An Analysis on the Economic Benefit of Simplified Cultivation Technology for Longan in Hills and Mountains of Maoming City

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Abstract According to the characteristics of longan cultivated in the hill and mountain regions of Maoming City, this paper analyzed the economic benefit of the simplified cultivation techniques. With 15-year-old Chuliang longan trees as materials, the economic benefit of four kinds of simplified cultivation technologies was compared and analyzed. After nine years of continuous technological application, it was found that the input costs increased by 1.62%, and the output profits increased by 56.10%; in input costs, labor cost decreased by 41.33%, pesticide cost decreased by 24.19%, and fertilizer cost increased by 33.57%.

Key words Hills and mountains, Longan, Simplified cultivation, Economic benefit

1 Introduction

Longan is the commodity woody fruit with the second cultivation area in Maoming City. In 2014, the cultivation area was about 53300 ha in the city, and more than 60% of longan was planted in hills and mountains. Due to steep slope, the production and management are difficult in the longan orchards in hills and mountains, and the agricultural labor costs are rising year by year. Furthermore, the maturity period of local longan is concentrated, and a lot of fresh fruits appear on the market, but the preservation and processing lag, the yield is unstable and benefits gradually decline. The simplified cultivation technology for longan in hills and mountains is to clear the orchard space, simplify technical operation, and introduce efficient equipments to achieve the combined effect of simpleness and high efficiency. The thinning and cutting-back technology is used to transform the canopy in the closed old orchards. In terms of spacing in the rows and spacing between rows, it is changed from 5 m ×5 m to 5 m ×10 m or 5 m ×8 m. Then the full cutting-back is conducted to shorten and rejuvenate the trees, and reserve the space for mechanical work. The organic fertilizer-based soil improvement technology stresses the application of decomposed manure to improve the nutritional status of the tree. By the drip irrigation system, the water and fertilizer integration technology is used for irrigation and fertilization, so as to achieve integrated use and management of water and fertilizer, and realize optimal combined state of water and fertilizer in soil for crop absorption. Under pesticide application with mechanical pipeline and pneumatic pruning, the orchard is divided into several pipeline work areas, and the dispensing pool is used as liquid chemical substance supply point. The pipeline network and mechanical power are used to complete the spraying and pruning in the orchard. The above four kinds of technologies are proved to be the simplified technologies with low input-output ratio. This paper conducts a comparative analysis on the economic benefits of single technology and integrated application, in order to provide the basis for various regions to select appropriate simplified cultivation methods, dissipate the worry of growers about technological application, and promote the upgrading of longan industry in Maoming City in the direction of simplification and high efficiency.

2 Materials and methods

2.1 Experimental sites and materials From 2007 to 2013, the experiment was conducted in longan base of Shenma Ecological Agriculture Development Co., Ltd. (Shatian Town, Gaozhou City) and longan base of Yangshi Agriculture Co., Ltd. (Dajing Town, Gaozhou City). The two bases were all hillside orchards, with slope of 5° – 20° and elevation of 80 m, and the soil was red soil. The longan for test was 15-year-old Chuliang longan, the test area covered 15 mu, and the spacing in the rows and spacing between rows were 5 m × 10 m. The thoroughly decomposed chicken manure was used as organic fertilizer, with application rate of 3000 kg/667 m^2. The experiment was conducted in the base of Dajing Town. The water and fertilizer integration equipment was designed and assembled independently using domestic materials, and the experiment was conducted in the base of Shatian Town. The pesticide application equipment with mechanical pipeline was designed and assembled independently using domestic materials, and the electric and diesel power equipment (with power of 3 kW electric motor or 165 F – 2.2 kW diesel engine) was compared with the knapsack sprayer in pesticide application. The experiment was conducted in the base of Dajing Town. The simplified

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cultivation technology was piloted in the base of Shatian Town. In 2007, the thinning and full cutting-back technology was implemented; in 2009, the organic fertilizer-based soil improvement technology was implemented; in 2011, the water and fertilizer integration equipment was introduced, and the input and output before and after transformation were compared.

2.2 Measurement items and methods

2.2.1 Yield measurement. The yield was measured using five diagonal point sampling method. The samples were randomly taken from the four corners and central part of the sample area, with single plant as biological replication and whole plant fruit as single plant yield. When the longan skin turned yellowish-brown and became thin and smooth, the fruit was ripe. The yield was measured in the middle supply period of Maoming's local longan market.

2.2.2 Economic indicator calculation. If the economic calculation period (n) takes 10 years and social discount rate (i) as 8%[1], then the total present value of benefits is calculated as follows:

$$B_N = B_{total} - K_{total} - C_{total}$$

where B_N is the present value of net benefits converted to the base year (the first year of investment); B_{total} is the total present value of benefits converted to base year; C_{total} is the present value of annual operating costs converted to the base year (only calculating the increased investment and benefits, $C_{total} = 0$); K_{total} is the total investment converted to the base year.

Therefore, $B_N = B_{total}[(1+i)^n - 1]/[(1+i)^n i] - K_{total}$; benefit-cost ratio $R_n = B_{total}/(K_{total} + C_{total})$; investment recovery time $T = K_{total}/(B_{total} + C_{total})$.

