

Challenges and Opportunities in Value Chain of Spices in South Asia



Editors
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SAARC Agriculture Centre (SAC)



ICAR-Indian Institute of Spices Research

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Regional Expert Consultation Meeting on Technology sharing of spice crops in SAARC Countries, 11-13 September 2017, SAARC Agriculture Centre, Dhaka, Bangladesh

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Foreword

Agriculture has played a central role in the economies of South Asian countries. Over two-thirds of the population still depends on it for a living, and it accounts for nearly one-third of the region's exports. In statistical terms, the region occupies a major position in the world in several agricultural commodities including with spice crops. Spices are important essential condiments in the SAARC countries and there are many spice crops commonly grown in the region. The total demands of these spices are increasing among the SAARC countries as well as outside the SAARC countries. Among the SAARC Countries, India holds an important position in the production of such commercial crops as spices, together with bananas, tobacco, oil seeds, and cotton. SAARC Member States have been made significant progress in Research and Development on these crops and have high export potentialities of spices. However, to achieve such progress our joint efforts would be the crux for remarkable achievement. Therefore, sharing of production and post-harvest technologies are important for development, improvement and marketing of spice crops. Thus, documentation of value chain activities (production, post-harvest handling, processing and storage) of spices would be mutually beneficial to each member country.



Considering the diverse use and high potentiality of the value added products of the spice crops in South Asia, SAARC Agriculture Centre in collaboration with Indian Council of Agriculture Research (ICAR)-Indian Institute of Spice Research (IISR), Kerala, India organized a regional consultation meeting on “Technology sharing of spice crops in SAARC Countries”. This book “Challenges and Opportunities in Value Chain of Spices in South Asia” is a collection of papers contributed by the experts from SAARC Member States.

I would like to take this Opportunities to express my sincere appreciation to Dr. Pradyumna Raj Pandey, Senior Program Specialist (Crops), SAARC Agriculture Centre, Dhaka and Mr. Indra Raj Pandey, Senior Horticulturist (Vegetable and Spice Crop specialist), CEAPRED Foundation, Nepal for their hard work to put together the manuscript in this form. I am confident that this compilation will facilitate further research and development in Spice value chain development in SAARC Region.

Dr. S.M. Bokhtiar

Director

SAARC Agriculture Centre

Foreword

Spices evoke a strong sense of ownership among the South Asian countries as these crops have a long history of association with the social fabric and geo-political developments, not to mention its pervasive influence on the local cuisines and traditional medicinal systems. Concerted efforts for the development and strengthening of the spice crop economy attains urgency considering the potential of spice crops to engineer positive and significant changes in the livelihood status of millions of small holder producer households spread across the various SAARC Member States. It was in this context that SAARC Agriculture Centre (SAC), Dhaka partnered with ICAR- Indian Institute of Spices Research, Kozhikode, a constituent of Indian Council of Agricultural Research, to organize the Regional Expert Consultation Meeting on “Technology Sharing of Spice Crops in SAARC Countries” at Kozhikode, Kerala State, India during 11-13 September 2017.



The core objective of the meeting was to discuss the current status and level of production and processing technologies for spice crops available in the SAARC Member States with a special focus on black pepper, cardamom, cinnamon, ginger and turmeric. This meeting with an exclusive focus on spice crops of SAARC Member States is first of its kind. As one of the leading institution in spices research at the international level, ICAR-IISR is proud to host the gathering of an elite group of policy planners, researchers and other stakeholders from the SAARC region to discuss pertinent issues, identify critical gaps and evolve efficient strategies for strengthening the spice value chain starting from the primary producers to the final consumers.

The SAARC region has the potential to emerge as the global hub of production and supply of high quality and food safe spices produced under sustainable practices by leveraging the synergies amongst the member states and by developing harmonized and common market and trade development strategies. Sharing of specific strengths in production and processing technologies of the spice crops can improve the productive efficiency of the region and help in optimizing resource allocation among research and development priorities. Institutional innovations in organizing spice production and processing while ensuring community participation and ownership can also bring revolutionary changes in the spice economy of the SAARC Member States.

I express my sincere gratitude to SAARC Agriculture Centre for partnering with ICAR- IISR in organizing this important event and to all participants who attended the meeting from member countries for their valuable contribution. ICAR-IISR is glad to pledge our unwavering support for all the initiatives for strengthening of spice value chains in the SAARC region.

Nirmal Babu

Director

ICAR-Indian Institute of Spices Research

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Executive Summary

The estimated growth rate for spices demand in the world is around 3.2%, which is just above the population growth rate. The forecasted population increase is up to 1619 million in 2050 with increased GDP and per capita food spending. The per capita demand for spices is expected to increase many fold by 2050. Therefore, there is urgent need to continuously strive to increase spices productivity by enhancing input use efficiency and reducing post-harvest losses with an eye on reducing the cost of production. Moreover, spice crops constitute an important element in the agrarian economy of all the SAARC Member States. It is therefore important to evolve strategies aimed at strengthening this sector for ushering in robust growth in agricultural sector. The growth potential of this sector and the potential to bring about equitable development in the agrarian sector underline the urgent need for the SAARC Member States to evolve creative policy guidelines and strategies for promoting overall development of the spices sector.

The total demands of spices are increasing among the SAARC countries as well as outside the SAARC countries. Among the SAARC Countries, India holds an important position in the production of such commercial crops as spices, together with bananas, tobacco, oilseeds, and cotton. Significant progresses in Research and Development on these crops have been made by SAARC member countries. In addition to domestic consumption, these crops also have high export potential. Sharing of production and post-harvest technologies are important for development, improvement and marketing of these crops. Thus, documentation of production and post-harvest handling, processing and storage of spices would be mutually beneficial to each member country. Considering these aforementioned facts, three days regional expert consultation meeting in collaboration with ICAR-IISR, India had been successfully accomplished to share the technologies of spices production and value chain management with an objective of benefitting the economy of SAARC countries by spices production and developing intra and inter regional spice trade among SAARC countries.

Currently, farmers and agricultural entrepreneurs of SAARC countries have made tremendous contributions for the health and wealth of their countries. Around 63 spices are documented in India, of which 20 are commercialized. Spices contribute 6% of total GDP and 50% of foreign exchange from export of horticulture produce. Other than its culinary value, there are huge importance of spices as pharmaceuticals and nutraceuticals. There is an increase in productivity of spices due to improved varieties and technological interventions for the management of pest and diseases, micro irrigation etc. Though 90 % of spices are

consumed domestically, the export during recent decades has increased tremendously owing to price competitiveness and quality produce which were addressed by technologies.

Spices, apart from earning foreign exchange and also it is the sustainable source for the livelihood for many farmers in South Asia and many industries are supported directly or indirectly by spices. The issues with spices are low productivity and price volatility. Low productivity can be addressed by developing improved varieties using the strong genetic pool and biodiversity available with us and developing efficient production and post-harvest technologies. To address the issue of price volatility, farm insurance would be the best option by the respective government. Moreover, support for trade and procurement at fair price by the government need to be set up. Varieties to address climate change effect, to tackle pest and diseases need to be promoted among farmers and farmers need to be empowered and trained in value addition and product diversification. On the other hand, the policy decisions on sharing good quality planting materials among SAARC countries would be the crucial for enhancing production and productivity of spice crop. For this, establishment of Spice Seed Bank, provision for exchange of planting material and corpus fund for trade issues among SAARC countries are also urgently required.

In this standpoint, there are huge possibilities of introducing potential spices in Afghanistan. There are high potentiality of large cardamom, ginger, turmeric and cinnamon; value chain development and Research and Development on spice crops; promotion of developmental programmes in traditional spices like black cumin, asafoetida, garlic etc.; and initiation of promotional programmes on saffron cultivation. However, Bangladesh is a country with a very high cropping intensity of about 200% with a predominance of subsistence farming system. Ginger and turmeric are the only major spice crops in spite of good potential of other spice crops like large cardamom and cinnamon. As well as, Bhutan identified critical gaps at all levels of the value chain of two major spice crops grown in the country, large cardamom and ginger. There is urgent need to government interventions at different levels in Bhutan. On the other hand, it is remarkable that India has done significant achievement about the germplasm wealth of different spice crops, varieties released, technologies developed and commercialized, protected cultivation, site specific nutrient management, irrigation, value addition and processing machineries. It is also noted that adoption of high density multi species cropping system for ensuring farmers income in India has been successfully implemented. Likewise, the status of major spice crops of Nepal for export is mainly ginger and large cardamom. In Nepal, the local practices of removal of mother seed rhizome of ginger (Bruni) and

value added product like Sutho/ dried ginger are very popular. However, skilled development training on tissue culture for the production of virus free planting materials would be crucial and important for Nepal. In Sri Lanka, the initiatives in value chain development of spice crops like black pepper, cinnamon, ginger and turmeric are encouraging from the government and private sectors. There is significant difference between Ceylon cinnamon and Cassia cinnamon. Pruning the black pepper standard *Glyricidia* four times/year improved the black pepper yield in Sri Lanka.

In conclusion, there is urgent need to regulate easy germplasm exchange mechanism, development of common gene bank of spices for SAARC countries and generation of collaborated and coordinated technologies. It is urgent need for maintaining a dynamic and current database of spice crops in SAARC countries and there is huge scope of collaborative project between SAC and ICAR-IISR for exploring the possibilities of value addition and agri-business promotion in SAARC region with the technical and financial supports of private sectors and development partners.

Key Issues and Suggestions

Some of the key issues and suggestions from the participants of SAARC Member States are as follows:

- Exchange of germplasm within SAARC countries need to be made easier through strong policy support.
- Spice crop network to be created at SAARC regional level.
- Need to involve private entrepreneurs in value chain development initiatives and research.
- The promotion of solar power in processing the spices.
- Networking and strengthening of human resource development in spices technology and research capability in SAARC countries.
- Identification of elite germplasm across all spices in SAARC countries.
- Creation of strong spice trade network amongst SAARC nations with provision for information sharing cooperation and trade facilitation.
- Establishment of scholarships for promoting research in spices.
- Strengthening germplasm exchange between SAARC countries through mutually binding MoU's for exchange of germplasm.
- Developing common testing and research approaches against major diseases and pest in spice crops and SAC to play a more proactive role for harnessing synergies among member countries.

- Establishment of expert exchange program (more than 3 months) for the technology sharing for the SAARC countries.
- Standards of production and phyto-sanitary standards need to be harmonized to facilitate inter-country trade and export to abroad.
- Spice Board of India can help to establishing quality testing lab and standards among SAARC countries.
- Spice Board of India is the member of CODEX and has to leverage its expertise to develop common standards of production, processing and trade of spices and related value added products common to SAARC Member States.
- More emphasis needs to be given to business planning and development for small farmers and small holder production systems.
- Value addition in small pockets through appropriate sized processing units suited to requirements.
- Need to create awareness on the necessity to maintain the hygiene and safety in the entire production process.

Furthermore, emphasizing the clear strategic advantage of SAARC region in order to spices production in the global scenario with identified needs to speedy redressal through creative strategies and cooperation among the SAARC Member States. Likewise, it is important to the commercial potential for expanding the user base for the technologies developed within the country, both in the public and private sector can create a win-win situation for the spice farmers in the SAARC region and the technology developers. Finally, it is urgent need for technology adoption in enhancing the quality of spice products and extracting more value out of the farm production process through creative strategies in product aggregation, marketing and value addition.

Key Recommendation of Policy and Technological Interventions for Improvement of Spices in SAARC Countries

- Develop an integrated and holistic value chain mechanism in all SAARC member countries through need based technological interventions in spices sector.
- The SAARC Member States should have a unified standard on food safety and sustainability which need to be codified through frequent dialogues and interaction.
- Spice knowledge portals need to be set up for information and knowledge management pertaining to spice value chain development.

- Integration and harmonization of Good Agriculture Practices (GAP) and trade policies among member countries.
- Country specific researchable issues in spices need to be identified, prioritized and shared among member states to realize spill over benefits from spices research in the entire SAARC region.
- Create a research platform to address common problems in member countries and facilitate visit of experts across the SAARC countries to share their expertise.
- Pilot studies on feasibility of introducing newer spices to member countries should be undertaken.
- Immediate efforts should be taken to identify and document the intrinsic qualities of ethnic spice varieties to fetch premium price to growers.
- New research initiatives should be undertaken to establish the superiority of natural spices over synthetic ones.
- An integrated research and development project may be prepared and submitted for external funding by SAC to the national, regional institutions and potential Development partners.
- A spice task force on technology sharing and sorting out trade related issues may be set up.
- Technology hubs need to be created for creating awareness and sharing of technologies including varieties among member countries.
- Mechanism for developing creative partnership models with industry and private sector in contract farming and cooperative marketing, value addition and processing to be promoted.
- Harmonization of Standard Operating Practices (SOP) in quality evaluation and processing of spices.
- A Centre of Excellence in Spices may be established for human resource development and skill enhancement in a suitable location.
- Institute scholarships for post graduate and doctoral studies in spices for scholars from SAARC member countries need to be established.

Value Chain Development and Technology Practices of Spices in Afghanistan

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Introduction

Afghanistan is a landlocked country located in the center of Asia, forming part of South Asia, Central Asia, and Greater Middle East. It is bordered by Pakistan in the south and the east, Iran in the west, Turkmenistan, Uzbekistan and Tajikistan in the north, and China in the far northeast. More than 85% of Population of the country is dependent on agriculture and related activities for livelihood. About 12% of the country's total land is arable, 3% is under forest cover, 46% is under permanent pastures, and the remaining 39% is mountainous and habitable (Afghanistan Statistical Yearbook 2009-10). Agriculture has been the mainstay of the people's economy, although several decades of war and drought have depressed agricultural activities and contributed to the degradation of the natural resource base.

Given highly variable rainfall and concomitant variations in production from the rain fed sector, the irrigated sector traditionally provided 85% of all crops. However, since 1978, the irrigable area has declined by about 60% turning a country that was approaching self-sufficiency in crop production into a major importer of food grains, fruit and vegetables. Wheat is the staple crop, accounting for about 83% of total cereal consumption in Afghanistan. Other grains include rice, maize, barley, and pulses, Potatoes, onions, and several fruit crops including melons, water melons, apricots, pomegranates and grapes are also produced both for domestic consumption and exports. Exports of dried fruits and nuts, mainly apricots and almonds, are still a significant source of foreign exchange but they are nowhere near the levels of the 1980s when Afghan dried fruits accounted for almost 60% of the world market share (Afghanistan Statistical Yearbook, 2009-10).

In the last two decades, there has been no systematic collection and analysis of agricultural statistics. Internal war and insecurity have made slow the collection and analysis of agricultural record and registration bringing gaps in data. There is a need to take up agricultural survey and census. (Afghanistan Statistical Yearbook, 2009-10).

Afghanistan mostly import spices (Cardamom, Ginger, Turmeric Black Pepper and Cinnamon) from other countries such as china, Sri-Lanka, India, Pakistan, UAE, Turkey, Vietnam, Iran and so on. Afghanistan produces and export spices like Saffron, Cumin, Asafetida, and other spices which cultivated locally in the deferent region of the country.

Agricultural Land in Afghanistan

Afghanistan is essentially semi-arid to desert and most crop production is limited to pockets of irrigable land, with some rain-fed areas in the north and at high-altitudes. Crops cover less than 10% of the total land area; most of the rest is extensive grazing, desert or High Mountain and permanent ice. By far the greatest part of the land surface of Afghanistan is extensive grazing land - desert; semi-desert or high or Steep Mountain; only about 40% is said to be suitable for winter grazing. From satellite imagery it has been estimated that more than 70% is rough grazing, it shown in table below.

Table 1. Afghanistan - Land Use (2009)

Land Use	Area (hectares)	Percentage
Irrigated Agricultural Land	3,302,007	5.1
Orchards	94,217	0.1
Intensively irrigated	1,559,654	2.4
Intermittently cropped	1,648,136	2.6
Rain fed Agricultural Land	4,517,714	7.0
Forest Land	1,337,582	2.1
Rangeland	29,176,732	45.2
Barren Land	24,067,016	37.3
Marsh Land	417,563	0.6
Water Bodies	248,187	0.4
Snow-covered Area	1,463,101	2.3
Urban Area	29,494	0.05
Total Land Area	64,559,396	100

Source: MAIL, Statistic Department, 2015 and 2016

Spices in Afghanistan

Afghan cuisine has been influenced over thousands of years by Persian, Indian, Chinese and Mediterranean cultures. Spiced rice, peppered with lentils, raisins, carrots and onions are featured at nearly all meals, with spice rubbed grilled kabobs and mint often included as well. We're also featuring Afghani saffron from a company we love, Rumi Spice, started

by a pair of US military veterans. Rumi Spice has helped to create a supply of high-quality, sustainably farmed saffron from rural Afghan farmers. Get inspired cooking with these freshly ground Afghan spices, plus we've got plenty of recipes for inspiration.

Afghanistan has favorable climatic and soil conditions for the growth of diverse plant species. Spices are the most important plant for Afghan people and mostly the people of Afghanistan uses in daily dishes to flavor the food. The spices which imported from outside the country is listed below:

Table 2. Imported Spices in 2015

No	Countries	Value in US\$
1	China	4176
2	Sri lanka	42000
3	Guatemala	49950
4	Iran	9452
5	Pakistan	200450
6	Vietnam	45000
7	UAE	3938
8	Turkey	45850
9	Turkmenistan	3259
16	USA	23429
Total	427504	\$

Source: MAIL, Statistic Department 2015 and 2016

Afghanistan Saffron

Historically the word saffron goes as back as 10000 years, saffron is said to be derived from the word “zarparan” in Dari language which means that a flower its stigma is valued the same as gold like precious and expensive metal and this word had been turned in to saffron later on. It is said differently in many languages in Pashto and Arabic it is pronounced as “Zaferan”, in Farsi and Turkish it is pronounce as “Zefrun”, in English Saffron, in Spanish “Azafran” and French “Safrane”. Experts says that saffron has long been grown in Greece, Turkey, Afghanistan and Iran, and it has spread from far north up to far east of India, China, from West up to Spain (Human Terrain System, 2011). Today, significant success has been achieved and saffron is increasingly been grown in Afghanistan, saffron is cultivated in more than 7 provinces regularly, a total area of around 250 hectares involving approximately 1,300 farmers. 67,500 work days have been created, and around 3000 kg of saffron is

the estimate for the current year – with a value of Page1around \$3900000, calculated according to an average price of \$1300/kg (in addition to annual 1406.25 MT of livestock fodder produced as a by-product). Country-wide investment so far resulted in 14 private Afghan companies which are now engaged in processing and marketing saffron and the interest in buying Afghan saffron from abroad is increasing (including the US and Europe, UAE where it can pay the increasing in saffron price.). Estimated total suitable area for saffron production in Afghanistan is about 7,000-10, 0000 hectares. After cultivation of this area total production will be about 50,000 to 70,000 kg. Countries which are mainly famous for the highest value of saffron production are Iran which produces 200 tons per year, Greece which produces 5 to 8 tons a year, Afghanistan produced about 4 tons in 2015 and its raised to about 6 tons in 2016, Murakish and Kashmir which produces from 2 to 3 tons/year, respectively India up to 2 tons, Spain and Italy produces up to 1 ton, however France, Algeria, Egypt, Germany, Australia and China also have minimum saffron productions, the current global demand sits at 180/tons a years but if they consider growth trend in saffron uses and if each individual a year uses .25/grams of saffron for personal use , not considering commercial uses it will amount to 1500 tons per year demand.

Table 3. Imported Spices in 2015

No	Countries	Value in US\$
1	Azerbaijan	1852
2	China	7821
3	Germany	3359
4	Guatemala	2195
5	Italy	1672
6	Holland	11251
7	Pakistan	967944
8	India	4240
9	Vietnam	65750
10	Switzerland	303
11	Tajikistan	175
12	Thailand	123
13	UAE	87011
14	Turkey	10291
15	UK	2289
16	USA	11558
Total	1177834 \$	

Source: MAIL, Statistic Department 2015 and 2016



Sources: MAIL/ARIA (Agricultural Research Institute of Afghanistan)

Regardless of what planting method is used, in Afghanistan in general planting of saffron corm is done from late May through early October. However, recent research results from Khorasan Province in Iran with similar climate conditions as Herat Province indicate that planting of saffron corm from April through June leads the best production. Planting of saffron corm should be done following the instruction described for the different planting methods (Aslami *et al*).

The yield of the crocus flowers is generally low in the first year and increases over time. The production reaches its peak at its 4th and 5th year. The total life cycle of the crocus flower is 8 years which is explained in the table below.

Table 4. Saffron Yield in Deffrent Years of Field Age

Age of field	Flower yield (kg/ha)	Dry saffron yield (kg/ha)
1 st year	100	1.32
2 nd year	400	3.94
3 rd year	600	7.8
4 th year	800	10.5
5 th year	1000	13.2
6 th year	700	9.15
7 th year	600	7.8
8 th year	400	5.2
Average of 8 years	562.5	7.36

Source: Peter Wyeth and Najib Malik, 2008.

Value addition of Saffron

Afghan saffron which is not packaged international standards and there is a great investment Opportunities to make a packaging unit for saffron. It should be packed in air tight and light protected containers like tin cans and dark glasses. However, some buyers prefer saffron to be packed in a transparent glass so that they can make the quality assessment easily without necessarily removing the saffron from the container. If saffron is packed in a clear glass, it must be stored in a dark place until it is sold to prevent deterioration and loss of quality. Most plastic bags and solid plastic containers are not recommended in packing saffron. Although it can also be sealed, the aroma of saffron can still escape and the quality of spice becomes lower. When foods are packaged, government regulations state what information must be on the labels and these regulations vary from country to country. In most cases the labels should specify: The package contents, Net weight of contents, Name, address, telephone, email of importer, a lot number to identify the source of the saffron. Afghan saffron also receives complaints from international buyer due to its unprofessional processing, because there is no standard processing and testing facility available in the country. Therefore, this is a great Opportunities to potential investors. This is a great Opportunities, this is very important for saffron because Saffron is a delicate spice and its most crucial characteristics of color, taste and aroma can only be objectively measured through testing in laboratories by trained technicians (MRRD/NABPD/UNDP,2015).

The Afghan saffron market in terms of market structure and performance, looked at potential opportunities from an investor's prospective, identified the constraints and factors of market failure, and finally suggested and recommended some measures and actions for the development of this industry. Comparing with the global and regional markets, it is found that there are plenty of export opportunities for Afghan saffron and it is widely accepted in Europe, USA, UAE and other markets for its best quality. By comparing Afghan Saffron with Iran who produces 80% of the world saffron found that Iran has lower quality of saffron compared to Afghanistan, though, its saffron industry is much bigger in terms of number of firms, level of production, exports value. Therefore, there is no doubt that saffron industry in Afghanistan has great potential to grow further if packaging in designed according to international standard and farmers growing capacity, and processing facilities are developed well (Aslami, 2010).

Key Marketing Strategies for Saffron

The prices that farmers receive are determined in negotiations that they conduct with the traders to whom they sell. This is a good system, as

long as the farmers or their representatives have a clear strategy in mind and are well informed about market conditions. There are at least three possibilities, of which the second seems the most appropriate.

1. Prestige pricing: Set the price at the top end or above to indicate luxury quality. This is a possibility. It works where volume is small (as it is at present in the case of Afghan saffron) and it brings good profits. However, before it is feasible, a reputation has to be established for the brand as much as the product, and Afghan saffron does not yet have this.
2. Value pricing: Provide good quality and set the price to cover costs and make a good profit, but low enough so that customers feel they are getting good value for their money.
3. Penetration pricing: Set the price low enough to attract customers on the basis of price alone, with quality considerations being secondary at best. This strategy is not as profitable as the other two, unless producers have large volumes to sell. This is not recommended for Afghan saffron.

Value pricing amounts to setting prices slightly below the top of the range applicable to the grades that the Afghan farmers are selling. The only real difficulty with this approach in the case of saffron knows what the relevant price range is and, as saffron prices appears to be somewhat erratic; this is where understanding the market becomes important. The following three tables illustrate this. Table 2 shows prices collected on the internet for saffron that is being sold by vendors in the USA. It is difficult to make close comparisons between the prices because there are variations in whether shipping is included, what the packaging is, and saffron quality. However, close comparisons are not needed because, even allowing for these factors, there is a considerable difference between the prices (Peter Wyeth and Najib Malik, 2008).

Opium in Afghanistan

Recent estimates disclosed that in 2007, Afghan opiate/opium production accounted for about 93% of the world's total. This paper presents a framework for estimating the potential for source-country drug-control policies to reduce this production. It contains a first pass at estimating the potential for policy to shift the supply of opium upward, as well as a range of supply and demand elasticities. The estimates suggest that meager reductions in production can be expected through alternative development programs alone (reductions are less than 6.5% in all but one of the specifications presented). They also suggest that substantial increases in crop eradication would be needed to achieve even moderate reductions in production (reductions range from 3.0% to 19.4% for

various specifications). The results also imply that, all else equal, the cessation of crop eradication would result in only modest increases in opiate production with estimates ranging from 1.6% to 9.6% (Amirzada, 2003).

Analyzing the potential for policy to affect a farmer's decision to cultivate poppy requires an understanding of the factors that determine the desirability of poppy relative to other crops. Principal among these are the net incomes available from growing alternative crops, the risks associated with each crop (in terms of both expected yields and expected prices), and farmers' relative tastes for cultivating various crops (of chief interest here being distaste towards poppy due to its illicit nature with respect to both Islamic and secular law). The analysis in this section proceeds largely through a presentation of stylized facts about the evolution of Afghan poppy cultivation, beginning in the 1990s (when poppy was neither illegal nor widely objected to on religious grounds) and continuing through the less stable last 7 years (Amirzada, 2003).

The total area under opium poppy cultivation in Afghanistan was estimated to be 201,000 hectares (182,000-221,000) in 2016, which represents a 10% increase from 2015. In 2016, 93% of total estimated opium poppy cultivation in Afghanistan took place in the Southern, Eastern and Western regions of the country. The Southern region accounted for 59% of total estimated cultivation; the Western region for 25% and the Eastern region for 9%. The remaining regions (Northern, North-Eastern and Central) together accounted for 7%. The geographical locations of opium poppy cultivated area are in the most insecure provinces, with a security risk classified as "high" or "extreme" by the United Nations Department of Safety and Security (UNDSS), and they are mostly inaccessible to the United Nations and NGOs. Day Kundi is the only province in the South where security is generally good, with the exception of Kejran district.

Hilmand remained the country's major opium-poppy-cultivating province (80,273 hectares), followed by Badghis (35,234 hectares), Kandahar (20,475 hectares), Uruzgan³ (15,503 hectares), Nangarhar (14,344 hectares), Farah (9,101 hectares), Badakhshan (6,298 hectares), Nimroz (5,303 hectares), Faryab (2,923 hectares), Balkh (2,085 hectares), Saripul (1,686 hectares), Laghman (1,380 hectares), Zabul (1,363 hectares), Kunar (1,276 hectares), Ghor (1,222 hectares), Baghlan (849 hectares), Kapisa (608 hectares), Jawzjan (409 hectares), Kabul (398 hectares), Day Kundi (374 hectares) and Hirat (208 hectares) (Afghanistan opium survey 2016).

Cumin in Afghanistan

Cumin, generally called Zeera in Afghanistan, it has small seeds similar to fennel and anise seeds but resemble caraway seeds, being yellow to dark brown in color, with an oblong shape. Around 9 ridges along its boat shaped length; the seeds are dried to retain only 10% of their moisture content. Scientifically called *Cuminum cyminum* the plant bearing cumin seeds, is an herbaceous annual plant that grows to a height of 30-50 cm. It has a small flower that is colored white or pink. It bears an oval fruit that is 4-5 mm long and its fruit contains a single seed. Able to adapt to the climate this plant can be grown anywhere up to the elevations of 1000 meters above the sea level.

In Afghanistan mostly cumin has been grown locally and collected from the wild varieties of different provinces, the local people collect cumin seeds from mountain and after cleaning sell it to the local markets in the regions.

Afghanistan produces cumin in wide range as wild from local areas and export to other countries such as India, Pakistan, Iran and etc.

Cumin destined for export to southern Pakistan or onward to the Middle East, as well as Western Europe and the USA, were trucked down to Quetta from the main collecting and processing centers of Kandahar, Zabul, and Herat. Quetta was always a transshipment point for imports and exports from southern and western Afghanistan. The exact data of the products are not available due to lack of security in the most of provinces.

Asafoetida in Afghanistan

Other items regularly exported from Afghanistan included air-freighted to India from Kabul. Asafoetida, a wild gum resin from the Northwest was destined almost entirely for the Indian market, although in 1981/82, over 183 tons of Asafoetida was imported into Pakistan either for domestic consumption or for re-export to the West. Fodder seeds, significant exports from time to time, were sent to Quetta and Lahore. Small quantities of a local, sour, dried plum were also sold in Pakistan.

Official trade statistics during the years from 1982 to 1990 situation for Afghanistan have not been published so official figures of the change in volume and value of exports. Even figures of Afghan imports into recipient countries are seldom accurate as large quantities of Afghan produce are re-exported from Pakistan, India, the Soviet Bloc countries and Iran, without information as to their point of origin.

Channeling in Development of Spices in Afghanistan

Afghanistan is a complex challenge for establishing security and promoting economic development. Its poverty is the result of its

isolation, conflict and lack of effective governance, the main problem is lack of security in different region of the country to prevent agricultural research, particularly spices research. However, due to prolonged conflicts Afghanistan lost most of their constrictions as well as agricultural research bases, therefore, the spices crops products are mostly collected from local region except saffron.

Marketing Strategy for Saffron

There are two main elements to the strategy outlined here, which aims to give Afghan saffron producers the possibility of earning the highest possible prices. The first is to establish a separate identity for Afghan saffron, one that is entirely separate from produce from Iran or any other country, and to couple it with a reputation for high quality. At the moment, in economic terms, Afghan saffron is simply an unbranded commodity and, because buyers⁴ have no particular reason to purchase it in preference to saffron from anywhere else, producers have very little scope for negotiating prices. If Afghan saffron were recognized as special because of its quality, producers could ask for more than buyers pay for saffron from other countries. Afghan saffron is largely unknown at the moment and if producers take care to export only good-quality saffron, spice buyers will learn to appreciate it.

The second element in the strategy is to put producers or, more specifically, their representatives, in direct touch with buyers overseas. Producers would then clearly understand what world market conditions are, and will know who is offering the best prices and how to sell to them. At present, producers sell to local traders and have to trust what they are told, again putting themselves in a poor negotiating position. This is not to suggest that each producer should have his own contacts with foreign buyers, which would be impractical. Producer groups are already organized and a few members with an aptitude for marketing could be given training in how the market operates and how to make contact with buyers. As an ability to communicate in English or some other European language will be necessary, the producers are still likely to have to work with intermediaries of some kind, but if the producers know the market themselves, they will be able to ensure that, whoever the intermediaries are, they are working for the producers' benefit and not their own.

Conclusion

It's clear that spices are extremely important for Afghanistan economy and it plays a vital role in economic development of the country particularly saffron which is most expensive among all other spices is extended and cultivated more in the region, although the problems are

there and due to lack of modern lab for saffron testing qualities. It is growing in most areas of the country and yearly the farmers are interesting to cultivate more saffron than other crops. The other spices such as Cinnamon, black Peppers, Cardamom, Ginger and so are not adapt in Afghanistan, thus, the mentioned spices are imported from other countries.

In the saffron market, prices are in practice somewhat erratic, so high quality may not always bring high prices. However, if farmers are well informed about market conditions and in direct contact with buyers in other countries, they will be able to look after their own interests effectively and obtain the best possible prices.

In case of cumin and Asafetida these are produce mostly commonly not under research experiments, therefore, it's difficult to discuss about.

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Value Chain Development and Technology Practices of Spice Crop Research and Development in Bangladesh Cardamom (small and large), Ginger, Turmeric, Black Pepper and Cinnamon

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Introduction

A spice is a dried seed, fruit, root, bark or vegetative substances primarily used for flavoring, coloring or preserving food. FAO (2005) defined spices as “vegetable products used for flavoring, seasoning and imparting aroma in foods”. Spices enrich our diet as a good source of minerals, vitamins, antioxidant and other food compounds. Moreover, they are used in pharmaceutical, perfumery, cosmetics and several other industries. Many other spices crop are used in traditional cooking, healthcare, or other applications, in particular regions and traded locally. Spices are high value crops, it has significant role in our national economy. Spice crops are grown as trees, shrubs, perennials, annuals, wild and cultivated forms for seeds and fruits, leaves and stems, flowers and buds, roots and rhizomes, bark and resins to use as spices. The spice products are commercialized in various forms: sold fresh, frozen, dried, whole or ground, distilled into oils or solvent extracted into oleoresins. There is ample trade potential for small-scale farmers where growing conditions are favorable and has good local market demand for spices.

Spices are high value low volume cash crops. Farmers can benefit from spices enhancing their income and thus improve their livelihoods. A large proportion of spices produced by small-scale farmers is traded in both local and export markets worldwide and multi-billion US dollars are earned for small-scale farmers. World markets for spices are particularly in industrialized countries and in local markets as well.

Around 109 spice crops are of global trade importance, however, in Bangladesh 27 are used and 20 are produced under organized cultivation (Anon, 2017). This paper discusses only 5 spice crops, namely,

cardamom (small and large), ginger, turmeric, black pepper, and cinnamon on their production, processing, storage, value addition, prospect and potentials in Bangladesh focusing SAARC perspective.

Agricultural use

Ginger

Origin and Agricultural use: Ginger (*Zingiber officinale* Roscoe) is a flowering plant whose rhizome called, ginger root or simply ginger is widely used as spice and folk medicine. Ginger believed to be originated from the tropical rainforest in Southern Asia. However, ginger no longer found grown wild now. It is thought to have originated from the Indian Subcontinent because the largest variability of the ginger plants is available in this area. Accordingly, Bangladesh is one of the centers of origin of ginger. It is grown in most of the homestead garden in high land and hilly regions of the country. Ginger is a hot and fragrant kitchen spice. Young ginger rhizomes are juicy and fleshy with mild taste. They are cooked as an ingredient in many dishes, often pickled in vinegar, or sherry as a snack, can be made into candy etc. Mature gingers are fibrous and nearly dry.

Therapeutic use: Ginger root has been known for over two thousand years as a medicinal herb effective in treating digestive problems, nausea, hangover and gases. Modern studies have found that it is effective in the treatment of vomiting, protects the gastric mucosa and improves inflammatory conditions. Ginger has a long history of medicinal use (Afzal *et al.*, 2001; Awang, 1992). Moreover, ginger has been used to treat a wide range of ailments including stomachaches, diarrhoea, nausea, asthma, respiratory disorders, toothache, gingivitis, and arthritis (Awang, 1992; Leung, 1980). Today, ginger and its extracts are recommended by herbal practitioners primarily for dyspepsia and the prevention of motion sickness (Blumenthal, 1998).

Turmeric

Origin and Agricultural use: Turmeric (*Curcuma longa*) is a rhizomatous herbaceous perennial plant of gingeraceae family; it's a native plant to Southeast Asia. Turmeric is a tropical plant that is cultivated extensively in Bangladesh, India, China, Nepal and other countries with a suitable climate. It is a perennial herb and can grow up to 1 m. high, and has oblong, tufted leaves. The yellow spice is made from the rhizomes (roots), which are boiled, dried, and then ground (Bharat *et al.*, 2005; Dobelis, 1986).

Therapeutic use: Turmeric has served mankind for thousands of years, as a safe and effective traditional medicine. Turmeric is anti-aging,

antioxidant, anti-inflammatory super spice. Curcumin is the magical substance which gives turmeric its golden color and its many health benefits, has been well studied over the past decades. It works as a powerful antioxidant and has anti-inflammatory and antiseptic properties. Turmeric is jam packed with healthy nutrients, vitamins and minerals and is a powerful and effective compound for treating a wide range of diseases. Studies have revealed that turmeric has low absorption and rapid metabolism that lead to relatively low bioavailability in the body. The anticancer properties of turmeric include inhibiting cell proliferation and inducing apoptosis of cancer cells. Yellow spice exhibits anticancer (Azuine and Bhide 1994; Deshpande, Ingle, and Maru 1997; Garg, Ingle, and Maru 2008), hepatic-protective (Miyakoshi et al. 2004), cardio-protective (Mohanty, Arya, and Gupta, 2006), hypoglycemic (Kuroda *et al.*, 2005; Honda *et al.*, 2006), and antiarthritic properties (Funk *et al.*, 2006). Phytochemical analysis of turmeric has revealed a large number of compounds, including curcumin, volatile oil, and curcuminoids, which have been found to have potent pharmacological properties.

