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ADOPTION OF IMPROVED TECHNOLOGY FOR SUSTAINABLE FARMING OF LARGE CARDAMOM (*Amomum subulatum* Roxb.) IN NAGALAND

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ABSTRACT

A sustainable farming system contributes towards overall welfare by providing sufficient food and goods in economically efficient and profitable ways, while also being socially responsible and improving environmental quality. Enhanced farm productivity requires the use of new technologies and farming methods. A study was done in Longleng and Mon districts of Nagaland using an ex-post facto research design to determine the status of adoption of improved technologies for sustainable large cardamom farming. The study included ten villages from five rural development blocks. For this study, 250 farmers were interviewed using a proportionate random sampling procedure. The results showed that the majority of the farmers adopted improved farming practices for large cardamom at a medium (56.80%) level, followed by high (24.80%) and low (18.40%) levels. The variables training exposure, extension contact, productivity, age, information source utilization, scientific orientation, marketing orientation, profitability, and knowledge were found to be positively correlated with adoption.

Keywords: Large cardamom cultivation, sustainable practices, adoption, Nagaland

INTRODUCTION

Sustainable agriculture seeks to integrate three major aspects viz., a healthy environment, economic profitability, and social and economic equity. Sustainable agriculture is more than a collection of practices. It is also process of negotiation - a push and pull between the sometimes competing interests of an individual farmer or of people in a community as they work to solve complex problems for growing food and fibre. When agricultural operations are sustainably managed, they can preserve and restore critical habitats, help protect watersheds, and improve soil health and water quality. The concept of acceptable technologies might vary depending on the setting, such as farm level, agri-food sector, or domestic economy. The agriculture sector has significantly increased farm revenue and productivity through the use of new technologies, as

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shown by the success of the green revolution. In low- and middle-income nations, where a large number of farmers depend on farming, increasing agricultural productivity is crucial to achieving food security and improving household income (Nguyen & Hung, 2022).

Adoption of new technology on farms is influenced by science, economics, and behavioral factors. Technology creation is often based on physical sciences or biology, with economic incentives driving adoption. Although less apparent, the psycho-social and behavioral aspects of technology adoption have a significant impact on change. Certain agricultural technologies or practices address the issues of farmers in particular ways. Any technology or method that farmers employ offers a specific approach to resolving one or more issues. The decision to choose between a technology or practice's benefits and drawbacks, as well as the limitations, resources, and personal preferences of each farmer, all play a significant role in whether one is chosen over another. Any new technology that is offered to farmers will either supplement or enhance the technological alternatives that they already have. Determining these possibilities and comprehending farmers' perspectives are essential.

Large cardamom, known as 'badi elaichi' in Hindi, is commonly referred to as the "Queen of Spices" due to its wonderful perfume and flavor. Large cardamom (*Amomum subulatum* Roxb.) is a perennial cash crop which belongs to the family Zingibereaceae and grown under tree shade that is agro-climatically suitable, economically valuable, and ecologically adaptable. Large cardamom is one of the earliest spices and the third most expensive spice after saffron and vanilla (Lepcha *et al*. 2023). It is a perennial cash crop with a modest volume but great value that thrives beneath forest cover. Its production is a remarkable example of the ecological and economic viability of a traditional farming system based on indigenous agro-forestry practices (Rai *et al*. 2023).

India is one of the largest producers of large cardamom with about 54 per cent share in world production. The total area and production of large cardamom in India during the year 2022-23 was recorded to be 45396 ha and 9074 tons respectively (Spices Board 2023). The North Eastern Hill Region contributes about 87.66% of the total production of large cardamom in the country. Within NE region, the state of Sikkim is leading in both area (54.42%) and production (58.02%) of large cardamom, followed by Arunachal Pradesh (23.12%), Nagaland (6.31%) and West Bengal (3.31%). Spices play an important part in transforming Naga farming practices from subsistence to revenue generation. Farmers in Nagaland now earn additional revenue from large cardamom plantations. Due to rising demand, huge cardamom gives growers a unique advantage over the other spices grown in the state. Large-scale cardamom planting has a big economic influence on the region because of the potential earnings. During 2022-2023, the total area and production of large cardamom in the state were 3879.52 ha and 2159 MT, respectively (Nagaland Statistical Handbook 2023). Farmers have begun to take an interest in large-scale cardamom farming, and the area under cultivation has risen in recent years as they recognize the crop's economic potential.

