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Research Article

Farmers' Perception of Drying and Storage Methods of Large Cardamom (*Amomum subulatum* Roxb.) among Smallholder Farmers in Gandaki Province, Nepal

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Abstract: Large cardamom (*Amomum subulatum* Roxb.) is one of the major high-value cash crops of the mid-hills of Nepal. Freshly harvested cardamom capsule requires proper drying and storage to maintain good quality of capsule and fetch better prices. The study was carried out to assess smallholder farmers' perception of the drying and storage methods of large cardamom in Gandaki province, Nepal. 320 samples were selected randomly from 1600 sampling populations in the study area. A household survey was conducted to collect information by using a semi-structured questionnaire. The collected data were coded, tabulated and analyzed by using Microsoft Excel and Statistical Package for Social Sciences. Likert scale and Chi-square test were applied to deduce farmers' perceptions on the effectiveness of drying and storage methods. Farmers perceived electric dryers as the most effective in drying capsules followed by solar dryers and jute sacks as the most effective storage technique for storing dried capsules. From the indexing technique, the study revealed that the topmost barrier to the drying and storage of cardamom as perceived by farmers was farmers' poor technical knowledge related to drying and storage of cardamom, followed by insufficient funds in the study area. Hence, the government and private sectors should invest in the provision of education to farmers on effective drying and storage methods via training, education campaigns or other awareness programs.

Keywords: Adoption, Dryer, Effective, Kiln, Post-Harvest.

Introduction

Large cardamom (*Amomum subulatum* Roxb.), locally known as *Alainchi* in Nepal and renounced as 'Black Cardamom or Black Gold', 'Nepalese Cardamom' or 'Greater Indian Cardamom', is renowned as the "Queen of Spices" [5]. It belongs to the botanical family Zingiberaceae and is a perennial herbaceous monocot plant with subterranean rhizomes, a low-volume, high-value crop [2]. Nepal is one of the highest producing as well as exporting countries of large cardamom. It is the second-largest export commodity and the largest agro-based export commodity in Nepal [4]. The quality of large cardamom from Nepal is considered to be of higher quality in the international market [11].

Currently, it is grown in 53 districts, mainly in the eastern hill and mountain areas and gradually expanding day by day from the eastern parts to the western parts of Nepal [6]. The western hills of Nepal are therefore the emerging production site. The total area, production and productivity of large cardamom in Nepal were 19145 ha, 8714 Mt and 0.55 Mt/ha respectively in the fiscal year 2021/22 [8]. Gandaki province ranks second after Koshi province in terms of area and production with a total area, productive area, production and productivity of 1841 ha, 1054 ha, 541 Mt and 0.51 Mt/ha respectively in fiscal year 2021/22 [8].

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Large cardamom produced in a single harvesting season, which may only last for a limited time, must be properly stored until the next harvest for future households' financial needs. Before storing, it is important to be dried properly to prevent the loss of flavour. However, it is generally observed that the farmers are more concentrated towards increasing production and less aware of the longevity of quality products by appropriately drying and storing them. Furthermore, they also lack proper technical knowledge about the drying and storage of fresh capsules and thus cannot take the utmost benefit from the premium prices during the lean seasons.

A lack of proper knowledge and awareness about the drying and storage of capsules poses a huge challenge to post-harvest loss reduction, but research and findings related to the farmers' perception and awareness of this are very limited. The research was conducted to assess and provide information on smallholder farmers' perception of drying and storage methods and their problems in drying and storage of large cardamom in Gandaki province. This study aimed at contributing to providing evidence-based recommendations to farmers, policymakers, and other stakeholders by determining farmers' perceptions of capsule drying and storage methods in the reduction of post-harvest loss.

Materials and Methods

1. Study Site, Sampling Frame, Sampling Procedure and Justification of Sample Selection

The research was conducted in Marshyangdi Rural Municipality of Lamjung district, Madi Rural Municipality of Kaski district and Arughat Rural Municipality of Gorkha district of Gandaki Province, Nepal.

