



Improving Household Income by Growing Medicinal Plants in Hoa Binh Province, Vietnam: A Case Study of *Celastrus hindsii*

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Authors' contributions

This work was carried out in collaboration among all authors. Author HNN designed the study and edited the manuscript, Author LTH performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author LPT managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The study focused on surveying and evaluating factors affecting the income of households growing medicinal plants in Hoa Binh province, Vietnam. To ensure the sample size, the expected number of samples was 120 to survey medicinal herb growers in Lac Thuy, Luong Son, Yen Thuy districts, and Hoa Binh City (it was expected that 30 samples were to be collected in each district or city). After screening the survey results, the collected data was reduced to 109 samples that met the requirements for providing all necessary survey information for analysis. These are good signs in the transformation of crop structure in Hoa Binh province, Vietnam. Factors affecting mixed income

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of farmer households growing medicinal plants include fertilizers and pesticide costs, selling prices, infield transportation, and propaganda – incentives. Therefore, necessary solutions in the coming period to improve household income of farmers growing medicinal plants in Hoa Binh province include: (i) Promoting training, propaganda and encouragement for farmers to grow medicinal herbs; (ii) Investing in upgrading the internal transport system in medicinal herb production areas; and (iii) Strengthening linkages in promoting the consumption of medicinal products. Developing the cultivation of medicinal plants is an effective solution for raising household income in Hoa Binh province, Vietnam.

Keywords: Medicinal herbs; household; income; economic efficiency; cultivation.

1. INTRODUCTION

Many studies have evaluated the production efficiency of households by measuring indicators of household income, which are important indicators in evaluating the effectiveness of farming models as well as evaluating the sustainable effectiveness of the models [1]. Income level is an indicator often used to represent the prosperity of farms and the agricultural sector [2]. The study of factors affecting the income and economic efficiency of farmer households is of significant importance to implement solutions to improve household income [3]. Factors such as production and consumption linkage [4], investment in machinery and technology [5], land area [6], farming qualifications and experience [7] are considered to play an important role in promoting the income of agricultural households.

Medicinal plants cultivation is a new direction in agricultural production in the highlands. Several previous studies have demonstrated that medicinal cultivation can bring higher income from the sale of medicinal herbs than traditional crops [8,9]. The restructuring of crops not only makes economic sense but also ensures the provision of public health benefits, preservation of traditional knowledge values, and development of international trade, etc. [10] All of the above demonstrate the need to develop medicinal cultivation in the current period.

Hoa Binh is one of the provinces with soil and climatic conditions that are very suitable for the cultivation of precious medicinal plants such as *Gynostemma pentaphyllum*, *Celastrus hindsii* Benth et Hook, *Lonicera japonica*, and *Solanum hainanense* Hance, etc. [11]. The situation of abandonment of land due to precarious and inefficient annual income from rice and some annual crops is increasingly in common; therefore, raising household income from agricultural production is always a matter of

economic development. After implementing the model of converting crops to medicinal cultivation, the total area of medicinal crops in Hoa Binh is up to more than 1,200 hectares by 2022, making it one of the leading localities in Vietnam in medicinal cultivation. Applying the model of converting the structure of crops to the direction of growing medicinal plants, Hoa Binh has improved part of people's income. In particular, the poverty rate decreased by 2.5%, from 15.49% in 2021 to 12.99% in 2022. Hoa Binh province needs to continuously consider and convert the area of low-income fields and gardens to grow higher-income crops, especially medicinal cultivation with the great potential of Hoa Binh province to improve production efficiency and increase income for local people. For the implementation of crop conversion to be carried out effectively, it is essential to assess household income and factors affecting household income [12]. Therefore, the study focused on assessing the income of households cultivating medicinal herbs to find practical solutions to improve economic efficiency and solve the problem of improving income for households growing medicinal plants in the area. The study will be valuable for policy making for agricultural development and income raising for farmer households in Hoa Binh province, Vietnam.

2. METHODOLOGY

2.1 Analytical Framework

The study analyzed factors affecting the income of households growing medicinal plants in Hoa Binh province. Household income was measured by the mixed-income indicator from *Celastrus hindsii* cultivation of households. *Celastrus hindsii* is one of the economically valuable medicinal herbs grown in many Hoa Binh districts and even in Hoa Binh city [11]. This research measured income earned from the cultivation of medicinal herbs

after deducting additional costs, including seed costs, fertilizer costs, and pesticide costs [13]. This is the portion of income not minus labor costs, especially family labor costs [14]. Household income is standardized through mixed-income/number of family workers engaged in medicinal cultivation or mixed-income per unit area [15].

The factors affecting the income of households analyzed in the study included fertilizer and pesticide costs, selling prices, infield traffic, consumption linkage, production training, and propaganda – incentives (Fig. 1).

Cost of fertilizers and pesticides: The cost of fertilizers and pesticides per unit area that contributes to the yield of medicinal herbs (assuming the difference in input prices between households is negligible) represents an increase in inputs including fertilizers and pesticides, within the boundary limits of the production function, as inputs increase, productivity will also increase; however, the increase of these costs can lead to a decline in profitability and productivity at different levels of cost investment [6,16].

