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Evaluating Large Cardamom Agriculture Practices: A Case Study from Panchthar, Nepal

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ABSTRACT

A study conducted in Phalelung rural municipality, Panchthar, Nepal, in 2023 examined agricultural practices and the economic analysis of large cardamom. A total of 60 households were randomly selected, and data were collected through primary and secondary sources using surveys, focus group discussions, key informant interviews and field observations to assess the large cardamom economy, package of practices and various challenges faced by farmers. The study revealed that 28% of farmers grew the Ramsai cultivar, with over 82% having access to irrigation. Most farmers (77%) managed shade well and maintained their orchards effectively. However, only 50% used specialized harvesting tools, and 63% employed improved kiln (*bhatti)*, though more education is needed. 68% of farmers received subsidies for constructing improved kiln (*bhatti)*. Notably, 70% of farmers lacked knowledge about cardamom grading, and 90% were unaware of value-added practices. Farmers predominantly used jute bags for packaging. Major issues identified included plant wilt, *furkey*, rhizome rot, and stem borer infestations. The total production cost was NPR. 114,460.5 per hectare, with a BC ratio of 1.54. Having high market value, large cardamom provides promising opportunity to uplift the economic and social condition of farmers and stakeholders. This study provides an overview of the status of large cardamom production, processing practices, best cultivation practices to be adopted, disease pest incidence on large cardamom, storage, grading with various cultural practices to be adopted and feasibility of large cardamom cultivation area. This study would help both governmental and non- governmental agencies to make effective plans for large cardamom cultivation to meet Phyto-Sanitary status and minimum requirements to enter export and import system of cardamom in global market.

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Introduction

Agricultural activities have stood out as a means of livelihood for most of the population, the main GDP source and an employment opportunity for many. Agriculture employs about 66% of the total population and supports 24.12% of the GDP of Nepal (MoALD, 2022/023). Large cardamom (*Amomum subulatum* Roxb.) is a valuable species of the family Zingiberaceae widely known as "Black Gold" or "Queen of Spices" and more popularly known as "*Kholsa ko sun*" in Nepal (Acharya, 2019).

Large cardamom was first introduced in the Ilam district in 1865, but commercial cultivation began in the late 1950s (Shrestha et al., 2018). Currently, it is grown in 51 districts, mainly in the eastern hill and mountain areas and gradually expanding to the western districts of Nepal. It is one of the highest commercial products among all Nepal's exportable products. This plant is a tall, perennial, evergreen herbaceous monocot with a height ranging from 1.5 to 3.0 meters. (Gopal et al., 2012; Bisht et al., 2011). It is a climate-dependent crop; the best production is between the temperature of 4-20°C, annual rainfall of 2000-2500 mm and more than 90% humidity (Chapagain, 2011). Large cardamom is cultivated in shady areas from 600 to 2000 masl (Uma et al., 2014). The plantation of large cardamom begins in June with a planting distance of 1.5 m, and it requires 3-4 years to reach maturity and produce cardamom.

Table 1. Trend analysis of large cardamom from the last 5 years

Year	Nepal			Panchthar District		
	Area (Ha)	Production (Mt)	Yield (Mt/ha)	Area (Ha)	Production (Mt)	Yield (Mt/ha)
2017/18	17004	6849	0.4	1961	829	0.47
2018/19	18273	7954	0.53	2920	1037	0.36
2019/20	18748	9545	0.58	3425	1178	0.37
2020/21	18791	8289	0.53	3432	1196	0.37
2021/22	19144	8714	0.55	3425	1,476	0.47

*Source: MoALD, (2018); MoALD (2019); MoALD (2020); MoALD (2021); MoALD (2022)

Table 1. represents the trend of large cardamom from the last five years. In Panchthar, the total area dedicated to large cardamom production is 3,425 hectares. Of this, 3,164 hectares were productive, resulting in a total production of 1,476 Mt and a yield of 0.47 Mt/ hectare (MoALD, 2021/22). In the fiscal year 2022/23, Nepal exported 9,991.15 metric tons of cardamom, valued at 8.28 billion Rupees (MOF, 2022/23). Most of the large cardamom produced in Nepal, i.e., more than 95% is marketed to India (Paudel & Malla, 2020). The government of Nepal has initiated the Prime Minister Agriculture Modernization Project (PMAMP) to overcome the problem of low productivity, and higher import rate of Agri-products under ADS (2015-2035) from the Fiscal Year 2015/16. PMAMP has selected the 500 ha of land of Falelung Rural Municipality (Ekteen & Sidin VDC) as the site of the zone area of the project in Panchthar district (AKC, 2022).