A multistage sampling technique was followed to conduct the research. At the initial stage, Gandaki province was purposively selected for the study. In the second stage, Lamjung Kaski and Gorkha districts of Gandaki Province were purposively selected as they cover 1510 ha (82.02%) out of 1841 ha of total large cardamom growing area, 393 Mt (72.59%) production out of 541.34 Mt of Gandaki province in 2021/22 [8]. One respective Rural Municipality from each district was selected at the third stage as these Rural Municipalities covered more than 70% cultivation area and more than 75% of the total production of respective districts. For sample selection, farmers having less than 2 ha land area for cardamom farming were taken for study.

The required sample size was determined using a formula for sample size determination as described by Kothari [7].

$$n = z^2pq/e^2$$

Where n = required sample size, z= confidence level at 95% (standard value of 1.96)

The proportion of the number of households cultivating large cardamom in the study area (30% estimated) (p) = 0.3

q=1-p=0.7

e = margin of error at 5% (standard value of 0.05).

Where;

$n= (1.96^{2}*0.3*0.7/0.05^{2}) =323$

130 samples were taken from Marshyangdi Rural Municipality, Lamjung, 100 samples were taken from Madi Rural Municipality, Kaski and 93 samples from Arughat Rural Municipality, Gorkha depending on the distribution of large cardamom farmers in each district, by simple random sampling procedure to avoid any sort of bias.

2. Instrument for Data Collection

The data collected for this study were obtained from primary and secondary sources. Primary data was collected from the household survey through the administration of pre pre-tested semi-structured questionnaire to collect information from the respondents on issues related to the objectives of the study.

Secondary data were collected from the various sources. The sources of the secondary information for the study were the province profile, annual progress report and statistics book of AKC, various reports from the Ministry of Agriculture and Livestock Development (MoALD), books, related reports on large cardamom, journals, newsletters, bulletins and relevant articles, proceedings of various NGOs and INGOs.

3. Data Analysis

Of the 323 questionnaires administered, 320 were retrieved and 3 were rejected for incompleteness. A total of 320 questionnaires were therefore available for analysis. Quantitative and qualitative data obtained from the survey was organized, processed, analyzed and interpreted by using Statistical Package for Social Sciences (SPSS-Version 26) and Microsoft Excel.

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The results were presented using descriptive tools like mean, standard deviation, frequency, percentage, bar diagrams and pie charts. 5 point Likert scale was used to analyze farmers' perception of the effectiveness of a particular drying technique. The chi-square test was applied to test the proportions of farmers with positive perceptions to those with negative perceptions of a particular storage container. Problems faced by respondents on drying and storage of cardamom capsules were ranked with the use of indexing.

Chi-Square Test

In order to study the weather two variables were independent or associated with each other; chi-square was applied.

$$\chi^2 = \sum \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

Where, χ^2=Chi-square

O_{ij} = observed frequency of each ijth term

E_{ij}= indicates expected frequency of ijth term

i= 1, 2, 3…….r

j= 1, 2, 3……k

This was tested at 0.05 level of probability for different degree of freedom.

Indexing

$$I_{prob} = \Sigma S_i F_i / N$$

Where,

I_{prob} = Index value for intensity

Σ = Summation

S_i = Scale value of i^{th} intensity

F_i = Frequency of i^{th} response

N = Total number of respondents

Results and Discussion

1. Socio-Demographic Characteristics of the Respondents

Results presented in table 1 illustrate the socio-demographic characteristics of respondent large cardamom farmers in the study area. The majority of respondents (74.7%) were male. This implies that large cardamom farming business is male-dominated in the study area. This may be due to the high degree of human energy and physical exertion associated with farming activities, as is evident from the significantly low frequency of involvement of women in large cardamom cultivation. From the survey, it was found that the education status of the majority of the respondents was higher secondary level (34%) followed by University level (21%) and Secondary level (18%). Only 7% of respondents hadn't taken any formal education. It implies that majority of Cardamom farmers are educated and hence play a significant role in making rational decisions [1]. The majority (54.4%) of respondents, attended training related to cardamom farming but only 23.1% of respondents attended training related to cardamom drying and storage. Farmer training programs are essential for the knowledge and capacity development of farmers related to cardamom capsule drying and storage management.

