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Cost – benefit Analysis of Chestnut Production in Xingtai County

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Abstract On the basis of market demand survey of chestnut, this article carries out cost – benefit analysis of the chestnut production in Xingtai County, to understand the profitability and payback period of local chestnut production. It points out that chestnut production has a high rate of return on investment, and chestnut can be promoted on a large scale in Xingtai County. However, there are still some problems in the production and marketing of chestnut in Xingtai County, such as low level of technology, extensive management, low level of organization, market imperfections and weak brand consciousness. Based on these problems, corresponding recommendations are put forth.

Key words Chestnut, Cost – benefit analysis, Xingtai County

The chestnut belongs to the same family as the oak and beech. The four main species are commonly known as European, Chinese, Japanese and American chestnuts. Fresh chestnut fruits have about 180 calories per 100 grams of edible parts, which is much lower than walnuts, almonds, other nuts and dried fruit. Chestnuts contain no cholesterol and contain very little fat, mostly unsaturated, and no gluten.

Their carbohydrate content compares with that of wheat and rice; chestnuts have twice as much starch as the potato. In addition, chestnuts contain about 8 percent of various sugars, mainly sucrose, glucose, fructose, and, in less amount, stachyose, and raffinose.

In some areas, sweet chestnut trees are called "the bread tree". When chestnuts are just starting to ripen, the fruit is mostly starch and is very firm under finger pressure from the high water content. As the chestnuts ripen, the starch is slowly converted into sugars; and moisture content also starts decreasing. Upon pressing the chestnut, a slight 'give' can be felt; the hull is not so tense, and there is space between it and the flesh of the fruit.

The water is being replaced by sugars, which means better conservation. They are the only "nuts" that contain vitamin C, with about 40 mg per 100 g of raw product, which is about 65 per

cent of the U. S. recommended daily intake. The amount of vitamin C decreases by about 40 percent after heating. Fresh chestnuts contain about 52 percent water by weight, which will evaporate relatively quickly during storage; they can lose even 1 percent of weight in one day at 20°C (68°F) and 70% relative humidity.

The nuts can also be eaten candied, boiled, steamed, deep fried, grilled, or roasted in sweet or savory recipes. They can be used to stuff vegetables, poultry, fowl and other edibles. There is the habit of eating chestnut in many countries and regions around the world, and the consumption is the largest in Europe, America and Japan.

1 The prospect of chestnut production in Xingtai County

1.1 International chestnut production pattern The world trade volume of chestnut every year is close to 0.1 million tons, and the consumer demand is increasingly rising. In 2009, the world chestnut production was 1.402 million tons, and the chestnut production of China was 1.085 million tons, ranking first in the world, accounting for 77.4% of total world production. China has become the first major chestnut-producing country, playing a pivotal role in the international trade of chestnut.

Table 1 The world production pattern of chestnut from 2003 to 2009

Unit: 10³ t

Country	2003	2004	2005	2006	2007	2008	2009
China	715.0	715.0	1031.9	850.0	925.0	925.0	1085.0
South Korea	72.4	72.4	76.5	76.5	70.0	80.0	82.0
Turkey	48.0	48.0	50.0	53.8	63.1	55.4	61.7
Italy	50.0	50.0	52.0	52.0	55.0	55.0	55.0
Bolivia	35.0	34.7	35.0	35.0	37.0	37.0	37.0
Japan	25.1	25.1	21.8	23.1	24.0	22.1	21.7
Portugal	33.3	31.1	32.0	32.8	33.0	33.0	33.0
Spain	9.5	9.5	8.6	9.5	10.0	15.0	15.8
Other countries	38.5	42.3	20.9	20.8	20.0	17.9	9.0
Total	1028.8	1030.1	1330.6	1155.4	1237.3	1242.4	1402.2

Data source: China Economic and Social Development Statistics Database (2010).

Note: Other countries include North Korea, France, Russia, Bulgaria, Romania, Poland, Hungary, Ukraine, etc.

As can be seen from Table 1, the chestnut production in China increased by 51.75% from 2003 to 2009, while the chestnut production in South Korea, Turkey, Italy, Bolivia increased by

13.26% , 28.54% , 10% and 5.71% , respectively; affected by various factors, the growth of chestnut production in other countries was slow, and even the production was reduced. China is the first chestnut-producing country.

1.2 Market demand forecast of the domestic chestnut

Chestnut is one of the oldest cultivated fruit trees in China, with a cultivation history of 2000 – 3000 years. Currently people's living standards are improved and their health consciousness is enhanced, so there is a growing demand for nutrient-rich chestnut and the supply falls short of demand in the market.