Black Pepper

Origin and Agricultural use: *Piper nigrum* (Piperaceae) is a valuable medicinal plant. It is one of the most commonly used spices and considered as "The King of the spices" among various spices and is grown in tropical and subtropical region including Bangladesh. *Piper nigrum* is commonly known as Kali Mirch in Urdu and Hindi, Pippali in Sanskrit, Milagu in Tamil and Peppercorn, White pepper, Green pepper, Black pepper, Madagascar pepper in English. Hot and pungent peppercorns are obtained from Black pepper, which is the most famous and one of the commonly used spices throughout the world. Black pepper is used as medicinal agent, a preservative, and in perfumery. Whole Peppercorn of *Piper nigrum* or its active components are being used in different types of foods and as medicine. Pepper is used worldwide in different types of sauces and dishes like meat dishes. It contains major pungent alkaloid Piperine (1-peperoyl piperidine) which is known to possess many interesting pharmacological actions. *Piper nigrum* is also used as a flavoring agent (Ahmad et al., 2012).

Therapeutic use: It is widely used in different traditional systems of medicine like Ayurvedic and Unani System of medicines (Ahmad et al., 2012; Acharya et al., 2012). Piperine exhibits diverse pharmacological activities like antihypertensive and antiplatelet (Taqvi et al., 2008), antioxidant, antitumor (Manoharan et al., 2009), antiasthmatics (Parganiha et al., 2011), antipyretic, analgesic, anti-inflammatory, anti-diarrheal, antispasmodic, anxiolytic, antidepressants (Li *et al.*, 2007), hepato-protective (Matsuda et al. 2008), immuno-modulatory,

antibacterial, antifungal, anti-thyroids, antiapoptotic, anti-metastatic, antimutagenic, anti-spermatogenic, anti-colon toxin, insecticidal and larvicidal (Damanhour, 2014) activities etc. Piperine has been found to enhance the therapeutic efficacy of many drugs, vaccines and nutrients by increasing oral bioavailability by inhibiting various metabolising enzymes (Johnson et al., 2011). It is also known to enhance cognitive action and Fertility (Wattanathorn, 2008). Piperine also found to stimulate the pancreatic and intestinal enzymes which aid to digestion. Many therapeutic activities of this spice are attributed to the presence of piperine apart from other chemical constituents. The fruits of *Piper nigrum* are used to produce white and green peppers.

Cinnamon

Origin and agricultural use: Cinnamon has been in use by human beings for thousands of years – as early as 2000 B.C. Around 1518, Portuguese traders discovered cinnamon at Ceylon, present day at Sri Lanka. The bushy evergreen tree of laurel family native to Sri Lanka, Malabar Coast of India, Bangladesh, Myanmar (Encyclopedia Britannica, 2008). Cinnamon is one of the most important flavoring agents in the food and beverage industry, and has been recognized for its flavoring and medicinal properties since antiquity. “True” cinnamon (Ceylon cinnamon) is the dried bark of *Cinnamomum verum* J. S. Presl (syn *C. zeylanicum*), of family Lauraceae, a small evergreen tree native to Sri Lanka and characterized by oval shaped tree, thick bark, and a berry fruits. The bark and leaves are the primary parts of the plant use.

Therapeutic use: Cinnamon is the bark of *Cinnamoni cassiae* and has been used as traditional folk herbs to treat inflammation for thousands of years in Asia. It is also used in food industry as antioxidant and spicy agent. In recent years, several studies have reported that cinnamon extract has antidiabetic (Rafehi, 2012, Murray 2002, Khan 2003). Talpur et al. (2005) showed that cinnamon oils can improve insulin sensitivity and Roffey et al. (2006) reported that cinnamon water extract (CE) increases glucose uptake in 3T₃-L1 adipocyte. However, the separated compounds derived from cinnamon displayed little insulin like or insulin-enhancing activity (Anderson et al., 2004).

Cardamom (Small and Large)

Origin and agricultural use: Cardamom is a spice made from the seeds of several plants in the genera *Elettaria* and *Amomum* in the family Zingiberace. Both genera are native to India, Bhutan, Indonesia and Nepal. They are recognized by small seed pods: triangular in cross section and spindle-shaped, with a thin papery outer shell and small black seed. *Elettaria* pods are light green and smaller, while *Amomum*

Pods are larger and dark brown. Both the forms of cardamom are used as flavorings and cooking spices in both food and drink, and as a medicine. Cardamom has a strong, unique taste, with intensely aromatic, resinous fragrances. Black cardamom has a distinctly smokier, though not bitter, aroma, with a coolness some consider similar to mint. Cardamom is a common ingredient in Bangladeshi cooking, although, it is not grown in Bangladesh but imported from India and Sri Lanka.

Therapeutic use: The main ingredients of cardamom consist of oil, wherein the main constituents are 1, 8-cineole (representing 50% or more), with trace amounts of α -terpineol, citronellol, phellandrene, sabinene, myrceneborneol, camphor, terpinene, p-cymene, terpinolene, linalool, and pinene (Ammam, 2015). In numerous experimental studies, cardamom showed to exhibit anticancer (Bhattacharjee 2007), gastroprotective (Jamal, 2006), antihypertensive (Gilani, 2008; Verma, 2009), anti-inflammatory (Al-Zuhair, 1996) and immune-modulatory (Majdalawieh, 2010) properties. Several studies have shown that cardamom is a potent blocker of lipid peroxides formation and scavenger of superoxide anions and hydroxyl radicals (Qiblawi, 2015; Yadav and Bhatnagar, 2007) (There is not mentioned in reference, pls. follow strictly.) The free radicals generated oxidative stress plays a critical role in the pathogenesis of MI and cardamom is reported to exert potent antioxidant and free radical scavenging activity (Yadav and Bhatnagar, 2007). Apart from antioxidant activities, the hypotensive, fibrinolytic, vaso-relaxant and antiplatelet properties are also reported (Suneetha, 2007), which may substantially aid to its cardio-protective actions.

Ginger, turmeric, black pepper, cardamom (small and large), and cinnamon spices can often be successfully cultivated on a small-scale or sustainably gathered from the wild. For the cultivation of many of these crops expensive machinery is not needed. In Bangladesh ginger, turmeric, black pepper are cultivated commercially, while cinnamon is grown very limited scale and cardamom is not grown at all. By importing from other countries, Bangladesh fulfills its internal demand. Moreover, ginger and turmeric are common in most of the homestead of the country and organized production by farmers, contract farming for company. High lands and hilly regions are suited for ginger, turmeric, and black pepper cultivation in Bangladesh.

Area and Production Status of Commonly Use Spices Crop (Cardamom, Ginger, Turmeric, Black Pepper, and Cinnamon)

According to AIS (2016) area under organized cultivation of spices crops is 374 thousand hectares, which shared only 3% of cultivable land (Figure 1). However, among the listed spices crop area and production status are available only of ginger and turmeric in the BBS 2017 (Figure

2). It is revealed that the area under turmeric was high as compared to ginger while, per hectare production was less in turmeric.

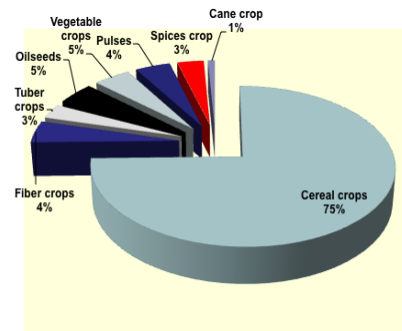


Figure1. Land shared of spices crop in Bangladesh

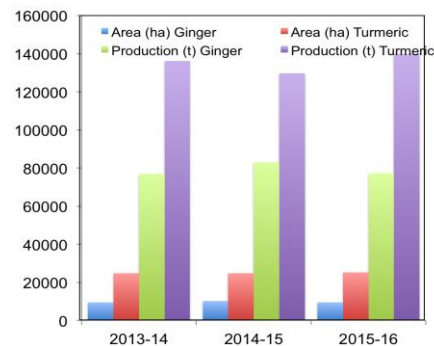


Figure 2. Area (ha) and production (t) under ginger and turmeric during 2013-16

Source: BBS, 2016

Bangladesh is almost meets the requirement of ginger and turmeric production, however, the country has a dream to earn foreign currency by exporting these spice crops. Therefore, policy makers have been underscoring to boost the production by increasing productivity, as the unit area production is low compared to neighboring countries.

Production Technology, Post-Harvest Handling, Processing, Value Addition and Storage of Spices

Production Technology

Turmeric

Soil: Different kinds of soils such as sandy loam to clay loam or alluvial soils are suitable to grow turmeric, while well-drained loamy soils are the best. Soil should be rich in organic matter and uniform in texture. Rich loamy soils having natural drainage and irrigation facilities are the best. Turmeric cannot withstand water stagnation or alkalinity.

Climate: As a tropical crop, turmeric require warm and humid climate. Temperature ranging from 24.6 to 28 °C is the best for turmeric. Growth ceases when, temperature falls below 20 °C, and hence early-planted turmeric gives good yield. It thrives well in localities with annual rainfall from 70 - 225 cm. It can be grown at an altitude of 1200 m.

Variety: landraces maintained by the farmers are common; besides, BARI released 5 varieties namely, BARI Halud 1, BARI Halud 2, BARI Halud 3, BARI Halud 4 and BARI Halud 5 (Anon 2016) and these are getting popular across the country.

Cultivation of Turmeric

Seed Material: Seed of turmeric consists of rhizomes. Both mother and finger rhizomes are used. The fingers are cut into pieces, each with 4-5 cm long having 1-2 buds. Mother rhizomes are planted as such or split into two, each having one sound bud. Large sized, plummy and healthy mother rhizomes at least 25 gm. in weight should be used. Seed Rates are varied according to type of planting material, spacing and weight of rhizomes. Mother rhizomes: 2500-2800 kg/ha, and Finger rhizomes: 1800-2200 kg/ha and as an intercrop in fruit garden: 400 - 500 kg/ha planting materials are required.

Land preparation: Land preparation starts immediately after harvest of previous crop or with/onset of early rains in plains. Land is ploughed 15-20 cm deep and exposed to sun for one month. A crosswise harrowing is given 2-3 times. Temporary ridges are opened to prevent soil erosion on sloppy lands.

Systems of Planting: Two planting systems are followed flat beds and ridges and furrow beds. Flat beds are used under rainfed conditions where soils are light. Flat beds 1 m. in width and of suitable length varying according to the length of land are prepared. Ridges and Furrows are followed under irrigated-conditions where the land is leveled or plain and soils are heavy, planting is done on ridges and furrows, opened at 75 cm distance and having length 3 - 3.5 m.

Planting of Turmeric: Season of Planting is April to May depending on tract. April is the best time of planting rhizomes.

Method of Planting: On Flat Beds 50 x 25 cm in each direction and on ridges and furrows: 60 x 25 cm. Rhizomes are planted at 1/3rd height of ridge on broad ridge.

Manuring and Fertilization: Turmeric is a heavy feeder crop. BARC recommended fertilizer dose is; 5 or 3 ton cow dung or poultry refuse, 120 kg N, 36 kg P2O5 and 105 kg K2O/ha (FRG, 2012).

Intercropping: Mixed crops like chili, onion, brinjal and cucurbits can be grown.

Intercultural Operation

Mulching is done when-planted on raised beds and 2-3 mulching are given with straw, water hyacinth. Weeding and intercultural operations are done 1st immediately after planting, 2nd and 3rd at an interval of 40 – 50 days. Earthing up is done to avoid exposure of developing underground rhizomes to sun due to soil erosion by light digging, 2 - 2.5 months after planting.

Weeding: Plot is kept clean during first 4-6 weeks. Depending on intensity of weeds, 5-6 weeding are given.

Irrigations: First irrigation is given before planting. It is generally cultivated as rainfed crops in Bangladesh. So, 2-3 irrigation in the early growth stage and 2-3 irrigation at later growth are needed.

Harvesting: Harvest is started from February, and continued till April. Rhizomes are ready for harvest in 7-9 months after planting. Turmeric is harvested when leaves start yellowing and ultimately the stem dries down. The plants are cut close to the ground. The crop is irrigated lightly for easy digging. Harvesting consists of digging of underground clumps of rhizomes.

Yield: Yield is varied on cultivar, climatic conditions, locations and other management issues. BARI released varieties have the yield potentiality for the fresh 15-30 t / ha while 5-9 t / ha for dry.

Ginger Production

Soils: Ginger requires fertile well-drained loamy soils. Heavy clays restrict the development of bold smooth rhizomes. On heavy soils, attention should be given to provide good drainage. Ginger thrives well in slightly acidic soils with pH range of 4.5-6.5.

Climates: Ginger is tolerant to a wide range of climatic conditions. It requires a tropical climate with heavy rain period followed by a hot dry spell. The optimum temperatures range for growing ginger is 25 - 30 °C with a mean annual range of 18-27 °C. Ginger is frost susceptible and low temperatures induce dormancy. Temperatures above 32 °C and intense sunlight can result in leaf scorch particularly in young plants. To minimize the leaf scorch due to high temperatures, it is recommended that the crop is interplanted with a cover crop to provide shade, but ginger is best grown under open cultivation. The crop can grow in areas ranging from coastal lowlands to 1500 m above sea level. Ginger requires 1000-2000 mm of rainfall annually.

Land preparation: Land preparation should be done early at least 2 months before planting. Deep cultivation is required to ensure adequate rooting depth and to eliminate perennial weeds. It is important to incorporate well-decomposed manure to adjust soil pH and organic matter levels by the time of planting. Ridging is necessary for best performance.

Cultivars grown: It is essential to get the right cultivars of ginger to meet specific market requirements. Traditional cultivars have been growing most of the cases in Bangladesh. However, BARI released 3 varieties namely; BARI Ada 1, BARI Ada 2 and BARI Ada 3 are also cultivated by the farmers.

Propagation: Rhizomes for propagation should be selected at harvest, hardened and stored until next season. The rhizome fingers are separated into setts each approximately 2.5cm long and with at least a visible eye to give rise to a new plant. Setts should be pre-germinated before planting by covering with moist organic layer of damp sawdust.

Planting: Before planting, the setts should be dipped in a fungicide solution to minimize fungal infection, followed by hot water treatment for 20 minutes at 48⁰ C to eliminate nematodes. Sets are planted on ridges 150 - 60 cm apart, 25-30 cm within rows and at a depth of 5-10 cm. Adequate watering is necessary for uniform germination. Shoots start appearing after 15-20 days and will continue over a period of 4-5 weeks.

Seed rate: The recommended seed rate varied from 1.5-1.7 tons/ha, depending on when the crop is to be harvested, higher rates used if the crop is to be harvested early.

Fertilizer requirement and application: Recommended fertilizer rates are 120 kg N/ha, 45 kg P/ha and 120 kg K/ha (FRG 2012). Phosphate fertilizers should be applied and incorporated into soil prior to planting, N and K should be applied in 2 splits- 1st at 1-2 months after planting, 2nd at 3-4 months after planting applied in bunds along ridges followed by earthing up.

Manure: Ginger responds to organic manure and recommended rates are 5 or 3 tons/ha as cow dung or poultry refuse to be applied before planting.

Weeding is critical due to an extended germination time, slow initial growth and poor early ground cover. Manual weed control should be done with minimal disturbance to avoid crop damage. Perennial grasses must be eliminated before planting.

Harvesting and post-harvest handling: Full maturity is attained at 8-10 months when leaves turn yellow and start to lodge. Harvesting is done when plants are fully matured but depending on the market, harvesting can be done before full maturity. As plant matures volatile oil content decreases and fiber contents increase. Ginger rhizomes for preservation are harvested at 7 months when fiber content and pungency is still low. Ginger for fresh and dried products is harvested when volatile oil content is at maximum, at 7-9 months. Fully matured ginger rhizomes are harvested and sun-dried for longer preservation.

Yield: The yield potentialities of BARI released varieties ranged 20-30 t / ha.

Black Pepper

Soil: Black pepper is cultivated in Sylhet, Chittagong, and Chittagong hill tract of Bangladesh by the indigenous communities of those areas. Pepper can be grown in clay loams, red loams and sandy loams slightly acidic soil. However, it thrives best on well drained virgin soil rich in humus content and other plant nutrients.

Climate: pepper is a plant of humid tropical climate. An annual rainfall of about 250 cm is required for its proper growth and successful cultivation. It tolerates a minimum of 10 °C and a maximum of 40 °C. Although pepper can be grown from almost sea level to an altitude of 1,200 meters, lower elevation may be preferable.

Variety: Traditional cultivars are popular across the growing areas and BARI Golmorich-1 is also used by the farmers.

Propagation: Generally propagation of black pepper is done from cuttings. During the month of March- April, pepper cuttings of 2 to 3 nodes length are put in the soil filled bamboo basket or in perforated polythene bags for initiation of rooting. These cuttings are ready for planting in about 3 months.

Rooted cuttings:

- Pits measuring 60 cm x 60 cm x 60 cm may be dug at a distance of about 1.8 meter apart each other. The pits may be filled with well rotten cow dung and soil in the ratio of 3:1 before planting. Three to four rooted cuttings are generally planted in each pit. The growing shoots are coiled on stakes planted at corners of the pit.
- Pits 60 cm x 60 cm x 60 cm are dug at a distance of 1 meter apart. Two or three rooted cuttings are planted in each pit. One stake is put at one end of each pit and the cuttings are tied on the same for climbing. In due course runners will extend from each cutting and the nodes of these runners may be fixed in the dug soil and stakes provided for each such point for support of the pepper vines. Horizontal stakes may be provided to connect the pits for climbing of the new shoots, coming up from each point. The new shoots may be coiled on the stakes. By following the above methods a large number of cuttings can be had within a short time.

Season of planting: May – June

Planting Methods: The pepper is a climber and hence, it needs support of some other plant (called standard) to climb. Many of the existing trees in a garden such as areca-nut, coconut, jackfruit, mango and other forest trees can be used as the standard or mother plant. When such plants are not available cuttings of *Erythrina indica* may be planted ahead of pepper cutting season to be used as a standard. Pepper should be planted

at a distance of three to four meters from plant to plant on either side. Pits measuring 0.5 m x 0.5 m x 0.5 m should be dug on the northern or eastern side at a distance of 30 cm away from the standard. With the onset of monsoon 2 to 3 rooted cuttings are to be planted in the pits prepared earlier at the base of each standard. It is to be ensured that at least one node of the cuttings goes underground and the upper portion of 45 cm or more being made to rest on the standard. The pits are then to be filled in with the soil mixed with about 9 kg of compost or well rotten cattle manure and should be pressed hard to avoid water stagnation. Adequate shade may be provided when the pepper plants are young.

Cultural operation: Rooted cuttings are to be tied up to the standard as and when required till the vines get established firmly on the standard. Two diggings around the standard and vines should be given once in the month of August – September and another in the months of October–November. The vines should be earthed up along with the operation of digging. In case of hill slope plantation, contour and terracing should be done to prevent soil erosion.

Manures & fertilizers:

- Apply about 10 kg of well rotten cattle manure or compost per vine per year during April- May.
- Apply ammonium sulphate 500 gm., super phosphate 1 kg and MoP 100 gm per year per vine in the month of August – September.
- Apply slaked lime at the rate of 500 gm per vine in alternate year during April – May.

The manure and fertilizers should be applied around the vine to a depth of about 15 cm. Manures and fertilizer should not be applied at too close or at the base of the plant. Harvesting and curing: Harvesting starts from November and continues up to March. Harvesting is done by hand picking the whole spikes when one or two berry on the spike turns into yellow or red.

Yield: BARI Golmorich-1 has the yield potential of 2.0 - 2.5 kg / plant.

Cinnamon

Soil: The quality of the bark is greatly influenced by soil and ecological factors. Well-drained soil rich in humus content is most suitable. Sandy loam soils liberally incorporated with organic manures are best. Red dark brown soils free from rock gravel or quartz are also good, for cinnamon cultivation.

Climate: Cinnamon requires hot and humid climate. Annual precipitation of 150 to 250 cm and average temperature of 27°C are ideal. It can be cultivated up to an elevation of 200 m from the sea level.

Prolonged spells of dry' weather are not conducive for successful growth.

Propagation: Cinnamon is commonly propagated through seed, though; it can be propagated by cuttings and air layering. The fully ripe fruits are either picked up from the tree or fallen ones are collected from the ground. Seeds are removed from fruits, washed free of pulp and sown without much delay, as the seeds have a low viability. The seeds are sown in sand beds or polythene bags containing a mixture of sand, soil and well - powdered cow dung in a 3:3:1 ratio. The seeds germinate within 10-20 days. Frequent irrigations are required for maintaining adequate moisture level. The seedlings require artificial shading till they become 6 months old.

Planting: Pits of 50 x 50 x 50 cm are dug at a spacing of 3 x 3 m. They are filled with compost and-topsoil before planting. Cinnamon is planted during June-July to take advantage of monsoon for the establishment of seedlings. One-year-seedlings are planted. In each pit, 5 seedlings can be planted. In some cases, the seeds are directly dibbled in pits that are filled with compost and soil. Partial shade in the initial years is advantageous for healthy and rapid growth of plants.

Manuring and Fertilization: 1st year: 20 g N, 18 g P₂O₅, and 25 g K₂O / seedling. Three years after planting: 29 kg F.Y.M., 4 kg neem cake, 150 g. N, 75 g P₂O₅ and 150 g K₂Q per plant. The fertilizers are applied in two doses during first week of September and in March.

Training and Pruning: When the seedlings become 2-3 years old, the shoot is cut back to a height of 30 cm from ground level to produce side shoots. This is called 'coppicing'. This is done till the whole tree assumes shape of a low bush with side shoots springing forth profusely. Sometimes, stooling is done by slight mounding of soil to encourage shoots.

Aftercare: Watering of newly planted seedling is done profusely and periodically. In the first 3-4 years, weeding is done 3-4 times in a year. Subsequently one or two weeding is required. Seedlings grow to a height of 2 m in 7 years.

Yield: It varies with type of variety and age.

- | | | |
|---------------------------|---|--------------------------|
| a. 3-4 year and onwards | - | 45 to 90 kg quills/ha. |
| b. 10-11 year and onwards | - | 178 to 260 kg quills/ha. |

Post Harvest Handling

Ginger

Washing and Drying: Fresh rhizomes are washed, and cleaned from debris, shoots and roots. Washing is carried out with clean water.

Another method is to scrape, peel, or slice rhizomes prior to drying. Peeling or scraping is advised for reducing drying time. However, while this process decreases the fiber content by removing the outside corky skin, it also tends to remove some of the oils constituents, as they are more concentrated in the peel, and therefore reduces some of the pungency. The peeled rhizomes may be bleached to improve appearance. After peeling and washing, rhizomes are first soaked in water for 2 to 3 hours, and then steeped in a solution of 1.5 to 2.0% lime (calcium oxide) for 6 hours, finally, that will be drained and sun-dried. This procedure is used when a light bright color is desired. Drying is done to 8-10% moisture, and should not exceed 12%. Expected weight loss during drying is 60-70%.

Turmeric

Curing, drying and polishing: Turmeric rhizomes are cured before drying. Curing involves boiling the rhizomes until soft. It is performed to gelatinize the starch for a more uniform drying, and to remove the fresh earthy odor. During this process, the coloring material is diffused uniformly through the rhizome. Traditional methods of boiling are common in water for 45-60 min to one hour, until froth appears at the surface and the typical turmeric aroma is released. The color may deteriorates as a results of over-cooking, but that the rhizome becomes brittle when undercooked. Optimum cooking is attained when the rhizome yields to finger pressure and can be perforated by a blunt piece of wood. To improve the color alkaline water by adding 1% sodium carbonate, or lime and boiling is done. For the curing process, it is important to boil batches of equal size rhizomes since different size material would require different cooking times. Practically, fingers and mother rhizomes are often cured in separate batches, and mother rhizomes are cut in halves. Cooking may vary from one to four or six hours, depending on the batch size. Curing is more uniform when done with small batches at a time.

Drying of turmeric: Sun drying is common in Bangladesh, usually drying is carried out on Bamboo mat and dried place. The boiled turmeric is kept on bamboo mat by 5-6 cm layer. On night the turmeric are wrapped with jute mat. This way takes 10-15 days it gets dry and the moisture percent becomes 8-10. The stone like feeling in finger is the characteristics symptom of adequate dryness. Usually from 100 kg of fresh turmeric 20-30 kg dried turmeric is produced. To produce quality dried turmeric BARI developed 1 solar and cabinet type drier is very suitable.

Polishing: Polishing is done to give an attractive color and getting higher price, for polishing 5-7 kg of dried turmeric are kept in plastic or jute bag

and hit on hard floor or log. Hitting by log inside the cement pot is a manual process of polishing.

Coloring: After keeping in the sun 2/3 days polished turmeric are kept inside a drum and add 100 g turmeric powder. Then the drum is rotated for 5 min thus give the attractive color of the turmeric. Another formulation is made for polishing.

Black Pepper

The fruits are kept in a pot after collecting and then boiled for 10 min. The hot water is poured and kept in a pot. Then the fruits are sun dried. During drying the leftover boiled water is sprayed manually on the fruits and fruits spared time to time to have desired color and flavor. Usually 6-7 days are required to dry. After that the fruits are ready to pack and selling and processing.

Processing

Ginger

Ginger powder: To prepare ginger powder, ginger and salt are required. Initially undamaged and diseased free fresh ginger are peeled and washed by clean water. The ginger chopped by 3-4 mm thick and boiled in water for 5-10 min. Then the materials are immersed into 10-15 % salt solution for 6 h and sliced ginger are dried in a mechanical/ solar/ sun dried at 50-60 °C adequately. Then the dried gingers are blended in a machine followed by packing in aluminum foil or hermetic jar. The ginger powder can be stored for 2-3 years. This type of ginger products is popular among the urban consumer even exported too.

Ginger pickle: For preparing ginger pickle ginger (250 g), lemon juice (200 ml), salt (5 g), chilli powder (5 g), green chilli (6 no.), black cumin (5 g), sugar (100 g) and adequate amount mustard oil are required. By squeezing lemon juice are taken out. Undamaged and diseased free fresh ginger are peeled and washed by clean water. The cleaned ginger are boiled for 20-25 min and drained out the water. The green chilies are chopped into small pieces. The salts, black cumin, chili dust, chopped chilies, and lemon juice are mingled and are kept under sun or 50 °C for 4 days. Then the mingle product are immersed into mustard oil in a glass jar. The prepared pickle might be stored at room up to one year.

Ginger jam: Ginger (250 g), sugar (350 g), honey (2 spoons), essence (2 drops), citric acid (5 g), pectin (5 g), K M S (60 mg) etc. are required for preparing ginger jam. Peeled ginger chopped into small pieces and mingled into 5-6 cup hot water until the pieces get soft. Then the soft ginger blended to pest. Syrup is prepare by heating sugar water solution and then mixed with ginger pest. Then adequate amount of pectin and

KMS solution and boiled 10-15 min. finally the honey and essence are added with the prepared materials and are allowed to cool down. Cool jam is stored at sterilized jar and keeps at refrigerators or room temperature.

Turmeric

Turmeric pest: Adequate amount of cleaned fresh turmeric are collected. To stop the enzymatic reaction the turmeric rhizomes are boiled in a pot for an hour. The boiled turmeric is crushed by stone or chopper machine. The halves smashed are poured into blender machine and add water in a ratio of water and turmeric 1:4, blended for 2 min. For storing longer time add 0.5% citric acid for adjusting pH 6 to 4 and 0.1% sodium benzoate.

Turmeric powder: Polished turmeric are crushed by machine and packed. In Bangladesh many industries are doing this for local consumptions.

Value Addition

The highest recognition of the value of the certain product through processing, packaging and marketing is value addition. It is the process of changing or transforming a product from its original state to a more valuable state. In Bangladesh, currently, many value-added spices are used and they impart a special taste to food preparations. The advantage of those products, viz. simple to carry, having long-lasting flavors, with low bacterial contamination, having higher income from food industry, used as preservatives and also in pharmaceutical industry. BSTI is the regulatory body to control the quality. Government of Bangladesh has been patronizing big entrepreneurship in large scale, and year round production of the value-added product for meeting the international demand. New product should be developed from different minor and underutilized spice crops, especially from herbal spices. Integrated approach for development, production and marketing strategies should give the new direction towards the value addition in spice crops.

Value chain

A value chain encompasses the whole range of activities needed for a product or service to move through the different stages of production, from its original design through to its delivery to consumers and final disposal after use (Kaplinsky and Morris, 2002). Each of the stages; conception and design, production of the good or service, transport of the merchandise, consumption and handling, and final recycling are generally referred to as links. The market channel of spices crops are presented in the Fig. 3. There is a two market channel one is local

production and marketing, and importation and marketing. Both the channel are influenced by production, seasonally, trade policy etc. Being a close neighbor India is the main source for importation in Bangladesh among SAARC member countries. The value chain map in the domestic market of ginger and turmeric is presented in the Figure 4. It is revealed that 4/ 5 stakeholders are involved in the map up to consumer. These stakeholders' activities are governed by natural calamities, festival, trade policy etc. The value addition of ginger are illustrated in the figure 5 and revealed that the highest value addition percent estimated farmers to local traders (33.91 %) followed by retailer to consumer (29.93 %) in general. But during crisis period wholesaler play the critical role for price hiking.

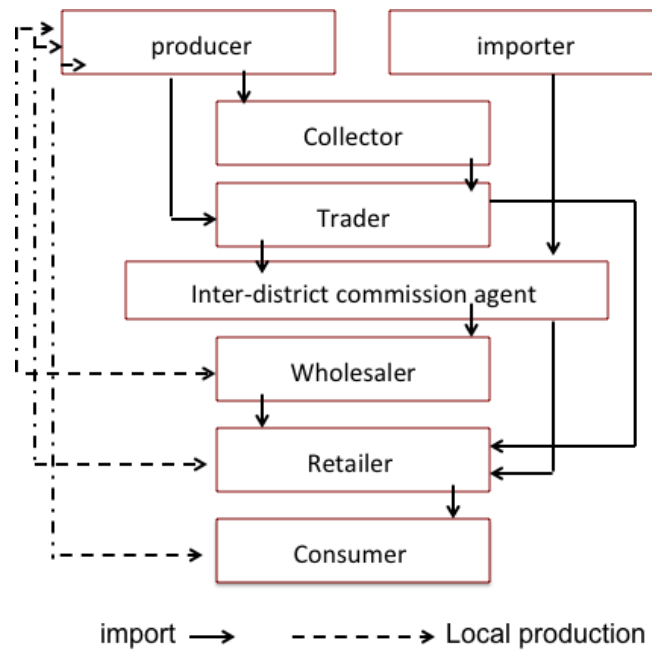


Figure 3. Marketing channel of ginger, turmeric, black pepper, cinnamon and cardamom in Bangladesh

Source: Hassan, 2016

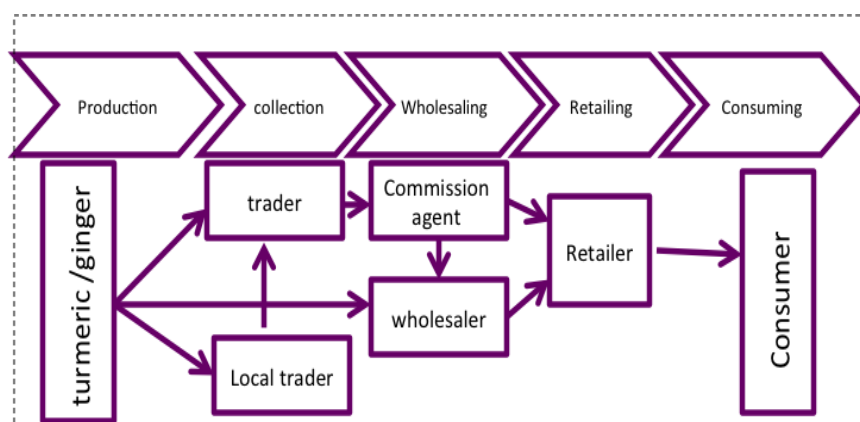


Figure 4. Value chain map in the domestic market of spices crops in Bangladesh

Source: Hassan, 2016

Distribution of value addition among major chains of ginger (Tk/100 kg)						
Value chain	farmer	Local trader	trader	Wholesaler	Retailer	consumer
Sale price (Tk/100 kg)	6900	7590	8425	9099	10919	
Purchase price (Tk/100 kg)	4838	6900	7590	8425	9099	
Gross value added (Tk/100 kg)	2062	690	835	674	1820	
% of total value added *	33.91	11.35	13.73	11.08	29.93	

* Total value added = Tk. 6081

Figure 5. Distribution of value addition among major chains of ginger in Bangladesh

Source: Hassan, 2016

The BCR of ginger and turmeric were estimated in Bangladesh (Hassan, 2016) and is revealed that ginger had the highest BCR (3.4) while almost half was observed at turmeric, indicates that ginger cultivation are more profitable than turmeric (Figure 6). However, to strengthen the value chain value addition activities must be emphasized and these products have global market.

In Bangladesh, turmeric, ginger, black peppers are sold in local market by processing. Some companies like PRAN, Square etc. has also been exported the turmeric and ginger item in Middle East EU, Japan and USA.

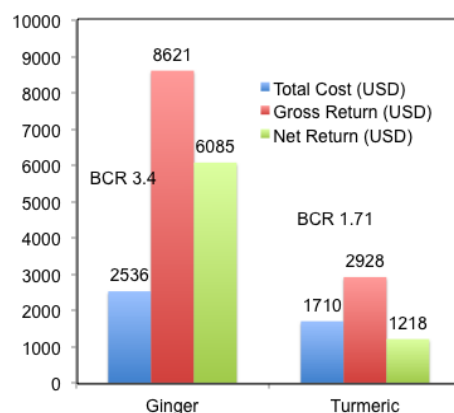


Figure 6. Estimated benefit cost ratio (BCR) of ginger and turmeric (per tones) in Bangladesh

Source: Calculated by the authors

Storage of spices

Ginger

Earthling pit: It is a very traditional method but common practices for the ginger storage. 1 m x 1m pits are dig out inside a room and exposed for 2-3 days to dry out. The fresh gingers are placed there by staking and add some mist soil. Finally pit is covered by mud soil. This way ginger might be stored for 20 week. The ginger may germinate due to faulty storage. Likewise, dried turmeric is kept in a tin box or plastic drum, while the powdered and pest turmeric may storage for 150-360 days using modern packing methods.

Spices Trade in SAARC Countries and Beyond the SAARC (Intra and Inter Regional Trade)

Import: Bangladesh import more than 120 thousand tones of turmeric, ginger, black pepper, cinnamom and cadrdimon (Figure7) mainly from SAARC member country India and tiny amounts from Sri Lanka. The contribution of ginger was the highest, while the black pepper was the lowest. Import of turmeric drastically dropped on 2014-15 due to bumper production.

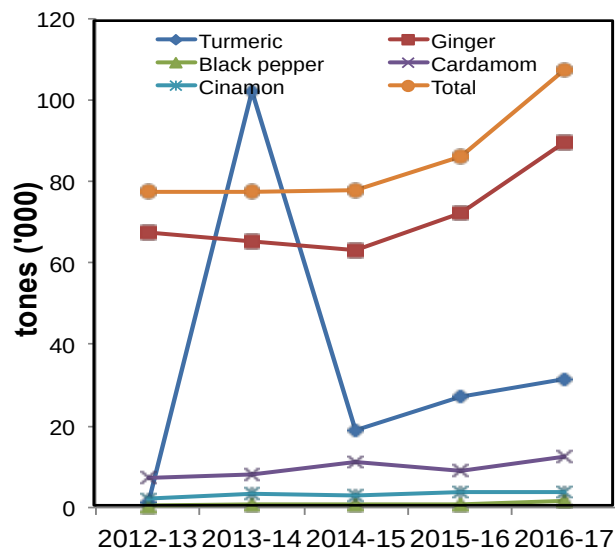


Figure 7. Import trend of spices crop

Source: EPB, 2017

Export: Bangladesh has been exporting turmeric to EU, USA and middle east mainly as dust form. A tinny amounts of cinnamon is also exported from 2014-15. However, the main consumer is the ethnic community. On 2012-13 the amount of turmeric export was 128.8 tonnes, but unfortunately dropped subsequent three years (Figure 8). However, situation now improving, as last fiscal year the of exported turmeric was 41.3 tonnes.