Access to credit is an important socio-economic variable that can influence smallholder farmers' ability to purchase inputs and can also improve the livelihood of the households. As indicated in table 1, only about 43.5% of the respondents had access to credit while the remaining 57.5% did not receive credit. The existing banks and their branches are concentrated in urban areas and provide credit to traders, wealthy individuals and government projects. In addition, the banks set high interest rates and request collateral which limits credit to mainly large landowners [3]. Therefore, most of the needy smallholder farmers are excluded from credit services provided by banks in Nepal [10].

The study revealed that Government organizations were the main source of extension services (52.8%) followed by both GOs and NGOs (40%). This implies that most of the farmers had a chance to get educated on the effective methods of cardamom capsule drying and storage management after harvest from various GOs and NGOs.

Cardamom drying and storage is a complicated process involving various activities where individual knowledge is not often enough. Interaction with other persons/organizations involved in the sector is crucial for knowledge and skill development.

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Among the surveyed farmers, it was found that their source of information regarding cardamom drying and storage were extension agents i.e. government and government offices like Agriculture Knowledge Center(AKC), Prime Minister Agriculture Modernization Project (PMAMP) zone office, Catholic Relief Services (CRS), Nepal, Caritas, Nepal etc. and Friends/relatives/fellow farmers and Media (Radio/TV/Information and Communication Technology etc.). It was found that nearly 60 percent of farmers were getting information about cardamom drying and storage from extension agents, nearly 28 percent from Friends/relatives/fellow farmers, and slightly less than 15 percent from Media.

Table 1: Socio-Demographic Characteristics of Respondents

Variables	Frequency	Percentage (%)
Gender of Respondents		
Male	239	74.7
Female	81	25.3
Ethnicity of Respondents		
Brahmin	125	39.1
Chhetri	62	19.4
Janajati	104	32.5
Dalit	19	5.9
Other	10	3.1
Education Level of Respondents		
Illiterate	21	6.6
Primary Level	32	10.0
Lower Secondary Level	32	10.0
Secondary	58	18.1
Higher Secondary Level	109	34.1
University Level	68	21.3
Training Related to Cardamom Farming		
Yes	174	54.4
No	146	45.6
Training Related to Cardamom Drying and Storage		
Yes	74	23.1
No	246	76.9
Credit Access		
Yes	204	63.8
No	116	36. 3
Source of Extension		
GO	169	52.8
NGO	23	7.2
Both	128	40
Source of Information about Cardamom Drying		
Extension Agent	187	58.4
Friends/Relatives	86	26.9
Media	47	14.7
Source of Information about Cardamom Storage		
Extension Agent	184	57.5
Friends/Relatives	89	27.8
Media	47	14.7

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2. Drying and Storage Methods Adopted by Respondents

Nearly 60% of respondents used a double drum dryer for drying fresh cardamom capsules in the study area followed by a traditional kiln (30.6%) and an electric dryer was the least used drying technique with only 10.3% of farmers for drying capsules as shown in figure 1. In the study area, out of four types of storage methods used for storing dried cardamom capsules by respondent farmers, 129 (40%) farmers used jute sack, 85 (27%) farmers used bamboo basket, 58 (18%) farmers used wooden box and 48 (15%) farmers used black polythene lined (BPL) gunny bag to store dried capsule as shown in figure 2.