(Mohamed *et. al*, 2021) stated that providing farmers with the information and resources they need to implement the innovations, teaching them how to use them correctly, encouraging experimentation by showcasing the advantages, and assisting farmers in evaluating the results of their application of the innovations can help determine whether or not to adopt them. The possibility that new technologies or improved cultivation practices will be adopted or modified to meet the needs of farmers is increased when their appropriateness is evaluated. Despite this,

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smallholders continue to produce low amounts of agricultural products, which can be attributed to a number of factors, including the poor and low adoption of modern production techniques. In context with this, a study was conducted in Longleng and Mon districts to study farmers' perceptions about the adoption of improved technology for sustainable farming of large cardamom growers. The study's findings will assist extension professionals in developing effective methods for promoting adoption of improved techniques for diverse potential farmers.

MATERIALS AND METHODS

The study was conducted in two districts of Nagaland *viz.*, Longleng and Mon districts of Nagaland by following ex-post facto research design. Five Rural Development (RD) Blocks from the two districts with significant cardamom production were purposefully chosen for this study. Ten villages namely – Bhumnyu, Phomching, Pongo, Yongpang, Longwa, Tangnyu, Langmeang, Chaoha Chingyu, Mohung and Sowa were chosen randomly from these RD blocks. Furthermore, 250 respondents were selected from these villages using a proportionate random sampling procedure. Variables such as age, education, size of land holding under large cardamom cultivation, annual income from large cardamom, training exposure, farming experience, information sources utilization, scientific orientation, marketing orientation, extension contact, productivity, profitability and knowledge were selected as independent variables and adoption of improved practices of large cardamom was dependent variable for the present study. Personal interviews were undertaken to acquire primary data using a pre-tested interview plan. Using SPSS software, data was examined in terms of mean, standard deviation, correlation coefficient, and other parameters. The following formula was used to measure the adoption index of different aspects of improved technology for sustainable farming of large cardamom growers.

$$Adoption\ index\ (AI) = \frac{Total\ score\ obtained\ by\ the\ respondents}{Maximum\ obtainable\ score}\ x\ 100$$

RESULTS AND DISCUSSION

Large cardamom growers' adoption level refers to their use of pre- and post-harvest management methods to improve their economic and living standards. It may be optimized to a certain innovation, individual, or environment. Adoption of improved cultivation practices or innovations varies by area and farmer. The farmers were able to increase both their output and economic standing by effectively implementing suggested pre- and post-harvesting methods. Only until the large cardamom growers implemented effective management techniques at their farm level would this be feasible.

Table 1. Distribution of respondents based on their adoption level of improved technology for sustainable farming of large cardamom

Sl. No	Recommended Practices	Total (N = 250)		
		Level of Adoption		
		Full Adoption F (%)	Partial Adoption F (%)	No Adoption F (%)
1.	**Suitable varieties:**			

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	a. Ramsey	**250 (100)**	0 (0)	0 (0)
	b. Golsey	0 (0)	0 (0)	**250 (100)**
	c. Sawney	0 (0)	0 (0)	**250 (100)**
2.	**Pit preparation:**			
	a. Pit size of 1x1x1 ft.	**130 (52.00)**	23 (9.20)	97 (38.80)
	b. Pit distance of 1.5x1.5 m	29 (11.60)	**184 (73.60)**	37 (14.80)
3.	**Pit manuring:** Add 25 kg neem cake, 2-4 kgs FYM or 10 gm compost inoculated with *Trichoderma*	0 (0)	0 (0)	**250 (100)**
4.	**Time of planting:** May to early July	**250 (100)**	0 (0)	0 (0)
5.	**Intercultural operations:**			
	Mulching			
	a. The base of the plant or the collar region of the clumps should be mulched with dried leaves during November to April	**171 (68.40)**	79 (31.60)	0 (0)
	b. It is done to conserve soil moisture and check the weed growth	105 (42.00)	**145 (58.00)**	0 (0)
	Weed Management			
	a. It is done twice a year, during May to June and before harvesting	90 (36.00)	**160 (64.00)**	0 (0)
	b. Weeding is practiced throughout the year depending upon the population of the weeds	79 (31.60)	**102 (40.80)**	69 (27.60)
	c. Uprooted weeds can be used as organic compost and mulch	**167 (66.80)**	83 (33.20)	0 (0)
	Irrigation			
	a. The optimum time of irrigation is from Dec to April	0 (0)	0 (0)	**250 (100)**
	b. The field is irrigated at an interval of 10 days during the dry period	0(0)	(0)	**250 (100)**
6.	**Shade regulation:** Tall-growing trees are pruned regularly at a height of 4-5 m	1 (0.40)	106 (42.40)	**143 (57.20)**
7.	**Nutrient Management:** NPK @20:30:40 kg along with 10-15 tonnes of FYM or compost per hectare, every once a year	0 (0)	0 (0)	**250 (100)**
8.	**Roguing and gap filling:** Removal of affected plant and replace them by healthy ones. The ideal time for gap filling is May-June	31 (12.40)	**219 (87.60)**	0 (0)
9.	**Integrated Disease Management (IDM)**			
	i. Leaf spot:			
	a. Maintain good drainage	1 (0.40)	50 (20.00)	**199 (79.60)**
	b. Apply *Trichoderma*	0 (0)	1 (0.40)	**249 (99.60)**
	c. Spray Bordeaux mixture (1.0 %)	0 (0)	49 (19.60)	**201 (80.40)**