Consumption connection: Consumption linkage is a factor that supports the development and increases the income of pharmaceutical producers in a sustainable way [17]. Households with consumption linkages will have better incomes thanks to stabilized output and selling prices of their products, thereby increasing consumption revenue [18].

Encouragement, support, and training: The encouragement, support, and improvement of production motivation resulting from income inequality which helps households to increase income can be explained by the impact of policies and the support, training, and motivation of local authorities [2].

Infield traffic: Traffic is a factor that needs to be attached importance to the development of medicinal herb production. The provision of convenient transport services supports farmers to access farming areas and access markets more conveniently [19]. Infield traffic positively affects productivity, due to convenient transportation to support travel and care [20].

2.2 Data Collection Methods

Secondary data was provided by the Hoa Binh People's Committee on the current situation of medicinal herb cultivation in the province. The primary data was collected based on the survey methodology of farmers growing medicinal plants in 2022. The study used a linear regression model with 10 observational variables, the minimum expected sample number was 10 samples for each observed variable corresponding to a minimum sample size of 100 samples [21]. The survey was conducted in districts and cities growing black musk in the province. To ensure the sample size, the expected number of samples was 120 to survey medicinal herb growers in Lac Thuy, Luong Son, Yen Thuy districts, and Hoa Binh City (it was expected that 30 samples were to be collected in each district or city). After screening the survey results, the collected data was reduced to 109 samples that met the requirements for providing all necessary survey information for analysis. In addition, the study conducted in-depth interviews with 52 district (city) officials to assess the current situation of developing medicinal plants in Hoa Binh province to summarize the general situation of the development and production of medicinal plants in the area.

2.3 Analysis Methods

Descriptive statistical methods were used to analyze the current situation of growing medicinal herbs in Hoa Binh province as well as the income of households growing black musk medicinal herbs in the province.

The linear regression analysis method was used to analyze factors affecting the income of medicinal herb growers in Hoa Binh province.

The model of factors affecting the income of medicinal herb growers employed in the study is as follows:

$$\ln(TN) = \alpha_1 \times \text{encourage} + \alpha_2 \times \text{Linkage} + \alpha_3 \times \text{training} + \alpha_4 \times \text{fertilizer and pesticide costs} + \alpha_5 \times \text{infield transport} + \epsilon_1$$

The variables used in the models are as follows (Table 1):

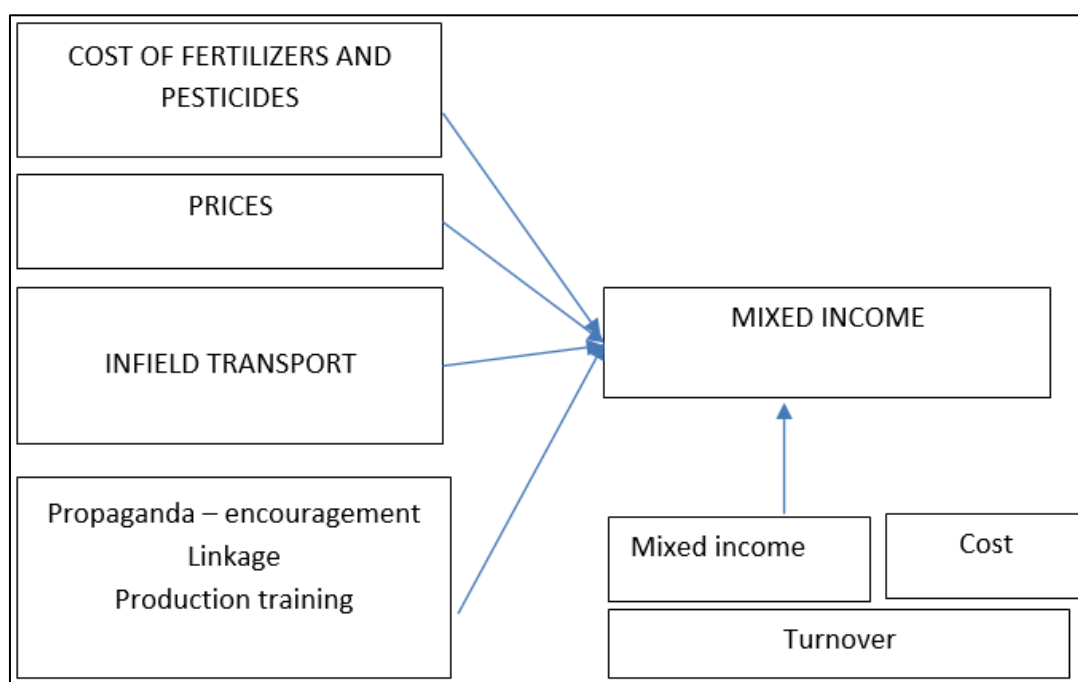


Fig. 1. Analytical framework

Table 1. Explanation of the variables used in the linear regression model

Code	Explanation	Unit
TN	Mixed-income per hectare of medicinal herbs	Million VND/ha
Encourage	Propaganda and encouragement of medicinal herbs	1= No; 2= Don't know; 3= There are incentives
Linkage	There is participation in link consumption	0=None; 1=Yes.
Training	Participate in training	0=None; 1=Yes.
Cost of fertilizers and pesticides	The total cost of fertilizers and pesticides per hectare	Million VND/ha
Infield transport	Assessment of the current situation of internal traffic	5= Very favorable; 4= Advantageous; 3= Okay; 2= Poor; 1 = Very poor

