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An economic analysis of organic apple cultivation in the Foothills of Saramati mountain range: A case study of Thanamir village of Kiphire district, Nagaland

Chubakumzuk Jamir

Assistant Professor, Department of Economics, Yingli College, Longleng, Nagaland, India
orcid.org/0000-0002-1414-0413

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Abstract— *A study was carried out to assess the production and marketing condition of apple (Malus domestica L.) in the Thanamir village of Nagaland. With diverse agro-climatic condition, varied soil and low temperature with wide regional variation, this region is highly suitable for cultivation of apple. This article focuses on the importance of apple fruit, its utilization and the economic profitability from apple crop based farming system. Research survey of farmers producing apple was conducted in 2022. Total of one hundred thirty (132) apple producers were selected using random sampling methods. The result shows BCR was estimated to be 1.95, which was found greater than unity. This showed that the apple farming is quite profitable in Thanamir. The finding shows that Cobb-Douglas production function exhibits increasing return to scale. The study concluded that apple cultivation can be made viable enterprise with increased focus on investment climate by subsidising farm input, providing affordable loans to the farmers for a sustainable production and strengthening rural infrastructure. The study pointed out that the apple cultivation could be a highly beneficial and market-oriented activity in Thanamir.*

Keywords— ***Apple (Malus domestica L.), Cultivation, Benefit-Cost Ratio, Cobb-Douglas production function***

I. INTRODUCTION

Apple (*Malus domestica L.*) is a deciduous tree species belonging to the rose family (*Rosaceae*) and one of the most widely cultivated tree fruits in the world (Lauri, et al., 2006; Cornille, et al., 2012; Coart, et al., 2006; Duan, et. al., 2017; Chand, et.al., 2017; Collett, L., 2011; Juniper, et.al., 1998; Wertheim, 1998; Wunsche, et. al., 1996; Amgai, et.al., 2015). Apple has been cultivated for thousands of years in Asia and Europe, and European colonists introduced them to North America. There are currently more than 7,500 apple varieties known, offering a variety of desired qualities. Different cultivars are bred for various tastes and uses, including cooking, fresh eating and cider production. Wild apples grow easily from seed, but domestic apples are typically propagated by grafting (Robinson, 2003). In 2022, there were 87 million tonnes of apples grown worldwide, with China producing approximately half of this total. With more over 6% of global output, United States comes in second place, followed by Turkey, Poland, India, Italy, and Iran. Although they are frequently consumed fresh, apples also appear in a variety of prepared foods and beverages, particularly desserts. Apple (*Malus domestica L.*) consumption is believed to have a number of positive health advantages, although two types of allergy to different proteins in the fruit have been observed.

II. THANAMIR: A BRIEF REVIEW

Thanamir is a Yimkhiung-Naga village in Pungro sub-division of Kiphire district, situated in the extreme foothill of Mt. Saramati mountain range, the highest peak in Nagaland, (see fig. 1&2). It is located about 82 km away from the district headquarter (Kiphire district), and it is the last village en route to the majestic mountain range of

Nagaland. The village jurisdiction lies at the international border between India and Myanmar (refer fig. 3&4). Thanamir was once undiscovered and an unreached destination however, after the road connectivity to the village in 2009, the pace of economic development accelerated and gave them a boon in all the aspects. Thanamir is also known as the apple village so often tagged by the state government is now known for producing one of the most flavour and organic apple in Nagaland (see fig. 5,6,7&8).

It was during those years of armed conflict in Nagaland, Naga army attacked Indian soldiers in the area and in retaliation, the Indian army imposed curfew at Thanamir and check post was erected. It was during that time Mr. J. Yongbokhiung, a village guard of Thanamir befriended a Nepali soldier of Assam Rifle posted in the village. The soldier gave Mr. J. Yongbokhiung three (3) apples in exchange of his goodwill gesture. He later planted those apple seeds in his backyard and later bore the apples. Meanwhile, Mr. J. Yongbokhiung taught himself the skill of grafting technique which were later distributed to his fellow villagers and therefore, Thanamir apple started to spread to other neighbouring village (Jamir, 2011). Thanamir apple was not known to the outside world until the arrival of Mr. Tangit Longkumer, a missionary from Nagaland Mission Movement under (Nagaland Baptist Church Council) who was a mission at Thanamir. The first ever *'Apple Festival'* was organised at Thanamir on 29th September, 2010 sponsored by the Department of Horticulture, Government of Nagaland (see fig. 11&12). In a major boost to apple cultivation, Thanamir village council under the Chairmanship of Mr. Tsueki, resolved to make it mandatory for every household to plant one thousand (1000) apple trees by 2014 in collaboration with the Department of Horticulture, GON (Government of Nagaland) under Horticulture Technology Mission (HTM-NE) under the supervision of Dr. N. Benjong Aier, and the District Horticulture Officer, Kiphire district. The Department of Horticulture has distributed more than 10000 apple graft to the farmers since 2009-10.

