



Food and Agriculture  
Organization of the  
United Nations

## **Report on**



## **Large Cardamom in Bhutan**

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Food and Agriculture Organization of the United Nations  
Thimphu, 2020

Required citation:

FAO, 2020. *Report on Large Cardamom in Bhutan*. Thimphu.

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## **Acknowledgments**

I would like to acknowledge the Food and Agriculture Organization of the United Nations, Bhutan for providing me an opportunity to fight against hunger by suggesting special interventions to improve large cardamom industry in Bhutan. I got moral support from Mr. Chadho Tenzin, Ms. Wangchuk Lhamo and the driver, Phurba, in my quest of knowledge on cardamom in Bhutan. I am equally grateful to all of them. I got opportunities to interact with officials of the Royal Government of Bhutan, farmers, and other interested people whose knowledge became assets in preparing this report. It is imperative to mention their contribution to this project. I am thankful for the precious guidance of Mr. Jimba Rabgyal, Mr. Rabi Rasaily, and authors of various articles related to large cardamom. I acknowledge all of them in my endeavors of research in large cardamom. In addition to this, I am grateful to the Spice Board of India; National Spice Crop Development Program, Lalitpur; Cardamom Development Center, Illam; National Agriculture Research Center, Pakhribas; and International Center for Integrated Mountain Development because I got an ample amount of knowledge, information, and found new doorways towards the completion of my study report because of them. Lastly, I would like to acknowledge all the unknown divine factors that may have contributed to the success of this effort.



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# **An Overview Of Large Cardamom In Bhutan**

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## **Summary**

Bhutan's large cardamom (hereafter referred to as "cardamom") industry emerged big mostly because of lucrative pricing, which encouraged farmers to grow cardamom in large scale irrespective of shade and overall management requirements needed for healthy production and processing of this spice. This has substantially reduced productive life, increased large number of problems related to diseases, insects and other factors. It is the right time to revive this industry with special interventions in deep collaboration with all stakeholders related to its value chain. In current practices, the shade management is not considered, altitude wise varieties are not cultivated and farmers are not introduced to proven technologies. Thus, using the appropriate scientific methods like nursery establishment and seedling preparations, soil management along with the introduction of disease resistant and high-yielding varieties, adopting the advanced technologies can promote cardamom industry and support the livelihood of the farmers involved in the cardamom cultivation in Bhutan.

## **1. Background**

Cardamom is an important spice crop of India, Nepal and Bhutan. The recorded area, production and productivity of the cardamom in Bhutan were 13,880 acres, 2245 tons and 162kg/acre respectively (Bhutan's statistical report of 2017). According to Dorji (2010), the agro-forestry comprises for 6% of the cardamom plantation, while dry land and shift agriculture accounts for 49% and 44% respectively. Socioeconomic factors are likely the major reason for this shift to cardamom cultivation. About 17,000 farmers in Bhutan are engaged in large cardamom farming earning US \$ 500 – 1,200 per farmer per year (Rabgyal, Jimba et al 2018).

The price of large cardamom in 2016 at Siliguri market was US \$15.60 per kilogram (Spice board of India). Major markets of large cardamom are Saudi Arabia, India, Pakistan, European countries and Australia. Review of the market unveils that price of cardamom in Mumbai market is marginally higher, but they are offered after packaging and branding in convenient packs according to the need of consumers.

The cardamom can be grown successfully from 600 to 2100 masl (Sharma al., 2000). It is being grown in natural forest areas in steep slopes. Cardamom is mostly used in making biryani, curry powder and as mouth freshener after meals. It is also used in making herbal medicines. To modernize cardamom industry in Bhutan, various interventions were seen like seed originated seedling production, repository of selected varieties, variety introduction like Seremna, and other research and development infrastructure promotion are a few of them. Cardamom is suited in hills that receive well-distributed rainfall for around 250 days with a total of about 3,000 to 4,000 mm per year. It is growing in lower altitudes (Below 1500, masl), receiving around 1,700-2,500 mm rainfall per annum, and preferably on north facing slopes. In the higher altitudes (Above 1500 m to 2100m), farmers grow the crop in high rainfall conditions (2,500-4,000 mm per annum). The crop exhibits slow growth during dry seasons and can withstand up to 1°C of temperature. The plant is highly susceptible to frostbite. According to cardamom growers, low intensity snowfall does not necessarily hamper the production potential but prolonged exposure to sunlight will dry out the leaves. Sikkim based research recommends that two irrigations per week in dry period for 3 to 4 hours are essential for cardamom. The agro-ecological conditions of Bhutan strongly advocate that cardamom is a highly suitable spice crop. The rainfall pattern, altitude range, farmer's participation are encouraging for further increase in cardamom production.

In Bhutan, cardamom cultivation is mostly done in the southern belt of the country including districts of Chukha, Dagana, Haa, Samtse, Sarpang and Tsirang. The cultivation area and production trends indicate that the

cardamom industry in Bhutan is growing (see table 1). There is an increase in the production of large cardamom in Bhutan because of increase in area but productivity is decreasing.

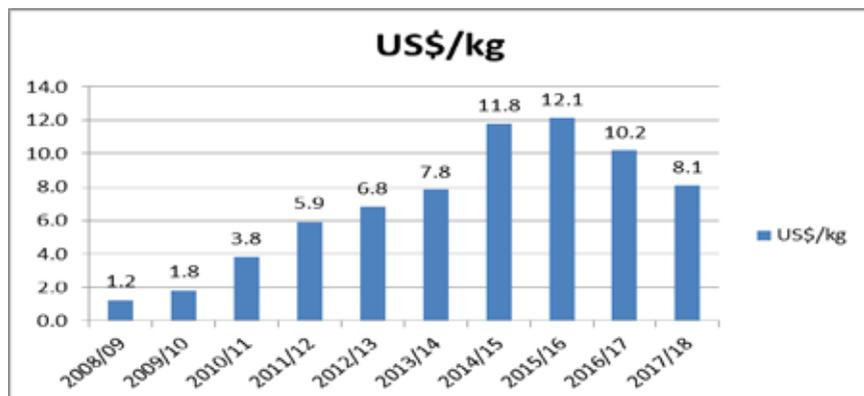


Figure 1: Price per kilogram of large cardamom (Source: Trade and Export Promotion Center, Lalitpur)

The Figure 1 shows increasing price trend. This has caused an increase in area under cardamom cultivation. Bhutan and Nepal share the Siliguri trading market and have similar price.

The above graph and the table below reveal Bhutan’s growing cardamom production trends where there is significant increase in area. However, there is decrease in productivity. Therefore, serious interventions are needed to increase productivity.

Table 1: Bhutan’s cardamom production scenario

Year	Total Area Acre	Production ton	Yield kg/acre
2017	13880	2245	162
2016	11086	2736	247
2015	10610	2091	197
2014	8683	1781	203
2013	6904	1162	168

## **2. Objective of study**

### **2.1. General Objective**

To study the current scenario of cardamom pests and diseases in Bhutan and to provide relevant short term, medium term and long term recommendations for interventions.

### **2.2. Specific Objectives**

- a) To find existing problems in large cardamom cultivation and recommend the solutions.
- b) To observe the cultivation practices by the farmers and recommend appropriate technologies.
- c) To conduct training to the trainers (ToT) regarding the scientific cultivation practices of large cardamom.
- d) To recommend high quality, fuel efficient and effective drying techniques including postharvest handling.

## **3. Limitations of the study**

- a) Limited time for the field visit and interactions with the stakeholders.
- b) Lack of laboratory test reports on soil diseases and pests of Cardamom.

## **4. Methodology**

The report is based on field visits in cardamom growing districts, interaction with cardamom farmers and extension officials. The primary data was collected through Focus Group Discussions (FGD), capturing about 10 to 15 households in the Gewogs of major cardamom growing districts in Bhutan with the help of Agriculture Extension Supervisors based in the Gewogs. The secondary information was desk reviewed from various sources both published and non-published.

The field visits to pest and disease affected cardamom plantation in the cardamom growing districts were made to understand the real field situation and to record issues and causes. The findings and the recommendations

provided in this report are mostly generated through problems observed during the field visits and interaction with the farmers. Details of visits are presented in the annex 1.

## **5. Major Findings and discussions**

### **5.1. Government nurseries**

During the field visit, it was observed that most of the cardamom orchards are infected with diseases; therefore, new plantations are required after removing the existing orchards. It requires large number of disease free high quality saplings corresponding to favorable altitudes. Regional Seed Centre, a government seed agency located near the Agriculture Research and Development Center (ARDC), Samtenling was procuring seed of Bharlange variety from the registered seed growers in Bhutan for the production of seedling at the Centre.