Source: Compilation author (2023)

3. RESULTS AND DISCUSSION

3.1 Development Situation of Medicinal Herb Cultivation in Hoa Binh Province

3.1.1 General situation of medicinal herb cultivation development in Hoa Binh Province

To develop medicinal herb production, Hoa Binh province has recently promoted the formation and development of medicinal growing areas with many solutions such as: (i) Encouraging the development of medicinal growing models; and (ii) Promoting the

transformation of inefficient crop structures in fields and low-lying hill areas such as rice, corn, and cassava, etc. to grow medicinal plants with high economic value such as *Gynostemma pentaphyllum*, *Celastrus hindsii* Benth et Hook, *Lonicera japonica*, and *Solanum hainanense* Hance, etc. From 2016 to 2019, the above policy achieved certain results in expanding the scale and area of medicinal herb cultivation.

In 2021 and 2022, the area of medicinal herbs tended to decrease due to the impact of the Covid-19 epidemic and difficulties in connecting production and consumption. Since then, the

scale of medicinal herb development has mostly declined very quickly and shrunk in localities, even sharply decreasing in some localities such as Luong Son district, Yen Thuy district, and Hoa Binh City. People in many places destroyed most of their medicinal cultivation area to switch back to corn, cassava, potato, and fruit tree cultivation to achieve better consumption. Another reason is that localities such as Luong Son district and Hoa Binh City are giving more priority to industrial development and services than agricultural development because they belong to the dynamic economic zone of Hoa Binh province.

The survey results in four districts (cities) of the score study show that in the period of 2018

– 2019, the development of medicinal areas increased very strongly (with an average assessment score of 4.29/5 points). In the period of 2020 – early 2022, due to the widespread occurrence of the Covid-19 epidemic, the area of medicinal herbs decreased sharply (the average assessment score was only 2.42/5 points). Along with the assessment of scale reduction, the assessment of the level of medicinal chain linkage was also weak (with 2.46/5 points) due to the disruption of pharmaceutical supply chains during and after the Covid-19 pandemic across the country. Therefore, it is essential to restore production and develop a sustainable medicinal value chain for Hoa Binh province.

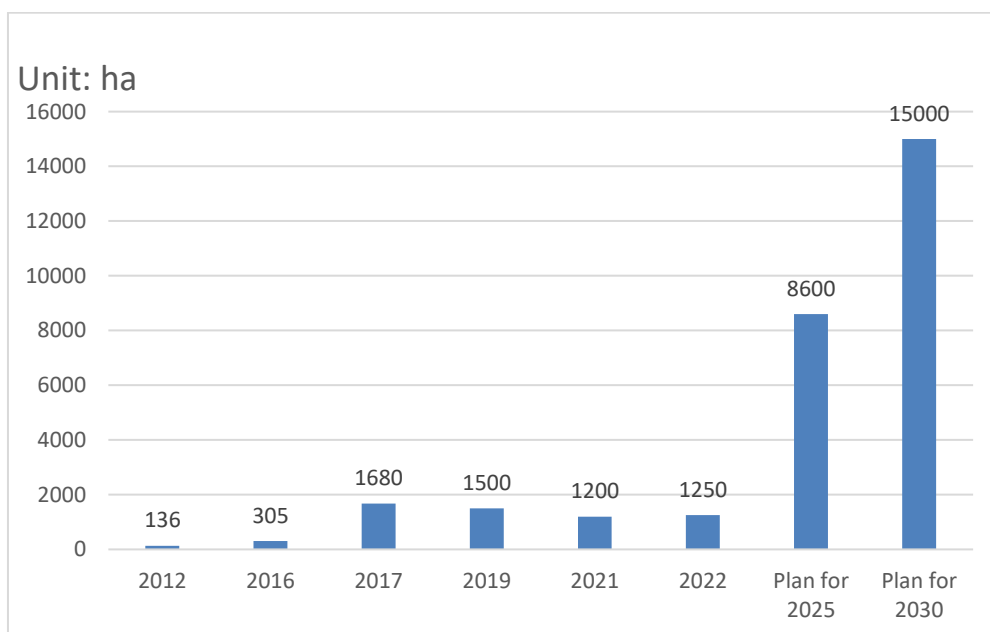


Fig. 2. Cultivation area of medicinal herbs in Hoa Binh province in the period of 2012-2022
Source: Hoa Binh People's Committee (2022)

Table 2. Assessment of managers on the development of medicinal herb production in some localities of Hoa Binh province in the period of 2018-2022

TT	Local	Development situation of medicinal area ⁽¹⁾		Regional-scale crops
		2018-2019	2020-2022	
1	Hoa Binh city	4.02 - Slight increase	1.71 - Plummeting	Discharge, Sachi, Blueneck, and Black musk
2	Liangshan county	3.93 - Slight increase	1.54 - Plummeting	Black musk and Tablespoon
3	Yen Thuy district	4.34 - Strong increase	1.77 - Plummeting	Climbing thorn, Black musk, and Huaishan
4	Luoshui county	4.11 - Slight increase	2.33 – Slight decrease	Discharge, Red ginseng, Black musk, and Huaishan

(1) Increase/decrease at 5 levels: 1 = strongly decrease; 2 = slightly decrease; 3 = remain the same; 4= slightly increase; 5= strongly increase

Source: Survey data (2022)

3.1.2 Development situation of *Celastrus hindsii* cultivation in Hoa Binh Province

Hoa Binh province supports farmers to grow medicinal herbs in connecting markets for consuming medicinal products, the cost of procurement of machinery, and technology application in the production and processing of medicinal herbs, especially the technology of deep processing and post-harvest preservation. Currently, there is a production model of *Celastrus hindsii* medicinal plants that producers have linkages with other stakeholders in the value chain [11].