In Panchthar, the total area dedicated to large cardamom production is 3,425 hectares. Of this, 3,164 hectares were productive, resulting in a total production of 1,476 Mt and a yield of 0.47 Mt/ hectare (MoALD, 2021/22). In the fiscal year 2022/23, Nepal exported 9,991.15 metric tons of cardamom, valued at 8.28 billion Rupees (MOF, 2022/23). Most of the large cardamom produced in Nepal, i.e., more than 95% is marketed to India (Paudel & Malla, 2020). The government of Nepal has initiated the Prime Minister Agriculture Modernization Project (PMAMP) to overcome the problem of low productivity, and higher import rate of Agri-products under ADS (2015-2035) from the Fiscal Year 2015/16. PMAMP has selected the 500 ha of land of Falelung Rural Municipality (Ekteen & Sidin VDC) as the site of the zone area of the project in Panchthar district (AKC, 2022).

Despite being an important cash crop for Nepalese farmers, the production trend of large cardamom has been stagnant and low because of various challenging factors such as lack of market, lack of improved varieties, disease infestations like *Chirkey* and *Furkey*, lack of suitable processing procedures, and lack of knowledge (Bhandari & Bhandari, 2018).

Thus, this study was conducted to assess the status of large cardamom production practices, major constraints of large cardamom production including disease and pest incidence, suitable storage conditions, along with grading techniques adopted and feasibility of large cardamom cultivation area. This study also indicates the government's role and responsibility in quality control to meet sanitary and Phyto-sanitary standards (SPS) and minimum requirements to enter in export and import system of cardamom in global markets. Thus, this article identifies existing cultivation practices and major production constraints, estimates cost of production and Benefit Cost ratio, discovers existing marketing channel and the post-harvest processes of the large cardamom in the Panchthar district .Thus, this article identifies existing cultivation practices and major production constraints, estimates cost of production and Benefit Cost ratio, discovers existing marketing channels and the post-harvest processes of the large cardamom in the Panchthar district.

Materials and Methods

About the Study Area

Panchthar district is one of the 14 districts of Koshi Province of eastern hilly region of Nepal. It is a hilly district of far east Nepal covering 1,241km² (479 sq. meters). According to the census of 2021, 172,400 total populations and Phidim is the district headquarter. The geographical coordinate of this district is 27°06′49.68″ North, 87°48′56.88″ East.

There are a total of 8 municipalities in Panchthar in which 1 is urban and 7 are rural. The survey research was conducted in Phalelung rural municipality was selected as a study area as being cardamom zone under. Most of the people of this area are involved in cardamom cultivation.The study site selected are Phalelung rural municipality ward 1, 2,4,7,8.

Preliminary Study

A preliminary study was carried out to collect different information regarding the feasibility of the research. Assessment of the features of the study site was done by direct observation and informal conversations with farmers.

Figure 1. Map of the Panchthar district of Nepal showing the study site

Sample and Sampling Technique

A list of farmers growing large cardamom under the command area of large cardamom zone was obtained from the office of PMAMP large cardamom zone and the sampling frame was made of 1000 farmers. A total of 60 households were selected based on simple random sampling. For this study, 60 respondents were selected from Phalelung rural municipality. Simple random sampling was adopted to avoid biases.

Research Methods and Techniques

Research instruments like household survey, focus group discussion, key informant interview, field observation, secondary information collection from various sources, etc. were used to collect and triangulate reliable data.

A) *Household survey:* Household survey was conducted with the help of pre-tested, structured interview schedule as well as via use of telephone. Pretesting of the questionnaire was done among 10 respondents from the area near the study site to check the validity and effectiveness of the interview schedule. Total of 60 samples was taken by using personal interview schedule (PIS). The information on prevailing cultivation practices, production, and productivity, processing practices, problems/constraints faced by farmers on the large cardamom production, processing and marketing in the study area were collected from the farmers by interview.

B) *Focus Group Discussion:* One Focus Group Discussions was conducted using a pre-determined semi-structured checklist on Chature, Phalelung-08, considering the cultural, gender, and ethnic backgrounds of respondents.