#### **Government Nursery at Regional Seed Centre, Samtenling:**

- a) Nursery had good infrastructure and was well managed.
- b) Seedlings were raised from seeds
- c) Few off-types (Different to Bharlange but unknown) seedlings were seen in the nursery.
- d) Incidence of Chirkey disease was seen in few seedlings.
- e) Germination of the seedlings was recorded to be after 45 days of sowing.
- f) Acid application was not practiced for removing mucilage.
- g) Jute bags were used to rub the seed for removing mucilage.

#### ***Advantages:***

- a) Authentic production of saplings
- b) Low in price
- c) Source of skilled manpower development
- d) High use of technology for the quality production

## **5.2. Private Nurseries**

- a) Private nurseries were getting capsules from Sikkim private sectors at market price. They were extracting seed by themselves.
- b) Nursery management practices were good.
- c) Bharlange was the variety raised.
- d) Germinations were after 30 days because of use of black plastic cover and higher temperature.
- e) Black plastic was used to cover the seedbeds.
- f) Use of combinations of irrigations and black plastic for fast germination.

### ***Advantages:***

- a) Creation of employment opportunities
- b) Entrepreneurship development and tax source for the nation
- c) Multiplier effect on other sectors of development
- d) Competition will develop high quality sapling at lower price
- e) Demand based production

## **5.3. Status of large cardamom bush management in Bhutan**

### **5.3.1. Disease**

Field visits at various cardamom growing areas unveil that there were many diseases invading cardamom bushes among which some are known and some are still unknown to the farmers as well as the government officials. Its implication is that there is substantial reduction in the yield and life span of the bushes. The suspected new diseases can be verified in the laboratory by the test results.

The normal yield of large cardamom in healthy plantation area is presented in the table below.

*Table 2: Normal average yield of healthy plantation*

<b>Sl. No.</b>	<b>Particulars</b>	<b>Average yield (kg/acre)</b>
1	1st picking	40.46
2	2 <sup>nd</sup> picking	80.96
3	3 <sup>rd</sup> picking	121.4
4	4 <sup>th</sup> to 16 <sup>th</sup> picking	182
5	17 <sup>th</sup> picking	162
6	18 <sup>th</sup> picking	212.4
7	19 <sup>th</sup> picking	80.96

(Source: National Spice Crop Development Program, Lalitpur. 2018)

This undesirable yield behavior is an outcome of inappropriate practices like variety selection, soil nutrient management, disease management, irrigation management and shade management. The problem identifications followed with solutions by the research laboratories and supply of disease free planting materials after breaking disease cycle can improve this yield behavior. The disease cycle can be disturbed by crop rotation and other integrated pest management techniques.

Cardamom orchard integration with cattle farming can help to remove the prevalence of diseases and pests. The Farm Yard Manure (FYM) provides micronutrient and Organic matter to the soil due to which there is the increase of microbial activity. These activities help to increase the nutrient content in the soil due to which plant will be able to uptake more nutrients and enhance sufficient production. The weak plants are more susceptible to diseases than the healthy plants. Furthermore, the bio-pesticide prepared from the cattle urine and dung helps to restrict most of the pests which are the vectors of diseases as well below the economic threshold level. Jibatu and many other fast decomposing bio-agents are available in the market for fast decomposition of the manures.

### **Problem 1: Leaf Burning**

This problem is severe in all cardamom-growing areas of Bhutan. It is mostly serious in the areas of large cardamom cultivation without any shade. This seems to be sunburn but can only be confirmed after laboratory analysis.



*Figure 2: Leaf burning*

### **Problem 2: Stem hardening disease**

Another problem in cardamom bush is that the pseudo-stem at base thickens and becomes stiff with scars in leaves. Itching in skin takes place whoever passes through the infected plant. The capsule size will increase but seed remain whitish and light. There will be no yield in the next year onward. This disease persists even after the burning of the infected bushes. There were a significant number of thrips observed in the infected bushes. Apart from well-known diseases, new diseases are also in existence which needs further investigation. It could be rhizome rot but to confirm, its samples should be tested in a well-equipped laboratory. This problem is acute in Gedu areas of Bhutan.

### **Problem 3: Chirkey Disease**

Chirkey disease (Figure 3) of cardamom in Bhutan. It is mostly present in lower hills where cardamoms are mostly grown without shade. Bharlange is the extensively liked and used variety though it is less tolerant to Chirkey disease (NCARP, 2018). Lack of irrigation and shade are shortening productive life to mostly 3 to 4 years. Altitude wise variety selection is not practiced in most of the orchards which is one of the reasons for the prevalence of the disease.



*Figure 3: Chirkey disease*

#### **Problem 4: Leaf infection and its translocation to rhizomes**

There will be an infection in the leaves first then the sheath of the pseudo-stem will detach and this disease enters inside rhizome and whole bush will die. Laboratory tests are required for the identification of the disease.



*Figure 4: First symptom of disease on leaf*



*Figure 5: Diseased pseudostem*



*Figure 6: The whole rhizome*



*Figure 7: Leaves infected and pseudo-stem split in between dies*

#### **Problem 5: Blight Disease (Dry leaves disease)**

This problem was acute in the Tsirang area of Bhutan (Figures 8 & 9)

The findings from the field visits conclude that cardamom cultivation management is not satisfactory and requires lot of efforts for improvement in shade management, irrigation, disease, pest management, appropriate

variety selection, bush management and post-harvest operations, grading, branding, packaging and merchandising. There are several pathological laboratories in Siliguri, Jorhat and Sikkim for replicated analysis of diseases with a check of national indigenous laboratory and design strategy to combat these problems. Other reliable laboratories around Bhutan and other countries can be utilized if necessary.



*Figure 9: Fungal disease of cardamom in Tsirang*

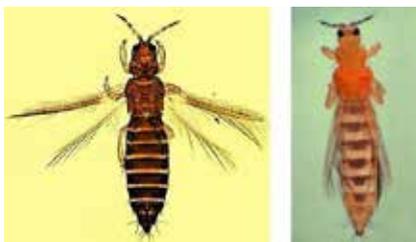


*Figure 8: Fungus seen on individual infected leaves*

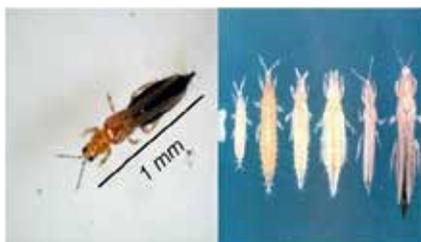
### **5.3.2. Insects**

#### **Problem 1: Thrips**

Field visit underlines prevalence of thrips and stem borer as major problem.



*Figure 11: Thrips*



*Figure 10: Various stages of Thrips*

## **Problem 2: Stem borer**

The other problem was the stem borer infestation.



*Figure 13: Stem borer moth (adult)*



*Figure 12: Stem borer larvae inside pseudostem*

### **5.4. Government-level problems**

Government farms and research stations are aware of diseases and they are trying to come up with management technologies. There are local collections of cardamom varieties at Agriculture Research and Development Sub-Center, Menchuna, Tsirang, which do not have identifications and are not performing well. It will be justifiable to remove them and keep new disease-free and well-known varieties with tagging not only in the record but also in the field. The government farm at Samtenling, is doing well in the production of saplings but it is out of the range of climatic requirement of cardamom so Tsirang based government farm (Agriculture Research and Development Sub-Center) should also actively participate in the production of the large cardamom saplings from seed. It will be beneficial to take advantage of the important practices being adopted in other successful cardamom growing countries. The government should introduce and adopt appropriate technology suitable for local condition. Strengthening the capacity of extension officers and improving national laboratories will help in identifying pests and diseases on time, underlying causes and potential solutions. Government can design its own policy to address different issues related with cardamom industry depending upon socioeconomic condition.

## **5.5. Farmer-level problems**

Productivity of cardamom at farmers' level is not satisfactory because:

- a) Disease has severely attacked cardamom bushes and the performance of the cardamom bush is far (below) than the normal level. Cardamom plant that is supposed to yield for 19 years is now producing only for 3 years. Disease like stem hardening and severe scratch in the leaves and itching in the skin whenever people pass through the bushes are reported. The prevalence of the disease did not decrease despite the burning of infected plant. There are prevalence of diseases in the large cardamom field, both known and unknown.
- b) The team had observed large coverage of cardamom without any shade which has resulted in low productivity plantations and high disease infestation and insect attack therein.
- c) There were problems of thrips and stem borer in the cardamom bush.
- d) Unknown varieties are also under cultivation.
- e) Levels of bush management were poor.
- f) No irrigation facilities were observed in the orchards in most of the cases.
- g) No record of soil test has been found in the Cardamom growing areas.
- h) Conventional fuel wood kiln type drier prone to smoke taint cardamom capsule

## **5.6. Private nurseries**

Private nurseries of Gelephu area are collecting cardamom seeds by themselves. The Royal Government of Bhutan should provide seed and standard guidelines on sapling production for quality control authority their sapling production should be under strict supervision by government authorities. The nursery owners should get incentives from the government for high quality disease free seedling production of desired varieties. There should be demand based seedling production; and the extension agents should co-ordinate in demand collections.