Moreover, with the development of the food processing industry and the further development of the chestnut nutritional value and medical value, the processing consumption with chestnut as the raw material will also be increased significantly. When a thing is scarce, it is precious. The chestnut prices remain at high level.

As can be seen from Fig. 1, the average price in 2011 reached 9.23 yuan per kilogram, an increase of 18.64% over the price in 2010 (7.78 yuan per kilogram). Conspicuously, the domestic chestnut market has great prospects.

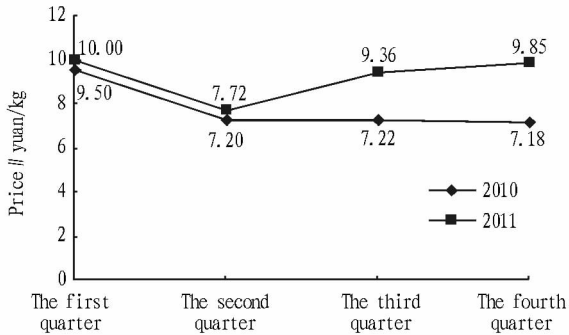


Fig. 1 The quarterly price changes in the period 2010 – 2011

1.3 Context of chestnut production in Xingtai County

1.3.1 Superior geographical environment. The life of chestnut tree is up to 300 years, and it can well adapt to the climate and

soil conditions. Xingtai County (Hebei Province) is located in the eastern foot of the southern Taihang Mountains, and it features a warm temperate continental monsoon climate.

Chestnut-producing areas are mainly concentrated in the Taihang mountains at an altitude of 500 – 1000m. The annual precipitation is 600 – 700 mm, the soil is leached cinnamon, and the pH value is 5.5 – 6.5 [1].

The unique climate and soil feature in Xingtai mountainous areas is particularly suitable for growing chestnut, and the chestnut is known as the "Taihang chestnut" due to its good taste and rich nutrition. In 2004, it was chosen as "Township of Chinese Chestnut" by the State Administration of Forestry.

In 2009, the growing area of chestnut in Xingtai County was close to 30000 ha, and the annual production was 7000 t, accounting for 0.645% of national output.

Superior natural environment creates high-quality Xingtai chestnut. Jingdong chestnut represented by Qianxi chestnut and Zunhua chestnut has long enjoyed a good reputation at home and abroad.

From Table 2, it is found that the protein content of Xingtai chestnut is slightly lower than that of Zunhua chestnut, while there is slight difference in the starch and fat content between Xingtai chestnut and Zunhua chestnut; the starch, protein and fat content of Xingtai chestnut is higher than that of Qianxi chestnut, indicating that the quality of the "Taihang chestnut" produced in Xingtai is good, comparable with Jingdong chestnut.

1.3.2 Policy environment . Xingtai County is a large mountainous county and a major forestry county. Over the years, the government has attached great importance to forestry work, and always put the development of fruit industry as a strategic measure.

Since the implementation of the project of returning farmland to forest, the county government has taken this work as a good opportunity for the county's forestry to achieve great strides.

Table 2 Comparison of major nutrients per 100 g dry weight of chestnut in different producing areas

Unit: %

Sample	Hebei Xingtai			Hebei Zunhua			Hebei Qianxi		
	Starch	Protein	Fat	Starch	Protein	Fat	Starch	Protein	Fat
Yanshan Zaofeng	51.5	14.2	2.2	52.6	15	3.6	36.7	8.3	1.1
Beiyu No. 2	49.2	18.1	1.3	46.6	23.2	0.9	–	–	–
Yanshan Kuili	50.1	15.5	1.9	48.5	19.8	1.2	38.6	10.2	1.1
Dabanhong	46.9	13.6	1.1	50.5	17.7	0.9	–	–	–

Data source: Chestnut nutrient analysis in Xingtai (2009) [2].

2 The cost – benefit analysis of chestnut production in Xingtai County

2.1 The cost and benefit of chestnut production Xingtai County administers 13 towns and townships, of which Jiangshui Town, Jiangjunmu Town, Luluo Town, Jijiacun Township, Songji-azhuang Township and Chengjitou Township produce chestnut. In terms of the planting area and output, Jiangshui Town and Jiangjunmu Town are the most typical.

This article takes the average production cost and benefit of 30 chestnut growers in 2 towns as the basic data for study, and takes one hectare of land planted with chestnut as the object of

study, to analyze the cost and benefit of chestnut production in Xingtai County. With 4m × 4m as the standard of plant and row spacing, 600 chestnut trees can be planted in one hectare of land; the labor costs are 60 yuan per person per day; the chestnut price is calculated based on the local average purchase price of 8.5 yuan/kg.