C) *Key Informant Interview (KII):* One KII was conducted with progressive farmers, farmer leaders, managers of private farms, and local extension workers to seek some key information about the overall trend of agriculture practices of large cardamom in the study area. about the ongoing situation in agriculture.

D) *Field Observation:* Frequent visits to farms with keen observations were conducted to assess a brief overview of field conditions throughout the research duration.

Source of Data

A) *Primary Data:* Primary data was collected by direct interviews with farmers through questionnaires and Telephone survey

B) *Secondary Data:* Secondary data was collected by reviewing relevant journal articles, relevant articles, annual publication reports of governmental authorities, proceedings of I/NGOs and browsing the websites of relevant institutions.

Data Analysis

The data was tabulated and analyzed using SPSS, and MS Excel. The total cost of production was calculated as:

Total cost of production = Total fixed cost + Total variable cost

Total fixed cost = $\sum C_L + C_E$

Total variable cost=$\sum C_{LP} + C_S + C_F + C_{IO} + C_P + C_H$

Where,

C_L = Cost of land rent

C_E = Cost of equipment

C_{LP} = Cost of land preparation

C_S = Cost of seedling

C_F = Cost of FYM

C_{IO} = Cost of intercultural operation

C_P = Cost of pesticide

C_H = Cost of harvesting

The BC ratio was also calculated to determine profitability from large cardamom production in the study area:

$$BC = \frac{\text{Total cost (Annual income} - \text{Prodution cost)}}{\text{Total production cost}},$$

$$= \frac{\text{Total benefit}}{\text{Total Cost}}$$

Indexing

The Likert scale is used to place different options in ascending or descending order of severity.

The mathematical approach for this index use is

$$I = \frac{\sum S_i f_i}{N}$$

Were,

I= Priority index such that $0 \leq I \leq 1$

S_i= scale value of i^{th} priority

F_i= frequency of i^{th} priority

N= Total number of observations

Results and Discussion

Socio-demographical Results

The data in Table. 2 presents the gender of the respondent who participated in the survey. Among the respondents, 87% were male while 13% were female.

Figure 3 presents the data regarding the Ethnicity of Respondents. Among the respondents, it was found that 60% respondents were Janajati, 32% were Brahmin and 18% were Chhetri.

Figure 2 presents data regarding the education status of the respondents in the study area. The level of education determines the well-being of the household. Education Status is classified into 4 categories: Illiterate, Primary, Secondary, and Bachelor or Bachelor above. Among the respondents it was found the majority (47%) had completed their primary level education while 37% were illiterate, 15% had completed secondary level education and only 1% had completed bachelor level education.