The Royal Government of Bhutan can follow certified nursery scheme which the Government of India is practicing. Under certified nursery scheme in India, nursery owners are getting two rupees per plant aid from the government.

## **6. Recommendations**

### **6.1. Government related**

#### **A. Strengthening laboratories**

##### **1. Pathological Laboratories**

The Lack of linkages between farmers and research laboratories has contributed towards less productive plantations. Immediately after any disease detection, concerned stakeholders should rough out the infected bushes completely. Thus, quantity and quality of laboratory should be strengthened to cover all the demands of fast disease test. This will also strengthen national quarantine system and decrease possibility of import of quarantine pests and diseases. For example, *Tuta absoluta* moth which came to Nepal from India is posing serious threats to the whole tomato production system.

*Pseudomonas fluorescens* is a bacterium which is used to treat saplings before they are dispatched for planting. As this gram negative bacteria play a major role in the plant growth promotion, induced systemic resistance, biological control of pathogens. Therefore, the pathological laboratories in Bhutan should produce sufficient amount of the bacteria as recommended by the research. Private sector can also play role in such business which will produce more bio-control agent and generate employment opportunity as well.

There are several friendly pathogens and insects which need rearing. It will help farmers to control insects and pest like thrips, aphid, borer, white grubs and fungal diseases. The metrazium production to control white grubs, trichoderma viridii can also be produced. In Bhutan, thrips are becoming a major threat in cardamom cultivation.

Lace-wing (*Chrysopidae*) is a predator of insects which is used in Chitwan, Nepal to control pests in various crops. Similar type of study should be conducted in Bhutan. It will be environment friendly, labor saving and organic practice. Its eggs are available in commercial scales in the international markets. Production of *Azadirachta* based organic insecticide should be available in Bhutan. *Azadirachta indica* can be cultivated below 900 m above average mean sea level. It will be wise to produce organic pesticide in Bhutan than to import. It will save cost of test on the reliability of imported pesticides. Bhutan has great potentiality for organic pesticide production, use and export.

## **2. Soil Laboratories**

Organic matter and other elements in the soil play vital role in cardamom cultivation. Soil test facilities are available in Bhutan but the service is not sufficient to meet demand of the farmers. Atomic absorption spectrophotometer is available in Bhutan but it is better to procure more and offer rapid soil tests. This machine can detect all macro and micro nutrients present in the soil. It is fast and convenient and will offer to explore cardamom plant in relation to soil micronutrients in detail. Spice board of India has reported that addition of magnesium, manganese and boron can increase the dried capsule yield. The portable field soil kits are generally used to test nitrogen, phosphorus, potash, pH and Organic matter content in the soil. Therefore, this machine is more relevant in the cardamom as well as for other crop production.

Addition of organic matter is very important in cardamom to increase water and nutrient holding capacity and thereby reduce impact of erratic rain due to change in climate. Production of organic matter and its use should be promoted.

The Royal Government of Bhutan can promote large-scale cattle farms which can be linked to the compost production farms for mass and continuous production and supply of compost. This compost production farms can be linked to the cardamom farmers for its application in the cardamom farms. Presently, poultry manures from poultry farms are available in the cardamom growing areas which need to be explored

for efficient and effective use in compost making. Green leaf manure application can also help to improve organic matter content in the soil.

There are several reports on the use of bio-chars for increasing crop productivity. It is worth applying these proven technologies in Bhutan. The shade trees other than non nitrogen fixing will compete for nutrients with cardamom bushes so in such cases application of well decomposed organic matter is a must.

### **3. Seed Laboratories**

The Agriculture Research and Development Centre in Bhutan should maintain enough breeder seed and supply to both private and state-owned seed companies as and when required. A strong collaboration between the Research Centre and the National Seed Testing Laboratory needs to be established for regular testing of its genetic and physical purity, germination percentage and so on. The variety identification can be done using the varietal identification manual 2019. Variety<sup>1</sup> can be identified by the methods given below:

#### **a. Morphological traits**

It is presented in the variety identification manual 2019.

#### **b. Electrophoresis**

In this method, proteins are extracted from the grain and the protein composition is used to identify the variety. In India, electrophoresis methods were in use at ICAR based facilities; we can use the facility and calibrate them. In small cardamom (*Elettaria cardamomum*), there are reports of its use but are not seen in large cardamom. This device can be useful for several uses in other cases too. Its use can detect varietal purity very fast because of computer added technology associated with it.

#### **c. Molecular Methods**

Molecular tools like PCR, RFLP, DNA Bar coding are recently used tools in variety identifications.

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<sup>1</sup> See variety identification manual for details.

Plant variety and cultivar identification is one of the most important aspects in agricultural systems. The large number of varieties or landraces among crop plants has made it difficult to identify and characterize varieties solely on the basis of morphological characters because they are non-stable and originate due to environmental and climatic conditions, and therefore phenotypic plasticity is an outcome of adaptation. To mitigate this, scientists have developed and employed molecular markers, statistical tests and software to identify and characterize the required plant cultivars or varieties for cultivation, breeding programs as well as for cultivar right-protection. (Nicholas et al 2012).

Molecular markers which detect variation at the DNA level overcome most of the limitations of morphological and biochemical markers hence potential application of RAPD markers has been demonstrated in many crops since long time (Bowditch et al., 1993 and Zhang et al., 2011). A comparative analysis of the different methods of variety identification in terms of accuracy, cost and time will be essential to follow the techniques according to the need.

#### **4. Tissue culture laboratory**

Bhutan should have its own strong tissue culture facility to cover demand of high quality saplings at large scale. The tissue culture laboratory which is used in case of G9 banana culture can be utilized in case of cardamom too. Protocol for the tissue culture is provided in sapling production manual 2019.

In case of any confusion, it will be possible to explore private tissue culture laboratories at Kathmandu. They are also practicing tissue culture in cardamom sapling production.

Production and distribution of virus free saplings/ seedlings is very important for healthy cardamom plants. So, for high quality disease free sapling production and make easy access to farmers. Though, there is tissue culture laboratory in the Bhutan, special laboratory for the tissue culture of Large Cardamom should be established which will enhance appropriate biotechnology for the crop.

## **B. Rodent control**

Interactions with the farmers unveiled that rodents damage on capsules was a serious threat. Israel is capable of controlling rodent without any use of poisonous rodenticides. It will be beneficial to see barn owl technology in controlling rodents. Barn Owl has strong night vision capacity, can identify the prey even under the soil, and lays up to thirteen eggs. It will be possible to increase the number for controlling the rodents. A barn owl eats 2000 to 6000 rodent in a year. It is a proven technology to control rodents in Israel. There is a possibility to introduce this technology in Bhutan.



*Figure 14: Bhutan Owl*

## **C. Seed originated saplings**

In general, this system requires primary and secondary nursery in seedling production. (Detail is in the propagation manual). But if the demand of the sapling turns out to be very high, it is better to practice a third nursery to expand volume of the sapling production. Saplings in second and third nursery are produced by asexual propagation method. In this nursery, extensive roughing of off- types and disease infected plant should be practiced. Better management practices should be equivalent to the secondary nursery. Due to which, a disease free and high quality saplings can be produced at a larger scale.

#### **D. Irrigation facilities**

The practices of other countries will give idea to design own strategies for irrigations. Two-horse power electric submersible water pumps which costs around Nu.5000/- can be useful in irrigating cardamom farms by lifting water from rivers and ponds.

Indian government offers irrigation facility for cardamom farmers as follows:

- Rainwater harvesting: The program for rainwater harvesting using devices made of earth excavated pits lined with silpauline sheets is implemented in North Eastern States for large cardamom. 33.33% of the actual cost of construction subject to a maximum of Rs.12000/- per device is provided as subsidy.
- Installation of Irrigation equipment: Board will assist in installing irrigation equipment at 50% subsidy subject to a maximum of Rs.10, 000/- to farmers of large cardamom.
- Nepal waives 60 percent tariff in electricity used for irrigation purpose.