Scenic view of Mount Saramati mountain in Kiphiredistrict (Photo by Topanthong)

Fig. 1 (Summer season)

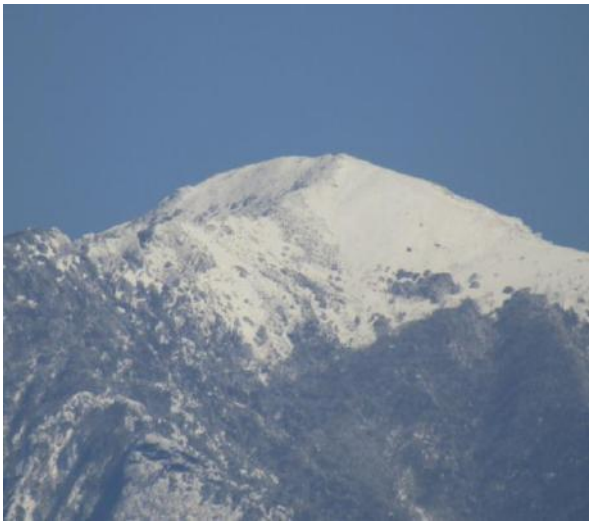

Fig. 2 (Winter season)

Thanamir village is the centre of apple production in Nagaland. In Saramati range, Thanamir and the surrounding villages have a comfortable climate with temperatures ranging from 2 °C to 20 °C and suitable soil conditions for growing apples. The farmer in Thanamir does not need to rely on irrigation to produce a crop because the area receives 19 inches of rainfall annually. The short, cool and moist growing season of Thanamir can provide a competitive advantage to growers with respect to input costs and apple quality. One of the greatest climatic advantages that Thanamir has over other regions is the ability to produce high quality organic apples due to the cool evening temperatures in late summer and the fall combined with good light diffusion. At present the apple grown in the Kiphire district covers an area of 130 hectares with a production of 1040 metric tons in 2020-21 (Statistical Handbook 2022). Thanamir village has the largest area under apple fruits in Nagaland as nearly hundreds of tons of fruits are annually produced from hundred of hectares. The production of deciduous fruits in Thanamir has a special significance among other fruit growing areas.

Panoramic view of Thanamir village (Photo by Topanthong)

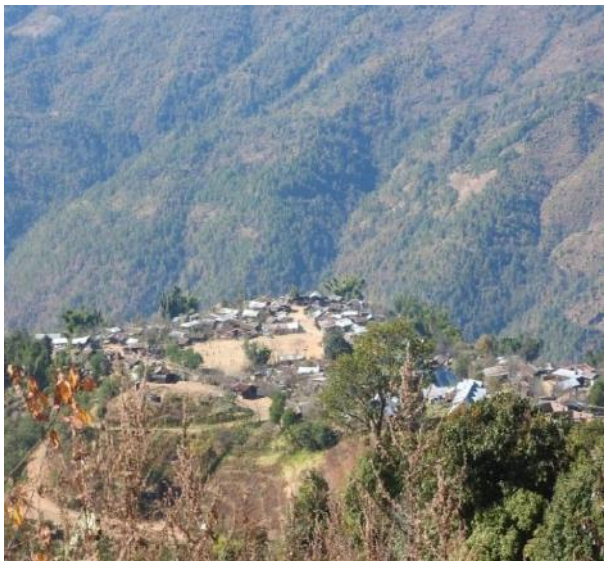

Fig. 3

Fig. 4

Farming of apple (*Malus domestica L.*) (Photo by Topanthong)

Fig. 5

Fig. 6

Apple production in Thanamir (Photo by Topanthong)