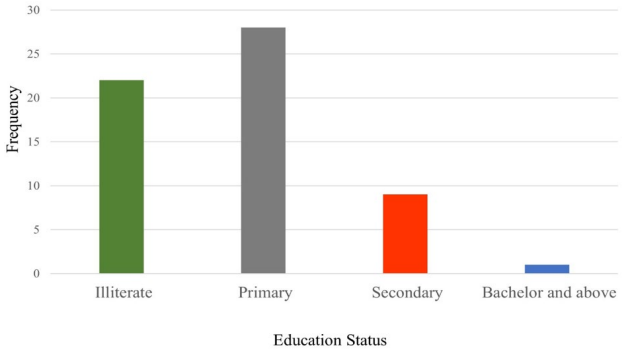


Figure 2. Education status of Respondents

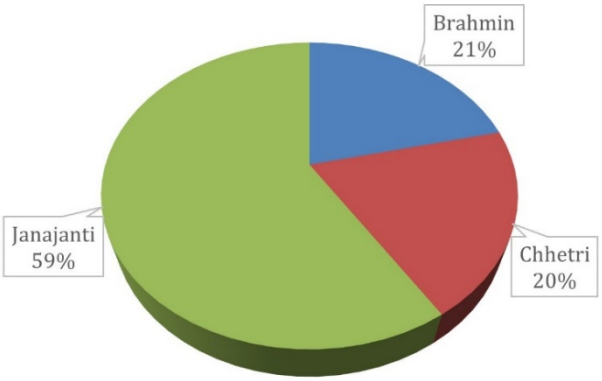


Figure 3. Ethnicity distribution in the study area

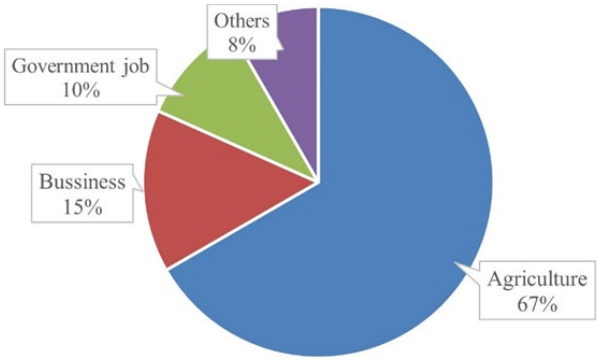


Figure 4. Sources of the household income

Table 2. The gender of respondents in the study area

Variables	Frequency	Percentage
Male	52	87
Female	8	13

Table 3. Distribution of respondents based on land holding size

Land Under Cardamom Cultivation	Frequency	Percentage of total land
(<0.17 hectare)	9	15
(0.17-0.34 hectare)	13	22
(>0.34 hectare)	38	63

Table 4. Land tenancy of the household in the study area.

Category	Frequency	Percentage
Rented	46	77
Owned	14	23

Table 5. Experience of large cardamom-producing farmers

Experience Category	Frequency	Percentage
0-5 years	10	17
5-10 years	31	52
More than 10 years	19	31

Distribution of Sources of Household Income of Respondents

The locals perform multiple activities to earn their living. Various activities may include agriculture, business, government jobs, etc. Figure 4 shows that 67% of the respondents had adopted agriculture as their major occupation, followed by 15% who had adopted business as a major occupation, 10% who adopted a government job, and 8% who adopted other occupations, respectively. It reveals that more than 50% of the households in the study area have adopted farming as their major source of income, and large cardamom farming seems to be the major farming practice supporting them.

The data in Table. 3 represents the distribution of respondents based on land under large cardamom cultivation. Among the respondents, it was also found that 63% of farmers cultivate Cardamom in more than 0.34 hectare while 22% of farmers cultivate in 0.17-0.34 katthas while only 15% of farmers cultivate in less than 0.34 hectare.

The data in Table 4. represent the land tenancy of households. Among the respondents, 77% rent up the land while 23% of farmers cultivate up cardamom on their land. The study reveals most farmers usually rent the land to perform cardamom cultivation.

The data in Table 5. represent the experience of large cardamom-producing farmers. Among the respondents, 52% of farmers have 5-10 years' experience, 31% of farmers have more than 10 years' experience, and 17% of farmers have 0-5 years' experience in large cardamom cultivation. The farmers were found to be quite experienced in the study area as the majority of them have been cultivating for more than 10 years.

Large Cardamom Production Cultural Practices

Frequency of cultivars in the Study Area

Figure 5 shows that most farmers use *Ramsai* (28.3%), *Golsai* (25%), and *Chibesai* (20%), but among all other varieties, *Ramsai* is found to be most commonly cultivated due to its suitability in the agro-ecological climatic conditions and easy availability around the Panchthar region. Out of sixteen varieties of large cardamom in the world, six types of large cardamom are cultivated in Nepal, namely *Ramsai*, *Golsai*, *Dambersai*, *Bharlange*, and *Jirmale*. Shrestha et al. (2018) found that in Panchthar, Ramsay had higher productivity than *Golsay* and *Chibesai*.

The data in Table 6 represent the planting distance of large cardamom. Most of the farmers in Panchthar prefer the planting distance of 0.92 to 1.22 m; 67% of the farmers are found to follow that spacing, while 28% follow spacing above 1.22 m and 5% follow spacing less than 0.92 m.

Table 7 shows that 82% of farms are provided with irrigation facilities, and the remaining farms were found to be in rainfed condition. 77% of the farmers were found to have good shade management, and 87% of farmers had good orchard management. These data are indicators of good agronomic practices. In the case of large cardamom, shade management is very important. Exposure of large cardamom directly to the sun causes sunburn along with a reduction in the soil's moisture content, so it's important to manage the shade to get optimum productivity. Plants like Titepati (*Artemisia vulgaris*), Bilaune (*Maesa indica*), Masysmdal (*Vigna umbelleta*), Alder (*Alnus nepalensis*), etc. are used as shading plants for large cardamoms (Shrestha et al., 2018).

Table 8 represents data regarding methods of irrigation. The farmers in the study area mostly use sprinkler irrigation and the Kulo system. It was found that 92% of respondents use a sprinkler system, while only 8% of respondents use *Kulo*.