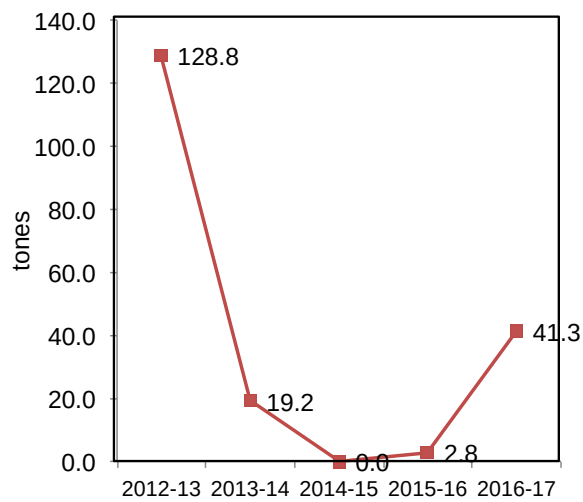


Figure 8. Export trend of main spices in amount

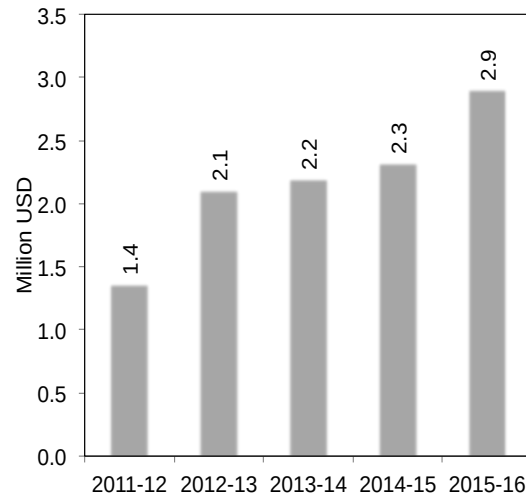


Figure 9. Export trend of spices in value

Source: EPB, 2017

Bangladesh earned around 3 million USD by exporting spices crop like, turmeric, ginger, cinnamom etc. (Figure 9). Although the growth is not like other sector as there are some trade barriers on quality assurance.

Key Policy Input for Developing Strategies Aimed at Strengthening of Spice Value Chain and Enhancing International Trade

One of the objectives under the SAARC Charter is acceleration of economic growth. Trade integration among SAARC members continues to be low as compared to the EU and the ASEAN. It is expected that with further reduction of tariff barriers under SAFTA, along with non-tariff barriers, would result in enhanced trade integration among SAARC members. Spice crop very often become political weapon for opposition of any government across the SAARC region. SAARC region contribute a huge quantity of spice in the global market. Therefore, it is a must to harmonizing the trade of spice in the member countries; policy has to be prepared to strengthen spice value chain of SAARC countries (SVSC) that are as follows;

Trade-related participation in SVSCs contributes to economic growth through the gains that firms achieve from specialization and improved productivity for both imports and exports (access to new technology and knowledge spill-overs). This is equally the case for investment, where the nature of the interaction between foreign firms and domestic producers can explain more of the potential productivity spill-overs than the level of FDI. Policies targeted to increase competitiveness of local

suppliers are likely to be more efficient. Integration into SVSCs should be only one part of a broader, pro-growth agenda. A well-crafted package of macroeconomic and structural policies is also required to stimulate growth, and the precise shape of these policies depends significantly on the specific situation in a given country. SAARC countries need to improve supply-side capacity through strategic investments in people as well as in physical infrastructure. For trade, the way that trade policy is conceived requires adjustment; to reduce time delays as well as tariffs, and to look “behind the border” at regulatory measures as well as “at the border” as regulatory measures. While tariffs are no longer as important in most channels of trade as they once were, the structure of spices value chain at SAARC countries (SVSC) can multiply the effects of even low-level rates of duty. Multilateral market opening is preferred over discriminatory arrangements, as barriers between third countries, upstream or downstream, can matter as much as barriers put in place by direct trade partners. Trade facilitation helps countries participation in SVSCs by cutting costs, avoiding unnecessary delays, and reducing uncertainty. The potential reduction in trade costs may be done after full of fully implementation of the SAPTA Agreement on Trade Facilitation. SVSCs are particularly sensitive to the quality and efficiency of services. Improving logistics services, in particular, is essential to effective SVSC participation. High-quality logistics affect trade even more than distance or transport costs; every extra day needed to ready goods for export and import could potentially reduce trade flows. International regulatory cooperation, including via mutual recognition agreements can help mitigate compliance costs that arise as a result of unnecessary complex or heterogeneous regulations, enhancing the ability of firms, in particular SMEs, to participate in SVSCs. For jobs, Policy needs to protect workers, not jobs, including against the loss of jobs as a consequence of trade policy reversals and “beggar thy neighbor” policies. Strong social, environmental, and governance frameworks and policies are important to maximizing the positive impact of SVSC activities and minimizing risks in all countries,

Finally, it is important to stress that trade liberalization is an important condition for generating inclusive employment and income growth from SVSC, but is alone insufficient. Investments in improving supply side capabilities will be needed in SAARC countries, in addition to creating an overall policy environment conducive to innovation.

Key Development and Strategies Aimed at Strengthening for Benefiting Spice Crop Economy in Bangladesh and South Asia

The demand of spices crop and their value added products are increasing tremendously as many of the active ingredients got the domestic and

export demand; therefore, development of spices sector is the crucial importance in Bangladesh. Making availability of raw materials is spice ingredient is the main constraints for Bangladesh, since productivity of those materials are very low as compared with neighboring countries. Increase coordination on research, extension on spices crop as to harvest the mutual benefits from the global trade. Sharing of Information regarding technology, processing, trade, value addition related to spices crop is essential. Moreover, enhance the investment on the production processing and storage, and ensure credit and SME environment.

Challenges and Way Forward For Research and Value Chain Development of South Asia

Challenges

There are several challenges influenced the research and value chain development of spices crop in Bangladesh, which ultimately affect the south Asia. Among the challenges; inadequate production and market information, insufficient processing and storage knowledge and skill are considered as key factor. In addition to this, different Trade policy of member countries, lack of one stop information sharing mechanism, inadequate research and development activities to exploit the value added technology are needed to address adequately.

Way Forward

Considering the aforesaid challenges it is speculated that open-minded dialogue among the member countries, establish separate SAARC spices network for research & development of value chain improvement are essential. Moreover, formation of special task force to work intensively to find out the potentials of trade of spice crop among the member countries and strengthen the SAFTA would nurture the way of forward.

Conclusion

SAARC countries have been contributing enormous by trading spices crop with the countries and across the SAARC countries, globally as well. Unfortunately there is lack of integration across the SAARC nation for spice crop. Therefore following recommendations are made to uplift the situation. These are:

- A Network on spices crop might be created comprising researcher, academicians, policy makers, legend farmers, extension personnel to find the traditional knowledge to share with the member countries through web circulation.
- Sharing of crops and problem specific knowledge and skill among the stakeholders of SAARC countries

- Free trade mechanism might create among the member countries by creating SAARC spices chamber and commerce (SSCHAC)
- A Special Taskforce might be formed with expert of the each country for exploring opportunities and mutual benefits.

Spices crop have been playing a significant role in the economic development through trade, medicine, and political stability from the medieval time. Share of spices crop in the global trade from SAARC countries is huge. Integration of value chain through production, processing, innovation among the member countries through SAC is expected to be fostered near future.

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Value Chain Development and Technology of Large Cardamom and Ginger in Bhutan

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Introduction

Bhutan is a small landlocked mountainous country located in the southern slopes of Eastern Himalayas. The country lies between latitudes 26° 45'N and 32° 10'N, and longitudes 88° 45'E and 92° 10'E. It has a total geographical area of 38,394 km² with 745,600 people. The forest cover of the country is about 70.46%, arable land 2.93%, meadow land 4.10%, shrub land 10.43%, snow cover land 7.44% and bare areas 4.64% of the total geographic area (LCAR, 2010). Agriculture is the mainstay of the people with an estimated 69% of the population engaged in farming. In 2015, agriculture sector accounted for about 17.7% of the total GDP of the country (MoAF, 2015). Majority of the Bhutanese farmers continue to practice self-sustaining, integrated and subsistence agricultural production system with small land holdings on average three acres cultivated agricultural land, where farmers grow a variety of crops under different farming practices and rear livestock to meet their household food security (MoAF, 2015). The productivity per unit area of major food crops is generally low due to limited use of external inputs, land terrain and lack of assured irrigation. Bhutanese farmers grow Rice, maize, wheat, vegetables and fruit crops.

In terms of spices, Bhutanese farmers cultivate mainly large cardamom (*Amomum subulatum*) and ginger (*Zingiber officinalis*) on a commercial scale since ancestral time. Cardamom was first introduced in Bhutan through Sikkim in the early 1900s by a Rai family based Sarbang district (Duba & Dorji, 1997). Sibsoo in Samtse district and Kalikhola in Dagana district were the entry points for cardamom cultivation. The farmers from these areas were the first to bring the cardamom planting materials. In 1973-74, the Department of Agriculture supported the supply of free cardamom planting material. In addition, with abrupt rise in market price, the cultivation of cardamom increased rapidly by the mid-1970s (Duba & Dorji, 1997). The Royal Government of Bhutan distributed three varieties namely *Ramsey*, *Golsey* and *Sikkimey*. However in contrary, there is no evidence how ginger has been introduced in Bhutan. Ginger was there in the southern part of the country and some of the old people believed that it was introduced from India boarder and some believe it has been introduced from Nepal.

Agricultural Land Use in Bhutan

The country is broadly categorized into three climatic zones, which are sub-tropical in the southern foothills, temperate in the middle valleys and inner hills and alpine in the northern mountains. The land use, farming systems, crops cultivated, opportunities and challenges in agriculture are thus predominantly dictated by climate, topography and altitude. For the purpose of agricultural planning, the country is broadly divided into six major agro-ecological zones corresponding with altitude range and climatic conditions (Table 1).

Table 1. Agro-ecological zones of Bhutan

Agro-ecological zones	Altitude Range	Area (hectare)	Area (%)
Wet Subtropical	100-600	214,918	5.60
Humid Subtropical	600-1,200	392,700	10.23
Dry Subtropical	1200-1,800	503,465	13.11
Warm Temperate	1,800-2,600	714,554	18.61
Cool Temperate	2,600-3,600	917,155	23.89
Alpine	3,600-7,500	1,096,618	28.56
Total		3,839,409	100.00

Source: RNR Statistics 2015, MoAF, Bhutan.

The alpine zone, which covers the northern region, is characterized by alpine meadows and is too high to grow any food crops. In the cool temperate zone, livestock rearing is most common way of living with some dryland farming. The main crops grown comprise wheat, potato, buckwheat, mustard and barley. The warm temperate zone has moderately warm temperature except during winter, when frost occurs and agriculture is widely practiced in terraced irrigated wetlands and drylands. In the wetland agricultural areas, rice is the main crop, which is rotated with wheat, potato, seasonal fodder, and several kinds of vegetables.

The dry subtropical zone is warm with moderate rainfall allowing the cultivation of wider range of crops. Rice, maize, mustard, barley, different types of legumes and vegetables are cultivated. The humid subtropical zone has a relatively higher rainfall and temperature. The main crop cultivated in the terraced irrigated wetland agricultural areas is rice followed by wheat and mustard. Citrus (mandarin orange) plantation in the lower altitude and cardamom in the higher elevations are the main cash crops. In the sloppy dryland agricultural areas, maize, millet, mustard, several types of legumes, ginger and vegetables are the predominant crops.

The wet subtropical zone has agro-ecological conditions that favor intensive subsistence agriculture through different forms of multiple cropping. Rice is the main crop grown in summer, which is rotated with wheat and maize in winter depending on irrigation. The sources of irrigation are mostly rain-fed and dry up during winter months. Large scale winter cropping is normally not practiced due to the scarcity of water although technically feasible. In the dryland agricultural areas, maize and different types of millets are the main crops, which are rotated with many types of legumes, mustard, Niger, millet, tuber crops and vegetables. The breakdown of land use in the agricultural areas is as follows:

Table 2. Land Use in the Cultivated Areas

Classification	Area (ha)	Percent (%)	% of owner operated	% of Leased out/share-out	% land left fellow
Wetland (irrigated)	31,911	29.82	84	8	8
Dryland	68,255	63.79	76	3	21
Apple Orchard	2,018	1.89	NA		
Citrus Orchard	5488	0.01			
Cardamom Plantation	3600	3.36			
Arecanut plantation	1199	1.12			
Other Horticultural crops	16	0.01			
Total	112,487	100			

Source: RNR Statistics 2015, MoAF, Bhutan.

The cultivated land in Bhutan accounts for 112,487 ha of which dryland accounts for 63.79% followed by wetland 29.82% and the remaining 6.39% as orchards. Land is fairly distributed about, 14% of the households each hold an acre or less. At least 56% of the households have land holdings ranging from 1 to 5 acres. About 2.6% of households do not own land, although many of these make their living from farming either renting land or sharecropping with absentee landowners. Sharecropping is done either on 50:50 share of the harvest between the owner and sharecropper or on an earlier fixed rate based on estimated yield in the past. Majority of the farm households in Bhutan are self-operated. Of the 31,911 acres of wetland, 84% is owner operated; about 8% is leased out mainly due to shortage of farm labor and another 8% is left fallow primarily due to acute water shortages or damage from wild animals. About 76% of the dry land cultivated is owner operated and about 3% is leased out while 21% left fallow.

Area and Production Status of Cardamom and Ginger in Bhutan

Southwestern districts are prominent cardamom producing areas in Bhutan. These areas share the western border with Sikkim, the leading cardamom producing state in India, and southern border with West Bengal and Assam. Samtse is the largest cardamom-growing district, contributing about 43% to the country's total production in 2016. The other major cardamom producing districts include Chukha, Dagana, Haa, Sarpang and Tsirang (Table 3). In the recent years, the cultivation of cardamom has spread to other districts of Pemagatshel, Zhemgang and Mongar but the production in these areas are at an emerging stage.

Table 3. Districts-wise detail of Large Cardamom in Bhutan, 2016

District	Cultivated Area (Acres)	Quantity Produced (MT)	Yield (Kg/acre)
Samtse	4,697.67	1,162.49	247.46
Chhukha	1,895.68	504.63	266.20
Dagana	1,075.00	357.67	332.72
Ha	1,047.51	307.48	293.53
Sarpang	934.64	187.36	200.47
Tsirang	656.86	123.57	188.12
Trongsa	316.56	52.81	166.82
Pemagatshel	216.56	2.17	10.02
Zhemgang	146.68	14.37	97.97
Other Districts	99.00	24.00	242.42
Bhutan	11,086.15	2,736.55	246.84

Source: Agricultural Statistics, 2016, DoA, MoAF

Note: Other districts include the non-traditional producing areas for large cardamom (SamdrupJongkhar, Mongar, Luntse and Trashigang), having less than 100 acres under large cardamom.

Ginger is grown in all the 20 districts in Bhutan, but Samdrup Jongkar and Pemagatshel in the east and Chukha, Samtse, Sarpang and Tsirang in the southwest are the major ginger producing areas. . In 2016, Samdrup Jongkar was the highest ginger producer district contributing 22% of the total production followed closely by Chukha with 21% (Table 4).

Table 4. Districts-wise detail of Ginger in Bhutan, 2016

Districts	Cultivated Area(Acres)	Production (MT)	Yield (kgs/acre)
Samdrup Jongkar	1,037.52	2661.78	2,565.53
Chhukha	978.95	1,345.80	1,374.74
Samtse	906.00	1,683.13	1,857.75
Sarpang	682.53	3,252.10	4,764.80
Pemagatshel	318.45	727.65	2,284.97
Tsirang	291.69	689.84	2,365.00
Dagana	179.56	139.74	778.26
Zhemgang	144.77	125.27	865.29
Monggar	112.82	49.90	442.34
Other Districts	120.49	195.36	1,621.36

Source: Agricultural Statistics, 2016, DoA, MoAF

Note: Other districts include the non-traditional producing areas for ginger Trongsa, Wangdue, Trashiyangtse and Trashigang having less than 100 acres.

The Figure 1 below shows the production trend of large cardamom and ginger for the last 10 years in Bhutan. After reviving from massive *chirkey* and *furkey* disease attack in early 1900s, farmers have gradually started establishing large cardamom plantation in the early 2000s. The highest production was recorded in 2016 at 10,870.58 MT. Ginger yield dropped in 2008 due to rhizome rot disease. The production trend continued to decline till 2014 due to rot disease. Besides ginger price fluctuation also demotivates farmers from increasing cultivation. However, ginger production revived after the Food Corporation of Bhutan stabilized the marketing process in 2015.

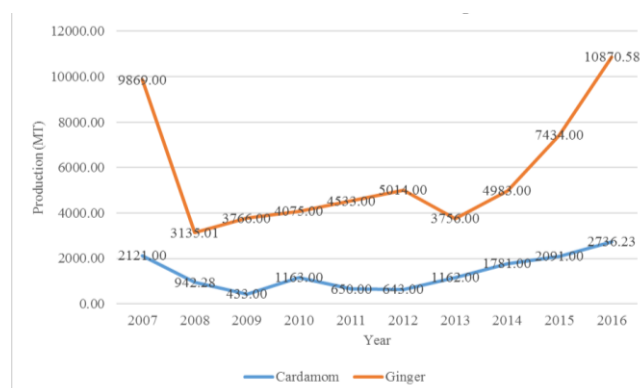


Figure 1. Production trends of Cardamom and Ginger in Bhutan

Source: Compiled from year wise Agricultural Statistics, and RNR Statistics, MoAF

Production technology, post-harvest handling, processing, value addition and storage of large cardamom

Large cardamom is a perennial, shade-loving crop found between 600–2,400 masl. It requires a high level of humidity (>90%) and soil moisture (>70%) and therefore, grows best in areas with annual rainfall of 2,000–4,000 mm with ambient air temperature of 10–22°C. The ideal sites are lands with gentle slope, instead of flat surfaces, as slopes aid a stronger root system and protect rhizomes against lifting up from the ground (Dorji, 2010). In Bhutan, it is grown under plenty of shade and good drainage condition between subtropics and temperate regions. Some of the preferred shade tree species and which abound the existing plantations are: *Macaranga denticulate*, *Alnus nepalensis*, *Jambosa formosa* Walp, *Schima wallichii* and *Saurauvia nepalensis*. Once the crop canopy is closed about 50-60% shade level is important.

In Bhutan, there are 12 local cultivars of cardamom suitable for cultivation at different elevations and adapted to local environmental extremes such as water deficit and frost (Duba & Dorji 1997). The local cultivars are grown in specific agro-ecological zones based on their altitudinal adaptability. For example, Ramsai, Swaney, and Barlang are cultivated above 1,500 masl whereas Golsai and Seremna are planted below 1,000 masl (Dorji, 2010).

Cardamom is propagated asexually through suckers obtained from healthy clumps of more than three years old. Usually cardamoms are cultivated in forest areas where a good amount of leaf litter is available; there is no system of using synthetic fertilizers and farmyard manure (FYM). The suckers are taken from mother clump in June-July and planted immediately. Two suckers are planted per hill at a spacing of 4-5 feet making holes with the help of a hoe. Removal of broken pseudostem while planting or on transportation also enhances growth. Large cardamom is the least labor-intensive agro-forestry crop as growers employ very few management practices. The maximum requirement of labor is only at the time of weeding and harvesting. Annually, weeding is done twice - the first is done in June-July, which is locally known as *Phulghor*, an operation done to clean the clumps in wet season to better expose flowers to pollinating agents, moisture and light; the second operation is conducted before harvest, which is locally called as *Ngahalghor*, meaning removal of old shoots/foilage and slashing of weeds.

Harvesting time is different in different agro-ecological zones. In the low and mid altitudes harvesting is done from August to September and in the high altitudes it is in November–December.

The plants are ready for harvesting within two or three years after planting. Plants start heavy yield from fourth year onwards. Sustained yields are normally expected up to fifteenth year from planting. However, constant replanting by replacing the old and degenerated clumps every year in the plantation along with optimum shade may keep them productive for many more years. The quality of produce depends on input quality, shading practice, altitude, temperature, rainfall etc. Usually, cardamom produce with high oil content, aroma, large capsule size and a characteristic maroon color is considered good quality (Punjabi, Rabgyal & Acharya, 2015).

Drying and curing are the most significant post-harvest operation of cardamom. Drying determines the market price that the crop will fetch. Curing is carried out in a kiln, or *Bhatti*, which is the traditional method of drying cardamom. The traditional curing system by smoking results in poor quality capsules due to absence of equal heat distribution system in the curing system structure. Drying process is slow and takes about 5-6 days to dry one lot, which is about 300-400 kg. Capsule tail is removed manually by rubbing with feet when the capsules are still hot but farmers are not able to remove the tail neatly. This results in damage of the capsules by exposing their inner seeds. For better curing, improved gasifier system has been experimented among the community with potential benefits. However, its adoption by the farmers has not been successful as the equipments are huge and it is difficult to transport to the far-flung areas where cardamom are grown mostly.

Production Technology, Post-Harvest Handling, Processing, Value Addition and Storage of Ginger

Ginger is best grown in warm and humid climate in the initial growth stages at an altitude up to 1,500 m. However, during harvest, it requires dry weather and mild temperatures ranging from 28 to 30°C. Ginger cultivation is common in the southern dry-lands of the country. Ginger grows in a wide variety of soil but the ideal soil is one that is rich in humus, light, loose and friable, well-drained and at least 30 cm deep. Red laterite, clay loam and heavy laterite containing not more than 30% sand or 20% clay are preferred as they give higher yields. Rhizome growth is better in slightly acidic soils (pH 6-6.5) than neutral soils. It is sensitive to waterlogging, frost and salinity. It is tolerant to drought and wind. In Bhutan, the local varieties have not been officially identified. A popular variety of Assam variety named Maran may be the source of the local varieties (Punjabi, Rabgyal & Acharya, 2015).

Ginger is universally propagated from cuttings of rhizome known as bits. Bits are made from mother rhizome having 3-5 cm length and 15-20 g weight with at least one good bud. Seed rate of 1,500-2,000 kg of

rhizome are required per hectare. In some areas planting is done with whole rhizome and they are unearthed when crop reaches 30-45 cm height so that they can harvest later as mother rhizome and capture off season market. In plains beds of 1 m width, 15 cm height and convenient length are prepared. Beds are separated with 30 cm drain for drainage. In hills ridges are prepared along the contours. Rhizomes are planted on ridges 25 cm apart, 15-20 cm within the ridges 5 cm deep. The planting period is from April to June. Sprouting takes 15-21 days, however it may prolong up to 2 months.

Ginger is an exhaustive crop so requires reasonable amount of manure and fertilizers. An average yield of 3900 kg of dry ginger/ha has been reported to remove 70:17: 117 Kg NPK/ha respectively. In Bhutan, well rotten cattle dung or compost at the rate of 25-30 tones/ha is applied at the time of planting. Ginger is grown as rainfed sole crop and also intercropped with maize. Mulching is essential as it enhances sprouting, increase infiltration and organic matter, conserves soil moisture and prevents weeds, evaporation and washing of soil due to heavy rains. First mulching is done at the time of planting with quick rotting green leaves at the rate of 1012 tons/ha or with dry leaves 5-6 tons/ha. Two earthling up are usually done, one 45- 90 days after Planting and another after 135 days after planting. Farmers carry out weeding as well as unearthing the rhizomes when it reaches the height of 30-45 cm. The crop is ready for harvest in 8 to 10 months for use as green ginger. Rhizomes are then lifted either with a digging fork or spade and cleaned thereon for distribution to traders. Rhizomes which are to be used as seeds for propagation are preserved carefully either in pits under shade or covering with layers of leaves on the ground.

The National Post Harvest Centre (NPHC) is actively involved in ginger processing and value added products development such as ginger pickle, ginger flakes, ginger oil and ginger powder to help farmers get higher returns. In the recent years, private enterprises like Bio-Bhutan is diversifying ginger products like ginger tea bag, ginger flake, ginger soap etc. It is also used by Bhutan Institute of Traditional Medicine Services for various traditional medicines.

Cardamom Trade in SAARC Countries and Beyond the SAARC

In Bhutan, spices (large cardamom and ginger) are most important cash crops that contribute significant source of income for livelihood of rural people. Cardamom stands 5th in terms of export value of Bhutanese exports goods (source trade). Since Bhutan is not a major consumer of cardamom, most of the cardamom produced in the country is sold to India and Bangladesh. According to Bhutan trade, Bhutan exported 1,289.01 MT of cardamom worth Nu. 1342.38M to India and Bangladesh

in 2016 (MoF, 2016). From the Commodity Chain Analysis (CCA) study on cardamom, of the total production of large cardamom, 42% goes outside Bhutan in the form of exports to Bangladesh and India (Punjabi, Rabgyal & Acharya, 2015). In recent years, exports to Bangladesh have increased significantly with exporters in Bhutan aggressively taking up exports of cardamom to ensure foreign exchange for their other commodities and evidently because it adds to the company profits. The remaining 58% of the total crop production is also exported to India but through informal marketing channels such as direct cross-border transactions by the farmers.

Figure 2 presents the trend of large cardamom exports from Bhutan in value and volume terms. It is important to note that the volume of exports has increased in recent years in accordance with the increase in production. Although the domestic consumption is very negligible, the volume of exports reflected in the statistics is significantly lower than the production figures, which indicates sales through informal means. Furthermore, the increase in value of exports is a reflection of the increase in prices of large cardamom.

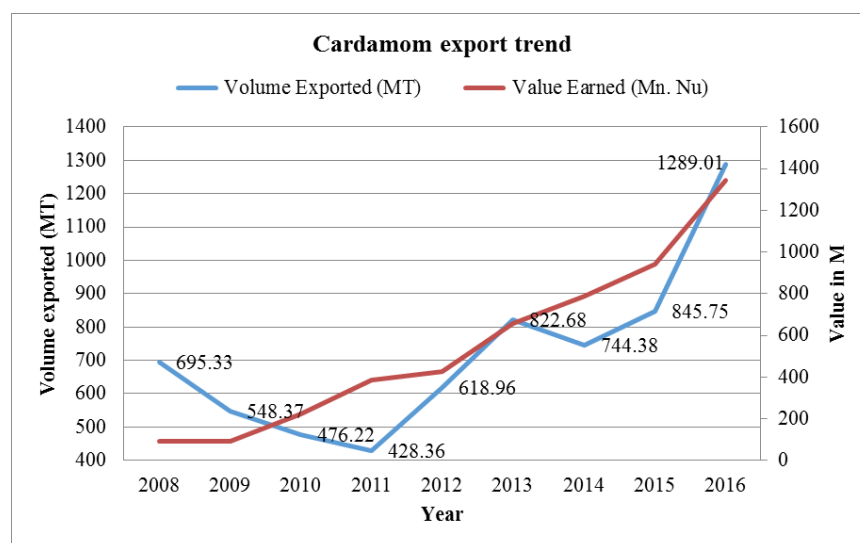


Figure 2: Graph showing ccardamom exports and value earned from the year 2008 to 2016

Source: Compiled data of different years from Bhutan Trade Statistics

Siliguri in West Bengal, India is the main hub for large cardamom trade in the region. As per industry sources, there are about 3-5 big players based in Siliguri are engaged in marketing of large cardamom from the region (Punjabi, Rabgyal & Acharya, 2015). The traders serve three key

market channels – retail sale of large cardamom to India, sale of cardamom to big processors in India and sale to exporters selling to other countries. Broadly, speaking, total volume of large cardamom is coming to the market is 10,000 tons.

The prices of cardamom in Siliguri are likely to influence the prices in Bhutan because Siliguri is the main market channel for Bhutanese cardamom. As per economic theory, we would expect prices in Bhutan to be a bit lower than the prices in Siliguri to cover for the costs and margins of the agents bringing the cardamom to Siliguri. However, sometimes the prices in Bhutan might be slightly higher than the prices in Siliguri because the exporters who are aggressively engaged in exports of large cardamom are willing to pay slightly higher to the farmers in Bhutan, which they can afford to do as they have the benefit of the zero tax treaty with Bangladesh.

Ginger Trade in SAARC Countries and Beyond the SAARC

Ginger is used as alternate cash crop to large cardamom in Bhutan. India is the major market for ginger from Bhutan as the domestic consumption is very low. In 2016, Bhutan exported 3052.97 MT of ginger worth Nu. 72.69 million to India (Bhutan Trade Statistics, 2016). According to Commodity Chain Analysis (CCA) Ginger, 2015 study about 80% of the ginger from Bhutan goes to India. While formal trade accounted for about 50% of the exports the rest was informal trade.

The Figure 2 represents the export of ginger in formal means to India. Although the local consumption is low in case of ginger too still the volume of exports reflected in the statistics is significantly lower than the production figures, which indicates sales through informal means like large cardamom.



Figure 3: Graph showing cardamom exports and value earned from the year 2008 to 2016

Source: Compiled data of different years from Bhutan Trade Statistics

Cardamom Value Chain

At present, there are six key large cardamom value chains in Bhutan at present as follows:

Table 5. Types of Cardamom Value chain in Bhutan

Chain 1	Farmers in Bhutan → Traders in India (Siliguri)
Chain 2	Farmers in Bhutan → Traders at the border towns (Phuentsholing) → Traders in India (Siliguri)
Chain 3	Farmers in Bhutan → Local traders in Bhutan → Traders in India (Siliguri)
Chain 4	Farmers in Bhutan → Local traders in Bhutan → Traders in India (Siliguri) → Processors
Chain 5	Farmers in Bhutan → Local traders in Bhutan → Traders in India (Siliguri)
Chain 6	Farmers in Bhutan → Local/border traders in Bhutan → Exporters in Bhutan → Importers in Bangladesh

Source: CCA Cardamom, 2015

Farmers are engaged in production of large cardamom from plantation to harvesting, curing (drying), storing and marketing. When the crop is ready for sale, farmers sell to local traders or who have access to border towns who sell directly to the traders of Siliguri or traders of the border town (Phuentsholing). Most of the production areas have borders with Indian states which are quite porous and easily accessible which causes a fair amount of informal trade. From Bhutan, cured capsules move sequentially from farmers to local traders to traders at borders, reaching wholesalers in Siliguri market, India from where it goes out to retailers and finally consumers across the country. In far flung remote small-scale farmers who do not have easy access to transportation sell the produce to the local traders in the vicinity of cardamom growing farmers. The traders collect the produce directly from farmers and sell the same to traders in border town (Phuentsholing) or directly to Indian traders across border. The Indian Traders then sell in major markets such as Siliguri wholesale market and in Cooch Behar and Kolkata. Some of these traders also sell to the organized processors in India and further export to third countries.

At present there are two-three key large cardamom exporting companies in Bhutan. While they are not typical agriculture export companies yet they are engaged in exports of construction materials and such others to Bangladesh. A key motivation for engaging in exports of large

cardamom is the foreign exchange they can generate to growth their other business. Furthermore, since they are already dealing with importers in Bangladesh for other products, it is easy to extend the same network to large cardamom.

As per information from the field, farmers' cost of production is Nu. 400/kg wherein their labor constitutes more than 60% of the total cost ((Punjabi, Rabgyal & Acharya, 2015). The same produce is sold to the trader for Nu. 1,000-1,200/kg with a gross margin at least as high as Nu.600/kg. Local traders make a gross margin ranging Nu. 200-250/kg and traders in border towns who export to India and Bangladesh have it between Nu 100-200/kg.

Ginger Value Chain

Unlike cardamom marketing, marketing of ginger takes place in accordance with the location. Ginger market players include small holder farmers, local traders, border/cross border traders, commission agents (CAs), wholesalers and retailers. At present, there are five identified marketing chains in case of ginger as classified in Table 6 below:

Table No. 6. Types of Ginger Value chain in Bhutan

Chain 1	Farmers → Local Retailers → Consumers
Chain 2	Farmers → Local Traders → Thimphu/other markets → Consumer
Chain 3	Farmers → Local traders → Traders in Border towns → Wholesale markets in India
Chain 4	Farmers → Traders at the border towns → Retailers in India & Bhutan (Phuntsholing) or Wholesale markets in India
Chain 5	Farmers → Gelephu Auction Yard → Traders across border → Commission Agents → Wholesale markets in India

Source: CCA Ginger, 2015

Farmers are the main actors in the ginger value chain. Farmers in far flung areas sell ginger to local traders or retailers in Bhutan. Farmers, who have access to border towns, sell in border town of Phuntsholing or Gelephu. Like cardamom, most of the ginger production areas have border with Indian states which is quite porous and easily accessible for a large amount of informal trade. Ginger from local traders is sold to retailers in Bhutan, or is brought for sale to Thimphu market. Traders located in border towns of Phuntsholing and Gelephu and traders

located in bordering towns of India get ginger both from farmers and local traders and sell it to the wholesale market in India. Commission Agents (CA) trade on the behalf of sellers for which they charge a fix commission. Traders at the border or cross border sell the ginger to wholesalers through CAs. These commission agents usually charge 6 to 7% as commission on the total sales amount. Indian wholesalers buy ginger from the traders through commission agents and sell them to retailers in India. Retailers purchase the ginger from local farmers/traders for sell to the end consumers through vegetable shop, cycle vendors, and cart pullers. Farmers with proximity to Phuntsholing or Gelephu Auction Yard bring the ginger to the auction yard for sale. Food Corporation of Bhutan officially organizes auctions for farmers in Gelephu wherein they can sell their produce at prices they find appropriate. Crops like potatoes and oranges, which grow in the central region of Bhutan, are marketed to India majorly through these auction centers, whereas, marketing of ginger through auction is rather limited.

The problem is that auction centers are as far as 40-50 km from the ginger-producing hub (as the auctions are mostly held in Gelephu), which is a major constraint to bringing the ginger to the auction yard. Farmers have the option of using the local bus. Hence farmers prefer to sell to the local traders. Also, sometimes farmers get better price than the price received at the auction. Traders who purchase from Gelephu auction yard sell to markets in India including Cooch Behar, Siliguri, Malda, depending on the volume. The traders in Phuntsholing auction yard sell to retailers in Phuntsholing or the border town of Jaigaon or if they have large volumes they bring the ginger to the local markets in India. From these locations, ginger reaches the consumer of north east region of India through retailers. Another important channel of trade is through traders in border towns of Phuntsholing and Gelephu. Farmers who stay close to these areas bring ginger to these locations. From here it is brought to the regulated markets in northeast India from where it is sold to the retailers and consumers in India. At the regulated markets, commission agents auction the ginger from Bhutan along with ginger from Nepal and other northeastern states.

Key Developments and Strategies for Benefitting Spice Crop Economy

Realizing the importance of the spices crops, some of the key developments strategies initiated by the Department of Agriculture (DoA), Ministry of Agriculture and Forest (MoAF) for benefitting spices crop economy in Bhutan includes the following.

- The crop prioritization and areas of focus for spices crops in 12th Five Year Plan (2018-2022) will increase by 20% both in terms of land

cover and productivity in the country. The priority will be given to those potential districts that are already initiating the programs.

- The strategy has been developed to enhance production through development of sustainable seeds and seedlings supply system. Realizing the unavailability of disease free planting materials is one of the main constraints faced in revitalization of spice plantation in Bhutan. Therefore, identifying and developing potential seed production pockets, promotion of ginger seed growers groups in strategic locations, building linking among and between the growers groups within the communities are some of the ongoing activities of DoA.
- The National Seed Centre (NSC) under DoA will develop cardamom nursery to support and supply quality tested seeds and seedlings as per farmers requirement. At the regional level, development of cardamom repository and nursery at research sub-station are prioritized. In addition, focuses are given in development of registered seed growers that are already functional.
- To enhance spices production, some of the ongoing research and development activities undertaken are as follow:
 - Disease management advocacy in cardamom to reduce the build-up of disease pressure
 - Enhanced income generation through product development & quality control
 - Value addition and product diversification
 - Promotion of improved curing system for cardamom

Challenges and Way Forward for Research and Value Chain Development

The current research on spices crops in Bhutan is limited; this is because the Government has realized that food security is more importance than income generation and priorities are given to improve cereal crops. However, conducting detail research on spices crops are critical now, considering the transition of cardamom crop from an agro-forestry based farming to agriculture based farming. Besides, spices crops are gaining momentum in production capacity due to its potential of earning foreign exchange through export.

Some of the challenges and way forward for development of spices crops in Bhutan include the following:

- Since the detection of problem of wilt, *chirkey* and *furkey* and ginger rhizome rot, the DoA took intensive efforts. However, no effective

techniques and technologies are devised to correct the issues perpetually. There is a further need for intensive scientific research on these problems to assist, encourage and build farmers' confidence to adopt the spices crops.