In cardamom, Critical Stages of Irrigation:

- Irrigate the large cardamom stands (Bushes) or nurseries during dry seasons until the first monsoon showers.
- Irrigate twice a week (3–4 hours a day) (Sharma et al., 2017).

No one can anticipate high quality of cardamom without such interventions on irrigations. Bhutan can design strategy of its own based on its conditions. Uttarakhand province of India is successful in installing water pumps even in the hills. It will be beneficial to explore this technology and see its possibility in Bhutan.

Separate research can be designed to see the cost effective and efficient method of irrigation under Bhutan condition.

#### **E. Variety introduction and evaluation**

Jirmale & Damberse varieties can be imported from reliable source for research purpose in Bhutan. Jirmale is suited for lower elevations and is comparatively drought resistant variety. In climate change context, it can

be helpful for farmers to grow cardamom at rainfed conditions. Damberse is a famous variety of Nepal for its quality capsules. Seremna, Bharlange, Ramala, and Zongu-Golse can be other varieties suitable for Bhutan. Details are presented in variety identification manuals. Research can also be conducted on variety trials and assess their comparative advantages under Bhutan conditions.

#### **F. Bumble bee**

Bumblebee is the pollinators of cardamom flowers which have role for increased cardamom production. Increase in their number by increasing their habit as it will have greater impact on cardamom capsule formation and production. Entomologists should design interventions to increase their colonies.

#### **G. Orchard Management**

Farmers may not be able to operate accurately, so it will be better to form several groups of youth who are drop out students or interested workers for cardamom cultivations and performing tasks such as weeding, removing off-types varieties, and manure applications and removing diseased bushes, machine use for cultural practices and so on.

These groups should get trainings from research centers and should possess all required equipment for orchard management. Such groups are active in Assam and in east Nepal in coconut plantations.

Such groups should be funded partly by The Royal Government of Bhutan and partly by the concerned farmers itself. The money collection should come from the very nominal tax on the sale of cardamom. The increase in labor cost has created big problem to the farmers. Low price of the dried cardamom for farmers is not encouraging them to take care of the bush.

#### **Extension workers (Agriculture Extension Supervisors)**

Agriculture Extension Supervisors should provide cropping schedules or calendar of operations to the farmers and also regularly send short messages (sms) to farmers to make them aware about the course of actions that farmers have to follow.

Roughing diseased plants/bushes is very critical to minimize the spread of diseases. With the guidance from extension workers, concerned stakeholders should clear severely disease infected bushes and plant other possible crops like vegetables or millet and garlic for a few years to break the disease cycle. If no crop is possible, land should remain fallow for at least one year. It will help to discontinue disease cycle.

Government should be able to offer:

1. High quality saplings suited at the local condition
2. Inputs like well-decomposed manures, efficient drying devices, firewood, and other inputs related with cardamom orchard management. The private entrepreneurs should be promoted by the government to address inputs need of the actors along the value chain.
3. Crop calendars indicating crop cycles and farm activities. Provide information in local language on best cardamom related practices.

## **H. Demarcations**

### **Farms**

The farms should be divided into intensive, semi intensive and ordinary cardamom farms. It will be possible to design strategies according to their needs. For example, cardamom gardens without any shades need red colored Alnus (It is more profitable compared to white Alnus because of better quality of timber), or Albizia for shade. Un-irrigated land may need draught tolerant variety. In well- managed farms, high yielding and high quality variety can be recommended. Farm areas nearby water source can perform well with two horsepower electrical submersible motors and construction of plastic ponds. Based on the quality of dried cardamom, the targeted markets will be different for each farm. Intensive farm products can be supplied to Mumbai market after improving quality. There will be many other areas of interventions based on local requirements and proven benefit cost ratios.

## **Definitions:**

### **Intensive farms**

Those farms/ public farms that are growing cardamom with high level of management, with irrigation facilities, and using modern technologies.

### **Semi intensive farms.**

Farms under medium level of management practices should fall in this category.

### **Ordinary farms**

Farms that are operating under very low management practices fall under this category. Problem will be different with the differences in the categories. Separate planning will be necessary to address their problems

## **I. Current drying methods at farmers' level**

- a) Farmers are using locally made driers (For instance: Sun drying, Local made fuel wood kiln drier) which has reduced quality of the cardamom capsule.
- b) Farmers are not using improved driers
- c) They are reluctant to use electric drier because of tariff associated with it in the one hand while in the other hand, they had no access on the modern kilns and technology required to handle them.

## **J. Study on driers**

- a) At Tsirang, the government farm possessed improved driers but in the farmers field, traditional driers were used.
- b) It will be better to explore on the feasibility of different driers available in the market such as S. Khuntia developed driers, Astra driers which are in extensive use in south India and electric drier which is in use at Panchthar of Nepal.
- c) Adaptive research at local conditions, on different types of dryers, needs to be conducted along with its feasibility study and quality attributes.
- d) Government can explore on the effective use of electric driers and provide subsidy on electricity consumption.

## **K. Grading and Packaging**

Cardamom grading is done based on the size, weight and color. India has its own standard grading system. It will be justifiable to take advantage of the grading systems and make grading according to the needs of importing business houses. Various grading machines are available in the market with different sieves. Bhutan cardamom can be marketed with proper grading and quality certifications.

It will be justifiable to explore markets in Mumbai and contact traders for their preferences and requirements. It will be beneficial to look on the popular packs offered by ‘Emperor Akbar’, Mumbai market offered cardamom packs and by the Chinese companies for their cardamom varieties mostly exported to Pakistan.

The Bhutan cardamom exporters should establish trust with importers by following respective countries need and quality standards. The quality standards developed by India can be a guide to design Bhutan’s own standard.

### **6.2. For farmers**

- 1. Soil related.** Soil test before plantation and use sufficient amount of fertilizer as recommended by soil laboratory. Use lime for maintaining pH as recommended by the soil laboratory.
- 2. Shade plants** like Alnus or Albizzia species trees before planting cardamom at 15 feet apart. Cut Alnus trees after 15 years as it will compete with cardamom bushes for nutrients after 15 years. Regular manure applications from outsource will be essential if other non-nitrogen fixing plants are selected as shade trees. In cardamom fifty to sixty percent shade is required.
- 3. Variety.** For lower altitudes above 600m asl request government authority for Jirmale, Zongu, Ramse and Damberse varieties. For higher altitude Bharlange, Seremna, Ramse. See varietal details of variety manual.
- 4. Irrigation.** Make provisions for irrigation wherever possible.

5. **Plant population** should be in accordance with the charts provided by government. Pseudo-stems without tips should be roughed and keep the bush loose to ease flowering and capsule formations.
6. **Crop cycle.** Use recommendations offered by the government for each step in each crop cycle. Follow thinning, weeding, leaves removing over the spikes, roughing technology in the cardamom bush
7. **Manure Application.** Apply manure before flowering and after harvest and do not let cardamom rhizomes to expose above ground. There will be low disturbance in the bushes and the plant will have enough nutrients for better production.
8. **Rodents.** Take advantage of owl rearing technology of Israel for rodent control.
9. **Cost and benefit record.** Follow drying technology recommended by government. Conduct cost benefit analysis in terms of quality and price in different drying system and other costs and benefits. Government should take a role to explore best market in the international level.
10. **Calculate.** Plants required per unit area.

*Table 3: Calculation of plant requirement per acre of land*

S.N	Type of the land	Pit distance	Per acre pit numbers
1	Fertile, flat land, High tillering variety	2m x2m	994
2	Fertile, flat land, low tillering variety	1.8 m x 1.8 m	1225
3	Sloppy land with high tillering variety	1.8 m x 1.8 m	1225
4	Sloppy land with low tillering variety	1.5m x 1.5m	1766
5	Highly sloppy land high tillering variety	1.5m x 1.5m	1766
6	Highly sloppy land low tillering variety	1.2m x 1.2m	2760

(Source: National Spice Crop Development Program, Lalitpur. 2018)

### **6.3. Extension**

Regular interaction with the Extension Officers should be practiced for the regular assistance for the crop production. Active contact with the extension officers can guide for:

1. Sapling procurement
2. Essential inputs for cardamom
3. Technical contact with laboratories
4. Leaflet and pamphlets regarding pumps cardamom
5. Calendar of operations indicated in the calendar
6. Construction of owl nest
7. Market and market information
8. To know about Royal Government business of Bhutan policy
9. Availability of the submersible water pumps
10. Provision of soft loan for the betterment of cardamom industry
11. Soil sample collections
12. Labeling

### **6.4. For Cardamom business-men**

1. Follow adequate grading and packaging and modern storage facility.
2. Explore on viability of cardamom value added products.
3. Explore best market and supply according to the price offered by the importing countries or consumers.
4. Update with latest and modern innovations related with cardamom value chain by mapping the existing status and apply probable applications. See quality standards of India in the annexure number 5 to generate idea on cardamom processing and packaging.