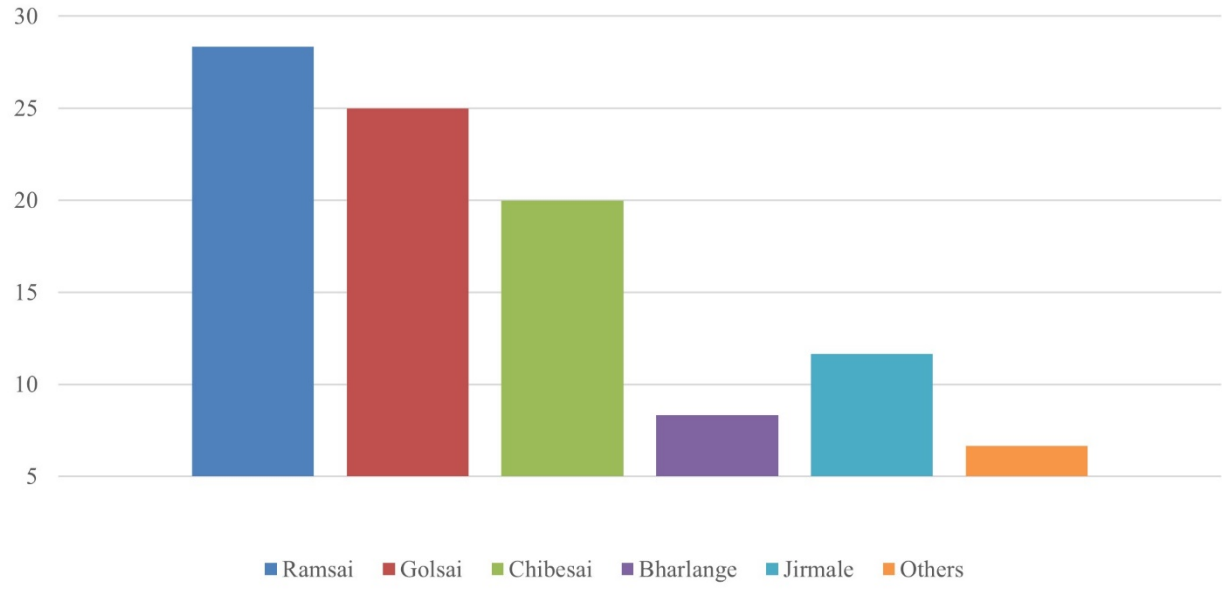


Figure 5. Cultivars in the study area

Table 6. Planting Distance of Large Cardamom

Planting Distance	Frequency	Percentage
Less than 0.92 m	3	5
0.92 to 1.22 m	40	67
Above 1.22 m	17	28

Table 7. Intercultural Practices adopted by the farmers

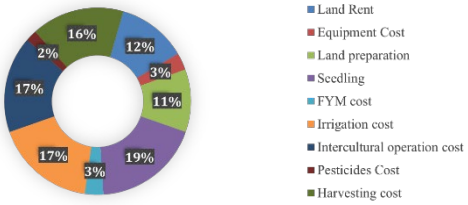
Intercultural Operation	Yes	No	Total
Irrigation	49 (82%)	11 (18%)	60 (100%)
Shade management	46 (77%)	14 (23%)	60 (100%
Orchard Management	52 (87%)	8 (13%)	60 (100%)

Table 8. Method of irrigation

Method of Irrigation	Frequency	Percentage
Sprinkler irrigation	55	92
Kulo	5	8

Table 9. Production cost of large cardamom

Activity	Cost (NPR/Ha)	Contribution to Average Cost
I) Fixed Cost		
Land Rent	13835.13	12.08%
Equipment Cost	3387.68	2.95%
Total Fixed Cost	17222.79	15.03%
II) Variable Cost		
Land preparation	12419.49	10.85%
Seedling	21349.20	18.65%
FYM cost	3672.65	3.20%
Irrigation cost	19979.73	17.45%
Intercultural operation cost	19116.38	16.70%
Pesticides Cost	2265.67	1.97%
Harvesting cost	18433.53	16.10%
Total variable cost	97237.84	84.97%
III) Total cost	114460.56	100%
Average cultivated land area for large cardamom (Ha)	0.78	
Average cost of production per farm (NPR)	2975.70	
Average production per hectare (kg)	420	
Average cost of production per kg per hectare	272.52	