- The critical gap for development of spices crops is availability and supply of quality planting materials for multiplication. It is also important to know the attributes of large cardamom and ginger originated from Bhutan. As such, policy and technological support are necessary to initiate scientific research on species crops to bridge the gaps.
- Owing to non-availability of quality planting materials in the country, the practice of sourcing planting materials through informal route that are not certified by the Bhutan Agriculture and Food Regulatory Authority(BAFRA) leads to introduction of spices crops diseases which is endemic in the country. Therefore, specific regulation for introduction of certified species crops in the country through formal channel is necessary. Besides, the National Seed Center should give importance to produce disease free planting materials.
- There are inadequate sensitization and awareness programs on scientific package of practices and use of disease resistant planting materials to the farmers. The farmers continue age-old traditional practices, which is less productive and prone to diseases. The role of research and extension is very crucial here to produce the start state of art technologies and build capacity of the producer farmers to adopt the technologies.
- Spices crops development in Bhutan is a multi-stakeholder process; there are different stakeholders (producers, research, extension, NCS, NPHC, BAFRA, DAMC, FCB, traders) involved during various processes (production to post-production and marketing). The interest of the stakeholders to support the producers also varies at different stages. To align the interest, there is need for formulation of the multi-stakeholder partnership process among the stakeholder and identify area of intervention to accomplish spices crops development in the country.
- With increasing demand and scope for marketing and export of spices crops, there are areas for improvement in the marketing channel. The existing system of exporting the spices is limited to the neighboring countries of India and Bangladesh. It can be further explored to other third countries, through which the producer farmers will have options to get better premium prices. In doing so, it is important to improve the quality of the produces through grading, sorting, packaging and “branding”. Most of the produces in

Bhutan are generally natural and perceived as organic and safe. The brand “organic” with proper certification and value addition will improve market chain and even international markets.

- Currently, the involvement of private sector in spices crops is negligible. There are opportunities to engage the private sector through the public-private partnership by providing incentives and opportunities such as tax incentives, investment credits and cheaper finance to attract investments for research, processing and marketing.

Conclusion

Spices are a high value crop for the Bhutanese economy in terms of earning higher income and improving foreign exchange. An overview of the global demand and supply situation reveals that there is significant demand in the global market, which Bhutan can capitalize on. Some of the constraints like climate change; disease attack and market price fluctuation have severely impacted on the large cardamom and ginger production in the region. This combined with changing socio-economic conditions pose severe constraints to the growth of this commodity.

There have been technical gaps in the spices value chain, while emphasizing the interventions to be undertaken at every level in the chain. As such, long-term strategic policies for the growth and development of the sector is essential and to provide direction for the development of spices industry in Bhutan. Such an initiative has to be multi-disciplinary enabling support for all the aspects from relevant stakeholders, beginning from research to reaching out to premium markets.

Spices value chain can witness immense development, if the technical gaps identified in the chain are addressed through strategic interventions. This requires adequate research for developing location specific-disease ensuring quality inputs, supporting scientific production practices and support for post-harvest processing and marketing. Besides, introduction of disease resistant varieties, package of practices and quality input material such as suckers and manures through involvement of NSC, AMC and ARDC are crucial. Similarly, improving extension services to sensitize farmers about new package of practices and technology; consistently creating best post-harvest practices are important determinant of the crop's marketability. This can be done in collaboration with the neighboring countries research units; exploring niche markets for species and establishing direct linkages for exports. Linking farmers to formal institutions for

improved market channels are a few interventions, which Bhutan can look upon to develop the Spices sector in the coming future. (Please use Harvard styles)

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Value Chain Development and Technology Practices of Spices Crop in India (Cardamom, Ginger, Turmeric, Black pepper & Cinnamon)

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Introduction

Spice crops form an integral part of agricultural economy in the South Asian countries. This is especially true in case of India, the largest producer, consumer and exporter of spices in the world. The range of agro-ecological diversity within its political boundaries and the diversity in climatic conditions ensure that the country is able to grow a wide range of spice crops. Historically, the country was known as a destination for high quality spices. This reputation together with its strategic location helped Indian peninsula to emerge as the hub of spice trade several centuries back. The modernization across several field like transport and communication, level of technology, enhanced knowledge sharing between countries and regions, horizontal spread of crops across countries, commercialization of agriculture and the impacts of globalization raise significant challenges before each countries in maintaining their advantages in core competencies while ensuring an equitable and efficient use of resources at the global stage.

India produced about 6.9 million tonnes of spices from an area of 3.5 million hectares during 2015-16. Among the spices, black pepper, cardamom, cinnamon, ginger and turmeric contribute about 30% of the total spice production. Though every state/Union Territory in India grows at least a few spice crops, Kerala, Andhra Pradesh, Gujarat, Maharashtra, West Bengal, Karnataka, Tamil Nadu, Orissa and Madhya Pradesh, Rajasthan and North Eastern states are the major spices producing states.

Spices are essentially low volume, high value commodities and generally grown as a cash crop by the farming community. The processed food industry and pharmaceutical industry, both of which has recorded robust growth rates in the recent past, has played a key role in maintain a global demand growth rate of 3.2%. Many high value commodities and value added products from spices are further integrated to the consumer value chain to produce a range of products that are intended to meet the

growing needs of the consumers across the world. The estimated growth rate for spices demand in the world is slightly above the population growth rate. Across South Asia, small holder production systems dominate the spice farming economy. The fortunes of spice farming sector, thus has a critical role to play in ensuring equitable development through enhanced livelihood security in small holdings in India as well as other South Asian countries.

Agricultural Land Use

The vast terrain of the country (328.7 m ha) has rich diversity in terms of climate, soil types, agro-ecological zones, fauna and flora. The extant agricultural land use pattern of the country has to be understood in the context of its socio-economic profile. About 65% of the country's population live in rural areas which is indicative of the heavy dependence on the primary sector for drawing their livelihood. Selected features of land use and parameters with bearing on agricultural economy of the country are presented in Table 1.

Table 1. Glimpses of Indian Agriculture

Particulars	Value
Geographical Area	328.73 Million ha
Forest	71.83 Million ha
Cultivable Waste lands	12.39 Million ha
Gross Cropped area	200.86 Million ha
Net Area Sown	141.43 Million ha
Cropping Intensity	142 Per cent
Gross Irrigated Area	95.77 Million ha
Population	1283 Million
Food Grain Production	252 Million tonnes
Share of Agriculture in Gross value of Output	15.4 Per cent
Rural population	834 Million
Total Workers	482 Million
Cultivators and Agricultural laborers	264 Million
Agricultural Imports	1402886 Million INR
Share of Agricultural Imports in total import	5.63 Per cent
Agricultural Exports	2153956 Million INR
Share of Agricultural Exports in total export	12.55 Per cent
Value of Spice Imports	1934 Million INR
Value of Spice Exports	8317 Million INR

Source: Agricultural statistics at a Glance, Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India

India has made giant strides in enhancing production and productivity of food grains, pulses, oilseeds, horticultural products, milk and other essential commodities over the last five decades. This has established a strong base for further innovations in agricultural development, diversification and value addition. The self-sufficiency achieved in several critical agricultural products like food grains and pulses will enable the country to focus on value chain development in horticultural crops like spices, where the value of output per unit area is much higher than that of cereals and pulses. This shift in the ability and capacity to focus more on farm business income and strengthening of value chain to generate more employment opportunities through value addition is of special significance for countries like India, where the small holding production systems is predominant form of organizing agricultural production. Nearly 85% of the total agricultural holdings can be classified as small and marginal operating parcels of land less than 2 ha. Any strategic interventions for agricultural development with equitable justice cannot ignore this skewed nature of distribution of agricultural holdings (Table 2).

Table 2. Distribution of agricultural holdings in India

Particulars	Number (‘000Nos)	Area (‘000 ha)	Average Size (ha)
Marginal (Less than 1 hectare)	92826 (67.1)	35908 (22.5)	0.39
Small (1.0 to 2.0 hectares)	24779 (17.9)	35244 (22.1)	1.42
Semi-Medium (2.0 to 4.0hectares)	13896 (10)	37705 (23.6)	2.71
Medium (4.0 to 10.0 hectares)	5875 (4.2)	33828 (21.2)	5.76
Large (> 10.0 hectares)	973 (0.7)	16907 (17.4)	10.6
All Holdings	138348 (100.0)	159592 (100.0)	1.15

Source: All India Report on Agricultural Census 2010-11, Ministry of Agriculture and Farmers Welfare, Government of India

Area and Production Status of Spice Crops

Spices have a relatively miniscule share in the gross cropped area in India. Though the area under spices have shown a positive trend in the recent years, it still occupies only 1.6 per cent of the gross cropped area of the country, which is still dominated by food grains oilseeds and pulses (Table 3).

Table 3. Share in area under different crops

Crop	% share in Gross Cropped area
Rice	22.70
Wheat	15.24
Coarse Cereals	12.61
Pulses	13.61
Food Grains	62.54
Oilseeds	14.03
Sugarcane	2.50
Cotton	5.98
Spices and condiments	1.60
Fruits and Vegetable	4.90
Others	6.83

Source: Agricultural statistics at a Glance, Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India

Among the major spice crops, the area under black pepper during 2014-15 was 128 thousand ha with a production of 64640 mt. Small cardamom is cultivated in an area of 99.56 thousand ha, with a production of 24360 mt. Kerala has 59% of total cardamom area and contributes 70% of production; Karnataka 34% of area and 23% of production and Tamil Nadu has 7% of area as well as production. India ranks first with respect to ginger and turmeric production contributing about 32.75 and 94% of world's production, respectively. The ginger production was 760310 mt in 2014-15 from an area of 141650 ha with a productivity of 5367 kg ha⁻¹. North Eastern states account for 37% area under ginger contributing 48.9% to production and states like Karnataka, Kerala, West Bengal, Odisha, Himachal Pradesh and Madhya Pradesh account for the remaining 51% of ginger production. Andhra Pradesh is the leading turmeric producing state (44%) in India followed by Tamil Nadu (19%). The area under the crop was 184440 ha with a production of 830390 t and productivity of 4502 kg ha⁻¹ in the year 2014-15. Even though India is the largest producer and consumer of ginger and turmeric, our

productivity is low compared to China. India also has 2060 and 18900 ha area under clove and nutmeg mainly cultivated in the Western Ghats slopes in Kerala and Tamil Nadu, producing 1070 and 12780 mt of produce, respectively.

Among the various states Andhra Pradesh is the leading spice producer with more than 10 lakh tonnes followed by the states of Rajasthan, Gujarat and Madhya Pradesh (Figure 1).

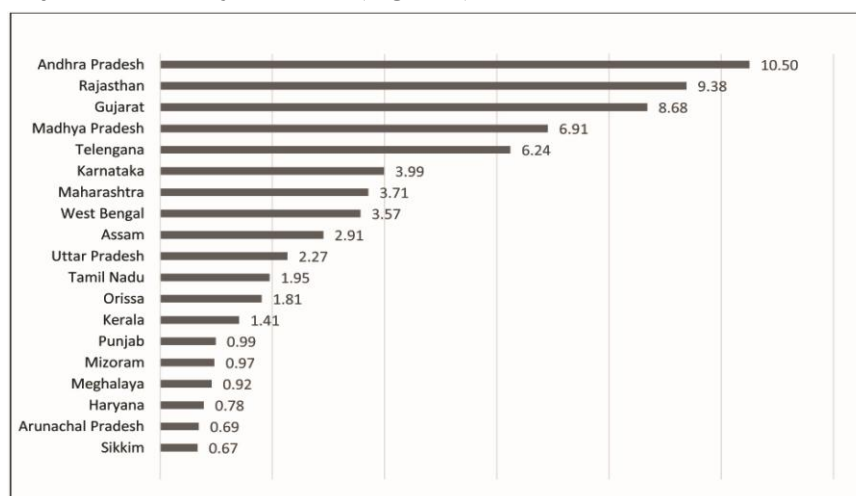


Figure 1. Major spice producing states in India

Source: Directorate of Arecanut and Spices Development (DASD), Ministry of Agriculture and Farmers Welfare, Government of India

Production Technology, Post-Harvest Handling, and Storage of Spices

The commonly practiced production technology, the major challenges in plant protection and the primary processing of the produce of four major spices viz., cardamom, black pepper, ginger and turmeric is discussed in this section.

Cardamom

Cardamom (*Elettaria cardamomum* Maton) is one of the oldest known spices in the world. Based on adaptability, nature of panicle, shape and size of capsules, the cultivars are categorized into Malabar, Mysore and Vazhukka. The cultivar Malabar with a prostrate panicle (panicles spreading on ground) is widely grown in Karnataka, while the cultivar Mysore, characterized with erect panicles is extensively cultivated in Kerala and parts of Tamil Nadu. Whereas, the cultivar Vazhukka, a natural hybrid between Malabar and Mysore types with a distinct semi-erect (pendent) panicle, is the most popular cultivar in Kerala.

Climate and soil

The crop thrives well in regions which receive a well-distributed annual rainfall of 1500-2500 mm with a mean temperature of 15°C to 35°C, relative humidity of 75-90% and 600-1200 m above mean sea level. Cardamom grows luxuriantly in forest loam soils, which are generally acidic in nature with a pH range of 5.5-6.5. Growth of cardamom is enhanced, when planted in humus rich soils with low to medium available phosphorus and medium to high available potassium.

Propagation

Propagation by vegetative means through suckers is considered to be the most preferred method. Production of planting materials from seeds and through tissue culture are alternative methods of propagation. Seedling propagated plants may not be true to its parent. Establishment of clonal nursery is recommended for large-scale multiplication of high yielding varieties/selections.

Nursery

Cardamom seedlings are raised in primary and secondary nurseries.

Primary nursery

The nursery site is selected in open, well-drained areas, near a water source. Prepare the area by removing existing vegetation, stumps, stubbles and stones and dig to a depth of 30 cm. In the prepared area, beds of size 6 m x 1 m x 0.2 m are made and a thin layer of humus rich forest soil is uniformly spread over the beds. Fully ripened bold capsules from high yielding, disease-free mother clumps are collected from second and third harvests during the month of September. One kg fresh capsules comprising of about 500-800 fruits is sufficient to produce 3000-5000 seedlings. The seeds are extracted by gently pressing the capsules and then washed 3-4 times in cold water to remove the mucilage adhering to the seeds. The washed seeds are drained, mixed with wood ash and dried under shade. To ensure early and uniform germination, seeds should be sown immediately after extraction. Acid scarification with 25% nitric acid increases the germination percentage. Sow the seeds in rows spaced at 10 cm and 1-2 cm apart within the row. The seed rate for 6 m x 1 m sized bed is 30-50 g. After sowing, the beds are covered with a thin layer of sand and mulched with grass or paddy straw to a thickness of 2 cm over which tree twigs are laid. Water the beds regularly to maintain sufficient moisture. Germination commences in about 20-25 days and may continue for a month or two. Once sprouting is observed, remove existing mulch and maintain thin mulch material between the rows. Protect the seedlings by providing overhead shade. Transplant the seedlings at 3-4 leaf stage to the secondary nursery.

Secondary nursery

Seedlings are raised in the secondary nursery by two methods.

Bed nursery: The beds are prepared as described in primary nursery. Spread a layer of compost on the bed and mix thoroughly with soil. Seedlings with 3-4 leaves are transplanted at a distance of 20 to 25 cm. Mulching and watering should be done immediately after transplanting. Apply 90:60:120 gm NPK per bed of 6 m × 1 m size, in three equal splits at an interval of 45 days. First dose of fertilizer may be applied at 30 days after transplanting. Earthing up need to be undertaken after each fertilizer application and hand weeding is done once in 20-25 days. One month before uprooting, the shade should be removed to encourage better tillering. The seedlings will be ready for transplanting after 8-10 months of planting.

Polybag nursery: Polythene bags of size 20 cm × 20 cm and 100 gauge thickness are filled with potting mixture consisting of forest top soil, cow dung and sand (ratio 3:1:1). Provide sufficient holes at the base of polybags to ensure good drainage. Seedlings at 3-4 leaf stages are transplanted into each bag (one seedling/bag). Seedlings raised in the polybags have a uniform growth and nursery period could be reduced by 5-6 months.

Planting and cultural practices

Planting

On slopes, prepare the land by contour terracing and in open areas like marshy valleys and grasslands, raise shade trees before planting cardamom seedlings. Plants fast growing shade trees to protect the seedlings from direct sunlight. Shade regulation, terracing and preparation of planting pits should be done during summer months in the areas identified for fresh planting. In newly planted areas, shade regulation is undertaken during the months of March-April by pruning branches of shade trees to provide 40 - 60% filtered light. Preferably, South-Western slopes should be provided with more shade than North-Eastern slopes. For planting, pits of required size are prepared before commencement of the monsoon season (April-May). For planting Malabar types, pits of size 45 cm x 45 cm x 45 cm are prepared and for Mysore and Vazhukka types, 90 cm × 90 cm × 45 cm or 90 cm × 90 × 90 cm are recommended. The pits are filled to one third with topsoil. Application of well decomposed farmyard manure or compost or leaf litter and 100 g of rock phosphate along with the topsoil will help in proper establishment and quick growth of suckers. Planting is normally done during June-July with the commencement of monsoon. Ten to 18 month old cardamom seedlings are selected for planting in the pits.

While planting, 50 g neem cake and rock phosphate (50 g) are applied to the pit. Deep planting should be avoided, as it results in suppression of the growth of new shoots and might result in death of the plants. Stakes may be provided to avoid the damage caused by wind and the plant base need to be covered with suitable mulching material. Planting diagonally to the slopes helps to prevent run off. Trench system of planting (60 cm $\times$ 30 cm) with a spacing of 2 m $\times$ 1 m is generally preferred over pit system, as it results in better establishment of the plants, higher yield and greater moisture retention. In sloppy lands, contour terraces need to be prepared and pits are taken along the contours at 2 m $\times$ 1 m spacing. For Mysore and Vazhukka cultivars, plant to plant distance can be 3 m $\times$ 3 m (1111 plants/hectare) and 2.4 m $\times$ 2.4 m (1736 plants/hectare) respectively. A spacing of 1.8 m $\times$ 1.8 m or 2.0 m $\times$ 2.0 m is ideal for Malabar types in Karnataka (2500-3000 plants/ha).

Irrigation

It is essential to irrigate the crop during January to May. Plants may be irrigated at an interval of 10-15 days till the onset of monsoon, by adopting a convenient method of irrigation either by hose/sprinkler/mini-sprinkler/drip. In case of drip irrigation, it needs to be supplemented with sprinkler irrigation once in a month. On gentle sloppy areas, opening of rectangular silt pits (1.0 m $\times$ 0.5 m $\times$ 0.6 m) between four plants will help in soil and water conservation.

Weeding

Cardamom being a surface feeder, in the first year of planting, weeding at frequent intervals is necessary. Later, depending on the intensity of weed growth, 2-3 rounds of hand weeding at the plant base during May, September and December/January and slash weeding in the interspaces are recommended. Mechanical weed cutters can be used for weeding.

Mulching

Entire plantation and particularly the plant bases should be mulched at 5-10 cm thickness using fallen leaves of the shade trees, except during periods of heavy monsoon (June-September). To facilitate honey bee movement, remove mulch during May-June after the receipt of pre-monsoon showers. Area where soil has become compact and hard, forking the plant base to a distance up to 90 cm and to a depth of 9-12 cm promotes better root penetration. Forking could be done with the cessation of North-East monsoon during November/December with least damage to the root system.

Trashing

Trashing may be carried out once in a year with the onset of monsoon under rainfed conditions and 2-3 times in high-density plantation provided with irrigation facilities. Trashing from November onwards may be avoided, due to summer. Pruning may be done during January and September which coincides with peak thrips population. Earthing up of the plant base and root zone with topsoil is recommended during October-December. In valleys and high rainfall areas with medium slopes, suitable drains (45 cm depth and 30 cm width) are provided in between two rows of cardamom. To provide adequate light during monsoon, shade regulation may be taken up before the commencement of rainy season (May). To maintain higher productivity, undertake replanting once in 8-10 years.

Manuring

Apply one-third of the recommended dose of fertilizers during the first year of planting both under rainfed and irrigated conditions with basal method of fertilizer application. Apply agricultural lime @ 1 kg/plant/year for soils with pH below 5.0 in one or two splits during May and September. Fertilizers shall be applied only after 15-20 days of lime application. Organic manures like cow dung/compost @ 5 kg/plant may be applied during May/June along with rock phosphate and muriate of potash. Under irrigated condition, manuring can be done in two splits (May and September). Application of neem cake, bone meal or vermicompost @ 1 kg/plant improves root proliferation and plant growth. Foliar spray of zinc (Zinc sulphate @ 250 g/100 litres of water) during April/May and September/October enhance growth, yield and quality of the produce. Soil application of boron in two splits along with NPK fertilizers (Borax @ 7.5 kg/ha) is also recommended. Foliar application of micronutrient mixture developed by ICAR-IISR specific to cardamom is also recommended (dosage @ 5 g/L) twice, in May – June and September-October, for higher yield.

Major Diseases and Pest

Nursery Leaf Rot

Nursery leaf rot is caused by fungi such as *Fusarium* and *Alternaria*. This disease commonly appears on three to four months old young seedlings. The symptoms develop as water soaked lesions on the foliage, which later turns to necrotic patches leading to the decay of affected areas. Usually the leaf tip and distal portions are damaged. In severe cases, rotting extends to the petiole and leaf sheaths also. Avoid excessive watering to the seedlings and spraying carbendazim (0.2%)

twice at 15 days interval after removal of the infected leaf portions manages the disease effectively.

Azhukal or Capsule Rot

Azhukal (*Phytophthora nicotianae* var. *nicotianae* and *P. meadii*) is a serious problem and a major constraint in the successful cultivation of cardamom. The disease appears after the onset of South-West monsoon in the form of water soaked lesions on tender leaves and capsules, which later form dead areas surrounded by yellow halo. As a result, the leaves rot and shred along the veins. In the advanced stages, the affected leaves break at the base of the petiole and remain hanging. On the immature capsules, the symptoms develop as water soaked discoloured areas, which later turn brownish. Upon decay, such capsules emit a foul smell and subsequently drop off.

Management

- Trashing and cleaning of the plant basin is to be carried out before the onset of monsoon.
- Thick shade may be regulated by lopping of tree branches.
- Provide drainage in low lying and marshy areas.
- Prophylactic sprays with Bordeaux mixture (1%) should be given during May-June and may be repeated during July-August.
- Alternatively, fungicides like fosetyl-aluminium (0.2%) or potassium phosphonate (0.3%) can be sprayed @ 500-750 ml/plant.
- Drenching plant basin with copper oxychloride (0.2%) reduces the soil inoculum and further spread of the disease.
- *Trichoderma viride* or *T. harzianum* mass multiplied on suitable carrier media may be applied to plant basins @ 1 kg during May and September-October.

Rhizome rot

Rhizome rot is also called as clump rot. Soil-borne pathogenic fungi, *Pythium vexans*, *Rhizoctonia solani* and *Fusarium spp.* are the causal organisms of rhizome rot disease in mature plants. The disease appears as yellowing of foliage, followed by drooping of leaves; collar region becomes brittle which breaks off at slight disturbance. As the disease advances, rotting extends to the rhizomes and roots. Severely affected tillers eventually falls off. Rotten rhizomes become soft, dark brown in colour and emit a foul smell. Rhizome rot and lodging of shoots are severe during monsoon season.

Management

- Trash and clean the plant base before the onset of monsoon.
- Regulate shade with the onset of pre-monsoon showers.
- Provide adequate drainage in the plantation.
- Uproot and destroy severely affected clumps from the plantation.
- Drench the plant basins with copper oxychloride 0.25% and spray the plants with Bordeaux mixture 1% with the onset of pre-monsoon showers during May-June.
- Alternatively, drench and spray potassium phosphonate 0.3% or metalaxyl-mancozeb 0.125% with the onset of pre-monsoon showers during May-June.
- *Trichoderma harzianum* mass multiplied on suitable carrier media may be applied to plant basins @ 1 kg during May and September-October.
- Cultivate rhizome rot resistant variety IISR Avinash in disease prone areas.

Mosaic or Katte disease

Mosaic disease is locally known as katte meaning a disorder. When plants are infected during the early stages, the loss will be almost total while, late infection results in gradual decline in productivity. Total decline of plants occurs after 3-5 years of infection with a yield reduction up to 70%. The first visible symptom appears on the youngest leaf as slender chlorotic flecks. These flecks later develop into pale green discontinuous stripes. Later, the characteristic mosaic symptoms appear on the leaf lamina. Mosaic type of mottling is also observed on the leaf sheaths and young pseudostems. In the advanced stages, the affected plants produce shorter and slender tillers with few shorter panicles and degenerate gradually. The disease is caused by Cardamom mosaic virus (CdMV). The disease is not transmitted through seed, soil, root to root contact and through manual operations. The virus is disseminated by the aphid vector (*Pentalonia caladii*) and also through infected rhizomes.

Integrated management of viral diseases of cardamom

- Prompt inspection of plantation, detection and rouging of virus sources reduces re-infection from the diseased source.
- Production and use of virus-free planting materials prevents introduction of disease into disease-free locations.
- Seedling and clonal nurseries have to be raised in isolated sites.

- Collection and using clones from severely infected gardens may be avoided.
- Remove infected volunteers in the replanted area and totally avoid the presence of volunteers from nursery area.
- Periodical removal of older parts is effective in reducing the aphid population and the spread of viral diseases.
- Plant resistant variety, IISR Vijetha in Katte prone areas.
- Removal of natural hosts like Colocasia and Caladium destroys the breeding sites and check population build-up of the vector.
- Neem based products at 0.1% concentration significantly reduces settlement of aphids on the cardamom leaves and are also lethal to the aphids at higher concentrations.

Cardamom thrips (*Sciothrips cardamomi*)

Cardamom thrips is the most destructive and persistent pest of cardamom, found in almost all the cardamom growing areas. Thrips breed inside the unopened leaf spindles, leaf sheaths, flower bracts and flower tubes. Adults as well as the larvae lacerate and feed on leaves, shoots, inflorescences and capsules. Infestation on the panicles results in shedding of flowers and immature capsules. Feeding activity on tender capsules leads to the formation of corky, scab-like encrustations. The extent of damage may be as high as 80% in certain areas. Population of thrips is generally high during the summer months (February- May) and declines with the onset of monsoon.

Management

- Regulate shade in the plantation by pruning branches of shade trees.
- Trash cardamom plants thrice a year i.e., during early monsoon, mid-monsoon and late monsoon periods to remove breeding sites of the pests.
- Spray insecticides like quinalphos (0.025%), during March, April, May, August and September.
- Spraying of Fipronil (0.005%) or spinosad (0.0135%) during February-March, March-April, April-May, September and October is also effective. Avoid spraying operations during peak periods of honey bee activity.

Shoot and capsule borer (*Conogethes punctiferalis*)

The shoot and capsule borer is a serious pest in nurseries as well as in plantations. The larvae bore into pseudostems and feed on the internal

contents leading to the formation of 'dead heart' symptom. When panicles are attacked, the portion ahead of point of entry dries off. The larvae also bore into the capsules and feed on the seeds resulting in empty capsules. The pest is prevalent throughout the year but higher incidence is pronounced during January-February, May-June, and September-October.

Management

- Remove infested suckers as indicated by extrusion of frass, during September-October when the infestation is less than 10%.
- Collect and destroy adults which are generally observed on the undersurface of leaves.
- Spray quinalphos (0.075%) twice, during February-March and September-October coinciding with emergence of panicles and new shoots.

Harvesting and processing

Cardamom plants start bearing two or three years after planting. The capsules ripen within a period of 120-135 days after its formation. Harvesting period commences from June-July and continues till January-February. Usually harvesting is done at an interval of 15 -30 days. The capsules are harvested when they attain physiological maturity, which is indicated by dark green colour of rind and black coloured seeds. Freshly harvested capsules are washed in water to remove the soil particles and other dirt adhering to it and to get good quality commodity. Curing of cardamom is the process by which moisture of freshly harvested capsules is reduced from 80 to 10-12% through indirect heating. Maturity of capsules and curing temperature influences the colour and quality of processed cardamom. During curing, a temperature range of 40-45°C is maintained during all the stages of drying which helps in good retention of green colour. Gradual increase of drying temperature to 50-60°C in the last two hours of curing enables easy removal of floral remnants during polishing. An increase in drying temperature also results in loss of oil from the seeds.

Flue curing is practiced for drying cardamom. A traditional curing unit consists of a furnace for burning the fuel, flue pipes for conveying the hot air and drying racks for stacking the trays. A drying chamber with dimensions of 4.5 m in length and breadth is sufficient for a plantation, which has a production capacity of 2 tonnes of fresh cardamom. The capsules are evenly spread as a single layer on the trays. After staking the trays on the racks in the drying chamber, the curing room is closed. Hot air generated by burning fuel in the furnace is circulated through the flue pipes, which are placed few centimetres above the floor. This process

enhances the room temperature to 45-55°C, which is maintained for a period of 3-4 hours. Proper curing takes about 16-18 hours. Dried capsules are polished either manually or with the help of machines. Polishing is carried out by rubbing the dried capsules in hot state against a hard surface. The polished produce is subsequently graded based on the quality parameters such as colour, weight per volume, size and percentage of empties, malformed, shrivelled and immature capsules. The capsules are stored at a moisture content of less than 10% to retain the original parrot green colour and to prevent mould growth. Use of 300 gauge black polythene lined gunny bags improves efficiency of storage. It is advisable to store the dried cardamom in wooden boxes at room temperature, preferably in the curing houses.

Black Pepper

Black pepper is a perennial vine grown for its berries extensively used as spice and in medicine. It is a plant of humid tropics requiring high rainfall and humidity. It grows successfully between 20° North and South latitudes, and, up to 1500 m above sea level. The favourable temperature range is 23- 32°C and the ideal temperature is around 28°C. Optimum soil temperature for root growth is 26 - 28°C. The ideal range of relative humidity for the crop is 75-80%. A well distributed annual rainfall of 1250-2000 mm is considered ideal for black pepper. Over 75 cultivars of black pepper are being cultivated in India. Eighteen improved varieties of black pepper have been released for cultivation.

Propagation

Cuttings are raised mainly from runner shoots, though terminal shoots can also be used. Cuttings from lateral branches develop a bushy habit. Rooted lateral branches are used for raising bush pepper. Though seeds (berries) are fully viable, they are not generally used for raising plantations as seedlings will not be genetically uniform.

Serpentine method: Serpentine layering technique can be used for production of rooted cuttings of black pepper in a cheap and effective manner. In a nursery shed with roofing sheet or shade net, rooted black pepper cuttings are planted in polythene bags holding about 500 gm potting mixture, which will serve as mother plants. As the plant grows and produces few nodes small polythene bags (20×10 cm) filled with potting mixture may be kept under each node. The node may be kept gently pressed in to the mixture assuring contact with the potting mixture with the help of a flexible twig such as mid rib of a coconut leaflet. Roots start growing from the nodes and the cuttings keep on growing further. The process of keeping potting mixture filled polythene bags at every node junction to induce rooting at each node is repeated. In three months

the first 10 to 12 nodes (from the mother plants) would have rooted profusely and will be ready for harvest. Each node with the polythene bag is cut just below the rooted node. The cut end is also buried into the mixture to induce more roots. Polythene bags used are filled with solarized potting mixture fortified with biocontrol agent. The rooted nodes will produce new sprouts in a week time and will be ready for field planting in 2-3 months. By this method, on an average, 60 cuttings can be harvested per mother plant in a year.

Vertical column method: A novel method of intensifying quality planting material production has been standardized using vertical columns with soil-less media. The technique involves growing orthotropes on vertical column (2 m height, 0.3 m diameter) made of half an inch plastic coated welded wire mesh. The column is filled with partially decomposed coirpith and vermicompost @ 3:1 ratio fortified with bio-control agent *Trichoderma harzianum*. Growing the vine on vertical column can be effectively utilized for the production of three types of planting material i.e., single node cuttings, top shoots with lateral branch and laterals or plagiotropes which can be used for production of bush pepper. The hi-tech poly house (temperature of 25-28°C and relative humidity 75-80% with intermittent misting) is advisable for the above production system. Eight to ten cuttings can be planted around each vertical column. The cuttings are allowed to trail on the column ensuring that each node comes in contact with the medium. It takes about four to five months for the cuttings to reach the top of the column. At this stage each vine will have around 20 nodes with few lateral branches (at 12th-15th node). The top 5-7 nodes with lateral branches can be used as orthotropic shoots for field planting.

Establishment of Plantations

For planting black pepper in slopes, the lower half of northern and north eastern slopes are preferred. This will save the vines from sun scorching from southern side during summer. With the receipt of first rains in May-June, primary stem cuttings of standard trees such as *Erythrina spp.*, *Garuga pinnata*, *Grevillea robusta* etc. are planted in pits at a spacing of 3 m × 3 m which would accommodate about 1110 standards per hectare. The black pepper vines can be trailed on the standards after three years when they attain sufficient height.

Planting

Pits of 50 cubic centimetres at a distance of 30 cm away from the base, on the north, eastern or north eastern side of supporting tree are taken with the onset of monsoon. The pits are filled with a mixture of top soil, farmyard manure @ 5 kg/pit and 150 gm rock phosphate. Neem cake @ 1

kg, *Trichoderma harzianum*@ 50 gm also may also be mixed with the mixture at the time of planting. With the onset of monsoon, 2-3 rooted cuttings of black pepper are planted individually in the pits.

Cultural Practices

As the plants grow, shoots are tied to the standard as often as required. The young vines should be protected from hot sun during summer by providing artificial shade. Regulation of shade by lopping the branches of standards is necessary not only for providing optimum light to the vines but also for enabling the standards to grow straight. Adequate mulch with green leaf or organic matter should be applied towards the end of north east monsoon. The base of the vines should not be disturbed to avoid root damage. During the second year, the same cultural practices are repeated. Lopping may be done twice (during June and September) in a year. Excessive shading during flowering and fruiting encourages pest infestations. Growing cover crops like *Calapogonium mucunoides* is also recommended as an effective soil cover to prevent soil erosion during rainy season.

Manuring and Fertilizer Application

Manuring and fertilizer application is critical for proper establishment and growth of plants. Application of lime or dolomite @ 500 g/vine in April-May during alternate years is recommended under highly acid soil conditions. Organic manures in the form of cattle manure or compost can be given @10 kg/vine during May. Neem cake @ 1 kg/vine can also be applied. Recommended blanket nutrient dosage for black pepper vines (3 years and above) is NPK 50: 50:150 gm/vine/year.

Only one-third of this dosage should be applied during the first year which is increased to two-thirds in the second year. The full dose is given from the third year onwards. As the soil fertility will be varying with the agro ecological conditions or management systems, site specific nutrient management for yielding gardens based on their soil test results for major nutrient is advocated. The fertilizers are to be applied in two split doses, one in May-June and the other in August-September and sufficient soil moisture must be ensured. The fertilizers are applied at a distance of about 30 cm all around the vine and covered with a layer of soil. Care should be taken to avoid direct contact of fertilizers with roots of black pepper. When Biofertilizer like *Azospirillum* is applied @ 50 g/vine, the recommended nitrogen dose may be reduced by half. Foliar application of micronutrient mixture specific to black pepper is also recommended (dosage @ 5 gm/L) twice, starting at flowering and followed at monthly intervals for higher yield.

Microbial Consortium

A talc based formulation (IISR Biomix) consisting of a consortium of Plant Growth Promoting Rhizobacteria is also applied to black pepper in the nursery and main field for enhanced growth and yield. During application, 20 gm of talc formulation is mixed in one litre of water and is applied at the rate of 250 ml per vine in the field and at the rate of 100 ml per bag in the nursery. Alternatively, 1 kg of talc formulation can be mixed with 100 kg of Farm Yard Manure (FYM) (or well decomposed cow dung) and applied at the rate of 1 kg per vine in the basin i.e. around the root zone. It can be applied twice a year (during May-June and September-October).

Summer Irrigation

Irrigating black pepper vines during summer (March 15th to May 15th) at fortnightly interval enhances productivity by 90 to 100% compared to unirrigated crop. Vines are irrigated at the basin through hose and 50 litres per vine is recommended (15 years and above). This can be reduced to 40 litres per vine for 11-15 years age group and 30 litres for vines aged between 5 -10 years. The spiking will be uniform in the irrigated crop as most of the spikes (> 90%) emerge by July while in rain fed crop only around 60% of spikes emerge in July and may extend till September. Spike length will be comparatively more in irrigated crop.