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	ii. Foorkey:			
	a. Diseased free certified rhizomes	1 (0.40)	**170 (68.00)**	79 (31.60)
	b. Dimecron/ Rogor (0.1%)	0 (0)	47 (18.80)	**203 (81.20)**
	c. Collateral host plant is destroyed	1 (0.40)	**139 (55.60)**	**110 (44.00)**
	d. Infected land is kept fallow for a year	0 (0)	93 (37.20)	**157 (37.20)**
	iii. Clump rot:			
	a. Mulching during summer	0 (0)	0 (0)	**250 (100)**
	b. Suckers dipped in *Trichoderma* or neem extract	0 (0)	0 (0)	**250 (100)**
	c. Spray fungicide at fortnightly interval	0 (0)	0 (0)	**250 (100)**
10.	**Integrated Pest Management (IPM)**			
	i. Stem borer:			
	a. Remove the plant with caterpillars	0 (0)	56 (22.40)	**194 (77.60)**
	b. Destroy dried shoots	0 (0)	**157 (62.80)**	93 (37.20)
	ii. Cardamom weevil:			
	a. Destroy plants along with weevil	0 (0)	49 (19.60)	**201 (80.40)**
	b. Base of clumps drench in malathion	0 (0)	0 (0)	**250 (100)**
11.	**Harvesting:**			
	a. Appropriate time: 5 years (seeds) 3 years (suckers)	**250 (100)**	0 (0)	0 (0)
	b. Physiological stage of maturity: When seeds of topmost capsules turn brown	**250 (100)**	0 (0)	0 (0)
	c. Time of harvest: August to September	**250 (100)**	0 (0)	0 (0)
12.	**Curing:**			
	a. Curing is done immediately after harvesting, to retain only about 10-13 % moisture on dry-weight basis	**211 (84.40)**	39 (15.60)	0 (0)
	b. Heating temperature for curing should be 50-55ºC	90 (36.00)	**153 (61.20)**	7 (2.80)
13.	**Packing:**			
	a. Coal tar coated and polythene lined gunny bags are effective during storage	**247 (98.80)**	3 (1.20)	0 (0)
	b. The cured produce needs to be packed in insect proof bags and in air tight containers	**247 (98.80)**	3 (1.20)	0 (0)

The Table 1 revealed the distribution of large cardamom growers as per their practice-wise knowledge level of large cardamom growers about improved large cardamom cultivation practices.

3.1. Adoption of varieties:

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Adoption of recommended varieties of large cardamom showed that 100 per cent of the respondents fully adopted that variety Ramsey and 100 per cent of the growers did not adopt the varieties Sawney and Golsey as per the recommendation.

3.2. Adoption of pit preparation:

Adoption of pit preparation of pit size (1x1x1 ft.) showed that higher number of respondents 52.00 per cent fully adopted, followed by 38.80 per cent of no adoption and 9.20 per cent partial adopted. Adoption of maintaining pit distance (1.5x1.5 m), only 11.60 per cent fully adopted the recommendation, with majority of 73.60 per cent partially adopted and 14.80 per cent of no adoption respectively.

3.3. Adoption of pit manuring:

Adoption of pit manuring (25 kg neem cake, 2-4 kgs FYM inoculated with *Trichoderma*) showed that 100 per cent of respondents did not adopt the improved recommendation.

3.4. Adoption of time of planting:

Adoption of proper time of planting (May to early June) showed that 100 per cent of the respondents fully adopted time of planting as per recommendation. Respondents believed that uniform planting procedures could slightly improve crop quality, yields, and income.