Some households cooperated with local agri-cooperatives to plant *Celastrus hindsii*, initially bringing positive results. This was a model with the association of three parties, in which the cooperatives would provide seedlings and sign a product offtake contract (Fig. 3). The survey results of households participating in the model showed that *Celastrus hindsii* brought a significant increase in household income. Many poor households gradually increased their incomes and living standards by planting *Celastrus hindsii*. The main reasons for households to grow *Celastrus hindsii* were due to increasing revenue, the availability of product consumption linkage, and the orientation of local medicinal herb development. *Celastrus hindsii* is the type of tree that retains its roots after harvest and can be harvested up to 3-4 times a year. Yen Tri Cooperative also connected with households in Yen Tri commune (Yen Thuy district) to specialize in cultivating *Celastrus hindsii* in gardens or fields around their houses, following the production process guided by the cooperative. The cooperative procured fresh or dried *Celastrus hindsii* from participating households (depending on market demand) to process *Celastrus hindsii* extracts along with other products.

The survey results showed that there were 67 surveyed households, corresponding to 61.5% of households, who participated in linkages - connecting production and consumption. The form of association was mainly through oral contracts. The form of linkage for selling products was not strong, specifically about 20% of household output was sold through self-retail, while the remaining 80% was sold through wholesale (in which, wholesale buyers included cooperatives, businesses, and private traders). In the province, there were also three

medical examination and treatment establishments and herbal medicine businesses, including the Provincial Traditional Medicine Hospital, Song Da Trading and Investment Joint Stock Company, and Hoa Binh Traditional Medicine Joint Stock Company [11]. However, up to now, these enterprises have only registered to purchase and consume a certain number and types of medicinal plants. Selling products for companies accounted for about 30-40% of the production of medicinal herbs (depending on the type of crop), the remaining quantity was still consumed by producers themselves on the free market through traders, so prices were still pressed and consumption faced a lot of difficulties.

The technical training situation of *Celastrus hindsii* production in the province is shown in Fig. 6. Results showed that about 67% of households were provided training in the production of medicinal herbs. However, training activities mainly focused on planting and caring for medicinal herbs, while post-harvest training was still very limited.

The survey results on the situation of preliminary processing and deep processing of *Celastrus hindsii* showed that *Celastrus hindsii* was processed by some establishments into extracts or tea bags, however, the output was still very low. The production was mainly rudimentary preservation by removing the plant, drying it, or taking fresh stems and leaves from the tea. Compared to *Solanum procumbens*, the processed products of *Celastrus hindsii* were fewer. However, compared to some other plants, there had also been developed such as post-harvest products and preliminary processing methods, such as applying machinery to preliminary processing and processing into extracts and tea bags while many other products were merely dry medicinal herbs in raw form.

Regarding the policy to encourage the cultivation of medicinal herbs, 36 households (33% of all surveyed households) did not know whether the locality encouraged the cultivation of medicinal herbs or not, 31.2% of households said that the locality did not encourage the cultivation of medicinal herbs and 35.8% of households said that the locality encouraged the cultivation of medicinal herbs. Thus, the number of households having access to the local propaganda and encouragement to grow medicinal herbs was still very limited.

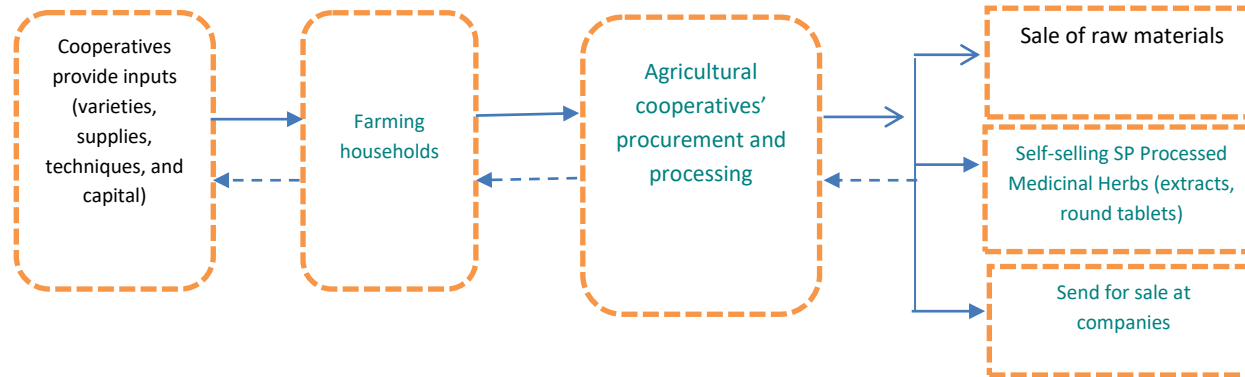


Fig. 3. Linkages model in *Celastrus hindsii* production and consumption in Hoa Binh province