Fig. 7

Fig. 8

III. MATERIALS AND METHODS

Study area and socio-economic determinants

In 2022, the study was carried out in Thanamir, a steep, hilly community in Kiphire district. This district is well-known for producing apples and is considered a pioneer of apple cultivation in Nagaland. Thanamir village is located in Khongsa circle of Kiphire district in Nagaland. It is situated about 15 km away from sub-district headquarter Khongsa and about 82 km away from district headquarter Kiphire. According to the 2011 Census, Thanamir has a total population of 746, of whom 384 are male and 362 are female. Thanamir village has a literacy rate of 20.24%, with 26.30% males and 13.81% females being literate. Thanamir village has about 166 household. In Thanamir village out of total population of 746 persons, 78.22% of workers describe their work as main work (employment or earning more than 6 Months) while 21.78% were involved in marginal activity providing livelihood for less than 6 months. Agriculture remains the main occupation of the people of the district. The primary mode of agricultural practice is *Jhum*, also known as swidden or slashes and burn method of cultivation (see fig 9 &10). The main crops grown in the *Jhum* are largely traditional crops such as paddy, maize, millet, beans and vegetables (Jamir, 2021b). The farmers are slowly taking to growing cash crops such as potatoes with encouragement from the Agriculture Department GON (Government of Nagaland). Also a traditional crop such as soybeans, local varieties of bean called ‘Kholar’ (*Phaseolus Vulgaris Linn*) is grown as cash crop using traditional methods.

Practice of Jhum Cultivation in Thanamir (Photo by Topanthong)

Fig. 9

Fig. 10

Annual celebration of apple festival in Thanamir (Photo by Topanthong)

Fig. 11

Fig. 12

The general climatic condition of the district is also favourable for horticultural farming. Apples are often grown in cooler areas, such as the foothills of Mount Saramati. The *'Apple Festival'* has become a yearly tradition in Thanamir, a frontier village bordering Myanmar (see fig. 11&12), where other fruits including oranges, peaches, pears, guavas, and bananas are also abundantly grown.

Research instruments and design

Data collection was done through personal interviews. Primary methods were used to collect data, shared experiences, observation and find out the real problems mostly faced by the apple grower which were collected through key informant interview and focus discussion (Bailey, 1978). To gather further information regarding apple production and trading, key informant interviews with farmers, traders, and other interested parties were conducted. Secondary information was collected from

journal articles and departmental reports of Government of Nagaland (Ackoff, 1961).

Sample and sampling technique

The study is built on a mixed-methods approach, with data from focus groups and key informant interviews supplementing two survey datasets that were gathered using a structured questionnaire. First, every villager involved in apple cultivation was located. The apple fruit growers were chosen from the villages using random sampling techniques. Area, production, productivity, input costs, output prices, and revenue are all covered by the data that was gathered. In 2022, a survey of farmers who grow apples was undertaken (Bowley, 1937).

Cost of production

The total cost of production per hectare was calculated by summation of variable and fixed cost. Variable cost includes input cost like organic manure, sapling, nursery planting, labour cost etc. Fixed cost includes the rental value of land and depreciation cost. The variable costs were separately calculated for the first and second year. From 3 to 15 years, the variable cost was increased each year by 10%. From 16 to 25 years, the cost was considered the same as that of 15 years but the production was assumed to be decreased by 20% than that of 15th year. The variable cost was estimated by using the following formula:

Variable cost = $C_{planting}$+ C_{labour}+ $C_{organic\ manure}$ +$C_{management}$+ $C_{other\ cost}$

Where,

$C_{planting}$ = Cost of planting (₹)

C_{labour}= Cost of human labour (₹)

C_{manure} = Cost of organic manure (₹)

$C_{management}$ = Cost of orchard management (₹)

C_{other} = Other miscellaneous costs (₹)

Similarly, the fixed cost was estimated by using the following formula:

Fixed cost = $C_{landrent}$+ $C_{depreciation}$

Where,

C_{land}= Cost of land rent (₹)

$C_{depreciation}$= Depreciation cost of farm equipment (₹)

Benefit-Cost analysis

Measurement of Cost-Benefit using Benefit-Cost Ratio Method

Benefit-cost ratio (BCR) is a quick and easy measure of the economic performance of any firm/producing unit. BCR was calculated by using the following formula:

Mathematical expression for BCR:

Mathematical expression for BCR:

$$BCR = \frac{\text{Discount Benefit}}{\text{Discounted Cost}}$$

Total cost of production and gross return from apple product were used to analyze the benefit-cost ratio (Gitting, 1984). Therefore, the BCR ratio was calculated using the following formula:

BCR = Gross return/total cost where, gross return was calculated from the income of sold product. The total cost of production was calculated by summing the variable cost and fixed cost items incurred in the production process.

