this paper analyzes the causality of fresh fruit production and marketing from four dimensions: fruit farmers' production, fruit merchants' sales, government's support and logistics transportation, and then constructs a four-dimensional dynamic model of fresh fruit production and marketing system, and simulates and analyzes the model with Vensim software. By changing the parameters of the model and taking the total output value of fresh fruit as the main output value, the influence law of fresh fruit production and marketing is studied and analyzed. The conclusions are as follows: a. The fruit farmers' production, fruit merchants' sales and logistics transportation have a great impact on the production and marketing of fresh fruits, which reflects the key role of the three main objects in solving the problem of unsalable fresh fruits; b. The government's support has a positive impact on the production and marketing of fresh fruits, but the effect is not significant. In this paper, the main shortcomings of this paper are the incompleteness of the obtained data. Only the simulation study of Guangxi Agricultural fresh fruit industry related data, the sample range is not wide enough, and the research conclusion has certain limitations. In addition, the system dynamics model constructed in this paper still needs to be improved and verified many times. In view of how to use the conclusion of this paper to put forward effective strategies to solve the problem of unsalable fresh fruit, which is worthy of further study.

Acknowledgments

This work was financially supported by the Key Research Institute of Philosophies and Social Sciences in Guangxi Universities: Research on supply side reform strategy of Guangxi agricultural special fresh fruits (19YB003). Guangxi Young and Middle-aged Teachers' Basic Ability Improvement Project: Research on supply side reform strategy of Guangxi agricultural special fresh fruits (2020KY06043).

References

- [1] Renko, N., Nikolasevic, S. and Pavicic, J. (2002), The market information system and state support for the market of agricultural products in Croatia. *British Food Journal*, vol.104 no.7, p.543-571.
- [2] Nakandala, D., Lau, H. and Zhang, J. (2016), Cost-optimization modelling for fresh food quality and transportation. *Industrial Management & Data Systems*, vol.116, no.3, p. 564-583.
- [3] J.P. Wei, J.B. Zhang and P. Li(2013). Research on the unsalable agricultural products from the perspective of farmers -Based on the survey of edible fungi farmers in 11 provinces and cities of China in 2009. *Journal of Huazhong Agricultural University*, vol.3, no.105, p.71-76.
- [4] J.H. Liu, Q. Cai and Q. Chang(2013). Identification and positioning of key control points of unsalable primary agricultural products: An Empirical Analysis Based on 32 unsalable agricultural products events. *Journal of rural economy*, vol.2, no.364, p.51-55.
- [5] J.Chen and X.Y. Chen(2018). Prediction model and application of unsalable fresh vegetables producing areas. *Jiangsu agricultural science*, vol.46, no.2, p.274-277.
- [6] S.H. Chen(2012). Institutional reflection on unsalable agricultural products. *Special economic zone*, no.12, p.161-162.
- [7] X.Y. Chen(2016). Study on the prediction and dredging strategy of the unsalable fresh agricultural products from the perspective of channel obstruction. Chongqing Jiaotong University.
- [8] Q.F.Wang(1994). *System dynamics (Revised Edition)*. Beijing: Tsinghua University Press,1994.
- [9] G.P. Richardson and P. Otto(2008). Applications of system dynamics in marketing: Editorial. *Journal of Business Research*, vol.61, no.11,p.1099-1101.
- [10] J.W. Forrester(1994). *System dynamics, systems thinking, And Soft OR*. *System Dynamics Review*. Vol.10, no.2-3, p.245-256.