* Note: —> : Product chain; - - -> : Financial chain
Source: Survey results (2022)

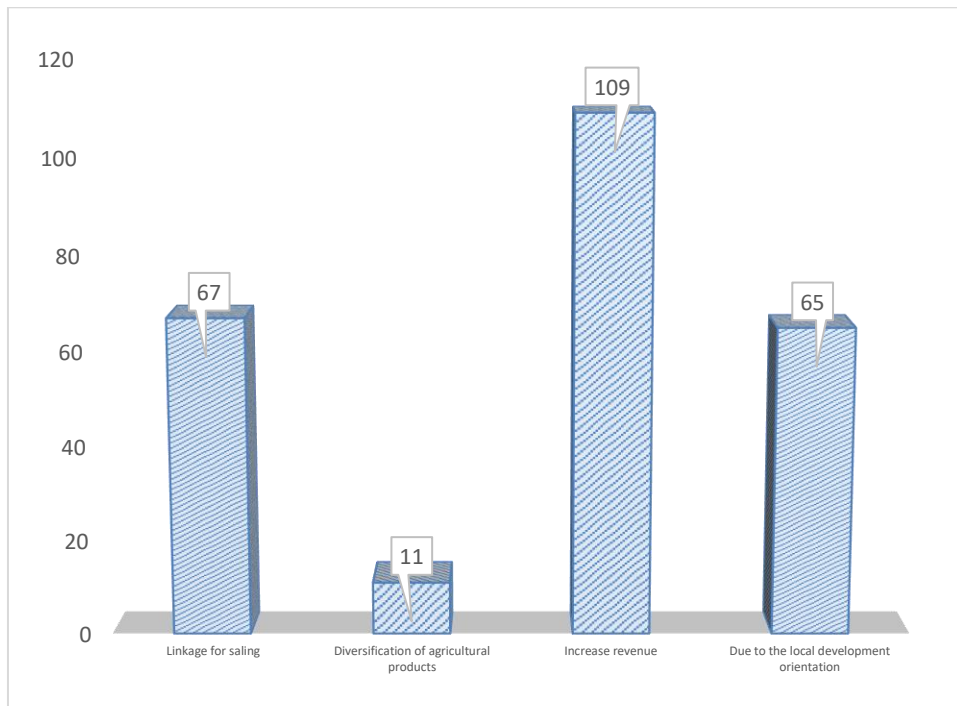


Fig. 4. The reasons for households to plant *Celastrus hindsii* medicinal herbs in Hoa Binh province

Source: Survey Results (2022)

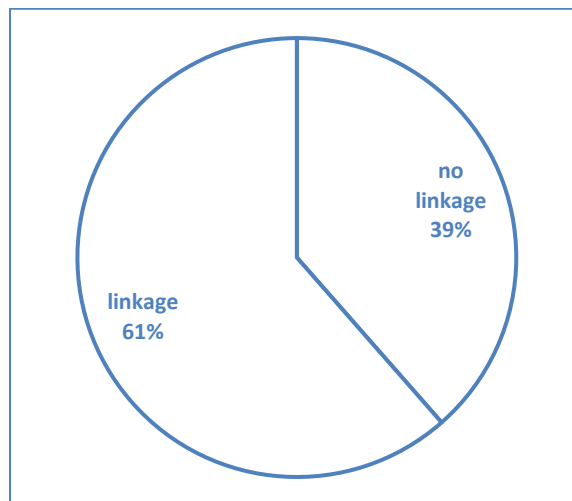


Fig. 5. Linkages in selling *Celastrus hindsii* products of growers in Hoa Binh

Source: Survey results (2022)

The issue of infield traffic was also of great concern. The current state of infield transport improved significantly due to support and investment from the New Rural National Target Program. However, the current situation of infield traffic was still not synchronous, many travel areas were still very inconvenient, therefore, besides many households assessing that internal traffic

was somewhat favorable and very favorable, there were still large proportions of the households assessing the quality of internal traffic as very poor (37.6%) and poor (7.3%). The average distance to the place where medicinal herbs were grown was quite far, some households had to travel about 3 km to reach their medicinal herb fields or gardens.

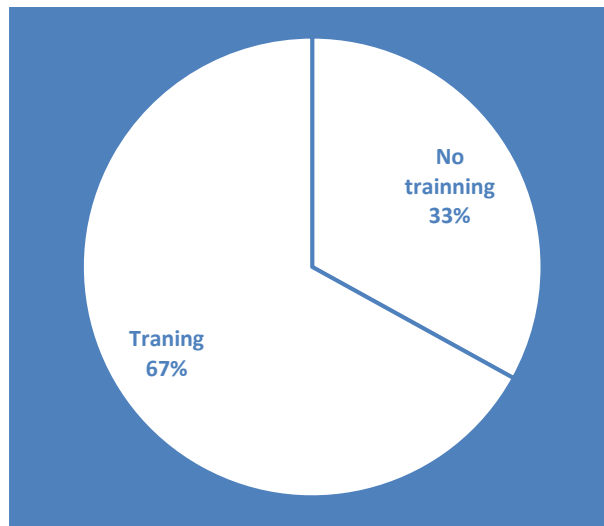


Fig. 6. Technical training provided to *Celastrus hindsii* growers in Hoa Binh
 Source: Survey results (2022)