Plant Protection

Foot rot disease

Foot rot (quick wilt) caused by *Phytophthora capsici* is the most destructive of all diseases and occurs mainly during the south west monsoon season. All parts of the vine are vulnerable to the disease and the expression of symptoms depend upon the site or plant part infected and the extent of damage. One or more black spots appear on the leaves which have characteristic fine fimbriate margins which rapidly enlarge and cause defoliation. The tender leaves and succulent shoot tips of freshly emerging runner shoots trailing on the soil turn black when infected. If the main stem at the ground level or the collar is damaged, the entire vine wilts followed by shedding of leaves and spikes with or without black spots.

Management

- Removal and destruction of dead vines along with root system from the garden is essential as this reduces the build-up of inoculum
- Planting material must be collected from disease free gardens and the nursery preferably raised in fumigated or solarized soil.

- Adequate drainage should be provided to reduce water stagnation.
- Avoid injury to the root system due to cultural practices such as digging
- The emerging runner shoots should not be allowed to trail on the ground.
- The branches of support trees must be pruned at the onset of monsoon to avoid build up of humidity and for better penetration of sunlight. Reduced humidity and presence of sunlight reduces the intensity of leaf infection.

Any one of the following chemical control measures can be adopted.

- After the receipt of a few monsoon showers (May-June), all the vines are to be drenched at a radius of 45-50 cm with copper oxychloride (0.2%) @ 5-10 litres/vine. A foliar spray with Bordeaux mixture (1%) is also to be given. Drenching and spraying are to be repeated during August-September. A third round of drenching may be given during October if the monsoon is prolonged.
- After the receipt of a few monsoon showers, all the vines are to be drenched with potassium phosphonate (0.3%) @ 5-10 litres/vine. A foliar spray with potassium phosphonate (0.3%) is also to be given. A second spraying with potassium phosphonate (0.3%) is to be repeated during August-September. If the monsoon is prolonged, a third round of drenching may also be given during October.
- After the receipt of a few monsoon showers, all the vines are to be drenched with metalaxyl mancozeb (0.125%) @ 5-10 litres/vine. A foliar spray with metalaxyl mancozeb (0.125%) may also be given. A second application can be given during August-September.

Pollu disease (Anthracnose)

This disease is caused by *Colletotrichum gloeosporioides*. It can be distinguished from the pollu (hollow berry) caused by the beetle by the presence of characteristic cracks on the infected berries. The disease appears towards the end of the monsoon. The affected berries show brown sunken patches during early stages and their further development is affected. In later stages, the discolouration gradually increases and the berries show the characteristic cross splitting. Finally, the berries turn black and dry. The fungus also causes angular to irregular brownish lesions with a chlorotic halo on the leaves. The disease can be managed by prophylactic spraying of Bordeaux mixture (1%) or carbendazim + mancozeb (0.1%).

Slow Decline (Slow Wilt)

Slow decline is a debilitating disease of black pepper. Foliar yellowing, defoliation and die-back are the aerial symptoms of this disease. The foliar yellowing appears from October onwards coinciding with depletion of soil moisture. With the onset of south west monsoon during May/June, some of the affected vines recover and put forth fresh foliage. However, the symptoms reappear in subsequent seasons after the cessation of the monsoon and the vines gradually lose their vigour and productivity. The affected vines show varying degrees of feeder root loss due to nematode infestation and the expression of symptoms on the aerial parts occur after a considerable portion of the feeder roots are lost. Nematodes such as *Radopholus similis* and *Meloidogyne incognita* infestations lead to necrosis and development of galls on roots and rotting of feeder roots. The damage to feeder roots is caused by these nematodes and *P. Capsici* either independently or combined. There is no spatial segregation of plant parasitic nematodes and *P. Capsici* in the soil under field conditions. Hence, it is necessary to adopt a combination of fungicide and nematicide application for the management of the disease.

Management

- Severely affected vines should be removed from the plantation and destroyed, as it is impossible to recover them whenever high population of nematode are noticed.
- Nematode free rooted cuttings raised in fumigated or steam sterilized nursery mixture should be used for planting in the field.
- Along with nematicides the basins should be drenched with either copper oxychloride (0.2%) or potassium phosphonate (0.3%) or metalaxyl-mancozeb (0.125%).
- In areas severely infested with root knot nematodes, cuttings of the resistant variety 'Pournami' may be planted. Biocontrol agents like *Pochonia chlamydosporia* Or *Trichoderma harzianum* can be applied @50 g/vine twice a year. The fungus load in the substrate should be 10^8 cfu/g. The control measures should be taken up during early stages of the disease.

Pollu beetle

Pollu beetle is the most destructive pest of black pepper and is more serious in plains and at altitudes below 300 m. The adult beetles feed and damage tender leaves and spikes. The females lay eggs on tender spikes and berries. The grubs bore into and feed on the internal tissues and the infested spikes turn black and decay. The infested berries also turn black and crumble when pressed. The pest infestation is more serious in shaded

areas in the plantation. The pest population is higher during September-October in the field. Regulation of shade in the plantation reduces the population of the pest in the field. Spraying quinalphos (0.05%) during June-July and September-October or quinalphos (0.05%) during July and Neemgold (0.6%) (Neem-based insecticide) during August, September and October is effective for the management of the pest. The underside of leaves (where adults are generally seen) and spikes are to be sprayed thoroughly.

Leaf gall thrips

Infestation by leaf gall thrips (*Liothrips karnyi*) is more serious at higher altitudes especially in younger vines and also in nurseries in the plains. The adults are black and measure 2.5 mm-3.0 mm in length. The larvae and pupae are creamy white. The feeding activity of thrips on leaves causes the leaf margins to curl downwards and inwards resulting in the formation of marginal leaf galls. Later the infested leaves become crinkled and malformed. In severe cases of infestation, the growth of younger vines and cuttings in the nursery is affected. Spray dimethoate (0.05%) during emergence of new flushes in young vines in the field and cuttings in the nursery.

Harvest and Post-Harvest Management

Black pepper takes about 7-8 months after flowering to reach full maturity. Harvest starts when one or two berries turn yellow. The spikes are nipped off by hand and collected in bags. Harvested spikes are generally collected in clean gunny bags. Recent advances in product diversification have necessitated harvesting of the berries at different stages of maturity.

Post-harvest processing operations followed for black pepper involves threshing, blanching, drying, cleaning, grading and packaging. During processing care should be taken to maintain the quality at each step of operation. Threshers with capacities varying from 50 kg/h to 2500 kg/h are available which can thresh quickly and provide clean product. The quality of the black pepper can be improved by a simple treatment of dipping the mature berries taken in perforated vessel in boiling water for a minute before drying.

Pepper has moisture content of 65% to 70% at harvest, which should be brought to safer levels of 10% by adequate drying. Sun drying is the conventional method followed for drying of black pepper. In order to achieve a quality dry product, pepper berries are spread on clean dry concrete floor / bamboo mats/ PVC sheets and dried in the sun for a period of 4 - 6 days. The average dry recovery varies between 33-37%

depending on the varieties and cultivars. Mechanical driers are also used to dry black pepper. The threshed and dried black pepper has extraneous matter like spent spikes, pinheads, stones, soil particles etc. mixed with it. Cleaning and grading are basic operations that enhance the value of the produce and help to get higher returns. Cleaning on a small scale is done by winnowing and hand picking which removes most of the impurities. Such units consist of a fan/ blower and a feeding assembly. The fan is placed at the rear end of the hopper. Cleaning is achieved by feeding the material through the hopper into a stream of air blowing in perpendicular direction. The lighter fractions (dust, immature berries, pin heads and spent spikes) are blown away. Grading of black pepper is done by using sieves and sifting black pepper into different grades based on size.

The major grades of black pepper are Tellicherry Garbled Special Extra Bold (TGSEB) (4.8 mm); Tellicherry Garbled Extra Bold (TGEB) (4.2mm); Tellicherry Garbled (TG) (4.0 mm); Malabar Garbled (MG grades 1 and 2) and Malabar Ungarbled (MUG grades 1 and 2).

White pepper

It is generally prepared by retting (with frequently changing of water) fully ripened red berries for 7-8 days followed by removal of outer skin, washing and drying to a moisture level of 12%. White pepper is also prepared by fermentation using matured green pepper and black pepper.

Packaging

Organically grown black pepper should be packaged separately and labelled. Mixing different types of pepper is not good from a commercial point of view. Eco friendly packaging materials such as clean gunny bags or paper bags may be adopted and the use of polythene bags may be minimized. Recyclable/ reusable packaging materials shall be used wherever possible.

Storage

Black pepper is hygroscopic in nature and absorption of moisture from air, during rainy season when there is high humidity may result in mould and insect infestation. Before storage it is to be dried to less than 10% moisture. The graded produce is bulk packed separately in multi layer paper bags or woven polypropylene bags provided with food grade liners or in jute bags. The bags are arranged one over the other on wooden pallets after laying polypropylene sheets on the floor.

Ginger

Ginger is a herbaceous perennial, the rhizomes of which are used as a spice. Ginger grows well in warm and humid climate and is cultivated from sea level to an altitude of 1500 m above sea level. Ginger can be grown both under rain fed and irrigated conditions. For successful cultivation of the crop, a moderate rainfall from sowing time till the rhizomes sprout, fairly heavy and well distributed showers during the growing period and dry weather for about a month before harvesting are necessary. Ginger thrives best in well drained soils like sandy loam, clay loam, red loam or lateritic loam. A friable loam with a pH of 6.0 to 6.5 rich in humus is ideal. However, being an exhausting crop it is not desirable to grow ginger in the same soil year after year. Some of the prominent indigenous cultivars are Maran, Kuruppampadi, Ernad, Wayanad, Himachal and Nadia. The variety IISR Varada is suited for fresh ginger, dry ginger and making candy while, IISR Rejatha is rich in essential oil. The best time for planting ginger in the West Coast of India is during the first fortnight of May with the receipt of pre-monsoon showers. Under irrigated conditions, it can be planted well in advance during the middle of February or early March.

Land Preparation and Planting

The land is to be ploughed 4 to 5 times with receipt of early summer showers to bring the soil to fine tilth. Beds of about 1 m width, 30 cm height and of convenient length are prepared with an inter-space of 50 cm in between beds. In the case of irrigated crop, ridges are formed 40 cm apart. Ginger is propagated by portions of rhizomes known as seed rhizomes. Carefully preserved seed rhizomes are cut into small pieces of 2.5-5.0 cm length weighing 20-25 gm each having one or two good buds. The seed rhizomes are treated with mancozeb 0.3% (3 gm/L of water) for 30 minutes, shade dried for 3-4 hours and planted at a spacing of 20-25 cm along the rows and 20-25 cm between the rows. The seed rhizome bits are placed in shallow pits prepared with a hand hoe and covered with well decomposed farm yard manure and a thin layer of soil and levelled.

Transplanting Technology for Reduction of Seed Cost

Though transplanting in ginger is not conventional, it is found profitable. A transplanting technique in ginger by using single bud sprouts (about 5 gm) has been standardized to produce good quality planting material with reduced cost. The yield level of ginger transplants is on-par with conventional planting system. The technique involves raising transplants from single sprout seed rhizomes in the pro-tray and planted in the field after 30-40 days. The advantages of this technology are production of healthy planting materials and reduction in seed rhizome quantity and eventually reduced cost on planting material.

Manuring

At the time of planting, well decomposed cattle manure or compost @ 25-30 tonnes/ha has to be applied either by broadcasting over the beds prior to planting or applied in the pits at the time of planting. Application of neem cake @ 2 tonnes/ha at the time of planting helps in reducing the incidence of rhizome rot disease/ nematode and increasing the yield. As the soil fertility will be varying with the soil type, agro ecological conditions or management systems, site specific nutrient management based on the soil test results for major nutrient is advocated.

Irrigation

Ginger is cultivated as rainfed crop in high rainfall areas (uniform distribution for 5 to 7 months) and irrigated crop in less rainfall areas where distribution is not uniform. Ginger requires 1300-1500 mm of water during its crop cycle. The critical stages for irrigation are during germination, rhizome initiation (90 DAP) and rhizome development stages (135 DAP). The first irrigation should be done immediately after planting and subsequent irrigations are given at intervals of 7 to 10 days in conventional irrigation (based on prevailing weather and soil type). Sprinklers and drip system can also be employed for better water use efficiency and enhanced yield.

Inter cultivation

Weeding is done just before fertilizer application and mulching; 2-3 hand weeding are required depending on the intensity of weed growth. Proper drainage channels are to be provided when there is stagnation of water. Earthing up is essential to prevent exposure of rhizomes and provide sufficient soil volume for free development of rhizomes. It is done at 45 and 90 days after planting immediately after weeding and application of fertilizers.

Inter cropping and crop rotation

Crop rotation is generally followed in ginger. The crops most commonly rotated with ginger are tapioca, millet, paddy, maize and vegetables. In Karnataka, ginger is also mix cropped with millet, red gram and castor. Ginger is also grown as an intercrop in coconut, arecanut, coffee and orange plantations in Kerala and Karnataka. However, crop rotation using tomato, potato, chillies, brinjal and peanut should be avoided, as these plants are hosts for the wilt causing organism, *Ralstonia solanacearum*

Plant Protection

Soft rot

Soft rot is the most destructive disease of ginger which results in total loss of affected clumps. The disease is soil-borne and is caused by *Pythium spp.* among which, *P. Aphanidermatum* and *P. Myriotylum* are widely distributed in the country. The fungus multiplies with build up of soil moisture with the onset of south west monsoon. The infection starts at the collar region of the pseudostem and progresses upwards as well as downwards. The collar region of the affected pseudostem becomes water-soaked and the rotting spreads to the rhizome resulting in soft rot with characteristic foul smell.

Management: Seed rhizomes are to be selected from disease free gardens, since the disease is also seed borne. Treatment of seed rhizomes with mancozeb 0.3% or metalaxyl mancozeb 0.125% for 30 minutes before storage, and once again before planting and drenching at 30 and 60 days after planting reduces the incidence of the disease. Cultural practices such as selection of well drained soils for planting is important, since stagnation of water predisposes the plant to infection. The soil may be solarized before planting by covering the moist soil with a transparent polythene film for 45-50 days. Application of *Trichoderma harzianum* along with neem cake @ 1 kg/bed helps in reducing the incidence of the disease. Once the disease is located in the field, removal of affected clumps and drenching the affected and surrounding beds with mancozeb 0.3% or metalaxyl mancozeb 0.125% or copper oxychloride 0.2% checks the spread of the disease.

Bacterial wilt

Bacterial wilt caused by *Ralstonia solanacearum* Biovar-3 is a soil and seed borne disease that occurs during south west monsoon. Water soaked spots appear at the collar region of the pseudostem and progresses upwards and downwards. The first conspicuous symptom is mild drooping and curling of leaf margins of the lower leaves which spread upwards. In the advanced stage, the plants exhibit severe yellowing and wilting symptoms. The vascular tissues of the affected pseudostems show dark streaks. The affected pseudostem and rhizome when pressed gently extrudes milky ooze from the vascular strands. Ultimately rhizomes rot emitting a foul smell.

Management: The cultural practices and seed rhizome treatment adopted for managing soft rot are also to be adopted for bacterial wilt. Seed rhizomes must be taken from disease free fields for planting. It is not advisable to plant ginger consecutively in the same field every year. Fields used for growing potato, or other solanaceous crops are to be

avoided. Once the disease is noticed in the field the affected clumps may be removed carefully without spilling the soil around and the affected area and surrounding areas drenched with copper oxychloride 0.2%. Care should be taken to dispose the removed plants far from the cultivated area or destroyed by burning.

Leaf spot

Leaf spot is caused by *Phyllosticta zingiberi*. The disease starts as water soaked spot and later turns as a white spot surrounded by dark brown margins and yellow halo. The lesions enlarge and adjacent lesions coalesce to form necrotic areas. The disease spreads through rain splashes during intermittent showers. The incidence of the disease is severe in ginger grown under exposed conditions. The disease can be managed by spraying of Bordeaux mixture 1% or mancozeb 0.2% or carbendazim 0.2%, with the appearance of disease symptoms. Care should be taken to see that the spray solution should reach lower surface of the leaves also.

Shoot borer

The shoot borer (*Conogethes punctiferalis*) is the most serious insect pest of ginger. The larvae bore into pseudostems and feed on internal tissues resulting in yellowing and drying of leaves of infested pseudostems. The presence of a bore-hole on the pseudostem through which frass is extruded and the withered and yellow central shoot is a characteristic symptom of pest infestation. The pest population is higher in the field during September-October.

Management: The shoot borer can be managed by spraying Malathion (0.1%) at 21 day intervals during July to October. The spraying is to be initiated when the first symptom of pest attack is seen on the top most leaf in the form of feeding marks on the margins on the pseudostem. An integrated strategy involving pruning and destroying freshly infested pseudostems during July-August (at fortnightly intervals) and spraying Malathion (0.1%) during September-October (at monthly intervals) is also effective against the pest.

Harvesting

Ginger attains full maturity in 210-240 days after planting. Harvesting of ginger for vegetable purpose starts after 180 days based on the demand. However, for making dry ginger, the matured rhizomes are harvested at full maturity i.e. when the leaves turn yellow and start drying. Irrigation is stopped one month before harvest and the rhizome clumps are lifted carefully with a spade or digging fork. In large scale cultivations, tractor or power tiller drawn harvesters are also used. The dry leaves, roots and

soil adhering on the rhizomes are manually separated. The most important criteria in assessing the suitability of ginger rhizomes for particular processing purposes is the fibre content, volatile-oil content and the pungency level. The relative abundance of these three components in the fresh rhizome is governed by its state of maturity at harvest.

Processing of Ginger

Processing of ginger to produce dry ginger basically involves two stages-peeling of the ginger rhizomes to remove the outer skin and sun drying to a safe moisture level. Peeling serves to remove the scaly epidermis and facilitate drying. Peeling of fully matured rhizomes is done by scrapping the outer skin with bamboo splits having pointed ends and this accelerates the drying process. Deep scraping with knives should be avoided to prevent the damage of oil bearing cells which are present just below the outer skin. The peeled rhizomes are washed before drying. The dry ginger so obtained is valued for its aroma, flavour and pungency.

Drying

The moisture content of fresh ginger at harvest is about 80-82% which is brought down up to 10% for its safe storage. Generally ginger is sun dried in a single layer in open yard which takes about 8 to 10 days for complete drying. The sun dried ginger is brown in colour with irregular wrinkled surface. The yield of dry ginger is about 19-25% of fresh ginger depending on the variety and climatic zone.

Polishing, Cleaning and Grading

Polishing of dried ginger is done to remove the dry skin and the wrinkles developed on the surface during drying process. It is generally done by rubbing against hard surface. Cleaning of dry ginger is done manually to remove the extraneous matter and the light pieces. Once the ginger is cleaned and it is graded manually based on size of the rhizome, its colour, shape and the extent of residual lime (in the case of bleached ginger).

Storage

Dry ginger, packaged in gunny bags are highly susceptible to infestation by insects like *Lasioderma serricone* (cigarette beetle) during storage. Fully dried rhizomes can be stored in airtight containers such as high density polyethylene or similar packaging materials. Long term storage for more than two years would result in deterioration of its aroma, flavour and pungency.

Bleached ginger

Bleached ginger is produced by dipping scrapped fresh ginger in a slurry of slaked lime, Ca (OH) _2 , (1 kg of slaked lime/120 kg of water) followed by sun drying. As the water adhering to the rhizomes dry, the ginger is again dipped in the slurry. This process is repeated until the rhizomes become uniformly white in colour. Dry ginger can also be bleached by the similar process. Liming gives ginger a better appearance and less susceptibility to the attack of insect pests during storage and shipping.

Turmeric

Turmeric is used as condiment, dye, drug and cosmetic in addition to its use in religious ceremonies. India is a leading producer and exporter of turmeric in the world. Turmeric can be grown in diverse tropical conditions from sea level to 1500 m above sea level, at a temperature range of 20-35°C with an annual rainfall of 1500 mm or more, under rainfed or irrigated conditions. A number of cultivars are available in the country. Some of the popular cultivars are Duggirala, Tekkurpet, Sugandham, Amalapuram, Erode local, Salem, Alleppey, Moovattupuzha and Lakdong.

Cultivation

The land is prepared with the receipt of early monsoon showers. The soil is brought to a fine tilth by giving about four deep ploughings. Hydrated lime @ 500 - 1000 kg/ha has to be applied for laterite soils based on the soil pH and thoroughly ploughed. Immediately with the receipt of pre monsoon showers, beds of 1.0 m width, 30 cm height and of convenient length are prepared with spacing of 50 cm between beds. Planting is also done by forming ridges and furrows. Whole or split mother and finger rhizomes are used for planting and well developed healthy and disease free rhizomes are to be selected. The seed rhizomes are treated with mancozeb 0.3% (3 g/L of water) for 30 minutes, shade dried for 3-4 hours and planted. A seed rate of 2,500 kg of rhizomes is required for planting one hectare of turmeric.

Transplanting

Though transplanting in turmeric is not conventional, it is found profitable. A transplanting technique in turmeric by using single bud sprouts (about 5 g) has been standardized to produce good quality planting material with reduced cost. The technique involves raising transplants from single sprout seed rhizomes in the pro-tray and planted in the field after 30-40 days. The advantages of this technology are production of healthy planting materials and reduction in seed rhizome quantity and eventually reduced cost on seeds.

Planting

In Kerala and other West Coast areas where the rainfall begins early, the crop can be planted during April-May with the receipt of pre-monsoon showers. Small pits are made with a hand hoe on the beds with a spacing of 25 cm x 30 cm. Pits are filled with well decomposed cattle manure or compost, seed rhizomes are placed over it then covered with soil. The optimum spacing in furrows and ridges is 45-60 cm between the rows and 25 cm between the plants.

Manuring and fertilizer application

Farmyard manure (FYM) or compost @ 30-40 mt/ha is applied by broadcasting and ploughing at the time of preparation of land or as basal dressing by spreading over the beds or in to the pits at the time of planting. Organic manures like oil cakes can also be applied @ 2 mt/ha. In such case, the dosage of FYM can be reduced. Integrated application of coir compost (@ 2.5 mt/ha) combined with FYM, biofertilizer (*Azospirillum*) and half recommended dose of NPK is also recommended. As the soil fertility will be varying with the soil type, agro ecological conditions or management systems, site specific nutrient management based on the soil test results for major nutrient is advocated. The fertilizers are to be applied in 2-3 split doses. Full dose of phosphorus is applied as basal at the time of planting. Equal split doses of N and K is top dressed at 45, 90 (and 120) DAP. In zinc deficient soils, basal application of zinc fertilizer up to 5 kg zinc/ha (25 kg of zinc sulphate/ha) gives good yield. Foliar application of micronutrient mixture specific to turmeric is also recommended (dosage @ 5 g/L) twice, 60 and 90 DAP, for higher yield.

Mulching

The crop is to be mulched immediately after planting with green leaves @ 12-15 t/ha. Mulching may be repeated @ 7.5 t/ha at 40 and 90 days after planting after weeding, application of fertilizers and earthing up.

Weeding and Irrigation

Weeding has to be done thrice at 60, 90 and 120 days after planting depending upon weed intensity. In the case of irrigated crop, depending upon the weather and the soil conditions, about 15 to 23 irrigations are to be given in clayey soils and 40 irrigations in sandy loams.

Plant Protection

Leaf blotch

Leaf blotch is caused by *Taphrina maculans* and appears as small, oval, rectangular or irregular brown spots on either side of the leaves which

soon become dirty yellow or dark brown. The leaves also turn yellow. In severe cases the plants present a scorched appearance and the rhizome yield is reduced. The disease can be controlled by spraying mancozeb 0.2%.

Leaf blight

Leaf blight is caused by *Rhizoctonia solani*. The disease is characterized by the appearance of necrotic patches with papery white centre of varying sizes on the lamina which spread on the whole surface leaving a blighted appearance. The disease occurs during the post monsoon season. The disease can be controlled by spraying Bavistin 0.2% or Bordeaux mixture 1% with the initiation of infection.

Rhizome rot

The disease is caused by *Pythium aphanidermatum*. The lower leaves of the infected pseudo stem show yellowing, collar region of the pseudo stem becomes soft and water soaked, resulting in collapse of the plant and decay of rhizomes. Treating the seed rhizomes with mancozeb 0.3% for 30 minutes prior to storage and at the time of sowing prevents the disease. When the disease is noticed in the field, the beds should be drenched with COC 0.2% or Metalaxyl -mancozeb 0.125%.

Nematode pests

Root knot nematodes (*Meloidogyne* spp.) and burrowing nematode (*Radopholus similis*) are the two important nematodes causing damage to turmeric. Root lesion nematodes (*Pratylenchus* spp.) are of common occurrence in Andhra Pradesh. In places where nematode problems are common, use only healthy, nematode-free planting material. Increasing the organic content of the soil also checks the multiplication of nematodes. *Pochonia chlamydosporia* can be applied to the beds at the time of sowing @ 20 g/bed (10^6 cfu/g) for management of nematode problems.

Harvesting and Processing

Well managed turmeric crop is ready for harvest in seven to nine months depending on the variety and time of sowing. The crop is generally harvested during January to March. On maturity, the leaves turn dry and are light brown to yellowish in colour. In case of manual harvesting, the land is ploughed, the clumps are carefully lifted with spade and the rhizomes are gathered by hand picking. Harvesting with a tractor attached to a turmeric harvester is followed when the raised beds are taken using a tractor. The harvested rhizomes are collected manually and all the extraneous matter adhering to them is cleared.

Preservation of Seed Rhizomes

Rhizomes for seed purpose are generally stored by heaping in well ventilated rooms and covered with turmeric leaves. The seed rhizomes can also be stored in pits with saw dust, sand along with leaves of *Stychnos nuxvomica*. The pits are to be covered with wooden planks with one or two openings for aeration. The rhizomes are to be dipped in quinalphos (0.075%) solution for 20-30 minutes if scale infestations are observed and in mancozeb (0.3%) to avoid storage losses due to fungi.

Post-Harvest Processing

The harvested turmeric rhizome before entering into the market is converted into a stable commodity through a number of post-harvest processing operations like boiling, drying and polishing. Boiling of turmeric is taken up within 3 or 4 days after harvest. The fingers and bulbs (or mother rhizomes) are separated and are cured separately, since the latter take a little longer to cook. The dry recovery of the different turmeric varieties vary widely ranging from 19 to 23%.

Boiling: Boiling is the first post-harvest operation to be performed at the farm level, which involves cooking of fresh rhizomes in water until soft before drying. Boiling destroys the vitality of fresh rhizomes, avoids the raw odour, reduces the drying time and yields uniformly coloured product. In the traditional method, a vessel made of galvanized iron sheet is used for turmeric boiling. Boiling of turmeric rhizomes is carried out till froth forms and white fumes come out of the pan with a characteristic odour. Boiling is considered complete by pressing a pointed stick in to the rhizomes with slight pressure. An effective cooking time of 45 to 60 minutes for fingers and 90 minutes for mother rhizomes is considered essential. Overcooking and under cooking are found to affect the quality of the rhizome. Improved turmeric boiler using steam boiling technique is followed when large quantities of turmeric are to be cured.

Drying: The cooked fingers are dried in the sun by spreading in 5-7 cm thick layers on the drying floor. During night time, the material should be heaped or covered. It may take 10-15 days for the rhizome to become completely dry. The bulbs and fingers are dried separately, the former takes more time to dry. Turmeric should be dried on clean surface to ensure that the product does not get contaminated by extraneous matter. Care should be taken to avoid mould growth on the rhizomes. Rhizomes are turned intermittently to ensure uniformity in drying.

Solar tunnel driers covered by UV stabilized semi-transparent polyfilm sheet of 200 microns thickness can also be used for drying turmeric. The solar radiation is transmitted through plastic sheet, which has a transmissivity of 90%. The yield of the dry product varies from 20-25%

depending upon the variety and the location where the crop is grown. The starch gelatinized during boiling shrink and during the drying process intercellular spaces increase, enhancing water diffusion and reducing the drying time.

Polishing and colouring: Dried turmeric has poor appearance and rough dull outer surface with scales and root bits. The appearance is improved by smoothening and polishing the outer surface by manual or mechanical rubbing. Polishing of dried turmeric also helps in removing the wrinkles. In an improved method, polishing is done by using hand operated/power operated barrel or drum mounted on a central axis, the sides of which are made of expanded metal screen. When the drum filled with turmeric is rotated, polishing is effected by abrasion of the surface against each other as they roll inside the drum. The turmeric is also polished in power operated drums. Large scale polishing units with capacity to polish 500 to 1000 kg per batch is used for polishing turmeric rhizomes at commercial units. It takes about 45-60 minutes per batch and about 4% is wasted as dust. The colour of the processed turmeric influences the price of the produce. Hence, to obtain attractive product, turmeric powder is sprinkled during the last phase of polishing.

Cleaning, Grading, Packing and Storage

Turmeric of commerce is described in three ways:

Fingers: These are the lateral branches or secondary ‘daughter’ rhizomes which are detached from the central rhizome before curing. Fingers usually range in size from 2.5 to 7.5 cm in length and may be over 1 cm in diameter.

Bulbs: These are central ‘mother’ rhizomes, which are ovate in shape and are of shorter length and having larger diameter than the fingers.

Splits: Splits are the bulbs that have been split into halves or quarters to facilitate curing and subsequent drying.

Turmeric being a natural produce, is bound to gather contaminants during various stages of processing. The spice is also cleaned to remove such foreign materials. A sifter, destoner, and an air screen separator will help remove materials such as stones, dead insects, excreta, and other extraneous matter. Cleaned and graded material is packed generally in new double burlap gunny bags and stored over wooden pallets in a cool, dry place protected from light. It is not recommended to apply pesticides on the dried/polished turmeric to prevent storage pests.

Spices Trade in SAARC Countries and beyond the SAARC

In terms of export, an estimated 8, 42,000 MT of spices and spice products valued INR 162382 million (US\$ 2482 million) were exported

from the country during 2015-16 registering an increase of 9% in value terms over previous year. The share of spices to total agri-products export is about 2.8% in quantity and 7.8% in value. Among the export of different spices, maximum share was from chilli followed by seed spices, turmeric and black pepper. However in terms of value, mint products and spice oils and oleoresins contributed a major share of the total export earnings. Spices contribute nearly 50% of the horticultural exports from the country. At the same time, India also imports a significant quantity of spices. Apart from the demand for domestic consumption some of the spices imported are also consumed by processing units and units involved in value addition in spices. The summary of spices trade from the country is given in Table 4.

Table 4. Summary of Spice Trade

Sl No	Particulars	Value
1	Area under spices (2016-17)	3.489 million ha
2	Production of spices (2016-17)	8.244 million tonnes
3	Export of spices (2015-16)	0.843 million tonnes
4	Export earnings (2015-16)	US \$ 2482.83 million (Rs 16238.23 Crores)
5	Import of spices (2015-16)	Quantity: 0.166 million tonnes Value: US \$ 698.02 million Rs 4466.22 crores
6	Share of spice exports in Agricultural GDP	Around 5%
7	Share of spices export earnings to total horticulture export earnings (except tea, coffee & rubber)	49%

Source: Directorate of Arecanut and Spices development, Ministry of Agriculture and Farmers Welfare, Government of India

Out of the total trade in spices the magnitude of trading within SAARC region is very small. The relatively high degree of self-sufficiency of different member countries in spices production could be one reason for low trade volumes within SAARC countries. However, in case of certain spices like black pepper industrial requirements and consumption requirements have necessitated trade within SAARC region. Once secondary and tertiary processing of spices and spice products gain currency such intra-regional spice trade could increase in terms of volume and value. Like most of the SAARC member countries, the spices from India are also exported to various countries across the world. The spice trade profile of the country is presented in Table 5.

Table 5. Composition of spice trade in India (2015-16)

Sl No	ITEM	Export		Import	
		Quantity (t)	Value (Million INR)	Quantity (t)	Value (Million INR)
1	Pepper	28,100	173,04.2	19,365	11629.6
2	Cardamom(s)	5,500	44,98.3	850	447.4
3	Cardamom(l)	600	7,55.1	3,410	3079.6
4	Chilli	347,500	399,74.4	425	102.4
5	Ginger	24,800	27,59.6	26,610	1011.6
6	Turmeric	88,500	92,16.5	15,330	1463.5
7	Coriander	40,100	42,68.1	25,305	1746.7
8	Cumin	97,790	153,11.3	2,000	344.1
9	Celery	5,310	5,32.8	1,325	81.3
10	Fennel	15,320	17,24.0	10,210	1837.9
11	Fenugreek	33,330	23,38.1	1,810	81.2
12	Other seeds (1)	23,880	16,20.6	20,235	10454.2
13	Garlic	23,085	15,95.9	490	195.5
14	Nutmeg & mace	4,050	20,92.8	1,200	795.0
15	Other spices (2)	43,955	58,34.9	19,405	2422.2
16	Curry powder/paste	26,550	53,17.5	4,810	905.1
17	Mint products (3)	23,250	258,13.1	11,135	5177.2
18	Spice oils & oleoresins	11,635	214,25.5	2,005	2887.8
Total		843,255	162382.3	165,920	44662.2
Value In Million Us \$			2482.83		698.02

Source: Spices Board, Ministry of Commerce and Industry, Government of India

Notes: (1) Include bishops weed (ajwan seed), dill seed, poppy seed, aniseed, mustard etc.

(2) Include asafoetida, cinnamon, cassia, saffron, spices (nes) etc.

(3) Include menthol, menthol crystals and mint oils.

One of the significant change in the recent past is the emergence of a strong export profile in value added commodities from spices. The export of value added products have happened across spice commodities and this development is favourable for strengthening value chain in spices and realizing the profit margins from organizing production activities along the value chain. The export profile of selected value added commodities during 2015-16 is given in Table 6.

Table 6. Export of selected spice value added commodities (2015-16)

Product	Quantity	Value (Million INR)
Pepper oleoresin	1,184,106	4063.67
Ginger Oleoresin	187,744	465.38
Cassia Oil	1,517	1.65
Cinnamon Bark/Leaf Oil	14125	23.96
Clove Leaf/Stem Oil	39,772	49.46
Ginger Oil	24,742	197.36
Clove Bud Oil	5,535	17.71
Nutmeg Oil	56,189	170.92
Pepper Oil	74,844	453.96
Turmeric Oil	85,087	338.01
Turmeric Oleoresin	814,654	2748.74
Cardamom Oleoresin	10,328	58.46
Nutmeg Oleoresin	167,659	316.45
Clove Oleoresin	9,834	37.04

Source: Export-Import data bank, Department of commerce, Ministry of Commerce and Industry, Government of India

Key Technology Developments / Strategies for Benefitting Spice Economy

The progress in technology in spices sector need to be seamlessly shared with other stakeholders for promoting the interest of primary producers of spices across national boundaries. In this sense, the technological developments and status of technological prowess of individual SAARC member countries is of significance. In this section we discuss the current status and developments in spices sector in the recent past. The section provides information on advances and capabilities which can be leveraged by other countries to suit their specific requirements.

Genetic resources: The Indian Institute of Spices Research (ICAR-IISR) has the world biggest spices germplasm collection. The present status of black pepper germplasm accessions conserved at the gene bank is 3181 (wild pepper - 1503, cultivars - 1669, exotic species - 9). In case of cardamom, IISR has 618 accessions in the National Active Germplasm Site (NAGS) at Cardamom Research Centre, Appangala, Coorg, Karnataka, India. The germplasm repository also includes 668 ginger accessions and 1404 turmeric accessions. The major varieties in the focus crops and their key features are presented in Annexure 1.

Cardamom variety for high yield and disease resistance: A high yielding cardamom hybrid “Appangala-2” with average yields of 985 kg/ha has been identified. The hybrid was evolved by crossing high yielding local cultivar with ‘katte’ virus resistant variety.

High yielding short duration turmeric variety: The high yielding short duration turmeric line (Acc. 48) was developed through germplasm selection. In the yield evaluation trial during 2009-2012, maximum mean yield over three years was recorded in Acc. 48 (31.95 t/ha). It is a short duration genotype (160-180 days) with high curcumin content (5%).

Breeding for *Ralstonia* resistance in ginger: Four mutants resistant to *Ralstonia solanacearum* infection and three resistant to *P. myriotylum* were developed and being clonally multiplied for further yield evaluations.

Identified two natural tetraploids of ginger: having high pollen fertility and bold rhizomes. Identified a true turmeric seedling (SLP 389/1) with consistently high curcumin content, moderate yield and having a specific morphological marker. A tri-parental hybrid of turmeric involving Hybrid-2 (389/1 × Surajana) × Roma is developed.