Cost = Expenses incurred for agronomic operation in terms of labour, tools and raw material costs.

Return to scale using Cobb-Douglas production function model

Cobb-Douglas production function = $Y=AL^{\beta}K^{\alpha}$

Y=Total production (the real value of all goods produced in a year)

L=Labour inputs,

K=Capital inputs,

A=Total factor productivity α and β are the output elasticity of capital and labour (Cobb and Douglas, 1928).

Linear regression model

Linear regression was used to analyse the impact of apple production on employment, income and poverty. The general functional forms of the model to point out dependent and explanatory variables are given as linear regression model estimation approach is adopted to obtain the coefficients.

Linear regression analysis

In the regression model, Y has normal distribution with mean

$Y=\beta_0+ \beta_1X_1+ \beta_2X_2+ \beta_3X_3+\ldots\ldots\ldots\ldots \ldots+ \sigma\ (Y)$,

sd (Y) = σ (independent of X's)

The model parameters $\beta_0+ \beta_1+ \beta_\rho$ and σ must be estimated from data.

β_0 = intercept

$\beta_1\beta_\rho$ = regression coefficients

σ = σres = residual standard deviation

In the equation $Y = \beta_0 + \beta_{11} + + \beta_\rho X_p$

β_1 equals the mean increase in Y per unit increase in Xi , while other Xi's are kept fixed. The estimation method follows the least squares criterion.

If b_0, b_1, ,bρ are the estimates of β_0, β_1, , β_ρ then the "fitted" value of Y is

$Y\ fit = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_\rho X_\rho$

Model Specification

The general functional form of the factors affecting the income of the farmers of Thanamir is expressed as:

Y=f (EM, IN, PR)

Table 1: Descriptions of variables

Variables	Abbreviation
Employment	EM
Income	IN
Poverty	PR

Compiled by authors

Scaling technique

Five-point scaling technique was used to measure the relative severity of production and marketing problems. The most severe, highly severe, moderately severe, less severe and least severe were given the scale values 1, 0.8, 0.6, 0.4 and 0.2 respectively. The index was calculated using the following formula:

The index of importance was computed by using the following formula.

$I_{imp} = \Sigma (Si\ Fi/N)$,

I: Index (0 < I <1)

Where,

I_{imp} = Index of importance

S_i: Scale value at i^{th}severity

f_i: Frequency of the i^{th}severity

n: Total number of respondents

IV. RESULTS AND DISCUSSION

All costs incurred to employ labour for production are referred to as labour inputs. During the period of apple production in the study area, labour inputs were used for all operational tasks (see fig.19&20). These tasks include clearing the forest, levelling the ground, digging pits, planting nursery crops, harvesting, weeding, and picking.

Table 2: Cost components of apple cultivation (in average)

Cost components	Expenditure
Cost for clearing plantation area	380800
Pit digging	101500
Nursery plantation	85700
Weeding removing twice a year	81300
Picked fruit/harvesting	90400
Labour cost of carrying harvest apple from farm to village	64000
Miscellaneous expenditure	74500
Total	**878200**

Source: Field survey report, 2022

In the study area, family members who worked in the apple orchard made up a considerable portion of the labour employed in the production of apples, which was calculated in monetary terms. The overall setup cost includes the expenses required in clearing the plantation land, digging the pit, planting the plantation, and planting saplings (TEC). The above table 2 showed the total cost of labour input, which included 380800 for clearing the forest for apple cultivation, 101500 for digging pits, 85700 for planting nurseries, 81300 for removing weeds, 90400 for picking fruit/harvesting, 64000 for labour to transport apple harvest to the village, and 74500 for other miscellaneous expenses in the study area. According to a study, farmers who have orchards with more than 100 plants had to pay much lower variable costs per plant (Kireeti, et. al., 2014; Malik and Choure, 2014; Panwar, 2011; Sharma, et. al., 2018).