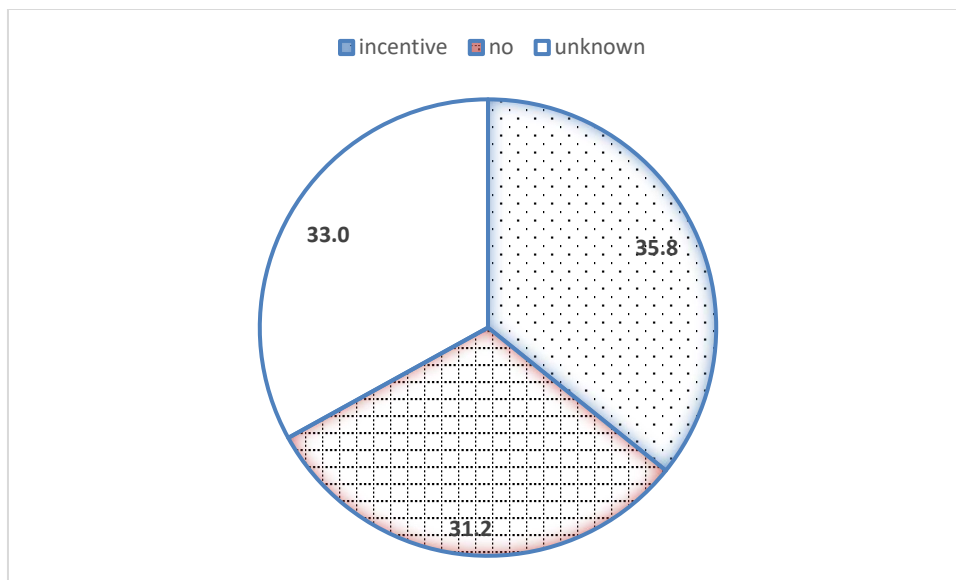


Fig. 7. Assessment of farming households on local encouragement and propaganda
 Source: Survey results (2022)

Celastrus hindsii farmers also made certain investments in tools. A little more than half of the surveyed households, 51.37%, invested in tillers, while 61.46% of the surveyed households invested in pumps to improve labor productivity and ensure technical and quality of medicinal care. However, the above figures were still quite low and the investment budget was not high because households still faced many capital difficulties or the area was not large enough for the farmers to decide to make significant investment in production machinery and equipment.

3.2 Income Situation of *Celastrus hindsii* Farming Households in Hoa Binh Province

Celastrus hindsii cultivation brings significant income to people in Hoa Binh province. Although the area of medicinal herbs is not much, many households have increased their income from medicinal herbs. The highest revenue that a household earned was over 100 million/season, corresponding to the mixed-income of up to 90.52 million VND/season.

Table 3. The situation of preliminary processing and processing of some major medicinal plants in Hoa Binh province

Species	Preliminary processing method	Processing methods	Infrastructure and implementation organization
1. <i>Celastrus hindsii</i>	<ul style="list-style-type: none"> - Method: machines already available - Preliminary processing form: remove damaged plants; dry or take fresh stems and leaves 	extracts, tea bags	<ul style="list-style-type: none"> - Nursery garden: Yes - Gathering and storage area: Yes - Implementing organization: Cooperatives, enterprises collaborating with households
- Reference trees			
2. <i>Solanum procumbens</i>	<ul style="list-style-type: none"> - Method: machines already available - Preliminary processing form: remove damaged plants; dry or take fresh stems and leaves 	extracts, tea bags, powder	<ul style="list-style-type: none"> - Nursery garden: Yes - Gathering and storage area: Yes - Implementing organization: Cooperatives, enterprises collaborating with households
3. <i>Gynostemma pentaphyllum</i>	<ul style="list-style-type: none"> - Method: machines already available - Preliminary processing form: remove damaged plants; dry or take fresh stems and leaves 	extracts, tea bags	<ul style="list-style-type: none"> - Nursery garden: Yes - Gathering and storage area: Yes - Implementing organization: Cooperatives, enterprises collaborating with households
4. <i>Amomum villosum</i>	<ul style="list-style-type: none"> - Method: manual - Forms of preliminary processing and preservation: - remove spoiled berries; dry 	not yet available	<ul style="list-style-type: none"> - Nursery garden: none yet - Gathering and preservation area: not available yet - Implementation organization: single-by-production households

Source: Survey results (2022)