DNA based diagnostics for adulterants in spice products: A DNA based method has been perfected to detect chilli adulteration in traded black pepper powder, *Cinnamomum cassia* in commercial samples of true cinnamon (*C. verum*) and *Curcuma zedoaria* and cassava starch in branded market samples of turmeric powder and this method can detect adulteration even at very low levels of adulteration (0.5%).

Unique SNP profile has been developed for 14 cultivars of black pepper.

Identified the key genes for curcumin biosynthesis and starch biosynthesis from turmeric based on the RNA-Seq approach. Besides, it could be established that curcumin biosynthesis is regulated with respect to environmental conditions and nutrient status.

About 200 Polymorphic microsatellite markers were developed and validated and about 7000 SSR primers designed for turmeric. Many of these markers have been used worldwide in turmeric and other Zingiberaceous crops for fingerprinting.

The complete genome of two *Phytophthora* isolates (05-06 and 98-93) infesting black pepper was sequenced using Illumina/Roche 454 platforms. Complete genome sequencing of PYMoV and CMV infecting black pepper were done.

Developed genetic transformation protocol for black pepper. Developed protocol for somatic embryo production and regeneration in six varieties of black pepper for testing for freedom from viruses.

Vertical column method for quality black pepper planting material production:

The continuous demand for quality planting material created a novel idea of producing orthotropes on vertical 2m column having one feet diameter made with half an inch plastic coated welded wire mesh filled with composted cocopeat and vermicompost @ 3:1 ratio fortified with bio-control agent *Trichoderma harzianum* in hi-tech poly house of fan and pad system. Eight to ten cuttings can be planted around the each vertical column, allowed to trail and root on the column and in four months produce more than 20 nodes. Growing the vine on vertical column can be effectively utilized for the production of three types of planting material i.e., single node cuttings, top shoots (top 5 nodes can be used as orthotropic shoots) and lateral branch (1-2 for bush pepper). In four months time, on an average 150 single nodes per column, one or two laterals and 10 top shoots can be harvested.

Novel transplanting technique in ginger: A novel transplanting technique using single bud sprouts (about 5 gm) has been standardized. The technique involves raising transplants from single sprout seed rhizomes in pro-trays and planting in the field after 30 days. The advantages of this technology are production of healthy planting materials and reduction in seed rhizome quantity and eventually reduced cost on seeds.

Potting medium for plug trays: Partially composted coir pith and vermicompost (75:25) enriched with *Trichoderma* (in talc formulation, 10^7 cfu g⁻¹ at the rate of 10 g kg⁻¹) is an ideal potting medium for black pepper nursery for healthy planting material production using plug-trays (cell dimension of 7.5 x 7.5 x 10.0 cm) compared to conventional multiplication.

Crop specific micronutrient mixture for spices: Nutrient mix (IISR Power Mix) for enhanced growth, yield and quality of spices: This is a novel soil pH based micronutrient mixture for promoting growth, yield and quality of turmeric, ginger, black pepper & cardamom. Under proper conditions it can be stored for up to one year/ one crop season. It is recommended as foliar spray at the rate of 5 gm/litre on 60th and 90th day after planting in case of turmeric and ginger and as foliar spray at the rate of 5 gm/litre in May-June and September-October every year in case of black pepper and cardamom. An approximate increase of up to 15% in yield and a cost benefit ratio of 1:2.5 are experienced by farmers. Patent for this delivery process has been filed and the technology is being commercialized through non-exclusive licenses.

Management of virus affected black pepper gardens for yield sustainability: By the application of treatments (FYM, NPK, micronutrients and PGPR) there was a marked improvement in the health

of virus affected the vines. The spike intensity (per 0.5 m²) and yield were also significantly higher in treatments with nutrients and PGPR supplementation (3.19 kg/ std) as compared to control (1.9 kg/ std).

Novel and smart delivery method of biocontrol agents through encapsulation: ICAR-IISR has made a significant breakthrough in the successful encapsulation and delivery of a plant growth promoting rhizobacteria for growth promotion and disease control in ginger and black pepper. The advantages include reduced cost and easy handling and transport, no harmful by products, less requirement of inorganic and inert material, storage at normal temperature and more importantly, enhanced shelf life. Besides, this encapsulation technique can be used to deliver all kinds agriculturally important microorganisms viz., N fixers, nutrient solubilizers/ mobilizers, PGPR, Trichoderma etc. Patent for this delivery process has been filed and the technology is being commercialized through non-exclusive licenses.

Encapsulated Bio-consortium formulation for growth promotion in black pepper and cardamom nursery: Biofertilizer consortia to supplement NPK for black pepper and cardamom were developed. The consortia for black pepper with *Azospirillum lipoferum* (N₂ fixer), *Bacillus subtilis* (P solubilizer), *Paenibacillus glucanilyticus* (K solubilizer) and consortia for cardamom with *Azospirillum brasilense* (N₂ fixer,) *Acinetobacter boumanni* (P solubilizer) and *Bacillus* sp. (K solubilizer) as encapsulated formulations has been developed. The formulations can be stored up to one year without loss of viability. The consortia application @ 1gm/plant (20-25 beads) along with vermicompost @ 100gm is recommended.

Liquid formulation of *Trichoderma harzianum*: *Trichoderma harzianum* the biocontrol agent for *Phytophthora* foot rot disease of black pepper is made into a liquid formulation, containing minimum population of 10⁸ fungal spores per ml that can be stored up to one year without significant reduction in the viable cells. The recommended dosage for application is 20 ml of the formulation (10⁸ spores per ml) mixed with 500 kg of well decomposed farmyard manure or vermicompost, incubate for 5-10 days and applied to the basin of the vine @ 2.5 kg (FYM) or 500 gm (VC) in the field. For nursery, the formulation can be mixed with the potting mixture at the rate of 2 ml per 50 kg of potting mixture.

Pre-split harvest and etherel treatment to prevent aflatoxin contamination in nutmeg: A simple technique of hormone treatment was developed to split open nutmeg fruits without exposure to soil. The methodology involves harvesting physiologically mature fruits when the colour of the rind change from green to pale yellow/yellow and dipping

them in 500 ppm ethrel (2- Chloroethyl phosphonic acid) solution for 10 minutes and then storing them in shade. By this method, 90-100% of fruits will be split in 18-20 hours.

Development of mechanical unit for white pepper: A mechanical unit was developed and evaluated for production of white pepper from black pepper. The white pepper obtained had a dry recovery of 68.7% and the capacity of the pulping unit was 125 kg/h.

Curing of turmeric: Curing of fresh turmeric rhizomes in improved turmeric boiler (TNAU model- 100 kg capacity) by using steam and curing for 60 minutes duration, ensures that drying is completed in 10 days and produces dry rhizomes of good quality. Slicing of fresh turmeric rhizomes (5 mm thick) without curing reduces the drying time. This operation is to be performed only when there is a requirement from powdering industries or when used with in a short period of time.

Turmeric curing with solar steam: The renewable solar energy unit has solar thermal collectors with curved parabolic mirrors which concentrates solar radiation on to a central pipe called as the receiver. The unit has a cooking vessel of capacity 50 kg turmeric/batch and complete cooking of turmeric could be achieved in 45 min.

Quality evaluation using E-nose: Hand-held electronic nose was modified with suitable sensor array for determining quality. Samples were analyzed using the modified hand-held electronic nose for essential oil content and could be graded into low (<4.0%), medium (4.0-6.0%) and high (>6%).

Diagnostics for viral disease: Loop-mediated isothermal amplification (LAMP) and real-time LAMP based assays were developed for quick and sensitive detection of virus diseases of black pepper and cardamom.

Field diagnostics for Biovar specific detection of *Ralstonia solanacearum* infecting ginger (*Zingiber officinale*): A strain specific and sensitive technique based on Real Time Loop Mediated Isothermal Amplification (Real Time- LAMP) was developed for detecting race 4 strain of *Ralstonia solanacearum* causing bacterial wilt in ginger. The method can be used to index both soil, water as well as seed rhizomes. There is no need for extraction of the genomic DNA as the technique is standardized with soil supernatant as the template. The time taken for detection is only 3-4 hours and the detection limit is 10^3 CFU/g of soil or rhizomes. The technology can be easily adopted in field for pathogen-free site selection as well as selecting disease-free seed materials for planting.

A new media for mass multiplication of entomopathogenic nematodes: A new artificial media for the mass production of infective

juveniles of entomopathogenic nematodes was developed. By this technique around 23 lakh infective juveniles of EPN can be recovered from a single flask (250 ml). The media is suitable to multiply infective juveniles of *Steinernema* spp., *Heterorhabditis* spp. and *Oscheius* spp. at a very low cost. Ingredients for this media are cheaper and locally available.

Real-Time LAMP based diagnostic tool for on-farm early detection was developed to detect ginger specific *Ralstonia solanacearum*.

Developed loop-mediated isothermal amplification (LAMP) and real-time PCR based diagnostics for *Piper yellow mottle virus* (PYMoV) and *Cucumber mosaic virus* (CMV) in black pepper and for *Cardamom mosaic virus* (CdMV) and *Banana bract mosaic virus* (BBrMV) infecting cardamom.

Bio control for cardamom thrips: Field trials with an entomopathogenic fungus, *Lecanicillium psalliotae*, at different agro-climatic conditions in Kerala and Karnataka indicated that basal application of the fungus (3-4 applications during May – September) was effective in controlling the thrips and the treatment was on par with chemical insecticides. The technology is ideal for adoption in organic horticulture.

Control of *Colletotrichum* infection in black pepper nurseries: Pre-planting treatment of two/three node cuttings of black pepper by immersing in the fungicidal solution of carbendazim + mancozeb (0.1%) for 30 minutes delays the initiation of anthracnose disease in nurseries. Spraying Bordeaux mixture (1%), alternating with carbendazim (0.1%) further prevents the spread of anthracnose disease.

Management of nematodes in black pepper nursery: Drenching of Carbosulfan 0.1 % @ 50 ml /poly bag containing 1.5 kg potting mixture is recommended for the management of plant parasitic nematodes in black pepper rooted cuttings in the nursery. The treatment ensures 100% kill of nematodes without any toxicity to black pepper plants.

Management of Cardamom thrips: A technology for the control of cardamom thrips (*Sciothrips cardamomi*) for Karnataka region using spinosad 0.0135% (which is derived from *Saccharopolyspora spinosa*) as 3 sprays during March, May and August is on par with imidacloprid 0.0089% and thiamethoxam 0.0075% and can substitute synthetic insecticides for thrips control in cardamom.

Management of leaf blight in Cardamom: Spraying carbendazim + mancozeb (0.1%) at 30 day intervals was promising in reducing leaf spot incidence under cardamom nursery conditions. Combined application of hexaconazole 0.1% and soil application of *T. harzianum* thrice at 30 days

interval was promising in reducing leaf blight incidence under field conditions.

Management of plant parasitic nematodes infesting black pepper:

Drenching 0.1% carbosulfan 25 EC (0.125 a. i.) @ 5 l/plant at the base of plant twice (pre monsoon -May and post monsoon - October) a year OR applying fipronil 0.3 GR @ 50 gm/plant at the base of plant thrice (May, September and January) a year are effective for the management of plant parasitic nematodes infesting black pepper.

Dimethyl trisulfide a new compound for soil fumigation: Soil fumigation assays with different concentrations of dimethyl trisulfide resulted in 100% inhibition of *Phytophthora capsici*, *Pythium myriotylum*, *Rhizoctonia solani*, *Gibberella moniliformis*, *Athelia rolfsii*, *Colletotrichum gloeosporioides* and *Radopholus similis* at different concentrations.

New databases: The Bioinformatics Centre has developed and hosted eight biological databases viz., RADOBASE, Indian Plant Virus Database, Phytophthora Piper Transcriptome DB, Ginger Transcriptome Database, Phytophthora Genome Database, SpiceComDB, PiperPepDB and Sequence Repository of IISR. SpiceCom comprising plant based compounds and their bioactivity. It allows the user to search using compound name, plant name as well as based on activity. Facility to download compounds individually as well as in batch mode is provided.

Key Policy Input and Strategies for Strengthening Spice Value Chain

Spice crops constitute an important element in the agrarian economy of all the SAARC member nations. It is therefore important to evolve strategies aimed at strengthening this sector for ushering in robust growth in agricultural sector. The growth potential of this sector and the potential to bring about equitable development in the agrarian sector underline the urgent need for the SAARC Member States to evolve creative policy guidelines and strategies for promoting overall development of the spices sector. Some of the elements of such comprehensive approach are indicated here.

- SAARC countries should have regular dialogue and interaction among themselves regarding the status and capabilities in technology in spice production, processing and value addition. This can reduce the time lag between technology generation in one region and its adoption across the region.
- The SAARC countries need to dovetail its trade policies in spices with the rest of the world with view to gain leverage from the production leadership in some of the spices like turmeric, ginger,

cinnamon etc. The SAARC countries can have common interest in spice trade and the joint market power of the members can be better utilized for mutual benefit of the region.

- The SAARC Member need to put up a united front in several key world fora concerning the trade and marketing of spices like CAC, FAO etc. This will help in protecting the interest of the member countries while negotiating on issues like food Safety laws and present a unified front at the various Codex Committee Meetings.
- There is an urgent need for consensus among SAARC member countries in setting uniform quality standards and also MRLs for Pesticide Residues and Mycotoxins. An intergovernmental expert panel to look into the issue may be created at the SAARC level.
- The socio-economic profile of the spice farmers across the SAARC countries is more or less similar in nature. The production scenario is dominated by small and marginal farmers. In this scenario, the issue of production of clean and food safe spices attains importance and all the member countries should have a clear cut action plan to ensure food safety and sustainability in spices production at the farm level.
- Training and skill development of research personnel working in various spice crops across the countries need to be accorded priority. Since each Member States has specific areas of expertise, a database of core competency in spices research need to be created by each member country and shared with other members. The training and skill development requirements of each country can also be circulated. Sharing of training and skill development infrastructure and capabilities can advance the spices research with limited time lag and lower cost.
- Explore the possibility of student exchange and research guidance across SAARC countries as a potential route for skill transfer and training.
- Value Chain development is important for the spices sector through which farming community can gain additional benefit from vertical movement along the value chain.
- Development of a common and crop specific package of practices incorporating the principles of Good Agricultural Practices and Sustainable Agricultural Practices should be taken up.
- Each member country should provide hand holding service for farmers/farming groups to undertake primary, secondary and tertiary processing along with facilitation of business development and marketing support services.

- A SAARC level spice documentation and knowledge management centre can be created as a repository of state of the art practices in spices production management, processing and value addition.
- Leveraging the traditional strength in cultivation of several spices a global Center for Excellence in Spices can be established by SAARC for better cooperation in spices related research and development in the region.

Challenges and Way Forward for Research and Value Chain Development

The estimated growth rate for spices demand in the world is around 3.2%, which is just above the population growth rate. The forecasted population increase is up to 1619 million in 2050 with increased GDP and per capita food spending. The per capita demand for spices is expected to increase many fold by 2050. Therefore, we need to continuously strive to increase spices productivity by enhancing input use efficiency, and reducing post-harvest losses with an eye on reducing the cost of production. Overall, the main researchable areas in spices should encompass:

- Conservation of genetic resources, bar coding and crop improvement using cutting edge technologies and science of '*omics*'
- Increasing productivity of spices through quality planting material production and supply and through better input management leveraging emerging capabilities in precision farming systems
- Focused efforts for development of ideotypes for quality and climate resilience can enhance our capacity to address abiotic risk. Bio-risk management should also be kept in focus while deploying strategies for varietal development.
- Progressive mechanization should be attempted in spices cultivation to realize better efficiency in spice production and to address issues arising from labour shortage in several regions. In this regard mechanization of harvesting agronomic practices of spices like black pepper, cardamom, ginger and turmeric need to be explored.
- Explore the possibilities for standardizing technologies and cultivation practices for large scale protected cultivation of spices for ensuring availability of spice commodities year round and to address undue intra-seasonal fluctuations in prices.
- The present levels of technological and technical skills available with the farming community in the member states require strengthening to address emerging challenges from climate change and market oriented commercial agriculture. The enhancement of skill sets

entails better technology dissemination infrastructure focused on reskilling and skill enhancement in specific areas. This would also include popularization and training on technologies for secondary agriculture and value addition.

- Spices and value added products from spices are gaining importance in the nutraceutical industry across the world. The SAARC region is ideally suited to exploit this commercial Opportunities through strategic research in nutraceutical research in spices and by evolving varieties matching specific requirements of firms involved in the industry. The spice production sector should develop better and meaningful linkages with the nutraceutical sector and other sectors which consume spices as intermediary raw material.

The major challenges confronted in the spice production sector in India would be applicable to most of the other SAARC member countries too. Some of the key challenges are indicated below.

- Climate change resulting in drought/excess moisture, high/low temperature during critical periods, etc. Climate change resilient technologies and varieties need to be deployed across the country to protect spice farmer interest.
- Spices production in small holder production system means that attaining uniformity in quality and food safety in spices production is more challenging.
- Emergence and epidemics of pests and diseases. Many emerging biotic and abiotic stress have the potential to adversely affect major spices production systems and agro-ecological regions. The ability to develop cost effective and efficient control measures to suitably address these stresses is a constant challenge in spices sector.
- Issues related to declining soil fertility and other soil related constraints – high acidity, low/ excessive accumulation of nutrients etc. Site specific nutrient management and other precision delivery mechanisms of nutrients need to be adopted in spices production.
- Adulteration of spices is one of the major challenges faced in the spices economy. The lack of proper knowledge of correct spices, the non-availability of protocols for quick and easy detection of adulteration and the existence of significant trade in unorganized markets also contribute to the problem.
- Pesticide residues and mycotoxin contaminants in the products and lack of MRL and ADI standards in some of the pesticides used in spices. The low level of awareness about safe use of plant protection chemicals and improper use of chemicals compound the problem of pesticide residue in spices.

- Shifting of interests of growers to more profitable/less risky crops.
- Like many other agricultural commodities, price instability is a major worry for spice producers. Most of the spices exhibit cyclic market fluctuations of various durations at international and national levels. The lack of development in accurate price forecasting services and demand forecasting often adversely affects resource allocation and farm planning.
- Competition from other major spice producing countries.

While all these present considerable challenges, there is a need to develop cutting edge technologies in spices sector that are simple, cost-effective and farmer-friendly. Apparently, changing environment, social concerns and the human factor itself contribute a lot towards crop success/failure; however, the spice sector has to deal with many other such risky situations, where the possibilities for adverse consequences that can cause marked disruptions are very high. Some of the specific and actionable strategic guidelines for strengthening the spices sector in SAARC region are indicated below. The deployment of these strategic guidelines can result in development of an integrated and holistic spice value chain in all member countries through need based technological interventions and policy harmonization.

- A unified stand on food safety and sustainability to be taken up by member countries through frequent dialogues and interaction.
- A knowledge portal to be set up for information and knowledge management pertaining to spices.
- Integration and harmonization of GAPs and trade policies among member countries.
- Country specific researchable issues in spices need to be identified and prioritized.
- Create a research platform to address common problems in member countries and facilitate visit of experts.
- Pilot studies on feasibility of introducing newer spices to member countries may be undertaken.
- Immediate efforts should be taken to identify and document the intrinsic qualities of ethnic spice varieties to fetch premium price to growers.
- New research initiatives to be undertaken to establish the superiority of natural spices over synthetic ones.

- An integrated research and development project for spices development may be prepared and implemented in SAARC countries.
- A spice task force on technology sharing and sorting out trade related issues may be set up.
- A technology hub needs to be created for creating awareness and sharing of technologies including varieties among member countries.
- Partnerships with industry in contract farming, value addition and processing to be promoted.
- Harmonization of Standard Operating Practices (SOP's) in quality evaluation and processing
- A Centre of Excellence in Spices may be established for human resource development and skill enhancement.
- Institute scholarships for post graduate and doctoral studies in spices.

Conclusion

There is great scope to improve the productivity of major spices by adopting technologies that will help bridge the gap between potential yields realized in the research stations/progressive farmers plots and those realized in other marginal farmers plots in all the major SAARC countries. While there is little scope for enhancing the area under spices in the traditional belts, we need to focus on newer niches where the potential for spices cultivation is immense.

The spice production, processing and marketing sector in the SAARC countries face considerable challenges across various functional areas like research and development, market infrastructure, technology dissemination, food safety and sustainability. Though the member countries face specific problems related to the extant social and economic conditions prevailing in the region, some of the underlying issues are common to the region and requires collaborative efforts and creative strategies. The spices sector offers tremendous scope for the countries in the region to benefit from a strengthening of the production sector and commensurate development in the value chain aimed at developing a fully integrated spice value chain benefiting all the stakeholders and actors along the value spectrum.

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Annexure 1

Varietal Technology in Spice Crops

Black pepper

Sl. No	Variety/Year of release	Pedigree/Parentage	Institute/University	Av. yield kg/ha (dry)	Salient features	Recommended State/ Region
1	Panniyur 1	F1 of Uthirankotta x Cheriyanakaniyakadan	Pepper Research Station (KAU), Panniyur, Karimbam-670 143 Kerala	1242	Suitable to all pepper growing regions. However, do not tolerate heavy shade	All over India
2	Panniyur 2	Open pollinated progeny of 'Balankotta'	Pepper Research Station (KAU), Panniyur, Karimbam-670 143 Kerala	2570	Suitable to all pepper growing tracts of Kerala. Tolerant to shade.	Kerala
3	Panniyur 3 1989	Inter-cultivar hybrid of Uthirankotta x Cheriyanakaniyakadan	Pepper Research Station (KAU), Panniyur, Karimbam-670 143 Kerala	1953	Suitable for all pepper growing regions, performs well under open condition. Late maturing type. Long spikes and bold berries, piperine 5.2%, oleoresin 12.7%, essential oil 3.1%, dry recovery 27.8%	Kerala, Karnataka and Tamil Nadu
4	Panniyur 4 1989	Clonal selection from Kuthiravally type II	Pepper Research Station (KAU), Panniyur, Karimbam-670 143 Kerala	1277	Stable yielder, performs well under adverse conditions also, tolerant to shade, late maturity, 4.4% piperine, 9.2% oleoresin, 2.1% essential oil and 34.7% dry recovery	Kerala, Karnataka and Tamil Nadu
5	Panniyur 5 1993	Clonal selection from open pollinated progeny of Perumkodi	Pepper Research Station (KAU), Panniyur, Karimbam-670 143 Kerala	1110	Suitable for both mono and mixed cropping in coconut/arecanut gardens, shade tolerant, medium maturity, tolerant to nursery diseases. Long spikes, piperine	Kerala

Sl. No	Variety/Year of release	Pedigree/Parentage	Institute/ University	Av. yield kg/ha (dry)	Salient features	Recommended State/ Region
6	Panniyur 6 1999	Clonal selection from Karimunda type III	Pepper Research Station (KAU), Panniyur, Karimbam-670 143 Kerala	2127	5.3%, oleoresin 12.33%, essential oil 3.8% and dry recovery 35.7% A vigorous vine. Tolerant to drought and adverse climatic conditions, stable and regular bearer, medium maturity group. Suitable for open condition as well as partial shade, spike 6-8 cm, more number of spikes/unit area, close setting and attractive bold berries, piperine 4.9%, oleoresin 8.27% and essential oil 1.33% and 33.0% dry recovery.	Kerala and Karnataka
7	Panniyur 7 1999	Open progeny Kalluvally	pollinated of Pepper Research Station (KAU), Panniyur, Karimbam-670 143 Kerala	1410	Vigorous vine and a regular bearer, long spike, a hardy type vine, tolerates adverse climatic conditions, suitable for open and shaded conditions, very long spike (16-24cm), high piperine content (5.6%), oleoresin 10.6%, essential oil 1.5%, and 34.0% dry recovery.	Kerala Karnataka and Tamil Nadu
8	Panniyur 8	Hybrid of Panniyur 6 x Panniyur 5	Pepper Research Station (KAU), Panniyur, Karimbam-670 143 Kerala	5760	Suited to all pepper growing regions of Kerala. Field tolerant to drought situations and Phytophthora foot rot.	Kerala
9	PLD -2 1996	Clonal selection from Kottanadan	NRC for Oil Palm, Regional Station, ICAR, Palode, Pacha (Post)-695	2475	Late maturity high quality cultivar contains piperine 3.0%, oleoresin 15.45%, and essential oil 4.8%. Suitable for plains and higher	Kerala

Sl. No	Variety/Year of release	Pedigree/Parentage	Institute/ University	Av. yield kg/ha (dry)	Salient features	Recommended State/ Region
			562, Kerala		elevations.	
10	Sreekara 1989	Clonal selection from Karimunda	Indian Institute of Spices Research, ICAR, Calicut-673 012.	2677	Adaptable to various climatic conditions in all the pepper growing tracts. Gives high quality pepper	Kerala
11	Subhakara 1989	Clonal selection from Karimunda	Indian Institute of Spices Research, ICAR, Calicut-673 012.	2352	A selection with high quality pepper and wider adaptability	Kerala
12	Panchami 1991	Clonal selection from Aimpiriyan	Indian Institute of Spices Research, ICAR, Calicut-673 012.	2828	A high yielding variety with excellent fruit set. Spike twisted in appearance due to high fruit set. Oleoresin content is high.	Kerala & Southern Karnataka
13	Pournami 1991	Clonal selection from germplasm	Indian Institute of Spices Research, ICAR, Calicut-673 012.	2333	Tolerant to root knot nematode (<i>Meloidogyne incognita</i>). A moderately high yielding vine with high oleoresin content.	Kerala
14	IISR Sakthi 2004	Open pollinated progeny of Perambamundi	Indian Institute of Spices Research, ICAR, Calicut-673 012.		Moderately resistant to Phytophthora	Kerala & Karnataka
15	IISR Thevam 2004	Clonal selection from germplasm	Indian Institute of Spices Research, ICAR, Calicut-673 012.	5.17 kg/vine (fresh)	Field tolerant to Phytophthora. Suitable to high altitude areas, Coffee & Tea Estates of South India	All over Kerala
16	IISR Girimunda 2004	Hybrid Narayakodii X Neelamundi	Indian Institute of Spices Research,	6.14 kg/vine (fresh)	Medium maturing type. Suited to high altitude areas. Coffee	All over Kerala

Sl. No	Variety/Year of release	Pedigree/Parentage	Institute/University	Av. yield kg/ha (dry)	Salient features	Recommended State/ Region
			ICAR, Calicut-673 012.		& Tea Estates	
17	IISR Malabar Excel 2004	Hybrid Cholanmundi Panniyur 1	Indian Institute of Spices Research, ICAR, Calicut-673 012.	2.78 kg/vine (fresh)	Suitable for higher elevation, plains and Coffee & Tea Estates. High oleoresin content.	All Kerala over
18	Arka Coorg Excel 2012	Seedling Selection	Central Horticultural Experiment Station, Chettalli, IIHR	3267 kg/ha	Bold seeded, long spiked, high yielding pepper variety	Kodagu district or similar climatic areas.
19.	Cul. (Panniyur 9)	5308 Open – progeny of 3	Pepper Research Station (KAU), Panniyur, Karimbam-670 143 Kerala	3150 kg/ha	High yield potential	Kerala, Karnataka and Andhra Pradesh

Cardamom

Sl. No	Variety/Year of release	Pedigree/Parentage & Plant type	Institute/University	*Av. yield kg/ha (dry)	Salient features	Recommended State/Region
1	Mudigere 1 1991	Clonal selection from Malabar type	Regional Research Station, UAS, Mudigere-577 132, Chikkamagalur (Dist) Karnataka	275	Erect and compact plant, short panicle, pale green, oval bold capsules, suitable for high density planting, moderately tolerant to thrips, hairy caterpillar and white grubs, pubescent leaves. Contains 8.0% oil, 36.0% 1, 8 cineol, 42.0% α -terpenyl acetate, dry recovery 20.0%.	Traditional cardamom growing tracts of Karnataka
2	Mudigere 2 1996	Clonal selection from open pollination of Malabar type	Regional Research Station, UAS, Mudigere-132, Chikkamagalur (Dist).	475	Early maturing, suitable for high density planting, round/oval and bold capsules, oil 8.0%, 1, 8 cineol 45.0%, α -terpenyl acetate 38.0%.	Hill zones of Karnataka

Sl. No	Variety/ Year of release	Pedigree/Parentage & Plant type	Institute/University	*Av. yield kg/ha (dry)	Salient features	Recommended State/Region
Karnataka						
3	PV 1 1991	A selection from Walayar collection, Malabar type	Cardamom Research Station, KAU, Pampadumpara, Idukki- 685 553, Kerala	260	An early maturing type, short panicle, elongated slightly ribbed light green capsules, essential oil 6.8%, 1, 8 cineol 33.0%, α -terpenyl acetate 46.0%, dry recovery 19.9%.	All cardamom growing tracts in Kerala
4	PV 2 2001	A selection from OP seedlings of PV-1, Malabar type.	Cardamom Research Station, KAU, Pampadumpara, Idukki- 685 553, Kerala	982	Early maturing, unbranched lengthy panicle, long bold capsules, high dry recovery (23.8%), essential oil 10.45%, field tolerant to stem borer and thrips. Suitable for elevation of 1000 to 1200 meters MSL.	Idukki area of Kerala
5	ICRI 1 1991	Selection from Chakkupallam collection, Malabar type	ICRI (Spices Board), Myladumpara, Kailasanadu - 685 535, Idukki (Dist.), Kerala	325 (656 kg under irrigated condition)	An early maturing variety, medium sized panicle with globose, round and extra bold dark green capsules contains oil 8.7%, 1,8 cineol 29.0%, α -terpenyl acetate 38.0% and dry recovery 22.9%.	South Idukki zone of Kerala
6	ICRI 2 1991	Clonal selection from germplasm collection, Mysore type	ICRI (Spices Board), Myladumpara, Kailasanadu - 685 535, Idukki (Dist.), Kerala	375 (766 kg under irrigated condition)	Performs well under high altitude and irrigated condition, medium long panicles, oblong bold and parrot green capsules, tolerant to <i>azukkal</i> disease. Dry recovery 22.5%. Suitable to Vandanmedu & Nelliapathy zone (Kerala), Annamalai & Meghamalai hills (Tamil Nadu)	Kerala and Tamil Nadu
7	ICRI 3 1993	Selection from Malabar type	ICRI (Spices Board) Sakleshpur, Donigal (PO), 573 134, Karnataka.	440 (790 kg under irrigation)	Early maturing, non-pubescent leaves, tolerant to rhizome rot disease, oblong, bold parrot green capsules, oil 6.6%, 1, 8 cineol 54.0%, α terpenyl acetate 24.0%, dry recovery 22.0%.	All cardamom growing tracts of Karnataka
8	ICRI 4 1997	Clonal selection from Vadagaraparai area of lower	ICRI (Spices Board), Thadiyankudisai -624212,	455 (960 kg)	Early maturity, medium sized panicle, globose bold capsules, and oil 6.4%. Suitable for low rainfall	Lower pulney hills of Tamil Nadu &

Sl. No	Variety/ Year of release	Pedigree/Parentage & Plant type	Institute/University	*Av. yield kg/ha (dry)	Salient features	Recommended State/Region
		pulenys, Malabar type	Tamil Nadu	under irrigation)	areas, relatively tolerant to rhizome rot and capsule borer	Wynad of Kerala
9	ICRI 5 2006	A hybrid between MCC-260 and MCC-49	ICRI (Spices Board), Myladumpara, Kailasanadu - 685 535, Idukki (Dist.), Kerala	1543	First hybrid variety; early maturity, moderately tolerant to drought, high yield under intensive management (responds to intensive management), capsule size – 68% > 7 mm, volatile oil – 7.13%; dry recovery – 23.15%. Kerala (900-1200 m MSL with annual rainfall of 2000 mm)	Kerala, parts of Tamil nadu
10	ICRI 6 2006	Selection from local germplasm (Anavilasam in Idukki Dist. of Kerala)	ICRI (Spices Board), Myladumpara, Kailasanadu - 685 535, Idukki (Dist.), Kerala	1200	High yield; medium maturity, relatively tolerant to drought high percentage of bold capsules and volatile oil content, capsule size – 71% > 7 mm, volatile oil – 7.33%; dry recovery – 19.0%. Suitable/specific to cardamom hill reserve (Anamalai area) of Idukki district of Kerala	Idukki district of Kerala
11	IISR Suvasini 1993	A selection from open pollinated progeny of CL-37	Indian Institute of Spices Research, ICAR, Calicut-673 012.	745 (potential yield 1322)	Highly adapted and produces 89% bold (7.2 mm and above) capsules. Suitable for high growing production technology. Responds well for nutritional inputs.	All cardamom tracts of Karnataka
12	IISR Avinash 1999	A selection from open pollinated progeny of CCS-1	Indian Institute of Spices Research, ICAR, Calicut-673 012.	847 (potential yield 1473)	High yielder, suitable for planting in valleys. Has extended flowering period. Yields well at 2.5 x 2 m spacing. Tolerant to rhizome rot.	Karnataka and Wynad of Kerala
13	ICRI 7 2010	Hybrid	ICRI (Spices Board), Myladumpara, Kerala		Suitable for Wayanad, Kerala, Semi-erect panicles Angular bold capsules, Oleoresin 7.99%, Volatile oil 8.84 %	Kerala
14	PV 3	Clonal Selection	Cardamom Research Station, KAU,	611 kg dry	Moderately tolerant to thrips and capsule borer	Kerala

Sl. No	Variety/Year of release	Pedigree/Parentage & Plant type	Institute/University	*Av. yield kg/ha (dry)	Salient features	Recommended State/Region
			Pampadumpara, Idukki- 685 553, Kerala	capsules/ha		
15	Appangala -2	Appangal NKE 19	1 × Indian Institute of Spices Research, ICAR, Calicut-673 012.	927.29 kg dry capsules/ha	First <i>Katte</i> resistant variety	Karnataka
16	Mudigere 3	Clonal selection from Clone- 692	Zonal Agricultural and Horticultural Research Station, (UAHS, Shimoga), Mudigere	400	Capsules are oval/ oblong in shape which is light green, turning pale yellow on ripening. Tolerant to thrips and borer	Cardamom growing tracts of Karnataka

Ginger

Sl. No	Variety/Year of release	Pedigree/Parentage	Institute/University	Av. yield t/ha (fresh)	Salient features	Recommended State/Region
1	Suprabha 1988	Clonal selection from Kunduli local	High Altitude Research Station, OUA &T, Pottangi, Orissa	16.6	Plumpy rhizome, less fibre, wide adaptability, suitable for both early and late sowing.	
2	Suravi 1991	Induced mutant of Rudrapur local	Indian Institute of Spices Research, ICAR, Calicut-673 012.	17.5	Plumpy rhizome, dark skinned yellow fleshed, suitable for both irrigated/rainfed, duration 225 days. 10.2% Oleoresin, 2.1% essential oil, 4.0% crude fibre, 23.6% dry recovery.	Orissa
3	Himgiri 1996	Clonal selection from Himachal collection	Department of Vegetable Crops, YSPUH &F, Nauni, Solan-173 230, Himachal Pradesh	13.5	Best for fresh ginger, less susceptible to rhizome rot disease, suitable for rainfed condition. 4.29% oleoresin, 1.6% essential oil, 6.05% crude fibre, 20.2%	Himachal Pradesh

Sl. No	Variety/Year of release	Pedigree/Parentage	Institute/University	Av. yield t/ha (fresh)	Salient features	Recommended State/Region
4	IISR Varada 1995	Clonal selection	Indian Institute of Spices Research, Calicut-673 012.	22.6	dry recovery, 230 days duration. Good quality, high yielding variety with plumpy rhizomes having flattened fingers and medium sized reddish brown scales. Dry ginger less prone to storage insect damage. Farmers are of opinion that Varada is tolerant to diseases. Low fibre content.	All over India
5	IISR Mahima 2004	Selection germplasm	from Indian Institute of Spices Research, Calicut-673 012.	23.2	High yielder, plumpy extra bold rhizomes, resistant to <i>M. incognita</i> and <i>M. javanica</i> pathotype 1	All over Kerala
6	IISR Rejatha 2004	Selection germplasm	from Indian Institute of Spices Research, Calicut-673 012	22.4	High yielder, plumpy and bold rhizomes	All over Kerala
7	Aswathy* (IC No. 0584128)	Single selection somaclones of cultivar Janeiro	plant from Department of Spices and Plantation of crops, Kerala Rio-de-Agriculture University, Trichur	23.0	Ideal for cultivation both as pure and intercrop. High yielding high quality clone suitable for green with high recovery of volatile oil and oleoresin. Field tolerant to <i>Phyllosticta</i> leaf spot.	Kerala
8	Athira* (IC No. 0584128)	Selection somaclones of cultivar Maran	form Department of Spices and Plantation of crops, Kerala Agriculture University, Trichur	21.0	Ideal for cultivation both as pure and intercrop. Suitable for fresh and dry ginger. Tolerant to soft rot and bacterial wilt diseases than parent cultivar. High yielding high	Kerala