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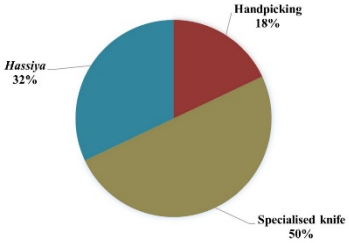

Figure 7. Harvesting technique used in the study area

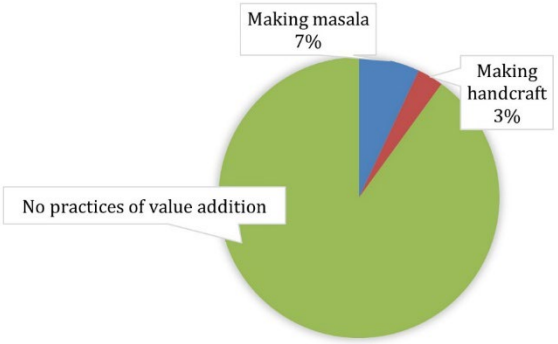

Figure 8. Value-addition practices adopted by farmers in the study area

Table 10. Ranking of Problems in Large Cardamom production in the study area

Problem	IV	R
Increased incidence of disease and insect/pests	0.85	I
Weather uncertainty	0.33	II
Difficulty in marketing	0.25	III
Poor availability of an improved variety	0.13	IV
Poor technical knowledge of farmers	0.11	V

IV: Index Value; R: Rank

Table 11. Prominent diseases of large cardamom in the area

Diseases	Index	Rank
Plant wilt	0.83	I
Furkey	0.73	II
Rhizome rot	0.55	III
Leaves decaying	0.21	IV
Chirkey	0.4	V

Table 12. Important Economic Insects and Pests in the study of the area

Insect/Pest	Index	Rank
Stem Borer	0.8	I
White Grub	0.46	II
Aphids	0.4	III
Caterpillar	0.33	IV

In the study performed by Shrestha et al. (2018), it was found that 90% of the people who responded were using various methods to irrigate their orchards, comprising sprinklers (15%), canal/surface irrigation (39.9%), and both (32.7%), while using *the kulo* system was considered a significant source of fungal disease transmission. However, the present study suggests that most farmers have transitioned to sprinkler irrigation to avoid fungal disease transmission through *kulo* irrigation.

Economic Analysis of Large Cardamom

The cost of production per Ha of large cardamom in the study area was found to be NPR. 114460.5

The BC ratio was found to be 1.54 which indicates that large cardamom production is a profitable business in the study area and farmers can earn profit return from large cardamom production in the study area.

From the study of (Baniya et al., 2019) BC ratios of Yangwarak-5, Phidim-14 and Falgunanda- 6 Panchthar were found to be 1.37, 1.21, and 0.66 respectively. This suggests that the BC ratio of Phalelung is comparatively more than adjacent local bodies.

From the field survey conducted at the Panchthar, the average production of large cardamom production was found to be 420kg/Ha.

Table 10 shows the ranking of problems in large cardamom production in the study area which concludes that increased incidence of disease and insect/pests is the most serious problem (0.85) followed by weather uncertainty (0.33). Difficulty in marketing (0.25) is ranked third while poor availability of an improved variety (0.13) is ranked fourth. Poor technical knowledge of farmers is the least serious issue (0.11).

One of the major constraints of large cardamom production in Nepal is that there is still haphazard planting of the crop without proper knowledge of variety and their climatic requirements which is the cause of higher disease, insects and sterility problems (Shrestha, Chapagain & Karna, 2004). *Chirkey* and *Furkey* are the most common viral diseases responsible for lower yield in the crop (Sharma, Sharma & Sharma, 2009). Managing the distribution of quality capsules also stands out as a major challenge (MoAC, 2012).

Ranking of Pests and Diseases Occurring in The Cardamom Field

Table 11 shows that Plant wilt (0.83) has the highest severity followed by *Furkey* (0.73), Rhizome rot (0.55), leaves decaying (0.21) and *Chirkey* (0.4) which indicates that currently *Chirkey* disease is under control, and rhizome rot, previously a significant issue, is also managed. However, efforts are needed to control Plant wilt and *Furkey* disease. Various disease pests have been detected while cultivating large cardamom, but major diseases include *Chirkey*, *Furkey* and rhizome rot that has caused severe yield loss to an extent of 68-100%. Likewise, the crop is also attacked by many insect species. Shrestha et al., (2018) reported that rhizome rot and *Chirkey* were severe, while plant wilt was moderate, and *Furkey* disease had the lowest severity in Panchthar.