According to the growth characteristics and results of chestnut trees, the chestnut production input is divided into three stages. The first stage is pure input period (first 4 years); at the second stage, the fruiting volume increases year by year, and it is the initial effectiveness period (the 5th to 9th year); the third stage is

the flourishing period (after the 10th year) when the yield is slightly increased and finally tends to be stabilized.

Table 3 The input costs and net profit of chestnut production

Year	1	2	3	4	5	6	7	8	9	10	11
Yield//kg/ha	–	–	–	–	600	1050	1800	2700	3900	4800	5400
Output value//yuan/ha	–	–	–	–	5100	8925	15300	22950	33150	40800	45900
Total costs//yuan/ha	12120 *	8250	7950	8850	7800	9600	10200	10200	11400	12825	12825
Herbicides//yuan/ha	150	150	150	150	150	150	150	150	150	150	150
Fertilization// yuan/ha	420	750	1350	1350	2100	2100	2700	2700	3900	3900	3900
Pest control yuan/ha	150	150	150	150	150	150	150	150	150	225	225
The amount of labor	180	120	105	120	90	120	120	120	120	142.5	142.5
Labor price //yuan/ha	10800	7200	6300	7200	5400	7200	7200	7200	7200	8550	8550
Profit //yuan/ha	–12120	–8250	–7950	–8850	–2700	–675	5100	12750	21750	27975	33075

Sources: Data are from the survey; total costs include the cost of 600 yuan saplings.

2.1.1 The first stage: pure input period. The chestnut saplings in Xingtai County are the natural saplings which are not grafted. Such fruit trees have a long growing season, and they bear less fruits, so the farmers adopt grafting technique for improvement.

In the 4th year, the fruit trees are deeply rooted after 3 years of growth, so the farmers choose to graft in the 4th year. The main inputs are material and labor costs.

The material inputs in the first 4 years are expenses of seedlings, herbicides, fertilizers and so on. At this stage, there is no yield, thereby resulting in zero income and negative net profit.

2.1.2 The second stage: initial effectiveness period. In the 5th year, the fruit trees begin to bear fruit, and subsequently the yield is increased year by year; the yield is basically stable after the 10th year.

Therefore, the period from the 5th year to the 9th year is classified as the second stage when the income is positive and it shows the signs of effectiveness.

In the 5 years, there is little change in the expense of herbicides, pest control and labor, but the fertilizer costs are increased. During this stage, the trees grow fast and have a huge demand for fertilizer, but due to the lack of scientific guidance to the farmers, there are many errors in the rational fertilization, which is not conducive to the growth of chestnut trees.

2.1.3 The third stage: flourishing period. When the fruit trees grow to the 10th year, the yield per hectare is about 4800kg; in the 11th year, the yield per hectare is about 5400kg; after the 11th year, the yield is increased slightly, but it is basically stable. After the 10th year, the input costs are stable (12825 yuan/ha each year).

In the 10th year, the income is 40800 yuan/ha, and the net profit is 27975 yuan/ha; in the 11th year, the income is 45900 yuan/ha, and the net profit is 33075 yuan/ha.

The flourishing period of chestnut is long, generally up to 50

Table 4 Cash flow of the chestnut production

Year	1	2	3	4	5	6	7	8	9	10	11
Investment spending	12120	8250	7950	8850	–	–	–	–	–	–	–
Other expenses	–	–	–	–	7800	9600	10200	10200	11400	12825	12825
Incomes	–	–	–	–	5100	8925	15300	22950	33150	40800	45900
Net cash flow	–12120	–8250	–7950	–8850	–2700	–675	5100	12750	21750	27975	33075
Cumulative net cash flow	–12120	–20370	–28320	–37170	–39870	–40545	–35445	–22695	–945	27030	60105

Unit: yuan/ha

years to 80 years. During the flourishing time, if the nutrients of trees do not match the fruiting, it will affect the next year's fruiting amount.

2.2 The profitability of chestnut production The cost – benefit ratio is used to analyze the profitability of chestnut production. Cost – benefit ratio = (profit/cost) × 100%.

From Table 3, the cost – benefit ratio of chestnut in various years can be calculated, as shown in Fig.2.