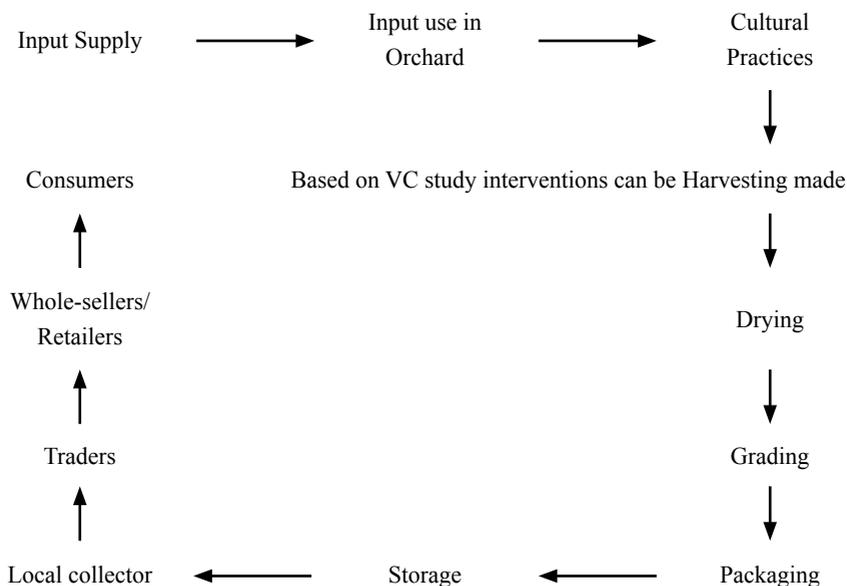


Figure 15: Simple value chain

**Few notes (It will provide glimpse on availability of necessary inputs)**

1. Nepal’s private tissue culture laboratories have experience of successful cardamom sapling production. It will be possible to share their expertise and experience in case of necessity.
2. *Sesbania rostrata* (for temporary shade tree in nursery/ field and for green leaf manure) is available at National Wheat Research Program, Bhairahawa, Nepal.
3. Red colored *Alnus* (for shade tree) is available in Dhankuta district of Nepal. It has better price compared to the white *Alnus*.
4. Jirmale variety of large cardamom is found in Jirmale area of Illam.
5. Damberse variety of large cardamom is available at Pakhribas of Dhankuta district of Nepal.
6. *Metarazium*, NPV and *Beuveria basiana* are produced at government laboratory in Nepal.

7. B.T is commercially manufactured in China to control caterpillars
8. Sikkim based Indian Cardamom Research Institute possess *Pseudomonas fluoresces* bacteria to control fungus attacking cardamom.
9. Barn owl technology is with Israel. Efforts should be there for technology transfer.
10. Atomic absorption spectrophotometers were imported from Japan to Nepal.
11. Electrophoresis facility was in use in Delhi, India. We need to explore further. Recently molecular methods are in use.
12. Virus test facilities should be developed or hire laboratories in India or Nepal.
13. Other pathological and entomological useful insects are found in the market.
14. Altitude wise varieties.
  - 14.1. See Variety Identification manual.
  - 14.2. Zongu-Golse, Seremna, Jirmale, Damberse, Ramse and Bharlange can be good variety for Bhutan.
15. Supply Jirmale variety of large cardamom at marginal and dry areas according to the altitude requirement in variety identification manual.
16. Supply Damberse variety in intensive areas of required altitude.
17. Bharlange and Ramse varieties are recommended for upper elevations.

Short term, Medium term and long-term Plan for cardamom development						
S.N.	What to do	Where to do	When to do	How to do	Why to do	Who will do
1 Short term	Prepare calendar of operations of the required interventions in cardamom industry. Categorize the farms in intensive, semi intensive & ordinary	At higher level	Immediately	By using data on the human and natural resource base of Bhutan.	For effective planning Assigning responsibility of each stakeholders	Government authority with collaboration with stakeholders.
2 Short Term	Take inventory of the data on the drop out students and interested people. Equip extension with necessary materials for labors in cardamom fields	In each district levels	Immediately	Levy minimum tax on the sale and ask little bit contribution of the farmers. Use internet facilities.	For cardamom improvement program. Labor supply.	In collaboration with farmers and the government authority.
3 Short term	Order <i>Sesbania rostrata</i> seed, Rajma bush bean seed, Soybean seed, and Develop wild asparagus planting materials by tissue culture. Give package practices for them by leaflets.	Supply centers, tissue culture laboratories. Forest authorities, Extension workers.	Before planting season	Initially by import later in Bhutan	For crop rotation after removal of disease infected cardamom. Himalayan batisha can be prepared with wild asparagus.	Private input suppliers, nursery owners, government, and farmers.
4 Short term	Remove all the diseased orchards. Crop rotation.	In all diseased places or area by rotation according to the availability of resources.	After harvest (August-September-October)	Campaign- Active participation of the drop out unemployed students.	To destroy source of disease	Farmer & Work force hired jointly by government and farmers.

<b>Short term, Medium term and long-term Plan for cardamom development</b>						
<b>S.N.</b>	<b>What to do</b>	<b>Where to do</b>	<b>When to do</b>	<b>How to do</b>	<b>Why to do</b>	<b>Who will do</b>
5 Medium Term	Crop rotation by Asparagus/Soybean/ Bush beans (Kajma or Contander) and garlic	In the uprooted places	In the growing season of asparagus	Mass supply of the planting materials and technical inputs	To minimize disease and increase soil productivity.	Farmers
6 short Term	Plant Sesbania rostrata	In fallow land /Uncultivated land.	Rainy season	Just broadcasting / Planting	To improve soil organic matter and nitrogen	Farmers
7 Medium Term	Plant Azadirachata indica	Below 900 masl	Rainy season	By transplanting in fallow land	For establishment of organic pesticide industry within the country	Government and interested entrepreneurs
8 Short Term	Train all the extension workers and farmers for developing skills on large cardamom.	Extension workers in the sub division level and farmers at local level.	For extension workers, immediately; For farmers before initiating interventions by the government	Organizing training with all technical materials. Pamphlets, booklets. Electronic copy etc.	To ensure right practices for cardamom	Government in collaboration with local bodies.
9 Medium term	Strengthen laboratories, Soil, seed, pathological,	At District levels	Immediately	Soil lab should have atomic absorption spectrophotometer and manpower to handle. Seed – Electrophoresis, Pathological – Virus test, bacterial test, and production of useful bio materials like bd, NPV, and others.	To ensure immediate response to the farmers problem using extension network.	Government in collaboration with local bodies.

<b>Short term, Medium term and long-term Plan for cardamom development</b>						
<b>S.N.</b>	<b>What to do</b>	<b>Where to do</b>	<b>When to do</b>	<b>How to do</b>	<b>Why to do</b>	<b>Who will do</b>
10 Medium term	Strengthen laboratories entomological, tissue culture	At District level	Immediately	Supply useful insects. Organic ways of controlling pests. Tissue culture tab- Desired varieties at sufficient level.	To ensure immediate response to the farmers problem using extension network.	Government in collaboration with local bodies.
11 Medium term	Rodent control	At local level	Immediately	Import barn owl and its technology from Israel.	Establish its rearing facilities in many places of farmers field	Government in collaboration with farmers or NGOs.
12 Short Term	Variety Introduction and multiplications	At tissue culture laboratory and Tsirang based government farm	Immediately	Keep collaboration with private tissue culture laboratories at Lalitpur Nepal. Later Bhutan's lab can independently work.	We need Jirmale drought tolerant variety and Damberse high quality cardamom	Government in collaboration with stakeholders.
13 Medium term	Strengthen Tsirang based government farm	Establish variety maintenance facilities as mentioned in variety identification manual	As soon as possible	Keep single varieties with full, take care inside single nets with irrigation facilities. Rough out all unproductive and unknown varieties present inside Tsirang farm.	The nurseries should correspond to the growing elevation and will reduce transportation cost.	Royal Government of Bhutan.