2.2.3 Fruit economic benefit calculation. The fruit economic benefit can be calculated as follows[2]:

$$F = PY - C$$

where F is the average fruit economic benefit, yuan/ha; P is the unit price for fruit tree, yuan/kg; Y is the fruit yield, kg/ha; C is the fruit tree investment, yuan/ha.

3 Results and analysis

3.1 Economic benefit analysis of water and fertilizer integration technology According to many years of statistical survey in the test point, compared with traditional simple sprinkler irrigation mode, it was found that the water and fertilizer integration technology implemented in longan orchards on hills and mountains could save water by 51.4% per 667 m^2, save fertilizer by 22.2%, save pesticide by 8.7%, save labor input by 22.9%, and save total production costs by 396.5 yuan. The saving proportion reached 19.8% and the yield growth rate was 9.9%. The input cost of domestic materials for water and fertilizer integration equipment was about 1000 yuan, about 2.7 to 6.0 times that of the simple sprinkler irrigation, indicating that the one-time investment was relatively large. In terms of the investment payback period, it took about 2.41 years to recover the equipment investment costs, and one-time investment could lead to benefits for many years.

3.2 Economic benefit analysis of pipeline facility spraying technology According to the statistical survey of test point, the electric equipment input was 342.3 yuan per mu, and the diesel-powered equipment input was 307.4 yuan per mu, but the efficiency of pipeline spraying was 3.33 times that of manual spraying, the labor cost per mu was only 19.2% of that of manual spraying, that is, the spraying cost per mu could be saved by 63.9%. In addition, mechanical spraying pipeline was more effective and rapid than artificial sprayer. In case of bad weather, manual spraying often delayed the best time of pest and disease control. Therefore, in terms of economic benefit or pest control effect, mechanical pipeline was significantly better than artificial sprayer in pesticide application.

Table 1 Cost-benefit analysis of water and fertilizer integration technology

Treatment	Equipment cost yuan/mu	Production cost//yuan/mu				Yield//kg/plant	Product life//year	Payback period year
		Labor	Water	Fertilizer	Pesticide			
Water and fertilizer integration	800 – 1200	529.8	28.1	576.2	470.1	57.6	5 – 7	2.41
Simple sprinkler irrigation	200 – 300	687.4	57.8	740.8	514.7	52.4	3 – 5	1.27

Note: The survey was conducted in longan base of Shenma Ecological Agriculture Development Co., Ltd. (Shatian Town, Gaozhou City) during 2011 – 2013.

Table 2 Economic benefit analysis of spraying pipeline facility and knapsack sprayer

Items		Work efficiency mu/h	Equipment input yuan/mu	Power consumption yuan/mu	Pesticide cost yuan/mu	Labor wage yuan/mu	Converted spraying wage and power cost each time yuan/mu
Spraying pipeline	Electric equipment	51.9	342.3	0.29	0.96	1.87	3.12
	Diesel-powered equipment		307.4	1.63			4.46
Knapsack sprayer		15.6	2.7	–	0.77	9.74	10.51

Note: The survey site is longan base of Yangshi Agriculture Co., Ltd. (2013).

3.3 Economic benefit comparison of several simplified technologies By comparing the economic benefits about four simplified technology modes applied for many years, it was found that all the technologies were high-input technologies, and the thinning and cutting-back technology had the highest indirect investment cost, but the yield increase effect was obvious. The benefit-cost ratio (5.67) of organic fertilizer-based soil improvement technology was significantly higher than that of the other three technologies, followed by the benefit-cost ratio (4.69) of pesticide application with mechanical pipeline. In terms of payback period, water and fertilizer integration had the longest payback period (2.41 years) while organic fertilizer-based soil improvement technology had the shortest payback period (1.51 years).

3.4 Economic benefit analysis about comprehensive application of several simplified technologies According to the 9-year input-output data survey of longan base in Shatian Town, the thinning technology and full cutting-back technology were implemented in 2007; organic fertilizer-based soil improvement technology was implemented in 2009; water and fertilizer integration equipment was introduced in 2011. After three times simplified cultivation transformation, the cost saving and income increase effect was obvious. Compared with 2005, the input cost increased by 1.62% in 2013, and the output increased by 56.10%. In input costs, labor cost decreased by 41.33%, pesticide cost decreased by 24.19%, and fertilizer cost increased by 33.57%. Although the one-time investment was high, the input equipment still continued to produce benefits, reduce labor costs, and improve the ability to resist market risks.