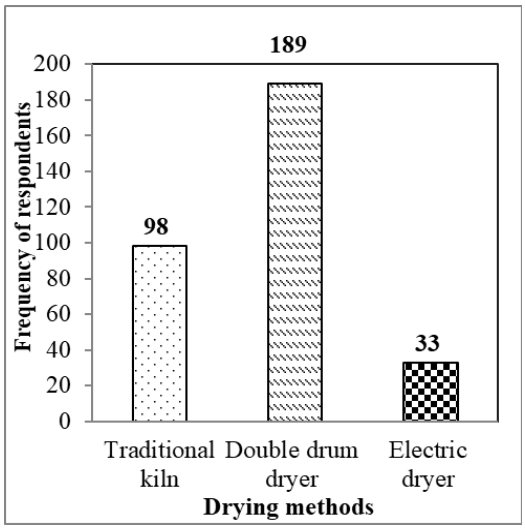

Figure 1: Drying Methods Adopted

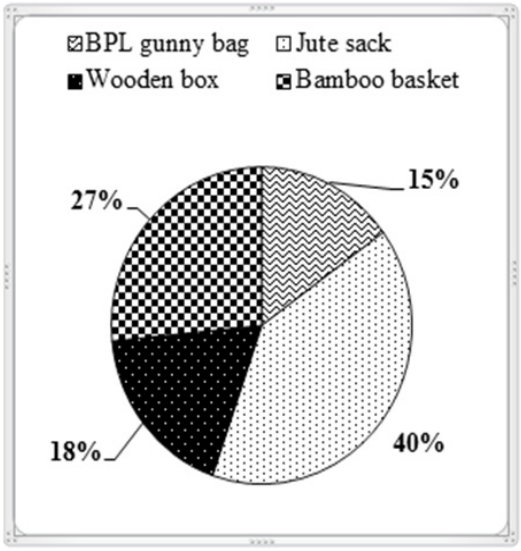

Figure 2: Storage Methods Used

3. Farmers' Perception of the Effectiveness of Drying Methods

Farmers rated drying methods as either extremely effective (EE), effective (E), Undecided (U), ineffective (I) or extremely ineffective (EI) for each of the nine given attributes on the effectiveness of the methods. Results from table 2 depict that, 62.5% and 29.38% of respondents rated Traditional kilns as strongly ineffective and ineffective respectively in quick reduction of moisture of freshly harvested capsules. However, 67.19% and 15.62% of respondents perceived Double drum dryers as effective and strongly effective respectively in quick reduction of moisture of freshly harvested capsules during drying. Furthermore, 62.50% and 56.56% of respondents perceived electric dryers and solar dryers as strongly effective in the quick reduction of moisture as shown in table 2.

The percentage of respondents who reported traditional kiln as strongly ineffective, undecided, effective and strongly effective were 64.06%, 25%, 5.94%, 4.06% and 0.94% respectively in the prevention of capsule to physical damage. Likewise, slightly more than 73% of respondents ranked double drum dryers as effective (both effective and strongly effective) in the prevention of capsule physical damage. More than 85% of respondents perceived both electric dryers and solar dryers as effective in the prevention of capsule physical damage as shown in table 2.

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In the case of traditional kilns, most farmers rated the technique as ineffective in providing higher prices for dried capsules (87%). The responses of the respondents on the effectiveness of double drum dryers in providing higher prices to dried capsules were ineffective (16.88%), neutral (5%) and effective (78.12%). Likewise, 5%, 6.88%, 4.06%, 13.75% and 70.31% of respondents reported electric dryers as strongly ineffective, ineffective, undecided, effective and strongly effective respectively in providing higher prices to the dried capsule. Only 20% of respondents negatively perceived or remained undecided about solar dryers providing higher prices to dried capsules.

Only 4.68% and 1.24% of respondents rated traditional kilns as effective and strongly effective in reduction of insect pests' infestation. Moreover, only one-fifth of farmers ranked double drum dryers as ineffective in the reduction of insect pests' infestation. Likewise, nearly equal respondents i.e. 86.82% and 86.25% reported electric dryers and solar dryers respectively as at least effective in the reduction of insect pests' infestation as shown in table 2.