<b>Short term, Medium term and long-term Plan for cardamom development</b>						
<b>S.N.</b>	<b>What to do</b>	<b>Where to do</b>	<b>When to do</b>	<b>How to do</b>	<b>Why to do</b>	<b>Who will do</b>
14 Medium term	Discourage nurseries at lower and encourage them in higher elevations levels.	All areas below 600 m from masl.	As soon as possible	By regulation or rule. Offer facilities to the nursery owners in higher elevations	The nurseries should correspond to the growing elevation and will reduce transportation cost.	Royal Government of Bhutan. In collaboration with interested farmers.
15 Medium /long term	Irrigation facilities development	Possible areas	As soon as possible	By offering concessions to the farmers and by 2hp electric motors. Reviewing Indian and Nepalese style and choosing best option.	For the output of quality cardamom	Royal Government of Bhutan. In collaboration with interested farmers.
16 Long term	Manure/ Milk production	Possible areas	As soon as possible	Encouraging private entrepreneurs for the establishment of large scale cattle farms	To increase milk and manure production	RGoB in collaboration with interested farmers.
17 Short Term	Supply red colored <i>Alnusnepalensis</i> saplings in sufficient amount	Possible areas	As soon as possible	Forest nursery collaboration	They are good shades for cardamom	RGoB and interested people.
18 Short term	Study on driers	At cardamom pockets of Bhutan	After harvest	Take S. Khuntia drier, electric drier and Astra driers and compare them	To know best option in terms of quality and cost.	The RGoB and interested people.

Short term, Medium term and long-term Plan for cardamom development						
S.N.	What to do	Where to do	When to do	How to do	Why to do	Who will do
19 Medium/ Long term	Quality control	Collection centers	Before harvesting season	By providing grading, packaging and segregating devices	If grading and quality control will be meaningful	Government in collaboration with the entrepreneur
20 Medium Term	Market study	Mumbai, India	Before harvesting	By dealing in small quantity	To see if we can reduce marketing cost	Government in collaboration with the entrepreneur
21 Long term	Construction of modern storage facility of large cardamom	Nearby Southern border	As soon as possible	Encourage private sector by offering various concessions	To explore market efficiently	Government in collaboration with the entrepreneurs.

## 7. Conclusion

Large cardamom is a very important spice crop of Bhutan. So, each stakeholder of its value chain should start research and development activities of their own. They should take advantage of research made so far in international level. The research and development activities should be economically justifiable.

## Annex 1 Detail of the works at Bhutan

Duration March 17, 2019 to April 06, 2019

Date	Observations
March 17 <sup>th</sup>	Stay at Thimphu
March 18 <sup>th</sup>	Stay at Gedu and field visit
March 19 <sup>th</sup>	Haa stay and interaction with district officer
March 20 <sup>th</sup>	Tsirang stay and government farm visit
March 21 <sup>st</sup> -31 <sup>st</sup>	Gelephu stay and training for government officials
April 1 <sup>st</sup>	Tsirang stay and field visits
April 2 <sup>nd</sup> -5 <sup>th</sup>	Thimphu stay and technical report presentation to the Royal Government of Bhutan
April 4 <sup>th</sup>	Consultation with FAO Bhutan
April 6 <sup>th</sup>	Departure to Kathmandu from Bhutan

### 1. List of farmers met

SN	Date of visit	Name of the farmer	Place	Technicians accompanied
1	2019/03/19	Tashi Dorji	Bongo	Tshewang Thinley
2	2019/03/19	Choden	Pakshikha	Ganga Ram Ghale
3	2019/03/19	Sangay Choden	Pakshikha	Sangay Choppel
4	2019/04/03	S.B. Mahat	Tsirang	Sonam Jamtsho
5	2019/04/02	Pasang Tshering Sherpa Ram B. Rai	Khenpagang	Sonam Jamtsho
6	2019/04/03	Dorji Samdrup	Gosarling	Sonam Jamtsho

## 2. List of Government Farm and private nursery visit

SN	Name of the Farm	Chief/Head	Place	Technicians accompanied
1	Agriculture Research and Development Center	Jimi Sir	Tsirang	Ganga Ram Ghaley, Sangay Chophel
2	Agriculture Research and Development Center, Samteling	-	Gelephu	Ganga Ram Ghaley, Sangay Dorji
3	Samtenling Agriculture Nursery	Santa Bir Subba	Gelephu	Ganga Ram Ghale, Sangay Dorji, Jimba Rabgyal

### List of private farms visited

#### 1. Gewog :- Bongo,

Village: -Gedu/Allakha

Date: - 2019/03/19

Government Agriculture extension: -Tshewang Thinley

Farmer/Owner: -Tashi Dorji

Area under Cardamom: - 2 Acre

Elevation: -1600 from mean sea level

Variety: -Ramse

#### 2. Village :- Pakshikha

Date: - 2019/03/19

Owner:-Choden

Date: - 2019/03/19

#### 3. Haa

Interaction with District Agriculture Officer

#### 4. Tsirang

Government Horticulture Farm Visit

Horticulture Officers

Jimi Sir

Plant protection Officer

Sangay Sir, Ganga Ram Ghale Sir

## **5. Gelephu**

Government Farm Visit

Sangay Dorji, Ganga Ram Ghale, all trainees and Jimba Rabgyal.

Off types saplings and diseased saplings were also observed inside government nursery.

Private nursery visit

Date: - 2019-03-28

Owner: - Santa Bir Subba

Name of the nursery: - Samtaling Agriculture Nursery

Source of the seed: - Samtse

Variety:-Varlange

Quantity: - 4 Kg

**Date of Sowing:** - August – September

## **6. Field Visit to Khenpagang**

Geog Samtaling, Sarpang

Owner: Ram B Rai (Group Interactions)

Gaychhu

Name: Pasang Tsiring Sherpa (Group Interaction)

Date: 2019-04-02

## **7. Field Visit to Tsirang**

Owner: S.B. Mahat

Altitude: 1256m from masl. Variety Seremna and Bharlange Plant

Age: 5 years age.

Date: 2019- 04- 03

Name of the Place: Gosarling

Farmer's name: Dorji Samde

Extension worker: Sonam Jamtsho

Age of cardamom bush: 3 years

Production: 63 kg Variety: Varlange Area: 1.75 acres.



### **Scope of the study**

The Regional Expert will work in close collaboration with the National Spice Coordinator, DoA and National Consultant from FSAPP to carry out the following activities

#### **1. Conduct survey on the persisting pests and disease in cardamom fields and provide recommendations**

With new trend of cultivation of large cardamom in the open field, numerous associated pests and diseases are being reported. Such incidence needs to be studied and provide recommendation of prevention and control. The Regional Expert is required to make field visits as per the program framed by the Department of Agriculture, MoAF, Thimphu mainly to get the overall understanding of pests and disease scenario in Bhutan. The Regional expert will visit two major cardamom growing districts i.e. Chhukha and Sarpang and is tentatively planned for one week. The expert is required to submit the draft questionnaire to the Department before coming to Bhutan. The survey questionnaire will be filled in by the sample Geog Extension Supervisors. At least 10% of total households cultivating cardamom in sample geogs of five project districts will be surveyed to get the representative figure. The questionnaires will be circulated to the geogs before fielding the expert.

#### **2. Training of Trainers (ToT) on scientific large cardamom production**

It is important to improve orchard management practices to increase production through new and climate smart technologies. All these management challenges, besides the risks from climate change impacts, require investment in building the capacity of research, extension and nurserymen. Research on breeding for better varieties and evaluation of local germplasm are not being initiated due to limited capacity of researchers. Rigorous trainings are required to update information on soil nutrient management; climate smart irrigation and post-harvest management, and to execute research programs to address these problems.

The main task of the expert is to provide ToT through theoretical and practical sessions including demonstration in the field on varietal identification, orchard establishment, management of soil and nutrient, pest management, water management and post-harvest options. The training will be organized in Agriculture Research and Development Center, Samtenling in first week of March 2019 for 5 days. A total of 10 agriculture officers from various Central Programs under the Department will participate in the ToT. These trained personnel will in turn train the extension personnel and farmers in future. The expert has to prepare adequate training materials both on soft and hard copies and make available for the trainees during the time of training.

The 5-day training will cover, but not limited to, the following themes:

- a. General cardamom production scenario across the world with focus on commercial cardamom cultivars and selection of suitable varieties for Bhutan;
- b. Identification of different cardamom varieties and their characteristics.
- c. Types and selection of shade trees in Bhutan's climate;
- d. Soil and integrated nutrient management using environmentally friendly techniques;
- e. Water requirement, irrigation technique in dry land and soil moisture conservation techniques;
- f. Scientific cardamom production techniques to enhance productivity including site selection, layout and design, plantation techniques in relation to Bhutan and its topography;
- g. Cardamom nursery production techniques; site selection, primary and secondary nursery;
- h. Climate Smart Irrigation widely adopted by other successful cardamom growers in the world to enhance crop productivity;
- i. Importance of post-harvest operations with more emphasis on the drying technologies including proper cleaning, sorting and degrading;
- j. General process of large cardamom germplasm selection, evaluation of local germplasm and repository establishment;
- k. Cardamom research and breeding;
- l. Common pests and disease and its control mechanism

#### **3. Variety identification guideline and nursery management manual**

Large cardamom in Bhutan has degenerated over the past years as there was no research-based nursery production. Due to lack of identified varieties the technical officials are facing difficulties in identification and providing suggestion as well as guidance to the cardamom growers.