Table 3 Economic benefit comparison of four kinds of simplified technologies

Technological items	Investment yuan/mu	Cost saving yuan/mu	Income increase yuan/mu	Annual net benefits (Btotal) yuan/mu	Present value of net benefits (BN)//yuan/mu	Benefit-cost ratio (Rn)	Payback period (T)//year
Thinning and cutting-back technology	2050	180	720	900	5652.48	3.76	2.28
Organic fertilizer-based soil improvement technology	830	–	550	550	3877.07	5.67	1.51
Water and fertilizer integration technology	1180	390	100	490	3013.57	3.55	2.41
Pesticide application with mechanical pipeline and pneumatic pruning	420	230	–	230	1548.41	4.69	1.83

Table 4 Annual input-output comparison of simplified cultivation and conventional cultivation Unit: 10^4 yuan

Items	Year	Input					Output	
		Fertilizer cost	Pesticide cost	Labor cost	Other costs	Total cost	Gross output value	Profit
Conventional cultivation	2005	1.28	0.78	1.43	0.23	3.71	6.17	2.46
	2006	1.13	0.77	1.47	0.23	3.59	6.12	2.54
Simplified cultivation	2007	0.87	0.33	0.38	0.24	1.82	2.06	0.24
	2008	0.98	0.38	0.41	0.23	1.98	2.64	0.66
	2009	1.80	0.72	0.98	0.24	3.74	7.04	3.30
	2010	1.70	0.69	1.01	0.24	3.63	7.14	3.51
	2011	1.62	0.71	0.92	1.59	4.83	7.19	2.36
	2012	2.19	0.68	0.78	0.23	3.87	7.73	3.86
	2013	2.00	0.71	0.81	0.26	3.77	7.61	3.84

Note: (i) Data takes 15 mu as statistical unit; (ii) profit is the output value after the production cost is deducted, including one-time investment in fixed assets; (iii) survey data are from longan base of Shenma Ecological Agriculture Development Co., Ltd.

4 Conclusions and discussions

4.1 Conclusions According to the characteristics of longan cultivated in the hill and mountain regions of Maoming City, this paper analyzed the economic benefit of the simplified cultivation techniques. With 15-year-old Chuliang longan trees as materials, the economic benefit of four kinds of simplified cultivation technologies was compared and analyzed. After nine years of continuous technological application, it was found that the input costs increased by 1.62%, and the output profits increased by 56.10%; in input costs, labor cost decreased by 41.33%, pesticide cost decreased by 24.19%, and fertilizer cost increased by 33.57%.

4.2 Discussions Simplified cultivation is suitable for the situation of high labor costs and low degree of organization in China's fruit industry[3]. Simplified cultivation technology is one of the development directions of fruit industry cultivation technology upgrade and industrial transformation. The traditional closed orchard cultivation in hills and mountains seriously hinders mechanized operation, with low efficiency. Reasonable thinning and cutting-back technology can improve the orchard damage[4-5] and transform the canopy to restore tree vigor, but within one year or two years after using thinning technology, the yield is low and investment is required to maintain the nutritional status of the tree[6]. After the tree rejuvenation, the production management is easy to operate, and the production potential is significantly increased. He Yingmei[7] conducted economic analysis of thinning and cutting-back technology, and concluded that the output was significantly increased after using thinning technology in most orchards. Organic fertilizer plays a role that chemical fertilizer can not play[8-10]. Liu Mei *et al.*[11] made empirical analysis on farmers' organic fertilizer application rate and its influencing factors, and came up with recommendations to guide the farmers to apply organic fertilizer. Currently, water and fertilizer integration technology has been widely used in the production of apple[12], banana[13], citrus, litchi and other fruits. Deng Lansheng *et al.*[14] explored the application mode in the hilly areas, and found that the rational use of water and fertilizer integration technology could significantly promote crop growth, increase yield and improve quality. Applying pipeline spraying technology in mountain orchard can help to reduce labor intensity of spraying operation, and benefit analysis and application prove that it can save costs and improve spraying quality[15-16]. Thinning and cutting-back technology, organic fertilizer-based soil improvement technology, water and fertilizer integration technology, and pipeline facility spraying technology, are four sub-technologies of simplified longan cultivation technology in hills and mountains, but they are all high-input, high-output technologies. Through the economic benefit analysis of integrated application for several years, it is found that simplified cultivation technology is an integrated technology suitable for the longan orchard in Maoming's hills and mountains, and the one-time investment is high, but it can produce long-term sustainable economic benefit and ecological benefit. In the context of increasingly scarce high-quality labor resources for agriculture, the industrial upgrading and transformation is a necessary way to break the obstacles to industrial development[17]. The simplified cultivation technology changes the traditional agricultural production model heavily dependent on chemical fertilizers, pesticides and cheap labor to the efficient agricultural production model with organic fertilizer as the basis and simplified technology as the support, and it is the agricultural technology and idea that should be fully promoted and used in the future.

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and the observed value. ARIMA model can not adjust uncertainty factors in the economic environment like good news in the market, market reaction to the news and the expectation of investors. Therefore, this model can only be used in short-term prediction, and it does not have good performance in long-term forecasting. In summary, although ARIMA model has shortcomings, it will acquire the precision data when it is used in short-term forecasting. This model provides an important method to predict price level of agricultural futures, and it will be of great significance to improving agricultural futures. This model can be used for the following aspects. First, it helps consumers to purchase agricultural products at lower price. This can reduce the non-necessary cost. The second one is that this model can show the arbitrage opportunities. Last but not least, it helps the investors who invest in futures market to receive the expected returns on investment, and it can make investors bear less loss in crisis or recession.

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