More than 86% of farmers perceived traditional kilns as ineffective in the reduction of mould growth/ Dam rot and other postharvest diseases of capsules. More than 3/4th of respondents ranked double drum dryers as effective in the reduction of mould growth/ Dam rot and other post-harvest diseases of cardamom capsules. Furthermore, 4.69%, 7.5%, 4.06%, 19.69% and 64.06% of respondents rated electric dryers as strongly ineffective, ineffective, neutral, effective and strongly effective respectively in reducing post-harvest diseases of the cardamom capsule.

Table 2 depicts that only 5% and 6.88% of respondents perceived traditional kilns as effective in maintaining good colour and good flavour of cardamom capsules for long periods respectively. Likewise, 72.5% and 78.12% of respondents ranked double drum dryers as effective in maintaining the good colour and flavour of cardamom capsules for a long time respectively. Similarly, an equal proportion of respondents (66.88%) perceived both electric dryers and solar dryers as strongly effective in maintaining the good colour of the cardamom capsule. Furthermore, 84.06% and 80% of respondents rated electric dryers and solar dryers as at least effective in maintaining the proper flavour of the cardamom capsule for a long period.

Nearly 90% (88.76%) of respondents negatively perceived traditional kilns in the minimization of quantitative loss of cardamom capsules. Likewise, the ratio of respondents having positive perceptions to negative and neutral responses to double drum dryer in minimization of quantitative loss of cardamom capsule was found to be 3:1. Proportion of respondents having positive perceptions to electric dryer (88.13%) was slightly more than to solar dryer (85.94%) in minimization of quantitative loss of cardamom capsule.

The percentage of respondents having a negative or neutral perception of the traditional kiln was 12 times more than the percentage of respondents having a positive perception of the minimization of qualitative loss of the cardamom capsule. Similarly, 78.12%, 84.07% and 79.69% of respondents expressed positive perceptions of double drum dryers, electric dryers and solar dryers respectively in the minimization of qualitative loss of cardamom capsules as shown in table 2.

4. Farmers' Perception of the Effectiveness of Capsule Storage Methods

To analyze farmers' perception of the effectiveness of the capsule storage methods, each storage method user farmers were asked to rate the effectiveness of their storage methods as either extremely effective (EE), effective (E), Undecided (U), ineffective (I) or extremely ineffective (EI) for each of the five given attributes on the effectiveness of the methods with each of eight different attributes. For the analysis, extremely effective and effective responses were taken as "effective" while extremely ineffective and ineffective responses were taken as "ineffective".

Results from table 3 show that, 39.58% of the farmers using Black polythene-lined gunny bags rated it as effective in the reduction of storage pests' infestation. An almost equal proportion of respondents using wooden boxes and Jute sacks perceived both of them as effective in reducing storage pest infestation. Only one-fifth of bamboo basket users rated it as effective in storage pests' infestation reduction.

The proportions of farmers using bamboo baskets were 3 times more than BPL gunny bag users reporting them as effective in proper air circulation during storage of cardamom capsules. Almost two-thirds of wooden box users rated it as effective in proper air circulation. Similarly, more than half of Jute sack users (58.14%) reported it to be effective in circulating proper air during storage.

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Table 2: Farmers' Perception of the Effectiveness of Drying Methods.