Sl. No	Variety/Year of release	Pedigree/Parentage	Institute/University	Av. yield t/ha (fresh)	Salient features	Recommended State/Region
9	Karthika (IC No. 0584129)	Selection form somaclones of cultivar Maran	Department of Spices and Plantation crops, Kerala Agriculture University, Trichur	19.0	quality clone with high gingerol. Ideal for cultivation both as pure and intercrop. Suitable for fresh and dry ginger. Tolerant to soft and bacterial wilt diseases. Low infestation of shoot borer under field conditions. High pungency clone with high gingerol.	Kerala
10.	Subhada*	Mutagen in EMS (40 PPM) treatment and selection mutants	High Altitude Research Station, OUA & Pottangi, Orissa	18.0	Suitable for hills and plains. Now under AICRPS testing	Hill areas & Plain areas of Orissa
11.	Mohini	Clonal selection from genotype GCP-49	Uttar Banga Krishi Viswavidyalaya, Pundibari, West Bengal	14.0	High yield potential	All ginger growing areas of the country
12.	Sourabh V1S1-2	Clonal selection	High Altitude Research Station (OUAT), Pottangi	18.0	High yield potential	Odisha

Turmeric

Sl. No	Variety/Year of release	Pedigree/Parentage	Institute/University	*Av. yield t/ha (fresh)	Salient features	Recommend State/Region
1	Roma 1991	Clonal selection from T.Sunder	High Altitude Research Station, OUA&T, Pottangi-764 039, Koraput (Dist), Orissa	20.7	Suitable for both rainfed and irrigated condition. Suitable for hilly areas and late season planting. Curcumin 6.1%, oleoresin 13.2%, essential oil 4.2% and dry recovery 31.0%, duration 250 days.	Orissa, TN, HP, AP and Kerala

Sl. No	Variety/Year of release	Pedigree/Parentage	Institute/University	*Av. yield t/ha (fresh)	Salient features	Recommend State/Region
2	Suroma 1988	Clonal selection from T. Sunder by x-ray irradiation	High Altitude Research Station, OUA&T, Pottangi-764 039, Koraput (Dist), Orissa	20.0	Round and plumpy rhizome, field tolerance to leaf blotch, leaf spot and rhizome scale, curcumin 6.1%, oleoresin 13.1%, essential oil 4.4% and dry recovery 26.0%, duration 253 days.	Orissa, TN, HP, AP and Kerala
3	Suranjana (TCP-2) 2001	Clonal selection from local types of West Bengal	Uttar Banga Krishi Viswa Vidyalaya, North Bengal Pundibari (PO)- 736 165, Dist. Cooch Behar, West Bengal	(Pot. yield 29.0)	Suitable for open and shaded conditions, sole or intercrop, suitable for rainfed as well as high rainfall areas. Curcumin 5.7%, oleoresin 10.9%, essential oil 4.1%, dry recovery 21.2%, duration 235 days, tolerant to leaf blotch and rhizome rot. Resistant to rhizome scales and moderately resistant to shoot borer.	West Bengal
4	Suguna 1989	Selection germplasm collected Assam	from Indian Institute of Spices Research, Calicut-673 012	29.3	Short duration type (190 days), curcumin 4.9%, oleoresin 13.5%, essential oil 6.0% and dry recovery 20.4%, field tolerant to rhizome rot.	Kerala and Andhra Pradesh
5	Sudarshana 1991	Selection germplasm, collected Singhat, Manipur	from Indian Institute of Spices Research, Calicut-673 012	28.8	Early maturing, field tolerant to rhizome rot.	
6	Suvarna 1989	Selection germplasm collected Assam	from Indian Institute of Spices Research, Calicut-673 012	17.4	Bright orange coloured rhizome with slender fingers. Maturity 200 days, field tolerant to pest and diseases. Curcumin 4.3%, oleoresin 13.5%, essential oil 7.0% and dry recovery 20.0%.	Kerala, Karnataka and Andhra Pradesh
7	IISR	Open pollinated	Indian Institute	37.47	High yielding	Kerala and

Sl. No	Variety/Year of release	Pedigree/Parentage	Institute/University	*Av. yield t/ha (fresh)	Salient features	Recommend State/Region
	Prabha 1995	progeny, selection	of Spices Research, ICAR, Calicut-673 012		variety, curcumin content 6.5%, oleoresin 15.0%, essential oil 6.5% and dry recovery 19.5%, crop duration 205 days.	Tamil Nadu
8	IISR Prathiba 1995	Open pollinated progeny selection	Indian Institute of Spices Research, ICAR, Calicut-673 012	39.12	High quality line, 6.2% curcumin content with high yield, 16.2% oleoresin, 6.2% essential oil, 18.5% dry recovery, crop duration 225 days.	Kerala, Tamil Nadu and other states
9	IISR Alleppy Supreme 2004	A clonal selection from Alleppy turmeric	Indian Institute of Spices Research, ICAR, Calicut-673 012	35.4 5.58 (dry)	Shows tolerance to leaf blotch disease. Rhizomes contain 5.55% curcumin, 16.0% oleoresin, 19.0% dry recovery, crop duration 210 days	Kerala (rainfed) Maharashtra, Karnataka and N. Bengal (irrigated)
10	IISR Kedaram 2004	Clonal selection from germplasm	Indian Institute of Spices Research, ICAR, Calicut-673 012	34.5 5.28 (dry)	Tolerant to leaf blotch disease, Rhizomes contain 5.5% curcumin, 13.6% oleoresin, maturity 210 days and 18.9% driage.	Kerala (rainfed) Maharashtra, Karnataka and N. Bengal (irrigated)
11	Narendra Haldi – 1 2007	Selection from germplasm (NDH 18)	Department of Vegetable Science, N.D. University of Agriculture & Technology, Kumarganj, Faizabad.	3000-3500	High yield potential, good size and colour of rhizomes, high amount of curcumin and essential oil	Uttar Pradesh
12	Narendra Haldi – 2 2012	Selection from germplasm (NDH 14)	Department of Vegetable Science, N.D. University of Agriculture & Technology, Kumarganj, Faizabad.	3500-4000	High yield potential, good size finger	Uttar Pradesh
13	Narendra Haldi – 3 2014	Selection from germplasm (NDH 9)	Department of Vegetable Science, N.D. University of Agriculture & Technology, Kumarganj,	3250-3500	High yielding,, Root knot resistant, Moderate resistant against leaf spot and leaf blotch	Uttar Pradesh

Sl. No	Variety/Year of release	Pedigree/Parentage	Institute/University	*Av. yield t/ha (fresh)	Salient features	Recommend State/Region
			Faizabad.			
14	Duggirala Red 2013	Mass selection	Dr. Y. S. R. Horticultural University, Turmeric Research station, Kammarapally	25	High yielding variety, Rhizomes are long, plumpy, strong and very deep orange in colour.	Andhra Pradesh
15	BSR-2	Induced mutant from Erode local	Department of Spice and Palntation crops, TNAU, Coimbatore, Tamil Nadu	32.7	High yielding short duration variety with bigger rhizomes, resistant to scale insects	
16	Surangi	Clonal Selection	High Altitude Research Station, OUA & T, Pottangi, Orissa	24.3 t/ha (fresh)	Short duration variety	Orissa
17	NDH-98	Clonal Selection of the local land race	N.D.University of Agriculture & Technology, Kumarganj, Faizabad (U.P.).	35-37 t/ha	High yield potential	All the turmeric growing regions of the country
18	IISR Pragathi 2017	clonal selection from germplasm collections.	ICAR-Indian Institute of Spices Research, Kozhikode, Kerala	33.19 t/ha	High yield potential, short duration, nature, moderately tolerant to root-knot and nematodes and curcumin content of 5%	Kerala, Karnataka, Andhra Pradesh, Chhattisgarh and Telangana
19	CO-3 XXVIII WS (2017)	Selection from Germplasm collections	Dept. of Spices & Plantation Crops, HC & RI, TNAU, Coimbatore	25.36t /ha	High curcumin content and resistant to leaf spot and blotch disease	Recommended for Erode, Coimbatore & Salem Districts of Tamil Nadu, Chhattisgarh & Uttar Pradesh
20	NARENDRA SARYU NDH-8 XXVIII WS (2017)	Clonal selection	Dr. V.P. Pandey, Dr. R.S.Mishra NDUA & T, Kumarganj	250-300 q/ha	High yielding with good size of rhizome, Tolerant against <i>Collectotrichum</i> leaf spot	Recommended for release in Andhra Pradesh, Kerala, Tamil Nadu, Telengana, Uttar Pradesh, Arunachal Pradesh and Gujrat

Cinnamom

Sl. No	Variety/Year of release	Pedigree/Parentage	Institute/University	Average yield kg bark/ha	Salient features	Recommended State/Region
1	PPI (C)-1 2001	Selection from OP seedlings progeny introduced from Sri Lanka seed from IISR.	HRS, (TNAU) Pechiparai-629 161 Kanyakumari Dist., Tamil Nadu	Fresh bark yield of 980 kg/ha.	Bark, higher oil recovery from the bark (2.9%) and leaf oil recovery of 3.3%, bark oil 2.9%, leaf oil 3.3%, and bark recovery 34.22%. Suitable for an altitude range of 100-500 m MSL.	High rainfall zones and hill ranges of Tamil Nadu.
2	IISR Navasree 1995	Seedling selection from srilankan collection	Indian Institute of Spices Research, ICAR, Calicut-673 012, Kerala	200 kg dry quills/ha	Higher shoot regeneration	All cinnamon growing areas of India
3	IISR Nithyasree 1995	Clonal Selection	-do-	200 kg dry quills/ha	Higher cinnamaldehyde and oleoresin	All cinnamon growing areas of India

Cassia

Sl. No	Variety/Year of release	Pedigree/parentage	Institute/University	Average yield (kg/ha)	Salient features	Recommended State/Region
1	IISR Cassia XXVIII WS (2017)	Clonal selection	Dr. Khandekar & Dr. Palanikumar HRS, TNAU, Pechiparai	446.62 kg/ha (dry leaf yield) 262.94 kg/ha (dry bark yield)	Maximum dry bark yield and higher per cent of leaf and bark oil	Identified for cultivation in Tamil Nadu, Kerala, Karnataka and Maharashtra

Value Chain Development and Technology Practices of Spice Crop (Cardamom (small and large), Ginger, Turmeric, Black pepper, and Cinnamon) in Nepal

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Introduction

Agriculture is the main source of livelihood for more than 65.6% of people of Nepal and contributes about 31.32% to national GDP (MoAD 2015). The total cultivated area of the country is 3.09 million hectares. The most important crops grown in Nepal are rice, maize, wheat, millet, barely, vegetables, potato and sugarcane. Different spice crops are grown all over the country mainly as minor cash crops. These crops have created good potential of employment creation and income generation.

Spices are very popular in Nepalese kitchen and the demand is in increasing trend. The major spices of daily use in Nepal are ginger, large cardamom, cumin, coriander, chili, etc. Among them; ginger and large cardamom are best known for export while others are produced in small quantity and also imported from other countries. India is the major trading partner for spices of Nepal.

Agricultural Land Use

Land use pattern in 2015 in Nepal is presented in Table 1. The table showed that the agricultural land cultivated was 3091 thousand hectare, cultivable but uncultivated land was 1030 thousand hectare, forest land including shrub was 5828 thousand hectare. Grass land and pastures was 1766 thousand hectare, water bodies was 383 thousand hectares and other land categories was 2620 thousand hectares.

Area and Production Status of Commonly used Spice Crops (Large cardamom, Ginger, Turmeric, Garlic and Chilli) in 2015 and 2016

Area, production and yield of commonly used Spice crops (Large cardamom, Ginger, Turmeric, Garlic and Chili) in 2015 and 2016 in Nepal are shown in Table 2. The area of cardamom, ginger, turmeric, garlic and chili were 12458, 23826, 7877, 7119 and 7680 hectares in 2015 and 12120, 21869, 6901, 7551 and 7707 hectares respectively in 2016. Production of cardamom, ginger, turmeric, garlic and chili were

5166, 242547, 71812, 44723 and 40172 ton in 2015 and 6439, 271863, 64400, 50426 and 41046 ton respectively in 2016. The yield of cardamom, ginger, turmeric, garlic and chili were 0.41, 10.81, 9.12, 6.28 and 5.23 ton/ha in 2015 and 0.53, 12.43, 9.33, 6.68 and 5.33 ton/ha respectively in 2016.

Table 1. Land use pattern in 2015 in Nepal

Land use pattern	Area in (000 ha)	Percentage of total area
Agricultural Land Cultivated	3091	21.00
Agricultural Land Uncultivated	1030	7.00
Forest (including Shrub 1560 thousand ha)	5828	39.60
Grass Land and Pastures	1766	12.00
Water bodies	383	2.60
Others	2620	17.80
Total area of the country	14718	100.00

Source: Statistical information on Nepalese Agriculture, 2015

Table 2. Area, production and yield of cardamom, ginger, and turmeric in 2015 and 2016 in Nepal

Year	Spices	Area (ha)	Production (ton)	Yield (ton/ha)
2015	Cardamom	12458	5166	0.41
	Ginger	23826	242547	10.81
	Turmeric	7877	71812	9.12
	Garlic	7119	44723	6.28
	Chili	7680	40172	5.23
	Cardamom	12120	6439	0.53
	Ginger	21869	271863	12.43
	Turmeric	6901	64400	9.33
	Garlic	7551	50426	6.68
	Chili	2016	41046	5.33

Source: Statistical information on Nepalese Agriculture 2015 and 2016

Black pepper is a minor spice crop in Nepal. In several districts few plants are grown in kitchen garden by some farmers. The crop is grown by relatively more number of farmers especially under areca nut orchard

in Jhapa district. The Area, production and yield of black pepper in Jhapa district as reported by District Agriculture Development Office Jhapa (personal communication) from 2014 to 2016 is shown in Table 3. The table showed that although the total area is very small there is an increase of two hectare of black pepper area from 2014 to 2015 and is further increasing very slowly. The productivity of the black pepper remained unchanged from 2014 to 2016 i.e. 0.2 ton/hectare.

Table 3. Area, production and yield of black pepper in Jhapa district from 2014 to 2016

Year	Area (ha)	Production (ton)	Yield (ton/ha)
2014	6	1.2	0.2
2015	8	1.6	0.2
2016	8.5	1.7	0.2

Source: Annual report, DADO, Jhapa, 2016

Production Technology, Post-Harvest Handling, Processing, Value Addition and Storage of Spices

Ginger (*Zingiber officinale* Rosc)

Production technology of ginger has been developed. Package of practices for cultivation technologies post-harvest handling, processing, value addition and storage has been developed.

Two improved varieties Kapurkot Aduwa-1 and Kapukot Aduwa-2 has been released and some others are in pipeline for release.

The major pest problems associated with the crops are rhizome rot, wilt and white grubs. Other problems included production storage and supply of quality planting materials, storage of the harvested rhizomes, washing, peeling, etc.

Ginger washing machine is developed which can clean/wash 400 kg rhizome per hour. Ginger peeling is also a very tough work. It is necessary for making other products. Ginger peeling machine has also been developed by Agricultural Engineering Research Division, Khumaltar. The machine can efficiently peel ginger soaked in water up to 12 hours. Sutho (dried ginger) is the major value added product and is suitable for storage for comparatively longer time and easy to transport. The drying under sun takes very longer time. A solar dryer designed locally is very much useful for drying ginger to make sutho. All of the above machineries developed need further improvement to increase their efficiencies. The machineries are slowly getting popularity among farmers.

Ginger Storage

Storage of fresh ginger rhizomes and seed rhizomes are very difficult. A large proportion of the rhizomes are damaged due to invasion of moulds and the quality of the seed rhizomes are also reduced during the storage period. Some improvements in the existing methods are made as follows:

Pit storage: Ginger research program had conducted trial on different pits for storing ginger and developed a suitable pit with arrangements of air circulation for the storage of ginger. This pit is cost effective and can be prepared easily. It can store up to 200-300 kg ginger in one pit at a time.

Bhakari storage: Bhakari storage is another local method for storing ginger. This Bhakari is made of bamboo *i.e.* split cane and has good aeration which ultimately improved the shelf life of the ginger. Recently bhakari made of raw bricks is found better over bhakari made of bamboo. Ginger rhizomes are stored in layers. Sand is placed in bottom and rhizomes in between in different layers.

Cellar store: Cellar store is an improved method for storing ginger. It is a zero energy store which does not require electric or mechanical power and can be easily made in remote village with low inputs. This can store up to 2000-3000 kg of ginger at a time. The main problem in the cellar store is development of moulds due to higher humidity. Some botanical pesticides are being tested to prevent/reduce the development of moulds.

Value added products from ginger

Ginger is also traded in dried form and processed form. Dried ginger (Sutho in Nepali) is the major value added product and occupies nearly 51 % of the total ginger trade (TEPC, 2015). The traded quantity of processed form of ginger is like candy. Ginger powder is negligible and only few are involved in the processing. Some of the major value added products from ginger are summarized as below.

Dried ginger (Sutho): Dried ginger or Sutho is the major ginger product traded in the international market. Dry ginger is obtained by drying of fresh ginger which can be preserved for longer time. Dried ginger is prepared from mature rhizomes which have developed full aroma, flavour and pungency. Harvesting is usually carried out at between eight to nine months after planting. For dry ginger making, cultivars with medium-sized rhizomes with high curing percentage are preferred.

Ginger Candy: Ginger candy is sweet and hot in taste. There are very limited processors producing the candy. It is mostly produced by microenterprises run by cooperative from ginger pocket area.

Ginger powder: Ginger powder is made by pulverizing dry ginger to a mesh size of 50 to 60. Ginger is ground to release the flavour, the finer the powder, the more readily available the flavour and readily dispensable in the matrix. The use of ginger powder is less in Nepal and there are limited processors in producing ginger powder.

Ginger paste: Ginger is usually made paste at household level for using in curry and other foods. Ginger paste is commercially available in the market, especially in the departmental stores.

Ginger oil: Ginger oil is produced commercially by steam distillation of freshly ground dry ginger. The yield of oil varies from 1.5 to 3.0% with an average of 2.0%.

Ginger oleoresin: Ginger oleoresin is obtained by extraction of powdered dry ginger with suitable organic solvents like alcohol, acetone and ethylene dichloride, etc. The yield, flavour and pungency of extracted oleoresin vary with cultivars, maturity of rhizome, choice of solvent and the method of extraction employed. Generally a yield of 3.9–9.3% with an average of 6.5% on dry weight of ginger is obtained. Ginger oleoresin has widespread uses as a flavouring agent in foods, beverages and medicines.

Ginger squash: Ginger squash is prepared by using fresh ginger mixing with water and preservatives. However, the ginger squash has short life and damage quickly. The popularity of ginger squash is also very less and proper market linkages has not been created.

Ginger crystal: Ginger crystal is prepared by using peeled fresh ginger and treated with 0.5 % citric acid and cooked in pressure cooker for an hour.

Ginger pickle: Pickle is prepared by fresh young peeled ginger sliced into different shapes and mixed with oil, salt, turmeric and pepper as per need.

Large Cardamom

Production technology, post-harvest handling, processing, value addition of large cardamom has been developed and practiced.

Processing Methods Adopted for Drying Large Cardamom

Sun drying: In some of the large cardamom growing areas, where there is sufficient sunshine hours and have less volume of the product, farmers follow the drying under the sunshine. It is not suitable for commercial growers.

Drying over the hearth: This method is adopted by the small holder farmers having less volume of production. The cardamom capsules are

placed over the hearth for drying which is done by smoke drying during the preparation of meals using the fire woods.

Drying in *Bhati*: The commercial farmers use *bhati* for drying the capsules of the cardamom. From the beginning of the cultivation of large cardamom farmers have been practicing traditional way of drying. Due course of time, there has been practice of improvements over the traditional *bhat*is for drying the cardamom capsules. The *bhat*is used in Nepal are:

Traditional *Bhati*: This is the traditional method of drying that has been adopted by the farmers. The capsules directly get contact with the smoke thus, quality is not maintained. It takes long time for drying more than 24 hrs. and is tedious for the farmers. The farmers along with the traders are always in search of the improved *bhati* for quality maintenance.

Double Drum Dryer: It is the modification of the traditional dryer. The capsules placed for drying in this dryer don't get contact with smoke thus, quality is maintained. The colours of the capsules remain as natural as compared to drying in the traditional dryer where capsule get contact with smoke. It is getting popular over the Eastern part of the country.

Electrical Drier: It is locally constructed dryer in the Eastern part of the country. The drying of the capsule is through the hot air through the heating chamber within the dryer. The colour of the capsule remains natural and the quality is maintained.

Turmeric

Production technology, post-harvest handling, processing, value addition of turmeric has been developed and practiced. An improved variety Kapurkot Haledo-1 is released.

Black pepper

The production technology on black pepper has not been developed. Production, post-harvest handling and processing of the crops are done as per the farmer's indigenous knowledge.

Cinnamon

Production, post-harvest handling and processing of the crops are done as per the farmer's indigenous knowledge.

Spices Trade in SAARC Countries and beyond the SAARC (Intra and Inter Regional Trade)

Nepal exports spices to SAARC Member States and other countries in 2015 are presented in Table 4. Among the listed spices, large cardamom

was exported to international market i.e. 2,930,339 kg and earned NRs 3,839,810,569 by Nepal. More than 99% of the large cardamom was exported to India. This large cardamom was followed by fresh and dried ginger.

Table 4. Nepal exports of spices to SAARC member and other countries in 2015

Export commodities	Unit	Total	SAARC	Value (Rs)
Cinnamon sticks	Kg.	1,146,274	1,145,679	82,772,806
Cinnamon	Kg.	568,032	567,736	47,443,498
Cinnamon, crushed or ground	Kg.	1,191		2,026,718
Large Cardamom neither crushed nor ground	Kg.	2,930,339	2,930,294	3,839,810,569
Ginger fresh	Kg.	11,260,281	11,260,081	228,479,240
Ginger dried	Kg.	12,515,986	12,515,986	175,601,265
Ginger, crushed or ground	Kg.	772,390	772,390	60,840,871
Turmeric dust or Powder	Kg.	3,340	3,040	634,998
Turmeric fresh	Kg.	920		55,000

Source: Nepal foreign trade statistics 2014/15 and A glimpse of Nepal's foreign trade

Nepal imports spices from SAARC member and other countries. The spices imported during 2015 are presented in Table 5. Among the listed spices, Nepal imports 794071 kg of small cardamom from international market. Country paid Rs 396,592,288 for the import of small cardamom.

Table 5. Nepal imports of spices from SAARC member and other countries in 2015

Import Commodities	Unit	Total	SAARC	Value (Rs)
Cinnamon	Kg.	141,356	356	20,627,893
Cinnamon, crushed or ground	Kg.	2,169	2,169	774,856
Small Cardamom	Kg.	24	24	2,760
Large Cardamom neither crushed nor ground	Kg.	397	397	70,117
Small Cardamom	Kg.	794,071	3,770	396,592,288
Large Cardamom, crushed or ground	Kg.	10,295	145	8,529,349
Small Cardamom	Kg.	26,651	4,651	10,990,830
Ginger, fresh	Kg.	193,756	27,875	4,359,349

Import Commodities	Unit	Total	SAARC	Value (Rs)
Ginger	Kg.	237,382	210,372	82,941,454
Ginger, crushed or ground	Kg.	10,654	10,614	4,009,682
Turmeric fresh	Kg.	12,408	12,408	1,558,719
Turmeric dust or Powder	Kg.	23,788	23,788	3,999,017
Turmeric	Kg.	342,877	342,869	45,248,371

Source: Nepal foreign trade statistics 2014/15 and A glimpse of Nepal's foreign trade

Key Policy Input for Deploying Strategies Aimed at Strengthening of Spice Value Chain and Enhancing International Trade

Large Cardamom

A value chain report of large cardamom is depicted in the Figure 1.

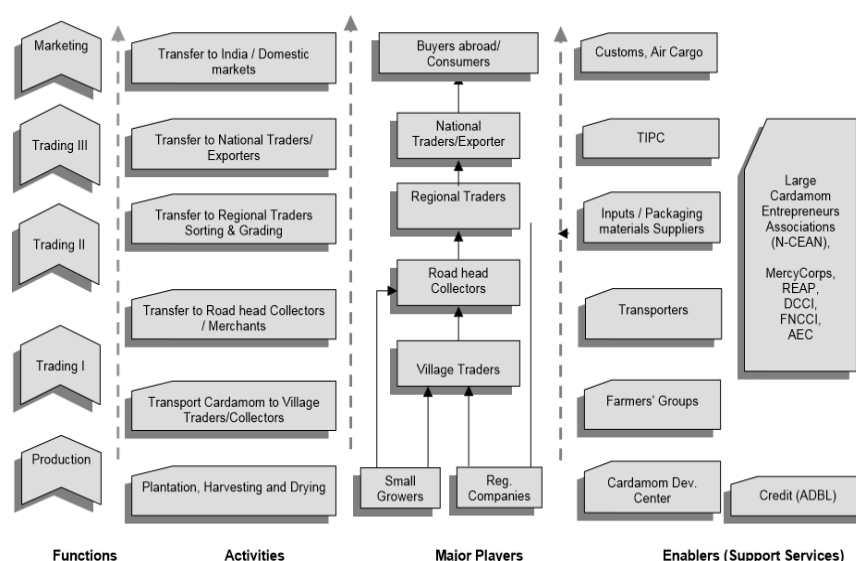


Figure 1. Value chain of large cardamom

Source: Product chain study cardamom, Full Bright Consultancy Pvt. Ltd., 2008

Trade Flow Analysis of Large Cardamom in Eastern Development Region was carried out in three production districts, namely Taplejung, Panchthar and Illam, and one market hub – Birtamod, Jhapa by MoAD, 2015. Ramsai, Golsai, Chibesai, Sambersai, Sawney and Kanti daar are the popular varieties growing in Nepal and are renowned for high quality product in world market. Its unique taste and powerful flavour are two major attributes which is paying good price in world market.

According to Trade Map of ITC, in 2014, total global export of large cardamom was worth \$ 356,494 and import was \$349,640. Its export was only 0.0019% as compared to total global export. Saudi Arabia, UAE, India, Bangladesh and Singapore are top importer of large cardamom. However, Nepalese cardamom has not good market access in SAARC countries except India. The highest tariff is applying by Bhutan which is 35% followed by Bangladesh which is 23.75%. Nevertheless, world's top importers like UAE, Singapore, India and other are providing 0% tariff to the Nepalese cardamom. No significant SPS and TBT measures had been observed during the study. However, moisture percentage and tail removing are predominant factor for price determination and market access too.

Production

Presence of cardamom policy may produce common understanding among growers and traders regarding its production process and its certifications like GAP, Organic and other. Possibility of productivity increments is high. In largest producer district, Taplejung, the productivity is only 0.54 MT/ha where as in Bajhang it is 1 MT/ha. Farmers are independently evaluating "Salakpure" as disease resistant cultivar which should be verified by research before large farmers adopted it. Cost Benefit ratio of cardamom farming was found 1:10. In existing practices, cardamom seeds take six month to germinate which can be shorten to get benefit to the farmers as well as nursery owners.

Processing/Value Addition

Due to price variation according to grade JJ, SD and "usual", value addition in processing existed. Minimal price differentiation (Rs. 3,000-5,000/Mond (1 Mound = 40 kg)) between product from local and improved dryers, 90% farmers are using local dryers. Despite its sound technological dimension, hesitation to adopt it by farmers is socio-economic paradigm. One fourth of the farmers and traders are using "jute sack with plastic inside" for packaging. This type of packaging materials is being distributed by DADOs in the respective districts. More than 89,400 numbers of such improved sacks of 50 kg capacity each is needed to store the cardamom of Eastern Region.

Marketing and Price

Cardamom marketing goes through multiple layers of transaction. Starting from big farmers as producers themselves found to be traders. Collection, storage and buying/selling phenomenon are performed by individual efforts not related to any organized institutions. Regarding districts exporting volume, more than 98% (2858 MT) of capsules are

set to trade and domestic consumptions have been found stagnant to 2% of produce. Export point of Jogbani/ Biratnagar found to be only one way to international market after closing of Kakadvitta export point. The trend shows incremental volume by 10% in each year over latest five years. In contrary, cardamom import is not yet found through this custom point. Price of cardamom capsule is fixed by internationally organized traders from India. No price control mechanism is found in Nepal. Price fluctuation is not directly related to production fluctuation. At present, FLCEN of Birtamod provides cardamom market price via internet and SMS. The code applied is SMS ALAICHI to 9842495060.

Policy and Institution

Despite cardamom specific policy, NTIS, 2010 and Agribusiness Promotion Policy, 2006 are effective to overall development and trade of cardamom. Intensively prioritized policy and highly authorized Board of cardamom have demanded by producers as well as traders. Quality control measures are verbally imposed by importers. Currently, JJ category measuring by <12% moisture, large size, extraneous materials <5% have been practiced providing high status of capsules. Stakeholders' workshop concluded that diversification could be achieved by providing straight route to Bangladesh *via* Fulwari route, Pakistan *via* Amritsar route, Arab countries *via* Kolkata and Mumbai shipping route. Indian border laboratory, uniform state taxation and insurance systems are key issues needed to be addressed by policy. A number of governmental and non-governmental organizations are engaged for the development and trade related activities like MoAD, NARC, DoA, NSDP, DADOs, CDCF, TEPC, AEC/FNCCI and FLCEN. The "Everest Big Cardamom" logo is still to become effective, presently under verification of standards.

Performance Appraisal

Strengths of Nepalese cardamom industry have been realized by its suitability in climatic conditions, virgin land availability, and utilization of underused land in production side. In trade side, economic volume of scale, assured nearby markets and fetching up good price are the main forces. Shortcomings in Nepalese cardamom production are remaining for insufficient saplings supply; large ageing of shading plants, lack of research outputs and quality based improved dryers. Weaknesses are also seen in marketing and trade as lacking of Auction Market, ware house, suitable brandings, equipped quarantine laboratory as well as organized trading systems importantly exists. Opportunities for cardamom industry are found to be multi-dimensional and potential in

many aspects. Such potentialities have been laying in expansion of cardamom land area with waste land too. Productivity gap is still very high and should be improved. Possibilities of trade diversification around the world, product diversification, and production of JJ categories are some of the opportunities of potential exploitation in cardamom industry. Nevertheless, having strength and opportunities in cardamom industry in Nepal, some of the uncertainties exist too. Such as decline labour inputs, reoccurrence of diseases and pests, vague price fixation mechanism, incremental use of chemicals and if no international trade, impaired domestic consumption, seriously threatening the cardamom industry, which compelled to higher attention.

Ginger

Value chain reports of fresh and dried ginger are depicted in the Figure 2 and 3 respectively.

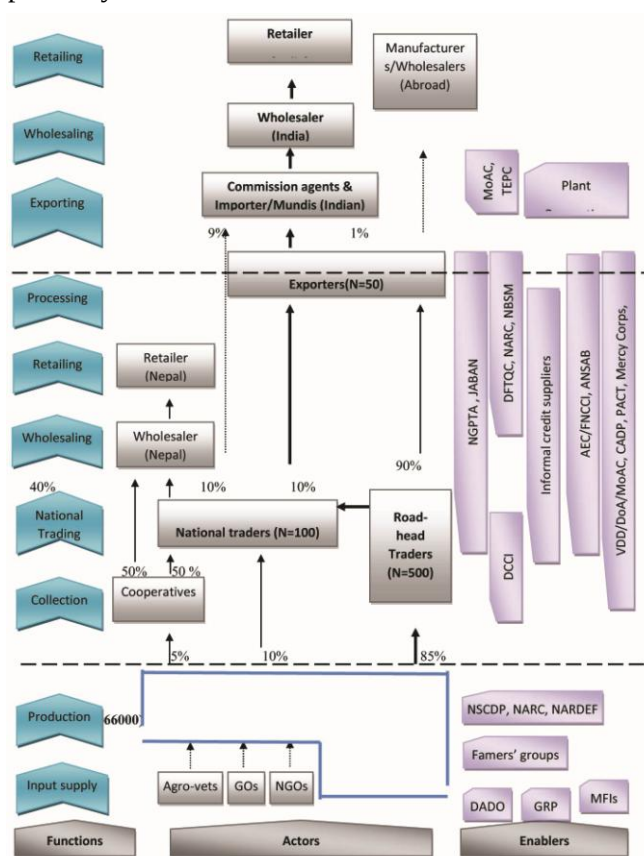


Figure 2. Value Chain Map of Fresh Ginger
Source: Value chain report, ANSAB, 2011

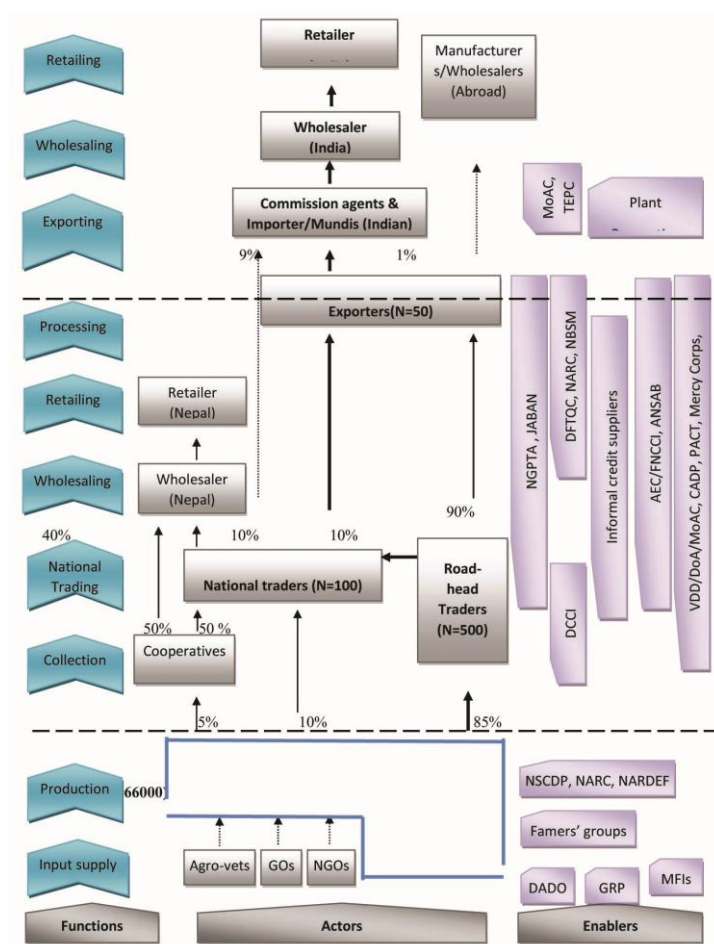


Figure 3. Value Chain Map of Dried and Processed Ginger

Source: Value chain report ANSAB, 2011

The major functions involved in this sub-sector are input supply, production, and local processing at the farmers' level; collection, domestic trading, and exporting at traders' level; and processing and manufacturing for value addition at the processors/manufactures' level. Final processing and manufacturing is limited within Nepal. Some companies like Dabur Nepal, and Gorkha Ayurved have been using ginger as an ingredient in various products.

In a value chain, the actors include value chain operators and operational service providers together. Those functionaries who are directly involved in transactions or directly support the actors involved in transactions are the value chain actors. The actors are classified below:

Input suppliers: Input suppliers are those who provide inputs for the production and marketing of ginger. Seed, FYM and labour are the major inputs for ginger farming and are usually managed by farmers themselves. Pesticides, which are rarely used in ginger, are provided by agro-vets and chemical fertilizers are provided by fertilizer dealers existing in nearby market centres'. Government and non-governmental agencies provide technical knowledge and inputs to some extent to the farmers; however, the flow of information and inputs is not satisfactory. For traders, sacks and threads for packaging are the major inputs.