3.5. Adoption of intercultural operations (mulching, weed management and irrigation):

Adoption of intercultural operation, mulching showed that higher percentage of respondents 68.40 per cent fully adopted followed by 31.60 per cent partial adopted. Weed management showed that 64.00 per cent partial adopted and 36.00 per cent full adopted weeding before harvesting.Respondents prioritize weeding as they believe it can negatively impact crop growth. Weeding is done by the family at no expense, which is another advantage. Intercultural operation, irrigation showed that 100 per cent of the respondents did not adopt the practice as per recommendation.

3.6. Adoption of shade regulation:

Adoption of shade regulation of pruning tall growing trees regularly at the height of 4 to 5 m. showed that 57.20 per cent did not practice it followed by 42.40 per cent of them partially adopted and 0.40 per cent of them fully adopted the practice.

3.7. Adoption of nutrient management:

Adoption of nutrient management (NPK @20:30:40) along with 10 to 15 tonnes of FYM or compost per hectare, every once a year, showed that 100 per cent of the respondents did not adopt nutrient application on large cardamom farm.

3.8. Adoption of roguing and gap filling:

Adoption of roguing and gap filling (May to June) showed that 87.60 per cent of the respondents partially adopted and 12.40 per cent of them had full adoption of removing the affected plants and replacing them with healthy plants.

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3.9. Adoption of integrated disease management:

i. Leaf spot: Adoption of management of leaf spot showed that majority of the respondents had no adoption of maintaining good drainage (79.60 %), applying *Trichoderma* (99.60 %) and spraying of Bordeaux mixture (80.40 %). Further respondents partially adopted the practice of maintaining good drainage (20.00 %), applying *Trichoderma* (0.40 %) and spraying of Bordeaux mixture (19.60 %). Only 0.40 per cent of the respondent fully adopted the practice of maintaining good drainage.

ii. Foorkey: In adoption of management practices of foorkey, it was found that only 0.40 per cent fully adopted the practice of disease free certified rhizomes and destroying of collateral host plant. Majority (68.00 %) of the respondents partially adopted the practice of disease free certified rhizomes, followed by destroying collateral host plant (55.60 %), keeping infected land fallow for a year (37.20 %) and applying dimecron/ rogor (18.80). Majority (81.20 %) did not apply dimecron/ rogor, followed by keeping infected land fallow for a year (37.20 %), using disease free certified rhizomes (31.60 %) and destroying collateral host plant (44.00 %).

iii. Clump rot: In adoption of management practices of clump rot, it was found that majority (100 %) of the respondents had no adoption of mulching during summer, suckers dipped in *Trichoderma* or neem extract and spraying fungicide at fortnightly interval.

3.10. Adoption of integrated pest management:

i. Stem borer: Adoption of integrated pest management of stem borer showed that in 22.40 per cent of respondents followed removal of plants infested with caterpillars and majority (62.80 %) partially adopted destroying of dry shoots of large cardamom plant. With regard to no adoption, majority (77.60 %) did not adopt removal of plants infested with caterpillars and 37.30 per cent did not adopt destroying of dry shoots.

ii. Cardamom weevil: With regards to adoption of management practices of cardamom weevil, it was found that only 19.60 per cent of the respondent partially adopted destroying of plants along with weevil. Majority (80.40 %) did not adopt destroying of plants along with weevil and 100 per cent of the respondents did not adopt the practice of drenching the base of clumps in malathion.

The large cardamom growers did not use recommended pest and disease control chemicals due to a lack of experience in recognizing pests, high labor costs, high input costs, and a shortage of skilled workers.

3.11. Adoption of harvesting:

Adoption of proper method of harvesting showed that 100 per cent of the respondents fully adopted the recommended time of harvest, August to September, when the seeds of topmost capsules turn brown.

3.12. Adoption of curing:

With respect to curing immediately after harvest it was revealed that 84.40 of the respondents fully adopted and 15.60 partially adopted this recommendation. Curing temperature

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of 50-55ºC showed that 61.20 partially adopted, 36.00 per cent full adopted and 2.80 per cent not adopted respectively.

3.13. Adoption of packaging:

Adoption of method of packaging with coal tar coated or polythene line gunny bags, and insect proof bags and air tight containers showed that 98.80 fully adopted this recommendation followed by 1.20 per cent who had partial adoption.

Table 2: Distribution of respondents based on Adoption Index

N = 250

Sl. No	Adoption Index	Longleng district		Mon district		Total	
		F	%	F	%	F	%
1.	Low (Less than 36)	26	26.00	20	13.33	46	18.40
2.	Medium (36 to 42)	**49**	**49.00**	**93**	**62.00**	**142**	**56.80**
3.	High (More than 42)	25	25.00	37	24.67	62	24.80
	Total	100	100	150	100	250	100
	Mean	38.66		39.39		39.09	
	S.D	3.60		3.11		3.33	

Z = -1.6894*

*Significant at 5 % level of probability

In case of the overall adoption level of sustainable agricultural practices as presented in Table 2, it was revealed that 49.00 per cent of the large cardamom growers of Longleng district had medium level of adoption followed by low (26.00 %) and high (25.00 %) level adoption of improved cultivation practices of large cardamom.