Effectiveness of Drying Methods	Drying Methods	Percentage Response (%)				
		Strongly Ineffective	Ineffective	Undecided	Effective	Strongly Effective
Quick reduction of moisture	Traditional kiln	62.5	29.38	4.06	2.81	1.25
	Double drum dryer	6.25	7.81	3.13	67.19	15.62
	Electric dryer	2.5	4.38	1.88	28.74	62.5
	Solar dryer	3.75	5.31	3.13	31.25	56.56
Prevention of capsule to physical damage	Traditional kiln	64.06	25.00	5.94	4.06	0.94
	Double drum dryer	9.38	10.62	6.88	60.94	12.18
	Electric dryer	2.81	5.63	4.06	23.44	64.06
	Solar dryer	3.13	5.63	5.00	26.56	59.68
Provides higher price to dried capsules of	Traditional kiln	61.56	25.31	5.94	5.63	1.56
	Double drum dryer	8.13	8.75	5.00	67.18	10.94
	Electric dryer	5.00	6.88	4.06	13.75	70.31
	Solar dryer	5.31	9.69	5.00	21.56	58.44
Reduction of insect pests' infestation	Traditional kiln	67.19	21.25	5.94	4.38	1.24
	Double drum dryer	8.75	11.25	6.88	65.00	8.12
	Electric dryer	3.13	5	4.05	16.88	70.94
	Solar dryer	3.44	5.31	5.00	23.75	62.50
Reduction of mould growth/Dam rot and other postharvest diseases	Traditional kiln	59.06	27.5	5.94	5.62	1.88
	Double drum dryer	7.19	10	5.00	65.31	12.5
	Electric dryer	4.69	7.5	4.06	19.69	64.06
	Solar dryer	5.62	10	5.00	15	64.38
Maintaining good colour of cardamom capsule for a long period	Traditional kiln	59.38	29.68	5.94	3.12	1.88
	Double drum dryer	9.38	10.94	6.88	62.5	10.3
	Electric dryer	2.81	5.31	4.06	20.94	66.88
	Solar dryer	3.13	5.93	5.00	19.06	66.88
Maintaining good flavour of cardamom capsule for a long period	Traditional kiln	55.94	31.24	5.94	5.63	1.25
	Double drum dryer	7.19	9.69	5	71.24	6.88
	Electric dryer	4.38	7.5	4.06	22.81	61.25
	Solar dryer	5.31	9.69	5	24.69	55.31
Minimization of quantitative loss of cardamom capsule	Traditional kiln	58.13	30.63	5.94	3.74	1.56
	Double drum dryer	8.75	10.63	6.88	63.12	10.62
	Electric dryer	3.44	4.38	4.05	13.75	74.38
	Solar dryer	3.75	5.31	5	12.81	73.13
Minimization of qualitative loss of cardamom capsule	Traditional kiln	54.69	31.55	5.94	6.88	0.94
	Double drum dryer	8.13	8.75	5	67.81	10.31
	Electric dryer	4.06	7.81	4.06	17.19	66.88
	Solar dryer	6.25	9.06	5	18.44	61.25

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Table 3: Farmers' Perception of the Effectiveness of Storage Methods

Effectiveness of Storage Methods	Storage Methods	Percentage Response (%)		
		Ineffective	Undecided	Effective
Reduction of Storage Pests Infestation	BPL gunny bag	50.00	10.42	39.58
	Wooden box	24.14	3.45	72.41
	Jute sack	24.03	3.88	72.09
	Bamboo basket	77.65	2.35	20.00
Proper Air Circulation	BPL gunny bag	72.92	2.08	25.00
	Wooden box	31.03	3.45	65.52
	Jute sack	40.31	1.55	58.14
	Bamboo basket	18.83	5.88	75.29
Ease in Space Management	BPL gunny bag	14.58	2.08	83.34
	Wooden box	74.14	3.45	22.41
	Jute sack	20.16	3.1	76.74
	Bamboo basket	82.35	3.53	14.12
Ease in Transport	BPL gunny bag	20.83	8.34	70.83
	Wooden box	39.66	5.17	55.17
	Jute sack	30.23	5.43	64.34
	Bamboo basket	44.71	7.05	48.24
Reduction of rodents' and Insects' Attack	BPL gunny bag	39.58	8.33	52.08
	Wooden box	32.76	3.45	63.79
	Jute sack	39.53	3.88	56.59
	Bamboo basket	75.29	2.35	22.35
Retention of Smell	BPL gunny bag	52.08	4.17	43.75
	Wooden box	37.93	6.9	55.17
	Jute sack	28.68	3.88	67.44
	Bamboo basket	54.12	3.53	42.35
Retention of Flavour	BPL gunny bag	50	4.17	45.83
	Wooden box	37.93	5.17	56.90
	Jute sack	36.43	3.1	60.47
	Bamboo basket	52.94	5.88	41.18
Retention of Oil Content	BPL gunny bag	43.75	8.33	47.92
	Wooden box	34.48	5.17	60.34
	Jute sack	40.31	5.43	54.26
	Bamboo basket	45.88	7.06	47.06