Nursery is one of the most important components in large cardamom production as it serves as the primary source of clean planting materials. Currently, almost all the farmers except few entrepreneurs source their planting materials from neighbors' orchards or from orchards in neighboring district. This has resulted into spreading of viral diseases like Chirkey and Foorkey diseases. Only countable nurseries are being established in the country where their success is subjected to their technical capacity.

Thus, in addition to above two tasks, the expert is required to prepare and submit varietal identification guideline and scientific nursery management manual at the end of his contract tenure. The document should be comprehensive, informative and should be in Bhutanese context.

4. In regular consultation and coordination with the Regional Communication Officer, FAORAP, the incumbent shall ensure coherence with FAO's corporate communication policy and operational guidelines for all communication and information outputs.

**Duration of Assignment**

The Regional Expert will be for 15 working days.

**Qualification and Experience**

- a. Minimum degree of MSc in Agriculture, Agriculture System or closely related fields.
- b. Minimum of 10 years of work experience in similar projects elsewhere and possess experiences in large cardamom
- c. Experience in working with international and national cardamom research center
- d. Experience in training methodology and conducting trainings
- e. Excellent report writing skills with good command of English language

**KEY PERFORMANCE INDICATORS**

<b>Expected Outputs:</b>	<b>Required Completion Date:</b>
a. Survey questionnaire, and training materials developed	28 February 2019
b. Varietal Identification Guidelines	05 March2019
c. Scientific Nursery Management Manual	05 March2019
d. Final Expert's report (including Package of Practices)	11 March2019

### Annex 3 Training Schedule

#### Training schedule for Large Cardamom

2019-03- 25 (Monday)	2019-03- 26 (Tuesday)	2019-03- 27 (Wednesday)	2019-03- 28 (Thursday)	2019-03- 29 ( Friday)
Opening ceremony/ Introduction Tea break with snacks Time 9:00 AM- 10:00 AM	Cardamom varieties Time 9:00 AM- 10:00 AM	Shade trees in cardamom Time 9:00 AM- 10:00 AM	Disease of cardamom Time 9:00 AM- 10:00 AM	Climate change & cardamom Time 9:00 AM- 10:00 AM
Tea break with snacks 10:00 AM- 10:15 AM	Tea break 10:00 AM- 10:15 AM	Tea break 10:00 AM- 10:15 AM	Tea break 10:00 AM- 10:15 AM	Tea break 10:00 AM- 10:15 AM
Global large cardamom production trend Time: 10:15 AM – 12:30 AM	Cardamom Propagation Time : 10:15 AM – 12:30 AM	Manure application/ IPNM Time : 10:15 AM – 12:30 AM	Orchard managements Time : 10:15 AM – 12:30 AM	Annual practice Time : 10:15 AM – 12:30 AM
Lunch Break Time: 12:30 PM – 01 :30 PM	Lunch Break Time: 12:30 PM – 01 :30 PM	Lunch Break Time: 12:30 PM – 01 :30 PM	Lunch Break Time: 12:30 PM – 01 :30 PM	Lunch Break Time: 12:30 PM – 01 :30 PM
Introduction to cardamom & Use Time: 1:30 PM-2:30 PM	Tissue culture Time: 1:30 PM-2:30 PM	Irrigation Time: 1:30 PM-2:30 PM	Harvesting & Post harvest Time: 1:30 PM-2:30 PM	Discussions Time: 1:30 PM-2:30 PM
Break Time: 2:30 PM-2:45 PM	Break Time: 2:30 PM-2:45 PM	Break Time: 2:30 PM-2:45 PM	Break Time: 2:30 PM-2:45 PM	Break Time: 2:30 PM-2:45 PM
Discussions/ idea sharing 3:30 PM-4:00 PM	Hardening of tissue Time: 2:45 PM-4:00 PM	Insects of cardamom Time: 2:45 PM-4:00 PM	Marketing Time: 2:45 PM-4:00 PM	Closing ceremony 2:45 PM-3:45 PM

## Annex 4. Test Questions after training Test

### Tick correct answer

1. Which country is the largest producer of *Ammomum subulatum* in the world?
  - a. India
  - b. Bhutan
  - c. Nepal
  - d. Indonesia
2. The cardamom variety produced in China Is
  - a. *Ammomum subulatum*
  - b. *Ammomum compactum*
  - c. *Ammomum costatum*
  - d. *Ammomum delibatatum*
3. Which is the drought resistant variety of cardamom?
  - a. Verlange
  - b. Jirmale
  - c. Zongu golsahi
  - d. Seremna
4. Why elder plant is important to large cardamom?
  - a. Gives nitrogen
  - b. Gives Phosphorus
  - c. Gives litters and nitrogen
  - d. All of them
5. What is toti-potency?
  - a. Capacity of any cell to give identical
  - b. Capacity of any tissue to grow whole
  - c. Capacity of any organ to give identical whole plant whole plant
  - d. All of them identical whole plant
6. We use water treatment for use in sapling hardening by
  - a. Chlorine application
  - b. By boiling and cooling
  - c. By adding potassium permanganate
  - d. UV light application
7. Packing is practiced in cardamom sapling by wrapping cardamom saplings
  - a. In-vermiculite
  - b. Quartz
  - c. Vermin-compost
  - d. Sphagnum moss
8. Blight disease in cardamom is caused by
  - a. *Pestalotiopsis sp*
  - b. *Phoma hedericola*
  - c. *Fusarium osolanixysporium*
  - d. *Colletotricum geosporides*

9. Foorkey disease vector is
  - a. Thrips
  - b. Myzus persica
  - c. Bemisia tabaci
  - d. Penthalonia nigronervosa
10. The length of the thrips is
  - a. 1 cm
  - b. 1- 1.5 mm
  - c. 2mm
  - d. 1.5 cm
11. In cardamom which nutrient deficiency is often seen?
  - a. Nitrogen
  - b. Phosphorus
  - c. Calcium
  - d. Potassium
12. What should be the since 1880 carbon dioxide concentration in the atmosphere has increased by 411ppm content of dried cardamom?
  - a. 9 %
  - b. 14 %
  - c. 13 %
  - d. 12 %
13. NASA report unveils that since 1880 carbon dioxide concentration in the atmosphere has increased by
  - a. 411ppm
  - b. 510 ppm
  - c. 400 ppm
  - d. 350 ppm
14. 20 ppm is
  - a. 20m g/liter
  - b. 20 kg/ gallon
  - c. 20 pond/ cubic meter
  - d. 20 ounce/ cubic feet
15. Why spike warming is practiced after harvest?
  - a. For easy detachment of capsules
  - b. To felicitate ripening
  - c. None of the two
  - d. All of the two
16. Greenhouse gases are
  - a. Chlorofluorocarbon
  - b. Methane
  - c. Carbon dioxide
  - d. All of them
17. How often we have to irrigate cardamom orchard in dry period?
  - a. Two time a week
  - b. Once a weak
  - c. Once in two week
  - d. Once a month

18. Why branding of products is essential?
- a. To assure consumers about the quality
  - b. To assure consumers about the quantity
  - c. To assure produce about the quality
  - d. None of them
19. Why country densification in trade is meant?
- a. Avoiding monopoly
  - b. Selling product two countries
  - c. Selling product in three countries
  - d. All of them
20. Which country is greatest consumer of large cardamom?
- a. Pakistan
  - b. Saudi Arabia
  - c. U. S. A
  - d. India

## Annex 5 Questionnaire developed for detail data collections Questionnaires

1. Any deviation from the normal is disease. The disease can be because of
  - Virus:-Chirkey (Streaks in leaves), Foorkey (New Dwarf Plants) time all the year round.
  - Fungus:-*Colletotricum geosporides* attack leaves & pseudo stem. Attack time October to February - Fungus: - Leaf streak *Pestalotiopsis sp* Summer through winter.
  - Fungus: - Leaf Spot *Phomahedericola* all year round.
  - Fungus:- Yellowing *Fusarium solanioxysporium*, attack leaves and pseudo stem
2. Bacteria: - See if any damage made by it. (For instance: Chenthal or Bacterial blight)
3. Nutritional Deficiencies: - Soil test and use of amendments. Use of amendments in soil based on laboratory test and recommendations.
4. Nematode:- If any
5. Mite Attack:- If any
6. Insects: - Stem borer: - Pod borer, Caterpillars, Thrips, Banana Aphid (*Pentalonia nigronervosa*), Green Peach Aphid (*Myzus persica*), Maize/ Corn Aphid (*Rhopalosiphum maidis*), White grub, Shoot fly. Nuclear Polyhedrosis Virus (NPV), *Bacillus thuringiensis* (Bt) and *Beuveria basiana* are the virus, bacteria and fungus commercially available in the market for caterpillar control organically.
7. Vertebrate Damage:- Rodents and other
8. Drought Stress
9. Shade management