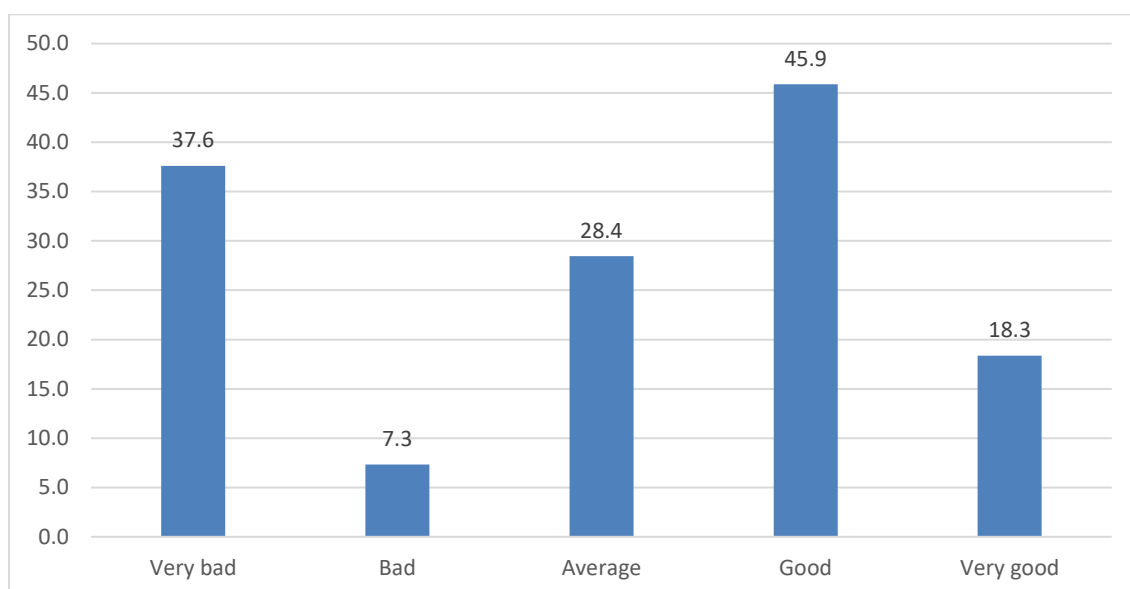


Fig. 8. Assessment of internal traffic of households

Source: Survey Results (2022)

Table 4. Current situation of investment in machinery and equipment of *Celastrus hindsii* farming households in Hoa Binh province

Device type	Number of investment households (households)	Proportion of investment households (%)	Average value (million VND)
Tillers	56	51.37	4.73
Pump	67	61.46	2.16
Tools and tools	109	100.00	0.49

Source: Survey Results (2022)

The mechanization of *Celastrus hindsii* medicinal herbs was not high, which could be shown by the largest investment in machinery and equipment of a household being only over VND 10 million, including tillage machines, pumps, and basic tools for agricultural production. The distance from farmers' houses to medicinal growing areas was quite far away, some households had to travel about 3km to reach their field or garden to grow medicinal herbs. The highest mixed income per employee of the households reached 60.5 million VND/person, on average, households earned 12 million VND per employee. The mixed-income per hectare could reach the highest of 90.52 million VND/ha, while the average mixed-income per hectare was 20.79 million VND/ha. The medicinal planting area of *Celastrus hindsii* of households was still quite fragmented, only ranging from 0.04ha to 0.46ha, and even had the tendency to decrease because part of agricultural land was prioritized for conversion to attract investment

in the development of industry, trade, and services.

The income of households if calculated per hectare of medicinal herbs was quite significant. The largest value was up to 279.38 million VND/ha, the average figure reached 98.04 million VND/ha. Households had years of experience in growing medicinal herbs ranging from 2 to 13 years. The number of years of experience in growing medicinal herbs was not high, which was reflected in the relatively low average number of years of experience in growing medicinal herbs of the surveyed households, about 6.72 years.

3.3 Factors Affecting the Household Income of *Celastrus hindsii* Growers in Hoa Binh Province

Model validation of factors affecting income showed that the model was consistent and statistically significant. Correlation coefficient $R^2 = 44.3\%$ shows that independent variables in the

Table 5. Income of households growing *Celastrus hindsii* medicinal herbs in Hoa Binh province

Criteria	Units of calculation	Min. Value	Max. value	Average value	Standard error
Area	Ha	0.04	0.46	0.18	0.09
Harvest time	Every month	12.00	16.00	14.03	1.42
The cost of buying the seeds	Million VND	1.20	26.60	8.08	6.24
Cost of fertilizers	Million VND	0.38	6.65	2.21	1.51
Cost of pesticides	Million VND	0.03	0.57	0.19	0.13
Total cost	Million VND	1.61	33.82	10.47	7.86
Productivity	Tons/ha	13.33	36.57	21.20	6.00
Production	Tons/Crops	0.62	14.40	4.09	2.98
Turnover	Million VND/case	5.75	103.92	35.52	24.65
Gross income	Million VND/case	0.50	95.40	25.05	19.57
Investment cost of machinery and equipment	Million VND	0.10	10.80	4.26	2.67
Allocated machinery investment costs	Million VND	0.03	3.6	1.41	0.89
Mixed-income (excluding family labor)	Million VND	-2.35	90.52	20.79	18.87
Number of family workers	Person	1.00	3.00	2.28	0.73
Income/family labor	Million VND/person	-1.3	60.5	9.88	9.67

Source: Survey results (2022)

Table 6. Household income of *Celastrus hindsii* medicinal herbs in Hoa Binh province is calculated per 1 ha

STT	Criteria	Units of calculation	Min. Value	Max. value	Average value	Standard error
1	Revenue	Million VND	92.79	315.25	187.04	60.01
2	Seed cost	Million VND	5.65	175.00	45.73	26.82
3	The cost of fertilizers and pesticides	Million VND	1.90	65.00	14.40	9.57
4	Cost of machinery and equipment	Million VND	0.10	56.48	9.62	9.28
5	Mixed-income	Million VND	-32.64	279.38	98.04	59.66
6	Years of cultivation of medicinal herbs	Years	2.00	13.00	6.72	3.17

Source: Survey results (2022)

model could explain 44.3% of the volatility of mixed earnings. The analysis results show that the cost factors of fertilizers and pesticides, selling price, and the factors of infield traffic, consumption linkage, propaganda – incentives, and training had a statistically significant impact on mixed-income.