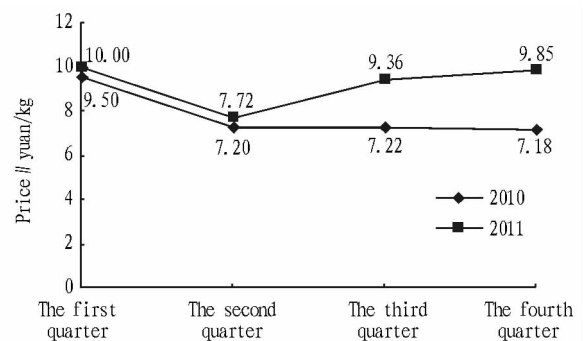


Fig. 1 The cost – benefit ratio of chestnut production from the 1st year to the 11th year

From Fig. 2, we can clearly see that it is at a loss from the 1st year to the 6th year, and it begins to make profit from the 7th year; the profit is 5100 yuan/ha, and the cost – benefit ratio is 50%.

From the 8th year, the profit is significantly increased, and the cost – benefit ratio is greater than 1 and grows year by year; to the 11th year, the cost – benefit ratio reaches 258%, and the fruiting period of chestnut trees is up to 50 – 80 years, indicating that the chestnut cultivation has good profitability.

2.3 The payback period of chestnut production Through the static payback period, this article analyzes the chestnut production.

The static payback period = The year when the cumulative net cash flow appeared for the first time - 1 + $\frac{\text{The absolute value of the cumulative net cash flow in the previous year}}{\text{The net cash flow in the year}}$ = $10 - 1 + \left| \frac{-945}{27\ 975} \right| = 9.03$ years

It can be found that the total investment can be recovered after 9.03 years, indicating that the payback time for chestnut production is long.

2.4 The sensitivity of chestnut production profit to cost and price

2.4.1 The sensitivity of chestnut production profit to price. In the normal years when the price is 8.5 yuan per kilogram, the profit is as follows:

$Profit_0 = Q \times P_0 - V = 5400 \times 8.5 - 12\ 825 = 33\ 075$ yuan/ha where Q is yield; P is price; V is variable cost.

Assuming price becomes 10 yuan per kilogram (17.65% of price change rate), when other factors remain unchanged, the profit is as follows:

$Profit_1 = Q \times P_1 - V = 5400 \times 10 - 12\ 825 = 41\ 175$ yuan/ha.

Profit change rate = $\frac{profit_1 - profit_0}{profit_0} \times 100\% = \frac{41175 - 33075}{33075} \times 100\% = 24.5\%$

Price sensitivity coefficient = Profit change rate/Price change rate = $\frac{24.5\%}{17.65\%} = 1.388$.

Price sensitivity coefficient is greater than 1, showing that the price has a great impact on the profit.

2.4.2 The sensitivity of chestnut production profit to cost. When the cost increases by 17.65% (i.e. the cost is 15088.62), the profit is as follows:

$Profit_2 = Q \times P - V = 5400 \times 8.5 - 15\ 088.62 = 30\ 811.38$ yuan/ha.

Profit change rate = $\frac{30\ 811.38 - 33075}{33075} \times 100 = -6.8\%$,

Cost sensitivity coefficient = $\frac{-6.8\%}{17.65\%} = -0.685$

The absolute value of cost sensitivity coefficient is less than 1, so the cost has a small impact on the profit.

It can be seen through the analysis that as to the two influencing factors, the profit is more sensitive to changes in the price. Price is not static but variable, and affected by supply and demand, competitors, substitute goods and other factors, so there is great uncertainty. And local markets are not mature, the level of organization is low, and the ability to resist market risk is poor, making the price more volatile.

2.5 Problems At the earlier stage of chestnut planting, there is huge input but less income and low profit margins. However, when it is in the flourishing period, the yield and income are high, the cost input is stable, and the profit margins are high.

And it is maintained at a high level during the whole flourishing period (50–80 years), so chestnut production has good profitability.

In the long term, compared with other economic trees, 50 years of flourishing time will make the chestnut cultivation have unparalleled advantages, so Xingtai County should vigorously sup-

port the development of chestnut cultivation.

However, through the analysis, it can be found that there are still some problems in the chestnut development of Xingtai.

(i) In the pure investment period, there is no income but input for the chestnut production.

(ii) Since the level of management technology is not high, the tree nutrition is unbalanced, and the payback period is too long.

(iii) Local chestnut markets are immature, the level of organization is low, and the ability to resist market risks is poor, making the profit more subject to price changes.

3 Recommendations for the development of chestnut production in Xingtai County

3.1 Applying the efficient under-forest economy model integrating farming and forestry It is necessary to make full use of the space under chestnut trees to develop the efficient agroforestry production model, which can greatly improve the economic efficiency per unit area, thereby stimulating the enthusiasm of farmers for production and promoting the farmers to pay more attention to chestnut management^[3].