Among large cardamom growers in Mon district, more than half (62.00 %) of the respondents had medium level of adoption followed by high (24.67 %) and low (13.33 %) level adoption of improved cultivation practices of large cardamom respectively. At the 0.05 level of probability, there was a negative correlation (Z= -1.6894*) implying that there is a significant difference in the adoption level of Longleng and Mon district respondents.

In overall category, large cardamom growers had medium (56.80 %) level adoption followed by high (24.80 %) and low (18.40 %) level of adoption of improved cultivation practices of large cardamom improved respectively. This finding is in conformity with the findings reported by Reddy *et. al* (2018), Chigadolli *et. al* (2019) and Odyuo *et. al* (2023). Knowledge limits an individual's action; thus, the most likely reason for the majority of respondents to fall into the medium adoption category is that they have medium to high knowledge, and because this is a new venture that is stabilizing, it will take some time to improve and adopt.

Table 3. Correlation of independent variables with adoption level

Sl. No	Independent Variables	Coefficient of correlation (r)	P value
1	Age	-0.185**	0.003
2	Education	0.022^{NS}	0.732

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3	Size of land holding under Large Cardamom	-0.069^{NS}	0.275
4	Annual income from Large Cardamom	0.105^{NS}	0.097
5	Training Exposure	0.146*	0.021
6	Farming Experience	0.063^{NS}	0.323
7	Information Source utilization	0.243**	0
8	Scientific Orientation	0.200**	0.002
9	Marketing orientation	0.225**	0
10	Extension Contact	0.124*	0.05
11	Productivity	0.155*	0.014
12	Profitability	0.194**	0.002
13	Knowledge	0.220**	0

**Correlation is Significant at 0.01 level (2 tailed)
* Correlation is Significant at 0.05 level (2 tailed)
^{NS} Correlation is Non Significant

The research findings in Table 3 clearly indicate that the most of the selected independent variables had significant correlations with the adoption of recommended large cardamom production technology. The variables education, size of land holding under large cardamom cultivation, annual income from large cardamom, and farming experience had no significant association with the adoption of recommended large cardamom production technology. These findings were similar to the findings of Barry (2016), Jha and Das (2019), John *et. al* (2023). Training exposure, extension contact, and productivity were found to be positively and significantly associated to adoption at the 0.05 percent level of significance. The finding is supported by Barry (2016), Khating*et. al* (2018). Information source use, scientific orientation, marketing orientation, profitability, and knowledge were found to be positively and highly significantly linked with adoption at the 0.01 percent level of significance, whereas Age, had negative and highly significant correlation. According to the preceding results, with increase of respondents' information source utilization, scientific orientation, marketing orientation, profitability, and knowledge thrive, and with selection of young farmers, adoption of the recommended practices is enhanced. The finding is supported by Midame (2020), Chavhan*et. al* (2021).

CONCLUSIONS

Promoting cultivation of large cardamom (*Amomum subulatum* Roxb.) in Nagaland is crucial for increasing agricultural production, given its economic importance as a cash crop. Large cardamom farming is an important source of income in the Mon and Longleng districts, although farmers are not receiving as much profit as they once did. It improves farmers' socio-economic condition, increasing their income and contributing to the state economy. Cultivation of large cardamom cultivation increased farmers' income and made them economically stronger. Farmers were motivated to cultivate cash crops due to the significant benefits achieved. Inadequate awareness of disease pests and market pricing information have led to reduced output of large cardamom, resulting in lower prices for farmers. Effective dissemination of information encourages farmers to embrace sustainable farming technologies. As a result, it is critical to promote the diffusion of improved farming system technology to farm households through

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farmer-participatory approaches, as well as to expand existing resource planning and research and extension capabilities. The study recommends that large cardamom farmers should follow conservation of natural resources and adoption of sustainable farming practices in order to increase productivity and profitability. Concerned extension agencies should make an effort to motivate farmers for widespread and up scaling of sustainable farming technology through intensive trainings, capacity building programs and various interventions to make large cardamom farming a profitable and sustainable venture. The current findings can provide a valuable insights to farmers and governments in making informed decisions on large-scale cardamom production and resource management.

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