Households that received medicinal incentives saw their mixed incomes increase by 16.1%. Households receiving production training were likely to increase their mixed-income by 23.1%. The propagation and encouragement, especially the training in medicinal cultivation

techniques, were important for medicinal herb growers in understanding how to cultivate, preserve, preliminarily process, and consume medicinal herbs. This was a factor that greatly affected the quality of medicinal herbs after harvesting.

When the selling price increased by \$1,000 (~VND22,000), the mixed income increased to 18.5%. The selling price of medicinal herbs is also a big problem when developing medicinal cultivation on a large scale. The market for medicinal herbs is quite limited. Because there are few domestic pharmaceutical companies and

Table 7. Factors affecting household income in growing *Celastrus hindsii* in Hoa Binh Province

Variable	Correlation coefficient		Normalized correlation coefficient	T-Accreditation	P-Value	Self-correlation coefficient	
	Coefficient	Standard error				Coefficient	VIF
(Constant)	2.232	0.383		5.830	<.000		
Cost of fertilizers and pesticides	-0.035	0.007	-0.400	-5.118	<.000	0.885	1.129
Price	0.185	0.037	0.388	5.060	<.000	0.919	1.088
Infield transport	0.232	0.068	0.269	3.387	.001	0.855	1.169
Encourage	0.161	0.071	0.183	2.272	.025	0.834	1.199
Training	0.231	0.118	0.152	1.967	.052	0.910	1.099
Linkage	0.198	0.114	0.132	1.735	.086	0.935	1.070

Source: SPSS metric analytics (2023)

traders distributing their products to China, the problem of expanding the area into a medicinal area still faces many difficulties. Therefore, to develop medicinal plants effectively, bring high economic value, truly be a crop to reduce poverty, and develop the household economy, Hoa Binh province needs to pay attention to regional planning and building a sustainable medicinal value chain.

The cost of fertilizers and pesticides increased to VND 1 million/ha, the mixed-income decreased by 2.9%. Medicinal plants can be collected from both wild and cultivated areas. The more natural the production of medicinal plants, the higher the value of medicinal plants, however, this can limit the growth capacity of medicinal plants, reducing yields. At this stage, black musk medicinal plants should not intensify fertilizer and plant protection costs for medicinal cultivation, as it can lead to an unnecessary decline in mixed-income.

When the appreciation of infield traffic increased by one level, mixed-income increased by 21.6%. Infield traffic is a factor that promotes production, in fact, inland traffic has been improved compared to before but has not been synchronized between regions. Infield traffic in some areas is still dirt roads, difficult to travel, and not convenient for motor vehicles. Therefore, better transportation improvements will encourage production and support the care and protection of medicinal herbs.

Affiliated households were likely to increase their income by about 19.8%. The study results are consistent with the results of previous studies on the effect of association on household income. Chain linkage is a useful solution in improving the efficiency of the promotion of consumption of medicinal products with criteria (Nature, Health, Wealth, and Prosperity) [17]. However, linkage requires strictly regulated production processes, e.g. cultivation, conservation, harvesting, processing, preservation, and packaging of the pharmaceutical industry to be standardized to meet the certification criteria as well as evaluate the quality and safety norms of products and extracts resulting from production.

4. CONCLUSION

The survey results show that the income of households growing medicinal herbs was quite

positive, but not commensurate with the value of medicinal herbs due to the low selling price, the process of preliminary processing and processing to improve the value of products was still simple. Some households deployed the model of medicinal cultivation quite well, which can reach more than 90 million per hectare per crop, however, some households suffer losses due to low product output and high production costs. On average, households growing medicinal herbs can achieve more than 20 million VND/ha/crop of medicinal herbs. Factors affecting the household income of *Celastrus hindsii* growers included infield traffic, local advocacy, and incentives along with fertilizer and pesticide costs and selling prices. Therefore, necessary solutions in the coming period to improve financial efficiency for households producing medicinal herbs in the fields in Yen Thuy district that need to be implemented include: (i) Promoting training, propaganda, and encouragement for people to grow medicinal herbs; (ii) Investing in upgrading the internal transport system in medicinal herb production areas; and (iii) Strengthening linkages to promote the consumption of medicinal products and create added value for medicinal herbs to raise selling prices. Developing the cultivation of medicinal plants is an effective solution for raising household income in Hoa Binh province. To accomplish the above task, some general policies are proposed to contribute to improving income for medicinal herb growers including: (i) The State should adopt policies to support, encourage and create conditions for households to participate in training about medicinal herb cultivation techniques and medicinal processing techniques; (ii) Policies on infrastructure investment, especially infield transport, are essential, and policies on mobilizing socialized capital can be applied to serve the creation of infield transport infrastructure in medicinal growing areas; (iii) There should be policies to encourage cooperatives, associated enterprises and support the sale of products to farmers growing medicinal herbs to stabilize the income of farmers and output products.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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