From Table 12, the most important economic insect and pest in the study area was found to be stem borer (index value 0.8), followed by white grub (index value 0.46), aphids (index value 0.4), and caterpillars (index value 0.33).

Table 13. Drying techniques used by farmers

Drying Techniques	Frequency	Percentage
Improved kilns (Bhatti)	38	63
Traditional kilns (Bhatti)	22	37

Table 14. Subsidy for making *Bhatti*

Subsidies received	Frequency	Percentage
Yes	41	68
No	19	31

Table 15. Calyx cutting techniques used by farmers

Calyx Cutting	Frequency	Percentage
Tail cut	51	85
Shave it off	9	15

Table 16. Grading of Large cardamom

Grading	Frequency	Percentage
Yes	18	30
No	42	70

Table 17. Packing materials used by the farmers in the study area

Packaging Material	Frequency	Percentage
Jute Bag	41	69
Plastic Bag	18	31
Total	60	100

Table 18. Adoption of various practices for value addition

Practices for value addition	Frequency	Percentage
Yes	6	10
No	54	90

Ten years ago, the major pest of Large Cardamom was the leaf caterpillar (*Artona chorista*, Jordan), while at present minor pests like stem borer (*Glyphopteryx* spp.), shoot fly (*Merochlorops dimorphous* Cherian), lacewing bug, and white grub (*Holotrichia* spp.) have emerged as major pests. Along with it, a significant pest of ginger, *Holothrichia* spp., has become a significant pest of large cardamom at present (Gurung et al., 2020). The stem borer, known as *Glyphepteryx sp*., is a pest that specifically targets large cardamom. It can be observed in the fields throughout the year. Its peak abundance occurs during December–January, March–April, May–June, and September–October (Bala & Bala, n.d.).

Harvesting and Post-Harvesting Techniques

Harvesting techniques used in the study area

From figure 7 it was found that half the farmers use specialized knives, while 32% use *hassiya,* and 18% use the handpicking technique. This shows that the farmers are slowly acknowledging and adopting the instruments and methods that are easy and timesaving. The harvesting practice is generally done from September to November. The maturity of the cardamom is assessed by opening the topmost capsule of the spike. After the topmost capsule fully matures, the shoot with spikes is cut at 45 cm and kept for another 10–15 days to ensure the maturity of the capsules (Board, 2001). To separate the capsule easily harvested spikes are stored for 2-3 days (Board, 2001). Separation and cleaning of capsule is done manually before curing to remove other plant materials. (Board, 2001).

Table 13 shows that the majority i.e., 63% farmers were using the improved kiln *(Bhatti)* while 37% were using the traditional kilns (*Bhatti)* and none of the farmers were found to be using Sun drying for drying of large cardamom for curing of cardamom. The use of improved *Bhatti* directly relates to excellent quality products with a maroon colour and volatile oil content.

Curing cardamom is usually associated with the colour balance, humidity, and maturity. According to Mande et al., (1999), fresh large cardamom capsules at harvest contain about 70 to 80% moisture (on a wet basis). Initially, flue-cured cardamom had a moisture content of 12.5% and 67% RH, but it was found, that a moisture content of 11.0% at 60% RH was optimum for the storage of large cardamom (Naik et al., 2000). Depending on the variety, the colour of these capsules varies from pale pink, and brownish pink to dark pink, which ultimately becomes black after drying. From the study of Deka et al., (2003) curing large cardamom at 45-55^{0}C was found to be ideal. Depending upon curing methods and capsule size, the weight ratio from fresh to cured capsule varies from 4:1 to 5:1(Bhutia et al., 2017). Some volatile substances that are components of the essential oil of large cardamom are lost during the process of curing (Rout et al., 2003). Curing is done in traditional and improved kilns (*bhattis)*.

Data in Table 14 shows that 68% of farmers receive subsidies for making the *Bhatti* for drying large cardamom. Farmers who received the subsidy for making *Bhatti* followed the improved *kiln (bhatti).*

The data in Table 15 shows that 85% of farmers perform tail cut while 31% were found to shave it off. Removing the tail from cardamom capsules is a crucial step undertaken by local traders before selling the product. Capsules without the tail fetch a higher price in the market (Shrestha et al., 2018). The process, known as tail cutting, involves manually removing the outer layer of the capsule using scissors. This step is essential for grading the cardamom, with capsules categorized as either "*kainchi-cut*" (with the tail removed) or "*non-kainchi cut*" (with the tail intact) (Mande et al., 1999). According to local dealers, the additional labour required for tail-cutting costs approximately US$ 0.41 per kilogram of capsules (Singh & Pothula, 2013).