Table 3: Size of land, number of tree and production

Farming pattern		Acreage (hectare)	Production (ton)	Total income (Lakhs)	Total Cost	BCR
Home garden	Orchard farm	43.2	57.31	17.19	8.78	1.95
22.32	77.67					

Source: Field survey report, 2022

The total area under apple cultivation was estimated to be 43.2 hectare. The average cultivated land owned by farmers of the study area was found 22.32% in home garden/backward and 77.67% in orchard farm. The details on benefit cost analysis of apple farming in the study area presented (refer table 3). It is evident from the analysis of benefit-cost ratio that all categories of the farmers enjoyed some profit level. Farmers with larger farms had higher profits per hectare since their costs are lower than those of farmers with smaller farms. The benefit-cost ratio (BCR) was used to determine the profitability of the apple farming. Any business or production unit with a BCR ratio below 1 is not feasible because they do not generate profits. However, BCR ratio greater than 1 denotes feasible enterprise/producing unit that could be sustained or making profit. So, overall BCR was estimated in the study area, which was found greater than unity (1.95).The findings show that the apple based farming is profitable in Thanamir. The benefit-cost ratio of apple orchard is found to be higher than the food crops due to its high value and higher production and productivity (Fadavi et. al., 2011; Wani and Songara, 2018; Ferree and Rhodus, 1987; Robinson and Lakso, 1991).

According to the Cobb-Douglas production function, if labour is increased by 10%, output rises by 2.2%, but if capital is increased by 10% for organic manure, land, and nurseries, output rises by 11.9% (refer table 4). Since the coefficients value of labour and capital cost is more than 1 it exhibits increasing return to scale and the Cobb-Douglas production function is statistically significant.

Table 4: Cobb-Douglas production function of apple growers

Observation	Coefficients	Standard Error	t-Stat	P-value
Intercept	4.63	5.12	2.16	0.34
Quantity of organic manure applied	0.28	0.22	1.23	0.02
Value of apple plantation	0.40	1.17	2.49	0.00
Land allocated	0.51	0.44	2.51	0.01
Labour used	0.22	0.70	1.20	0.05

Source: Author calculation using field survey data

Table 5: Household experience and plant age

Parameters	Overall (N=85)	Chi-square	P-value
Household experience in apple cultivation (yrs.)			
0-5	22 (16.66)	3.61	0.002
5-10	69 (52.27)	7.87	0.000
10-above	40 (30.30)	4.16	0.001
Plant population of age			
0-5	15 (11.36)	2.11	0.021
5-10	67 (50.75)	6.08	0.000
10-above	49 (37.12)	5.39	0.000

Source: Author calculation using field survey data

Table 5 shows years of experience of farmers in apple cultivation and age of plants. The study found that 52.94% of the household have 5-10 years of experience in apple cultivation. The number of plants of age 5–10 years was found highest.

Apple orchard during peak season (Photo by Topanthong)

Fig. 13

Fig. 14

Apple orchard during winter season (Photo by Topanthong)

Fig. 15

Fig. 16

Fig. 17

Fig. 18

Cleaning of apple orchard (Photo by Topanthong)

Fig. 19

Fig. 20

Table 6: Crop managerial practice in plantation area

Parameters	Overall (N=132)	Chi-square	P-value
Manuring (Yes/No)	100 (75.75)	5.45	0.001
Intercropping (Yes/No)	25 (18.93)	3.85	0.000
Regular- training pruning (Yes/No)	51 (38.63)	6.07	0.000
Mulching (Yes/No)	69 (52.27)	5.42	0.001
Weeding clearing once a year	86 (65.15)	7.06	0.002
Twice a year	73 (55.30)	4.88	0.000

Source: Calculation based on field survey report, 2022

Table 7: Relationship between education, employment, income and poverty

Independent variable Production	Correlation		Regression				
	r	*'t' value*	R^2	*a*	*beta*	*'t' value*	*S.E*
Employment	0.86	3.21**	0.73	50.80	10.21	2.58**	2.08
Income	0.83	4.18*	0.68	1396.8	3819.93	8.68*	9.10
Poverty	-0.93	-6.98*	0.86	62.98	-15.59	-8.14*	1.16

Source: Calculation based on field survey report, 2022

Note 't' values., ** and *** indicates significant level at 1%, 5% and 10%.*

b is beta SE is Standard Error.