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The majority of BPL gunny bag users (83.34%) rated it as effective in space management. Proportions of jute sack users having positive perceptions (76.74%) were almost equal to the proportions of wooden box users having negative responses (74.14%) in space management. The ratio of proportions of farmers using bamboo baskets having negative response (82.35%) to positive response (14.12%) in space management was nearly 6:1 as shown in table 3.

The difference in the percentage of BPL gunny bag users having positive perception to negative perception about it in ease of transport was found to be 50%. More than half of wooden box users (55.17%) reported it as effective in ease of transportation. Moreover, the proportion of jute sack users having positive perceptions (64.34%) to negative responses (30.23%) was more than double in ease of transportation. Proportions of bamboo basket users rating it as effective (48.24%) and as ineffective (44.71%) was almost equal in ease of transport as shown in table 3.

Table 3 revealed that the proportions of both BPL gunny bag users and airtight jute sack reporting both as ineffective in the reduction of rodent and insect attacks were almost equal. The ratio of proportions of wooden box users rating it as effective (63.79%) and as ineffective (32.76%) in reduction of rodents' and insects' attacks during storage was almost 2:1. More than three fourth bamboo basket users (75.29%) rated it as ineffective in reduction of rodents' and insects' attack during storage period.

In the case of jute sacks, most of the farmers rated it as effective in the retention of smell (67.44%) and flavour (60.47%) during the storage period. Proportions of bamboo basket users having positive perceptions (42.35%) were almost equal to the proportions of BPL gunny bag users (43.75%) with positive responses in retention of smell. Nearly equal proportions of wooden box users perceived it as effective in both retentions of smell and flavour. A similar result was also observed in the BPL gunny bags and the bamboo baskets as shown in table 3.

The effectiveness of bamboo baskets and BPL gunny bags as perceived by their users was almost equal in retention of oil content. Out of total wooden box users, 60.34%, 5.17% and 34.48% perceived it as effective, neutral and ineffective in retention of oil content during storage. Furthermore, more than half of airtight jute sack users (54.26%) rated it as effective in the retention of oil content during storage as shown in table 3.

Table 4: A Chi-Square Test on the Difference in Farmers' Perception of Storage Methods

Effectiveness of Storage Methods in	Percentage of Respondents (%)				X^2 Value	P Value
	BPL Gunny Bag	Wooden Box	Jute Sack	Bamboo Basket		
Reduction of Storage Pests' Infestation	39.58	72.41	72.09 (93)	20 (17)	41.23***	.000
	(19)	(42)				
Proper Air Circulation	25	65.52	58.14 (75)	75.29 (64)	25.14***	.000
	(12)	(38)				
Ease in Space Management	83. 34	22.41	76.74 (99)	14. 12 (12)	76.44***	.000
	(40)	(13)				
Ease in Transport	70.83	55.17	64.34 (83)	48.24 (41)	6.933	.076
	(34)	(32)				
Reduction of Rodents' and Insects' Attack	52.08	63.79	56.59 (73)	22.35 (19)	7.08*	.049
	(25)	(37)				
Retention of smell	43.75	55.17	67.44 (87)	42.35 (36)	7.19*	.045
	(21)	(32)				
Retention of Flavour	45.83	56.90	60.47 (78)	41.18 (35)	6.34	.095
	(22)	(33)				
Retention of Oil Content	47.92	60.34	54.26 (70)	47.92 (23)	6.14	.107
	(23)	(35)				

Note: Figures inside parenthesis indicate the number of respondents having positive perceptions
*, **, *** mean significant at 5%, 1% and 0.1% respectively.