Growing the economic crops under forest (legume crops in particular) can fertilize the soil, improve the soil's ability to retain water and nutrients, and promote the chestnut quality and yield. Using the composite agroforestry model in the production can help to increase chestnut farmers' incomes, and especially reduce capital turnover pressures for farmers when there is no yield in the earlier period.

3.2 Strengthening the construction of management technology service system to improve the level of farmers' management skills In order to keep the balanced tree nutrition, and shorten the payback period, it is necessary to pay close attention to the management technology, and improve farmers' management skills.

3.2.1 Strengthening chestnut nutrition regulation technology and rational fertilization. The management is extensive in the real production, and farmers rarely conduct fertilization. The main reason is that the benefit is not high in the earlier period of chestnut planting, and chestnut is mostly planted in the mountains areas or slopes, causing difficulties in the fertilization.

In the production, it is generally required to timely replenish organic fertilizer after chestnut harvest, which can reserve adequate nutrients for chestnut bud differentiation and fruition rate improvement in the second year.

Before flowering, applying the nitrogen, phosphorus and potassium fertilizers can promote female flower differentiation; during the fruit enlargement period, applying the potash fertilizer can promote fruit growth and improve fruit weight.

3.2.2 Strengthening the pruning technology. The traditional

pruning method in the Taihang chestnut-producing areas often leads to the alternate bearing of chestnut. Pruning is a major measure to adjust the nutritional balance of the tree so that when there is nutrient loss, the trees can still fruit well and when there are sufficient nutrients, the trees will bear more fruits.

In addition, high planting density can achieve the chestnut yield per unit area in the earlier period of cultivation. But once the chestnut forest begins to be at the close canopy, the chestnut production will significantly decline.

If the intermediate cutting or transplanting pruning technique is timely adopted when the close canopy comes, the chestnut can obtain adequate lighting and the flourishing period of chestnut can be extended, thereby obtaining high yield in the long run.

3.2.3 Directly cultivating the grafted seedlings. Through year-round research and experience, the grafted seedlings can be planted directly. This shortens the initial input period, and the seedlings grafted with improved varieties can increase production, increase income and greatly shorten the payback period.

3.2.4 Strengthening technology promotion. It is necessary to establish the technology promotion network within the county, to realize the integration of county – township – village technology promotion network; strengthen technical team building, and increase efforts to train the technical staff to improve the scientific and technological quality of technical personnel; increase technical training for farmers to improve the fruit growers' overall technical management level.

3.3 Strengthening the organization building and constructing the chestnut industrial chain to enhance competitiveness

3.3.1 Strengthening the organization building. The operating scale of chestnut growers in Xingtai County is small, and there is a shortage of unified organizations for coordination and linkage. The level of organization is low and farmers' technology quality is poor, resulting in low yields of fruit and poor quality of fruit, and lack of competitiveness in the market.

Through the analysis, it is found that profits are more sensitive to price, so it is necessary to strengthen the organization building. The construction of the chestnut industrial chain is essentially to combine the links in the chestnut industrial chain, so that various stakeholders in the chestnut industrial chain achieve a win-win through good interests linking mechanism and interests coordination mechanism ^[4].

So there is a need to vigorously cultivate the intermediary organizations, making them become the carriers for the operation of interest distribution mechanism. The intermediary organizations

can link the enterprises and farmers together.

The intermediary organizations should be the professional associations or cooperatives that are constituted by farmers voluntarily, such as chestnut cooperatives, and fruit associations. The cooperatives can organize many scattered farmers together to withstand market risks.

3.3.2 Implementing the brand strategy and creating famous brand to enhance competitiveness.

(i) Developing the brand perspective plan and improving the brand management system. To build the regional brands in Xingtai County, it is necessary to have a perspective plan and establish a long-term development model, to give full play to the role of brand in the market.

At the same time, it is necessary to establish a sound management system, and establish a three-dimensional all-around brand management system, so that the brand becomes the linkage bond within the organization.

(ii) Implementing the brand-oriented strategy, carrying out the scientific positioning and building the brand image. It is necessary to attach importance to regional brand positioning; according to the characteristics of the chestnut market consumption, use advanced marketing concepts, and improve the brand image to attract consumers; fully focus on agricultural sales channels and brand publicity channels to increase brand awareness.

(iii) Implementing the brand management strategy and strengthening the brand maintenance. First, it is necessary to make full use of legal means to strengthen the registration and certification; second, it is necessary to create an appropriate unique brand image, to prevent others from imitating; third, it is necessary to establish a perfect sales service system, and fight against counterfeit products to come into the market; fourth, it is necessary to use advanced technological means such as security signs and information query system to prevent counterfeit products.

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