The empirical results of the investigation are highlighted in table 7 above. The positive coefficient of the production variable suggests that an increase in apple production causes an increase in employment. A one-unit increase in apple output, according to the coefficient, results in a 10.21 increase in employment, and the b value is statistically significant at 5%. Therefore, the hypothesis is accepted which means higher the production of apple fruit higher is the employment.The findings show that higher the apple production level, lower is the poverty level. The poverty variable's coefficient is negative, indicating that an increase in apple production leads to a fall in the poverty level of the household. According to the coefficient, a one-unit increase in apple production results in a -15.59 fall in poverty. Therefore, the value of b is statistically significant at 1%. Therefore, altering apple production would have a significant negative influence on lowering the poverty rate. As a result, the theory is confirmed, which suggests that poverty levels decrease as productivity increases. The results demonstrate that a rise in apple output significantly affects how much money an individual earns. The positive coefficient value means that when apple output rises, so does their level of revenue. According to the coefficient, increasing apple production by one unit should result in a 3819.93 rise in household income. The coefficient of production, which was determined to be 1%, was substantial, positive, and statistically significant.

Problems

It was reported that the marketing channel that involved transaction of apples from producer to primary wholesaler, secondary wholesaler, retailer and consumer is most efficient (Chand et al., 2017; Ma and Abdulai, 2016; Atreya and Kafle, 2018).

Table 8: Problems faced by the apple growers in the study area

Problems	Index value	Rank
Lack of training and promotional activities	0.362	5
Transportation problem	0.915	1
Lack of post harvest storage	0.720	2
Insect pest infestation	0.329	5
Difficult in getting credit from banks	0.686	4
Lack of market information	0.374	5
Unavailability of saplings and organic manure	0.453	3

Source: Calculation based on field survey report, 2022

The major marketing problems of apple in Thanamir, Kiphire district were identified to be lack of transportation facility, lack of training and promotional activities, credit facilities, short of packaging materials, need of processing facility, price instability and require of storage facility. Problems related to lack of marketing information are the major problems in the marketing of apple fruits in Thanamir (Mehta et al., 2013). Study from the Mustang district establishes a fact that apple farmers make a lucrative profit when the region is connected by road

transportation (Sachs, 2017). Similar problems were also highlighted in Himachal Pradesh in the field of production marketing, transportation, financing and packing material. Their study suggested that for proper development of fruit industry, the government should pay immediate attention towards the regulating the fruit market in the state, development of market infrastructure within the state, provision of refrigerated vagons/trucks and opening of processing units (Singh et. al., 1975 and Singh et. al., 1978; Parikh, 1979; Swarup and Sikka 1983; Maine et. al., 1983).

V. CONCLUSIONS

Apple (*Malus domestica L.*) fruit is the important food crop for nutritional security, employment, income, reduction of poverty and sustainable livelihood to hundreds of farmers in Thanamir village (Jamir and Ezung 2017; Jamir, 2019a; Jamir, 2019b; Jamir, 2020a; Jamir, 2020b; Jamir, 2021a; Jamir, 2021c). Most of the farmers residing in the rural sector are engaged in apple cultivation. From the present investigation, the highly competitive benefit cost ratio of 1.95, wide adaptability with rich genetic resources and nutritional content revealed that apple crop based farming system has a huge potential for food and nutritional security for livelihood improvement which can transform subsistence based *Jhum* farming system into sustainability farming approach with remunerative return. The study found that apple is the major source of income and employment generation as most of the farmers are actively engaged in apple production (Kashyap and Guleria, 2015; Singh, 2006). The return of apple is higher than other food crops cultivated in the village. The results also show that apple produced in Thanamir is organic in nature and the demand is high in the market but due to the lack of proper infrastructure and credit market demand is not fulfilled by the apple from Thanamir (Jamir and Ezung 2020c). There is the huge potentiality for organic apple production in Thanamir through coordinated approaches from different stakeholders and agencies. Thus, the district can have a potential to produce more fruits for demand of growing population, there is also need for study the efficient apple fruits production practices and issues in the production process for policy making.

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Author declares that they do not have any competing financial, professional, or personal interests from other parties.

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