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After obtaining the perceptions for each category of storage methods, a chi-square test was done to test whether there was a significant difference in farmers' perception of the effectiveness of storage methods or not. Results on the chi-square test in Table 4 revealed significant differences in perception concerning the reduction of storage pests' infestation, proper air circulation and ease in space management at a 0.1% level of significance. Likewise, there were significant differences in perception concerning the reduction of rodents' and insects' attacks and retention of smell a 5% level of significance. This shows that farmers perceived all four storage methods to have the same level of effectiveness in ease of transport, retention of flavour and retention of oil content during storage.

5. Ranking of Drying and Storage Methods According to Preference of Use

Farmers also ranked large cardamom capsule drying and storage methods used based on their preference of use. Most of the respondents preferred an electric dryer followed by a solar dryer and double drum dryer as shown in table 5. Farmers ranked the traditional kiln as the least preferred drying technique because of higher wastage loss percentage than other methods, poor quality of dried capsules and buyers' least preference for capsules dried from the traditional kiln.

Likewise, farmers preferred jute sacks to store dried capsules followed by wooden boxes, black polythene-lined gunny bags and bamboo baskets the least as shown in Table 5. This implies that, in terms of convenience of use, most farmers found airtight jute sacks more appealing especially considering the initial investment costs, handling and maintenance, and maintenance of quality during the storage period.

Table 5: Preference of Use among Drying and Storage Methods of Cardamom Capsule.

Drying Methods	Index Value	Rank	Storage Methods	Index Value	Rank
Traditional Bhatti	0.216	IV	Jute sack	0.814	I
Double Drum Dryer	0.539	III	Black polythene-lined gunny bag	0.572	III
Electric Dryer	0.854	I	Wooden box	0.774	II
Solar Dryer	0.731	II	Bamboo basket	0.482	IV

6. Major Constraints of Drying and Storage of Cardamom Capsule

Table 6 compares the rank of the major constraints of farmers regarding the drying and storage of cardamom capsules in the study area.

Table 6: Ranking of Constraints of Drying and Storage of Cardamom Capsule

Problems	Index Value	Rank
Insufficient Fund	0.7239	II
Poor Technical Knowledge	0.8177	I
Poor Access to Credit Facility	0.5849	IV
Insufficient Space	0.4661	VI
Irregular Energy Supply (Electricity/Firewood)	0.6512	III
Insufficient Organizational (GOs/NGOs) Support	0.5145	V

The topmost constraint among the six analyzed was farmers' poor technical knowledge about drying and storage followed by insufficient funds, and irregular energy supply (electricity/firewood). The study estimated insufficient space to set up the drying and storage structure as the lowest rank. Murodullayevich [9] reported high initial investment, improper design and management, insufficient credit access and insufficient incentives as the major constraints on the feasibility of farm grain drying and storage facilities.

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Conclusion and Policy Implications

The study concluded that among all drying and storage methods, farmers perceived that the electric dryer was the most effective for drying freshly harvested large cardamom capsules and the jute sack was the most effective storage method to store the dried capsules. The topmost barrier to the drying and storage of cardamom is the farmers' poor technical knowledge related to the drying and storage of cardamom, followed by insufficient funds and irregular energy supply (electricity/firewood). To enhance the technical knowledge of farmers about cardamom drying and storage, it is necessary to run training and other awareness programs in the study area. The farmers should be provided with sufficient skill and support with a regular supply of electricity.

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