The data in Table 16 shows that 70% of the farmers had no idea of grading and only 30% farmers graded their large cardamom. Thus, cumulatively it was found farmers got low market prices of the produced items around the study area. The majority of the farmers were found to be not using grading techniques because of a lack of grading technology and a lack of proper knowledge about grading.

There is a variation in the size of large cardamom due to cultivar differences or pre-harvest conditions. Mechanical grading machines are not reported in Nepal so manual screening method is applied for grading the capsules. Large cardamom is graded in the local market as *badadana* (big capsules) or *chotadana* (small capsules) and, as discussed previously, as *kainchi-cut* (capsule tail removed) or *non-kaichi-cut* (capsule tail intact) (Sharma et al., 2009).

Table 17 shows that 69% of farmers were found to use jute bags as a packaging material and 31% were found to use plastic bags. Dried large cardamom capsules are usually packed in polythene-lined jute bags. For storage, a dried capsule with an optimal moisture level of 11% is recommended (Naik et al., 2000). Polypropylene and ethylene terephthalate/polyethene have been reported to considerably reduce moisture and volatile oil exchange under normal storage conditions (Sulochanamma et al., 2008).

Storage stability has been maintained for large cardamom capsules with up to 11% moisture content. (Gurudutt et al., 2000). The use of fumigants like Methyl bromide (0.016 kg m^{-3}), Phosphine (0.0015 kg m^{-3}) and ethyl formate (0.30 kg m^{-3}) are suggested to control the storage insect pest that affects the quality of large cardamom (Naik et al., 2005).

From Table. 18 it was found that 90% of farmers were found to have no idea about the value addition of large cardamom and only 10% of farmers were found to practice the value addition of large cardamom.

Value-addition practices adopted by farmers in the study area

Figure 8. shows that 7% of the farmers were found to make masala from the capsule of large cardamom and 3% were making handcraft like *Gundri*, *Chakati* and Bags from the pseudo-stem of large cardamom.

Conclusion

Large cardamom, locally known as *'Kholsa ko sun*,' is a valuable spice crop that uplifts farmers' rural economy of the Panchthar district and eastern Nepal. This area is emerging as a key producer of large cardamom and holds substantial potential. A significant portion of the economically active population is engaged in its cultivation. While farmers have considerable experience, their cultivation, harvesting, and processing techniques still lack scientific knowledge. This has increased issues with pests, diseases, and particularly plant wilt and stem borer infestations. Many farmers still use traditional kilns (*bhatti*), and large cardamoms are often not graded or packed properly, leading to rapid quality deterioration during storage. Despite these challenges, large cardamom farming remains profitable, with an acceptable BC ratio and an average production cost. With the provision of proper marketing system, IPM and IDM integrated clean cultivation practices and right support from the government, extension services, and other agencies, Panchthar can potentially become a leading centre for large cardamom production in Nepal.

Recommendations

The assessment of this research findings was informative for farmers, policy implications and for further researchers.

- Large cardamom cultivating farmers of Panchthar district should improve their cultivation practices like selecting agro-ecologically suitable varieties, maintaining recommended planting distance, orchard management to get higher yield.
- Farmers should use specialized large cardamom harvesting knife to minimize plant damage as well as capsule and disease infestation.
- Grading and appropriate drying, packaging and practices of value addition must be done to get higher prices.
- Appropriate interventions should be done to capacitate farmers like training.
- Marketing Information should be made easily available.
- The economic aspect of the traditional and modern method of large cardamom cultivation practices should be analyzed.
- Action research on detailed study of problems must be carried out.

Declarations

Ethical Approval Certificate

The procedures of this study were approved by the Faculty of Science and Technology, Nepal Polytechnic Institute (NPI), Purbanchal University

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Author Contribution Statement

S. B.: Conceptualization, Conducting survey, Data collection, Formal analysis

A. B.: Interpretation of data, Data analysis, technical assistance, Manuscript writing and designing

S. G.: Conducting survey, Data collection, Formal analysis

S. D.: Conducting survey, Data collection, Formal analysis

S. A.: Assisting, Validation

Conflict of Interest

The authors declare no conflict of interest.

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