All of these factors decrease the yield of large cardamom. They will not be produced according to anticipations.  
The normal production of large cardamom (Capsule yield) will be
10. First Year Picking 100kg/ha = 40.46 kg per acre
11. Second year 200kg/ha = 80.96 kg per acre

12. Third Year 300 Kg/ha = 121.4 kg/ acre
13. Fourth year to Sixteen year 450 kg/ha = 182 kg/acre
14. Seventeenth year 400 kg/ha = 162 kg/ acre
15. Eighteenth year 300kg/ha = 121.4 kg/acre
16. Nineteenth Year 200 kg/ha = 80.96 kg/acre

S.N	Type of the land	Pit distance	Per acre pit numbers
1	Fertile, Flat land, High tillering variety	2m x2m	994
2	Fertile, Flat land, low tillering variety	1.8 m x 1.8 m	1225
3	Sloppy land with high tillering variety	1.8 m x 1.8 m	1225
4	Sloppy land with low tillering variety	1.5m x 1.5m	1766
5	Highly sloppy land high tillering variety	1.5m x 1.5m	1766
6	Highly sloppy land low tillering variety	1.2m x 1.2m	2760

So with the help of this chart, we can calculate disease infected plants/ ropani or ha, and other calculations.

Cardamom is never alone; it has its friends like shade trees. We have calculated the additional income made so far from the shade trees. The income will be different based on local conditions. For example, if 1. Fire wood is costly 2. Timber is costly 3. Fruits of shade tree are costly 4. Nitrogen fixation cost. The organic matter originated fertilizer will have organic value which will have great influence in the price of the cardamom.

After understanding these facts it will be easier to go through questionnaires. Two advices for the interviewer to consider

1. The interviewer has to inform the farmers before starting the survey that their answers will be anonymous. They may, at any time, withdraw their participation, including the withdrawal of any information they have provided. If they complete the interview, however, it will be

understood that they have consented to participate in this research and agree to the publication of the overall results of this research with the understanding that anonymity of the interviewees will be taken into account.

2. Furthermore, the interviewer has to be aware that some questions in this questionnaire have extra information italicized in brackets. Thus, the interviewer should read this extra information only in case of the question is not clear for the interviewees.

### **Part 1: Introduction of the farm and General Information (Demographic Study)**

1. Name of the farmer  
.....
2. Address  
.....
3. Contact cell number  
.....
4. Number of Family member .....
5. Son: ..... Daughter: .....
6. Number of family members engaged in the cardamom production .....  
.....
7. Annual income from Cardamom .....
8. Altitude .....
9. Posture/Orientation of plantation (South faced/North faced etc.)  
.....
10. Shade tree .....
11. Number of seedlings per acre.....
12. Total area covered under large cardamom plantation .....
13. Manure application/Year .....

### Variety Detail

Variety of large cardamom planted (Please right tick):

- i. Ramshahi/ Ramsey
- ii. Golshahi/ Golse
- iii. Seremna
- iv. Barlangey
- v. Dambershahi
- vi. Ramala
- vii. Sawane
- viii. Chibeshahi
- ix. Madhushahi
- x. Rangbhang
- xi. Jirmale/Salakpure/Pakhe
- xii. Other

14. Year of Plantation.....

15. How many years old is the orchard? ..... Years

### Part 2: Meteorological Study (Provided by nearby station)

Year	Annual Average Rainfall (mm)	Average Relative humidity	Temperature	
			Minimum	Maximum
201...				
201...				
201...				
201...				

### Part 3: Insect Details

#### 1. Insect Problem(*Please tick right by pen*)

Insect Damage	Present	Absent	Damage Scale		
			Slight	Moderate	Severe
Aphid Banana					
Aphid Peach					
Aphid Maize					
Caterpillars					
Stem Borer					
Pod Borer					
Ant					
Stem weevil					
White Grub					
Shoot fly					
Other insects					

#### 2. What are the organic pesticides/ agents being used if any?

Name	Doze/Ropani	Successful	Unsuccessful	Remark
Nuclear Polyhedrosis Virus (NPV)				
Beuveria basiana (Fungus)				
Bacillus thuringiensis (Bt)				
Metarazium				

Trichoderma				
Neem Based				
Tobacco based				
Sichuan Pepper (Timur) based				
Ash				
<b>Chiuri</b> ( <i>Diploknema butyracea e</i> ) cakes				
Physical Method ..... .....				
<b>Use of Natural Enemy</b>				
Lady bird beetle				
Lace Wing				
Spider				
Syrphid larva				
<b>Any other means</b>				

3. Any new insect attacking cardamom due to climate change?

Yes

No

If any

.....

4. Do you feel intensity of insect attack has increased?

Yes

No

If so, % increase .....





5. Do you know green leaf manure application?
  - A. Sesbania/Daicha ( *S. rostrata* or, *S. acuminata*),
  - B. Sunhemp
  - C. Mug-Wort/Titepati
  - D. Crofton weed or sticky snakeroot/ Banmara
  - E. Albizia leaves
  - F. Other:

.....

**Part 6: Other problem**

1. Rodent Problem in the bush
 

Yes	No
-----	----
2. If Yes Do you know Owl are greatest rodent hunters?
 

Yes	No
-----	----
3. Do you have monkey problem
 

Yes	No
-----	----

 If yes how you control it? Write Farmers Experience.
  - a.
  - b.
  - c.
  - d.
4. Kala ( Himalia Palm Civet) problem
 

Yes	No
-----	----

 If yes, how you control it?
  - a. By dogs chase
  - b. Using traps
  - c. Other ways:

.....
5. Do you know nematode?
 

Yes	No
-----	----





Part 9 Cost of Production(Cardamom)												
ITEMS/ PARTICULAR	1 <sup>st</sup> Year		2 <sup>nd</sup> Year		3 <sup>rd</sup> Year		4 <sup>th</sup> Year		5 <sup>th</sup> Year		6 <sup>th</sup> -10 <sup>th</sup> Year	
	Quantity (Units)	Value	Quantity (Units)	Value								
<b>Gross Revenue</b>												
Main Products												
By-Products												
<b>A. Gross Income</b>												
<b>Cash costs components</b>												
Seeds												
Fertilizers												
Manures-purchased												
Pesticides												
Herbicides												
Hired labor												
Human												
Animal												
Machine												
Fuel and oil												
Electricity												
Irrigation fee												
Land rent												
Land tax												
Interest paid on crop loan												
Repairs of equipment/ machinery's												
Others (e.g. transport of inputs, supplies)												
<b>B. Total cash costs</b>												
<b>Non-Cash Components</b>												
Home grown seeds/ saplings												
Farm manures produced												
Hired labor paid in kind												
Value of unpaid labor												
Human												
Animal												
Irrigation fee in kind												

Land rent in kind (tenanted farms)														
Imputed rent on owned land														
Interest on (own) operating capital														
Depreciation of farm implements, machinery, farm budget														
Other costs														
<b>C. Total non-cash costs</b>														
<b>D. TOTAL COSTS (B + C)</b>														
<b>NET RETURN = PROFIT (A - D)</b>														

Thank you very much for participating in this interview!

Participant ID	
Date of visit	
Name of the Interviewee	
Address	
Telephone	
Email address	
Name of the Interviewer	
Signature:	

**Quality standard of large cardamom capsule (Source: BIS (Bureau of Indian Standards), 2009).**

<b>Quality parameters</b>	<b>Requirements</b>
1. Odor and taste	Free from foreign odor and taste, including rancidity and mustiness
2. Insects, molds and other infestations	Not more than 10% on visual observation
3. 1. Extraneous matter: Calyx and Stalks	Not more than 5% (by weight)
3.2. Other extraneous matter	Not more than 1% (m/m)
4. Empty and malformed capsules	Not more than 2% (by count)
5. Immature and shriveled capsules	Not more than 2% (by weight)
6. Light seeds	Not more than 3%
7. Insect damaged matter	Not more than 1% (by mass)
8. Moisture	Not more than 12% (by weight)
9. Volatile oil	Not less than 1% (mL/100 g) on dry basis

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