Farmers: 1) small farmers with subsistence ginger production, 2) small commercial farmers characterized by small production volume but still targeting the market, and 3) large- scale commercial producers. The produce from small farmers generally does not enter the market, or enters in a very limited quantity, especially in the local retail market. Small and large-scale commercial farmers sell most of their produce to various market intermediaries. Farmers are also engaged in local processing of ginger, especially dried ginger (*Sutho*). There are 442 farmers' groups and 83 farmers' cooperative (excluding tea) in Ilam district (DADO, Ilam, 2065/66). Similarly, 333 farmers, including 97 related to ginger, and 38 cooperatives are reported in Surkhet district (DADO, Surkhet, 2065/66). Some cooperatives are engaged in processing and product development, as seen in Salyan, Surkhet (candy), and Palpa (dry slice).

Local processors: Ginger is locally processed into dry ginger (*Sutho*), candy, pickles, squash, and powder. *Sutho*, the main processed product at the local level, is mostly processed by the farmers themselves using traditional techniques and sold to either road-head traders or national traders. More than 75% of the production is traded as fresh, and the remaining is traded in dried form (ITC, 2007). Ginger candy, pickles, squash and other processed products are prepared by local cooperatives in very little quantity and sold locally or through local exhibitions. Some of the cooperatives sell their processed products (dry slice) to exporters in Kathmandu. Though there is scope of value addition through processing, both in increased price and through the creation of local employment, this is not a commercial practice in Nepal.

Road-head traders: Road-head traders are those traders located at road-heads who collect goods directly from farmers. Road-head traders are usually from the local community and conduct trading activity of various goods. Ginger is collected and stored until the truck load is collected. Sorting to some extent, such as removing the decayed and spoiled ginger, is done at this level. Most of the ginger from road-head traders goes to exporters who primarily export to India, though some quantity goes to national traders. In Ilam, the major road-heads for

ginger are Jeetpur, Mangalbare, Biblate, Ilam municipality, and Fikkal. In Salyan the major collection points are Ghodcharu, Srinagar, and Kapurkot. Similarly, Chhinchu, Ramghat, Birendranagar, Botechaur, and Sallibazar are the main collection points of Surkhet. In Palpa, road-head traders are mostly stationed in Dumre, Aaryabhajyang, Tahun, Batashe, and Bhairbathan.

National Traders: The traders who have been active in trade of ginger and its products at national market are called national traders. They get ginger both from cooperatives and road-head traders and sell the ginger to the national market, national level manufacturers, and exporters. Sometimes national traders provide ginger directly to Indian buyers. This is the case in the Nepalgunj region. They also sell ginger to the local markets.

National processors/manufacturers: The firms which are engaged in producing ginger products and other products using ginger as one of the ingredients are termed as national processors/manufacturers. There is evidence of ginger slices exported to Japan, US and EU markets from national level processors/manufacturers. The products using ginger as an ingredient, such as Ayurvedic medicine and food items, are sold locally to wholesalers or to wholesalers in India. Dabur Nepal, Gorkha Ayurved, Singh durbar Vaidyakhana, Male International, Coffee Plantec and local spice producers are some of the examples of national processors/manufactures.

Exporters: The firms which are engaged in export business of ginger and ginger products are regarded as exporters. The majority of the fresh dry ginger that is exported goes to India, while very small amount of ginger products are exported overseas. Some of the exporters also perform simple processing activities like washing, cleaning, and sorting. This is more common in the eastern region and rare in the west.

Commission Agents: Most of the ginger exported to India initially goes to Indian commission agents (CAs) who are based in major market hubs of India and border cities of Nepal. These commission agents usually charge 6 to 7% as commission on the total sales amount. Depending upon the relationship with the exporters, payment of 50 to 70% is made by the commission agent during delivery of the goods. The rest of the payment is made once the goods are sold completely by deducting the commission.

Wholesalers: Wholesalers are defined as those who sell the goods to retailers, hotels, industries, and institutional users. The minimum quantity sold by wholesalers in the Kalimati, and Kathmandu market is 5 kg at a time.

Retailers: Retailers are traders who purchase the goods from wholesalers and sell to end consumers. In each city, ginger is sold by vegetable shops, cycle vendors, and cart pullers.

End Markets: India, the major market for Nepalese ginger, is vast and dynamic. Most of the trading occurs in the northern part of India. Ginger from eastern Nepal mainly goes to Siliguri and Kolkata after washing at Naxalbari. Ginger from the mid- and far-western regions are mainly sent to Gorakhpur, Lucknow, Kanpur, Bareilly, and Banarash. Some ginger is also exported to Delhi, Jaipur, and Amritsar markets.

Turmeric

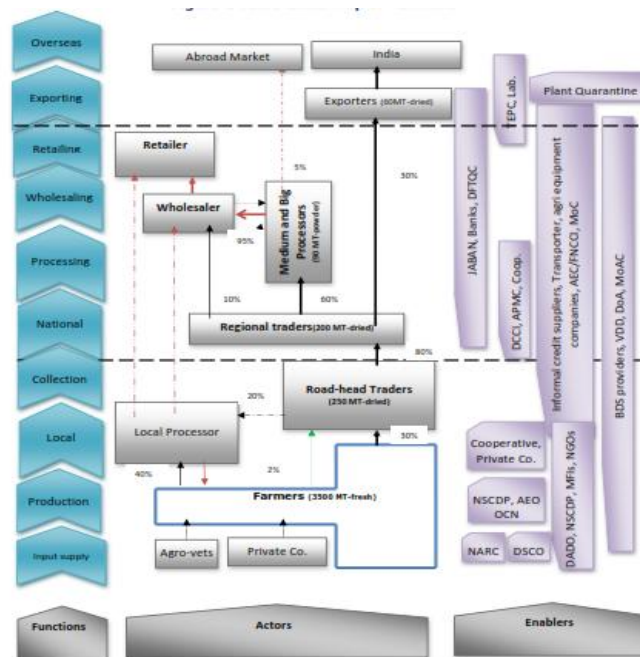


Figure 4. Value chain of turmeric

Source: HVAP, 2011. A report on value chain analysis of turmeric

Turmeric is an essential spice for the Nepalese households and is listed as one of the top five major spice crops in Nepal. The turmeric value chain was prepared by Asia Network for Sustainable Agriculture and Bioresources (ANSAB) commissioned by High Value Agriculture Project in Hill and Mountain Areas (HVAP) in order to design its activities for the value chain promotion. The study was focused in HVAP districts along the three road corridors - Chhinchu-Jajarkot, Surkhet-Dailekh and Surkhet-Jumla - and suggests possible interventions to the project.

Turmeric can be regarded as a good cash crop for the hilly regions as it requires less water and less capital investment for its production, grows with comparatively less use of fertiliser, adoption of simple technology and has low pest/disease infestation. The total national production of turmeric in 2010/11 was 35,295 MT and was cultivated in 4,080 hectares. The production of turmeric over past some years show the increasing trend both in terms of volume and area cultivated. Major portion of the production has gone for the domestic consumption with only a recorded volume of 104 MT of export in 2009/10, mostly to India. HVAP districts account for about 10% of the national production having major share of Salyan, Achham, Surkhet and Dailekh districts.

The estimated total transaction of dried turmeric in the three road corridors is 247 MT. Among the three road corridors, Chhinchu-Jajarkot has the largest production and transaction of turmeric with a calculated transaction volume of around 223 MT. The major turmeric market centres of this road corridor are Chhinchu, Ramghat, Botechaur, Gairibazaar and Baluwa Sangrahi. The other two corridors: Surkhet-Jumla and Surkhet- Dailekh are comparatively new in terms of regional trading and account about 9% and 1% respectively of the total transactions in the three corridors. Birendranagar and Nepalgunj are the major regional markets for turmeric from the project districts. The market price of the turmeric is not stable in the project area; in 2010/11, the price was varied from NPR 100 to 300 with an average of NPR 200 per Kg. But in first quarter of 2012, the price for local dried turmeric was NPR 110 to 140 per Kg.

Farmers process and make turmeric powder by themselves in their houses or avail the service of local water mills and small processors. The commercial processing of the powder is done by both the medium and big processors in the project area, which are mainly located in Birendranagar and in surrounding areas such as Botechaur. These processors supply their products to all of the three road-corridors and especially in Karnali Highway. Powder from other regional markets such as Birgunj, Nepalgunj, Butwal and Biratnagar are also found in significant volume in the project area.

Turmeric from Nepal possesses limitation to be exported to India. The neighbouring country India is the largest producer and exporter of turmeric with world's export share of more than 70% in 2010. In 2009/10 Nepal imported 615 tons of turmeric, mostly from India, and the import is in increasing trend. Because of the highly competitive Indian market, both in terms of price and quality (e.g. good finish, high *curcumin* content), Nepal has less competitive and comparative advantages to export turmeric to India.

This study has assessed the specific constraints and opportunities in the turmeric value chain. The major constraints as identified by the study are: low volume of production, low access to market and market information, lack of information and availability of seeds, dispersed production, lack of knowledge on proper cultivation and post-harvest handling, low number of processing mills and lack of proper processing technologies, lack of access to finance, problem of storage and transportation, lack of turmeric specific farmers' groups and no specific programmes on turmeric.

The prioritised areas of short term interventions in production and processing sector are: piloting high yielding varieties; development of seed production pockets; development of turmeric specific farmers' groups, supporting farmers on production and post-harvest handling methods, introduction of improved and efficient processing technology and support for establishment of processing mills and upgrading of existing processors. Similarly, interventions suggested in marketing are strengthening the institutional capacity of DCCI of the project districts, facilitate for contract arrangements and training on business planning and enterprise development. Facilitation to produce improved seeds, initiation of work towards GAPs and GMPs, and supporting in establishment of infrastructures are some long-term interventions suggested.

Key Developments and Strategies for Benefitting Spice Crop Economy in Nepal

Nepal is one of the world's largest exporter of large cardamom. It is the highest foreign currency earning commodity of Nepal. In 2015 Nepal earned NRs 3.84 billion by cardamom export. Ginger is second important export spice commodity with export value of NRs 0.46 billion in 2015. Nepal is third largest producer and sixth largest exporter of ginger in the world. Similarly, black pepper, turmeric and cinnamon are also exported in low volume from the country. Lack of knowledge and adoption of best practice of cultivation, quality planting materials and improper post-harvest handling are reported to be associated with low quality product hindering to maximum exploitation of its potentiality.

Strategies for Benefitting Spice Crops

- Adopt the effective extension service to transfer the developed technologies
- Make available the quality planting materials
- Improve the post-harvest and processing techniques
- Broaden the market area; remove the dependency on one market-India

Challenges and Way Forward for Research and Value Chain Development of South Asia

Challenges

- Availability of the quality planting material
- Prevalence of rhizome rots disease in ginger and large cardamom
- Lack of efficient management practices for stem borer problem in both ginger and large cardamom
- Lack of proper knowledge on cultivation practices and post-harvest handling
- Lack of skilled technical manpower
- Weak extension services to transfer technology
- Lack of credit facility during the lean period (before harvest)
- Multiple taxes and unofficial payments during transportation
- Lack of effective research and development
- Poor orchard management resulting into low yield

Way Forward

- Sufficient land area for the expansion of the plantation area
- High demand in both the domestic and international market
- Increase yield through the adoption of improved production technology
- Great Opportunities for product diversification in ginger (paste, powder, pickle etc.)

Conclusion

Spice crops are the important cash crops for marginal farmers of Nepal. Large cardamom and ginger are regarded as market sensitive crops. India is the only country where our product is exported. The price of the product depends on the Indian market. The market of the products has been seen affected during the enough production in India.

Nepal is following the traditional practice of cultivation and processing the large cardamom and ginger. Drying the capsules of large cardamom is done in local *Bhatti* where smoke is used for drying. Improvements in the drying technologies have been practiced for quality processing of the large cardamom. *Sutho* (dry form of ginger) is the value added product from ginger which is made traditionally by drying under the sun. Diversification in the product candy, pickle, squash are the other products from ginger crop that are exported in low volume.

There is less consumption of fresh ginger and large cardamom in the local market. In the study of the value chain by different organizations, lack of ‘Technology and technical inputs’ and ‘Storage facility’ and primary processing Centres ‘Access to market’ and ‘Access to finance’ etc. are the major barriers to upgrade the sector. In some cases, the traders of large cardamom are enforced to pay double tax during the transport of the produce from one district to other. This shows that the Government of Nepal has to focus on the project to develop effective value chain of the spice crops. Thus, there should be supports on product diversification, post-harvest handling, processing, branding and market diversification by the government for development of the value chain.

Introduction of high yielding varieties and quality planting materials in different spice crops, management of rhizome rot disease and stem borer of large cardamom and ginger are some key production constraints. Support for product diversification, branding and market diversification are other important issues. All those need urgent attention by government for overall development of spice sector in Nepal.

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Value Chain Development and Technology Practices of Spice Crops (Black Pepper, Cinnamon, Cardamom, Ginger and Turmeric) in Sri Lanka

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Introduction

Spices are important essential additive to enhance or vary the flavour of their foods. Spices were also flavour disguisers masking the taste of the tasteless foods that was nutritious, but if unspiced. Especially, Sri Lanka holds an important position in the production of such commercial crops such as cinnamon, pepper, cardamom, ginger and turmeric. Spices are low volume high value commodity, primarily used for flavouring, colouring and preserving food. The characteristic quality of spices is imparted by volatile and non-volatile constituents. Quality determinants vary with the end user, trader or industry. Sri Lankan spices are having intrinsic qualities mainly due to agro-climatic conditions. Sri Lanka is having 46 agro ecological zone which have a variation in total rainfall, number of rainy days, rainfall distribution, soil type, elevation, land form and temperature range (Panabokke, 1996).

Sri Lanka is divided into 3 main rainfall zones, namely wet, intermediate and dry zones. These zones are sub divided into seven major agro ecological zones based on altitudes. Both wet and intermediate zones consist of low country (0-300 m above mean sea level), wet country (300-900m above mean sea level) and up country (> 900m above mean sea level). The dry zone prevails only in the low country (Mapa *et.al.*1999).

Table 1. Area and Production of Spices 2016

Crop	Area (Ha)	Production (Mt)
Cinnamon	32682	18945
Pepper	39515	18476
Cardamom	1242	120
Ginger	2487	23184
Turmeric	1986	25200

Source: Department of Export Agriculture, 2016

Pepper

Annual global pepper production is about 400,000 mt and current Sri Lankan share in the world market is only 6%. At present extent under pepper cultivation in Sri Lanka is around 39,000 ha and produces 30,000 MT black pepper annually (Anon 2016).

Production Technology

Sri Lankan commercial pepper cultivations are trained on gliricidia (*Gliricidia sepium*) trees. Plants are mainly produced from rapid multiplication techniques at nursery stage. They are; heap method, polythene tube method and bamboo method. Novel techniques of cuttings obtained from terminal shoots were currently developed in Sri Lanka. Following advantages are having with the use of terminal shoots for plant production. The cuttings collected from the mother plants already having axillary buds and roots, help to increase establishment rate in nursery. Pepper plants originated from terminal shoots produce lateral branches from the base itself which leads to develop conical shape canopy at the initial stage and later to uniform, cylindrical canopy with more number of laterals which help to increase the important yield parameters such as number of lateral branches and spikes per plant (Gunaratne *et al.* 2015). Under plant certification system healthy sapling-plant with 5 leaves and well-developed root system is certified.

Research focussed on increasing the establishment rate of pepper plants in field at first two years showed application of supplementary irrigation and mulching has a positive effect. Since, the pepper plant has trained on gliricidia, the system has greater potential to recycle green manure generated from leaf and green stems which are produced after the shade tree pruning at regular intervals (Heenkende *et.al.*2012).In pepper, Department of Export Agriculture recommended to provide the nutrients through integrated plant nutrient management system.

Forty-year's crop improvement programme of pepper has developed number of pepper selections (KW 21, GK49, MB12, TD 7 etc.) and 3 hybrid varieties of pepper released in 2015. Hybrid line 14/3 is having parents of Panniyur I and DM 7, spike length of 14 cm, 80% filling percentage and average yield of 4576 Kg/ ha/Per year and 3.1 % oil, 12.9% oleoresins and 6.3% piperin. Hybrid line of 27/1 is having parents of MW-21 X panniyur I, spike length of 12 cm, 80% filling percentage and average yield of 3931Kg/ha/year and 3.6% oil and 6% piperin, 15.4% oleoresin. Hybrid line of 11/2 is having parents of Panniyur I and GK 49, spike length of 12 cm, 80% filling percentage, average yield of 3771 Kg/ha/Year with 2.8% oil and 5.6% piperin (Seneviratne *et al.* 2014).

The common diseases of pepper found in Sri Lanka are quick wilt, slow wilt, pepper yellow mosaic virus and pepper blight. Integrated approaches of pepper disease control have developed by research innovation.

Sri Lankan black pepper varieties have an excellent aroma, being characterized by high contents of volatile oil, oleoresins and piperin. Pepper processing is mostly done at farm level in traditional manner. Improvement of traditional black and white pepper processing methods through mechanical processing coupled with GMP are implemented by Department of Export Agriculture in Sri Lanka. The machineries and equipment introduced to farmers are thresher, fresh berry separator, blanching kit, decorticator, dryers and grader. In order to develop the pepper industry in Sri Lanka, quality improvement is one of the high priorities in black and white pepper production (Heenkende and Induruwa, 2014). The technology of hygienic processing practices is being disseminated through training and advisory programmes. A post-harvest assistant scheme is implemented since 2007 to encourage the usage of processing machineries and to establish spice processing centres in order to improve the quality of black and white pepper with the objective of enhancing livelihood of the producers and overall economy of the country.

Value Added Products of Pepper

Ground Pepper

This is the commonest form of pepper used for domestic consumption. A limited quantity is exported in bulk form as well dried pepper berries are ground according to the users' specifications, particularly with regard to particle size. Microbial cleanliness of raw material used for grinding is essential. Recently, cryogenic (low temperature) technology has been introduced to help avoid loss of volatile oil in the grinding process. Quality of the products and packaging are more important when exporting is done in bulk form (Anon, 2015).

Pepper Oil

The pepper oil is a volatile oil commercially extracted from crushed black pepper by steam distillation. It yields from 3- 7% of colorless to pale green colour essential oil with mild or non pungent flavour. Pepper oil gives its characteristic aroma.

Pepper Oleoresin

Oleoresin of pepper is a concentrated, resinous extract obtained by organic solvent extraction. The solvent extracted products of pepper give

full flavour and pungent principles of pepper. It is the exact representative of the pepper. It yields 10 to 20 % dark green viscous and heavy liquid with strong aroma.

Green pepper in liquid media

A number of products can be developed from harvested green pepper. Bottled green pepper has a great demand in nontraditional areas. Technology was developed recently to make green pepper products which are introduced into the commercial market.

Green pepper in brine

The green colour is maintained under a high salinity of steeping liquid. It is prepared from immature green pepper berries, after careful separation from stalks. Salts levels can be within the range of 4 – 16% depending on the buyer requirement. Products add salty taste to the pungency of green pepper.

Green pepper in vinegar

The green colour is maintained under acidic medium. Acetic acid solution should be around 45 and products give sour taste to the hot green pepper.

Green pepper in brine and vinegar

The green colour is maintained under an acidic and salt medium. Acetic acid and brine solutions of different concentrations could be selected as per the consumer preference and the mixed together. Products add savory and sour taste to the pungency of green pepper.

Rose (Red) pepper

This product is prepared by using selected ripe red pepper berries. Red colour is more attractive compared to the other colours of black pepper. The red colour berries are preserved in brine, vinegar or in a mixture of both solutions. These products are used as same as the green pepper. Technology was developed recently to make rose pepper product which is introduced into the commercial market.

Pepper sauce

Technology was developed recently to make pepper sauce products which are introduced into the commercial market. Among them green pepper sauce and red pepper sauce are the major products developed and introduced by the Division of Post Harvest Technology (PHTD), Central Research Station, Department of Export Agriculture.

Green pepper sauce

Green pepper sauce is produced by using immature black pepper fruits, vinegar, garlic, sugar and some other spices. This product can substitute for green chili sauce in the market and can be used to decorate foods and taste food with a little pungent flavour.

Red pepper sauce

Fully ripe pepper corns are used to produce red pepper sauce. Other main ingredients are vinegar, garlic, sugar and some other spices. This product is more or less same to the chili sauce but the taste is different and attractive.

Other value added products

There are many products that can be produced from pepper apart from traditional black and white pepper. Some of these products are pepper toffee, pepper flavoured jujubes, and pepper flavoured cookies. Technology was developed recently to make above products which are introduced into the commercial market in near future.

Spice Cinnamon

Ceylon cinnamon, a world-renowned spice is the dried inner bark of *Cinnamomum zeylanicum* Blume (syn. *C. verum* Presl). *C. zeylanicum*, a perennial hardy plant among the rest of the spice plants belongs to family Lauraceae. Currently Sri Lanka produces 90% of true cinnamon (Anonymous, 2015) for the world market and cinnamon production is the primary source of income for around 60,000 farm families of Sri Lanka which accounts for 300,000 individuals (Jayasinghe *et al.*, 2016). Foreign exchange earnings through cinnamon bark and oil in Sri Lanka accounts for almost 25 billion rupees (\$ million 167), which is 40% of the total earnings of spices in 2016 (Anonymous, 2016).

Cinnamon is cultivated in wet and intermediate zones of Sri Lanka, and mainly in Galle, Matara, Ratnapura, Kalutara and part of Hambantota Districts. The extent of cinnamon cultivation in Sri Lanka is approximately about 30,130 ha (Department of statistics, 2016). Average national yield of quills is around 487 kg per hectare while potential yield is 1250 kg per hectare (Jayasinghe *et al.* 2017). Cinnamon quills produced from cinnamon bark is an export commodity.

Even today Sri Lanka enjoys as a number one producer of true cinnamon in the world supplying 90 % of true cinnamon to global export market. Cinnamon (*Cinnamomum zeylanicum*) is hardy perennial crop that grown in warm humid climate with over 1500 mm rainfall. It is indigenous to the island. In 2016, Sri Lanka earned US\$ 167 m by exporting cinnamon (Anonymous, 2016).

Introduction of high quality (4 % leaf and bark) oil and high yielding (more than 1000 kg of dry bark per ha) two cinnamon selections namely 'Sri Gemunu' and 'Sri Wijaya' were excellent achievement under crop improvement programme (Wijesinghe *et al.*, 2004) and several varietal development and hybridization programmes are underway.

Several seed germination researches have been conducted. Pericarp of cinnamon seed contains chemicals that inhibit germination of the seeds. When the pericarp is removed and plant them, within a week achieve maximum germination percentage (Wijesinghe, 1997). Some studies have been conducted to keep seed viability for few months so as to avoid difficulties getting seedling plant throughout the year using management of moisture in the seeds (Samaraweera, 1998). Cinnamon intercropping studies were conducted with coconut (Dias and Sumanasena, 1998) and rubber (Pathirana and Edirisinghe, 2003). Best plant spacing of cinnamon is 4' x 3' (Samaraweera *et al.*, 2001). Recommended fertilizer mixture for cinnamon is 210 N, 60 P₂O₅ and 135 K₂O kg/ha/year (Gunaratne *et al.*, 1997). Eppawala rock phosphate performs well than imported rock phosphate in cinnamon cultivation (Heenkenda *et al.*, 2003; Samaraweera *et al.*, 2012). Application of inorganic fertilizer negatively effects on vesicular arbuscular mycorrhiza population in cinnamon (Dharshaneet *et al.*, 2010).

Most proper weed control method in cinnamon was slash weeding (Jayasinghe *et al.*, 2002; Dharshaneet *et al.*, 2007) and it protects the healthy soil invertebrate community in cinnamon ecosystem (Buddika *et al.*, 2013; Senaratne *et al.*, 2015).

Chemical and alternative management practices were introduced for management of pest and disease (Jayasinghe *et al.*, 2016) in cinnamon. Major pest of cinnamon is the wood boring moth (*Ichneumoniptera cinnamomumi* Tosevski) and it's identification (Dharmadasa and Jayasinghe, 2000; Jayasinghe *et al.*, 2006), biology (Dharshaneet *et al.*, 2008) and management practices (Jayasinghe and Wickramasinghe, 2001) have been studied in detail. Feeding and tunneling of stem bases at ground level by the larvae of this pest results in damage to the vascular system of the plant, depletion of the plant food reserves, weakening and breakage of stems, shoot dieback and rotting of stem bases without producing essential new shoots for next generation. Considerable yield loss, up to 50 % can take place (Jayasinghe, 2013). Two types of economic injury level (EIL), based on damage bushes and number of pests in 100 bushes were established using Benefit Cost Ratio and it can be used in decision making to manage wood boring moth at cinnamon fields in Sri Lanka (Jayasinghe, 2015).

Rough bark disease (RBD) has become a major biotic threat to cinnamon industry in Sri Lanka causing yield losses quantitatively and qualitatively. A fungal culture was isolated from affected cinnamon sample and confirmed it by Commonwealth Institute of Mycology as *Phomopsis* sp. (Jayasinghe and Ratnasoma, 2013). The disease reaches critical stages when the fungus invades the xylem tissues of stem showing interveinal chlorosis of leaves as the pathogen blocks the water and mineral nutrient translocation (Jayasinghe *et al.*, 2017).

Several studies have been conducted on stored product pests and fungi in cinnamon quills. Several kinds of mites and different kind of insects (mostly psocids) were observed when they were not stored in proper condition (less than 14% of moisture) (Jayasinghe, 2012). *Rhizopus* sp., *Penicillium* sp. and *Aspergillus* sp. were the most common species of fungi grown on cinnamon quills. The most favourable conditions for microbial growth were 80% - 90% of relative humidity, 28 to 31°C of ambient temperature, 12 to 20% of moisture content in quills and 20 to 30 days of storage (Pathirana *et al.*, 2015).

Some studies have been conducted to mechanize cinnamon harvesting. One step of cinnamon peeling is the rubbing of inner bark before removing the peel and that stage was semi mechanized (Weerasinghe, *et al.*, 1998). Freezing and thawing technique can be used for cinnamon peeling without rubbing in bronze rod (Wijesinghe *et al.*, 2012). Some observations report the ability of cinnamon leaf and bark oil for inhibition of Aflatoxin formation (Jayaratne *et al.*, 2002). Some studies showed that sulphur fumigation could be done in safe manner when 3 kg of sulphur is used for 1000 kg of dried cinnamon (Weerasuriya *et al.*, 2008). Indrasena *et al.*, (2010) reported that Sri Lanka true cinnamon is safer to use as food ingredient than cheap cassia with high levels of coumarin.

Recent study revealed that there was a huge variation in yield. 19 % of lands were very poor productivity level (less than 250 kg/ ha) while only 9 % lands were in the highest productivity level (more than 750 kg/ ha). Use of preferable cultural practices such as earthing up, selective pruning, proper slash weeding (Senaratne *et al.*, 2015; Jayasinghe *et al.*, 2002) and application of recommended fertilizer doze with organic manure seems to influence on reducing the pest and diseases incidences and indirectly increasing the productivity of cinnamon lands.

Soil, Agronomic and Some Other Aspects for Cinnamon

Cinnamon has been originated in Sri Lanka and it thrives well under tropical climatic conditions. The climatic conditions significantly influence not only growth and yield but also the harvesting and post

harvest operations. It is well established fact that the crop is a hardy plant which can grow well under wide range of soil and climatic conditions. Soil depth and texture, pH, temperature, rainfall, altitude, topography are the main decisive factors for desirable growth and yield of the crop. Unlike most of agricultural crops, most of the aerial parts of cinnamon plant are removed at harvest and their by considerable nutrients also get removed. Most of the cultivations are established on moderate slopes and the nutrient removal is accelerated with the harvesting with soil exposure particularly in rainy seasons. Therefore, soil management and moisture conservation practices are very crucial for better growth of cinnamon. Since cinnamon is harvested for stems, enhancement of vegetative growth is important. Hence, the crop responds well to the nitrogenous fertilizers. Soil acidity control is very important as the crop is distributed in comparatively high rain fall areas where basic nutrient removal is also high making the soil more acidic. Therefore, liming has become an essential operation in order to make the soil less acidic. Similarly it enhances the fertilizer use efficiency leading to increase economic benefits. Cinnamon should be established with optimum spacing (4'X3' and 4'X2') and having uniform cultivation. This particularly controls weed growth, bush formation, reduce soil erosion and higher yields per unit area. Bush management is also important from the field establishment with gap filling, selective pruning and following proper harvesting methods.

Value Addition of Cinnamon

Cinnamon (*Cinnamomum verum*.Presl) is one of the most important spices used by people since historic time. True cinnamon is native to Sri Lanka. Mainly, five important products are produced from cinnamon plant namely, quills, featherings, chip, bark oil Oleoresin and leaf oil. These products find their main uses in food industry to flavor a variety of food items. The major export product out of them is always quills that accounts for about 90% of the whole industry.

It is important to understand and appreciate 'market dynamism' of the global cinnamon industry, reviewing the processing and products development aspects of cinnamon industry in Sri Lanka. Processing and products development are emerging with the evolution of world trade and changes in consumption pattern in respect to the cinnamon industry. It is in this context a producer or a processor has to concern on some strategies to exploit potential and opportunities in the trade on the following.

Major share of the market is shifting from domestic uses to food industry and service sector. This sector is growing rapidly inflating demand for spices including cinnamon.

- Concern over quality, cleanliness, and food safety of cinnamon are becoming more and more significant.
- Main direct usage of cinnamon is inclining towards extractives such as oil and oleoresin.
- The trade is becoming globalized and as a result, price of true cinnamon increasingly competitive.

Sri Lanka need to gradually move from raw spices to export of more and more value added products. This paper aims at the processing aspects of value added products of the Sri Lankan cinnamon industry.

Processing and the Products of Cinnamon in Sri Lanka

Processing of cinnamon can be considered as primary (traditional) and secondary processing: In primary processing there is no major transformation of the harvested materials in producing the major final product; such as Quills, Quillings, featherings and chips. In the secondary processing the form of the harvested material is significantly transformed from its original status. Both primary and secondary processing adds value to the commodity. However, secondary processing adds more value to the products by adding three major tools such as human resource, machines and technology which have money values. Addition of money value to primary products is generally referred to as value addition or secondary processing and thus produces value added products.

Value addition of cinnamon can be done by three methods;

- Low tech processes,
- High tech processes, and;
- Packaging and branding

Use of Different Products of Cinnamon

Cinnamon bark is widely used as a spice. It is principally employed in cookery as a condiment and flavoring material. It is used in the preparation of chocolate, especially in Mexico, which is the main importer of true cinnamon. It is also used in many desserts recipes, such as apple pie, donuts, and cinnamon buns as well as spicy candies, tea, hot cocoa, and liqueurs. In addition cinnamon oil and oleoresin are also used in pharmaceutically formations, Perfumery industry, cosmetic formulation etc. A number of value added products of cinnamon have been developed to use for different purposes.

Cinnamon Quills

Sri Lanka is the only country that process in the form of quills. The quills are entirely manually produced. These pipe shape quills are processed by using the finer portions of the inner bark of cinnamon stick, which were harvested at correct stage of maturity. Having scraped off the brownish outer layer, the inner bark is rubbed with a brass rod. The bark is then peeled off and made into 42 inches long pipes, which are dried in shade later.

The Sri Lankan grading system divides the cinnamon quills into four groups:

- Alba, less than 6 mm (0.24 in) in diameter
- Continental, less than 16 mm (0.63 in) in diameter
- Mexican, less than 19 mm (0.75 in) in diameter
- Hamburg, less than 32 mm (1.3 in) in diameter

These groups are further divided into specific grades. For example, Mexican is divided into M00000 special, M000000, and M0000, depending on quill diameter and numbers of quills per kg. Cinnamon grades with high quality receive a premium price in the market. The lower grades of cinnamon obtained as byproducts in the preparation of quills are exported in the following forms.

Quillings

These are broken pieces of quills of various grades. The only difference between the quills and quillings is their shape. The aroma and taste of both are of same quality. This is marketed as medium quality cinnamon.

Featherings

These are feather like shavings and small pieces of bark left over in the process of making quills. This grade consists of the inner bark of twigs and twisted shoots, which will not give straight shoots of normal length. Featherings have a flavor similar to that of other grades. This is marketed as medium quality cinnamon.

Chips

Chips are the greenish brown mature thick unpeelable bark. They are scraped off from the bark and not peeled. They invariably contain more or less woody material and are frequently contaminated with sand, stones and other debris. This is an inferior quality cinnamon of which is lacking in the characteristics of both aroma and taste.

Cut quills

Cut quills are another product in the customer-producer sector. The quills of lengths shorter than 42 inches are also produced and exported. They are mostly around 8 to 10 cm length these are easily used for culinary and other purposes. Some are used as swizzle sticks in the liquor trade.

Cinnamon powder

This is the commonest form of cinnamon used for domestic consumption. A limited quantity is produced in bulk form as well. Quality of the product and packaging are more important.

Seasoning and spice mixtures

Sri Lanka produces ready to use seasoning and spice mixture using cinnamon as the basic ingredient mixed with other spices. Curry powder with a variety of ethnic tastes is another popular domestic food ingredient. Demand for these products is increasing in domestic market and some quantity is exported too.

Cinnamon oil

The volatile oil is extracted by steam distillation of crushed cinnamon bark. Its flavor is due to an aromatic essential oil that makes up 0.5% to 1% of its composition. It is of a golden-yellow color, with the characteristic odor of cinnamon and a very hot aromatic taste. The pungent taste and scent come from cinnamic aldehyde or cinnamaldehyde (about 60 % of the bark oil). Other chemical components of the essential oil include ethyl cinnamate, eugenol (found mostly in the leaves), beta-caryophyllene, linalool, and methyl chavicol.

Cinnamon Leaf Essential Oil has been known to spicy, it is effective in combating against exhaustion, weakness and depression as well. It has somewhat anti-rheumatic agents that could be useful enough. And it is also quite effective in curing colds and cough as well as flu. The cinnamon leaf oil has spicy, warm scent and its color is yellow. Essential oil is carefully extracted through steam distillation from the leaves and yields 1.6 to 1.8% oil. The oil extracted from leaves is more delicate than those extracted from the bark.

The Cinnamon Leaf Essential Oil is known for non-toxic. But this essential oil must be used with extra care since it contains eugenol and cinnamaldehyde that could cause strong irritation specifically on the mucus membranes so better use this oil with extreme caution and should be avoided to use on pregnant women since it has emmenagogue properties. Be careful in using this must be use in minimal to moderate amount since using this on high dosage may cause convulsions.

Cinnamon oleoresin

Cinnamon is extracted with a suitable organic solvent to produce cinnamon oleoresin. The solvents used for extraction of oleoresin are ethanol, acetone, dichloro -ethane, and liquid carbon dioxide etc. The solvent extracted product of cinnamon gives flavor and pungent principles of cinnamon. It is dark green viscous and strong aroma. Oleoresin is mainly used in flavouring industry.

Cinnamon drink

The product is carbonated, sweetened, ready to serve soft beverage with food and medicinal value that is produced by using potable water as the liquid medium mixed with cinnamon flavor and taste peculiar to natural herbal cinnamon. Department of export Agriculture has obtained patent rights for this product.

Cinnamon candy and other value added product of cinnamon

Technology was developed recently to make cinnamon flavoured candy which would be introduced in to the commercial market in near future. Cinnamon cookies, cinnamon flavoured cakes, cinnamon flavour herbal tea cinnamon gift packs and cinnamon tooth stick are other value added products.

Cinnamon is the fourth largest export crop and the only crop that Sri Lanka has without a successful competitor at the international market. Sri Lanka export mainly raw cinnamon with small quantities of cinnamon oil and other products. The environment is inductive for more value addition which can bring in more income. In order to develop the cinnamon sector with special reference to process and product development, the present activities of the Department of export agriculture are concentrating mainly on the value addition of cinnamon.

Ginger

With the objective of maximizing the productivity of ginger in Sri Lanka, we initiated some agronomic, plant breeding, soil and plant nutrients and crop protection research in last few years. Agronomic research to find out the effect of planting spacing on yield of ginger (Idamekorala *et al.*, 2012), effect of seed rhizome position during planting on growth and yield of ginger, effect of time of planting (month of planting) on growth and yield of ginger, feasibility of planting ginger during off-season in the different agro- ecological zones of Sri Lanka, effect of different storage conditions on germination ability of ginger and turmeric and feasibility of in- vitro multiplication of ginger (*Zingiber officinale* Rosc.) cultivars were conducted. Those research revealed that 25cm x 25cm planting

spacing showed the maximum yield (30tons/ha) out of four spacing treatments and there is no significant difference in positioning of seed rhizome at planting (vertical and horizontal). Planting time of ginger from April to June found as the best time for ginger cultivation, however in feasibility study of off-season ginger cultivation revealed that with the availability of supplementary irrigation, ginger can be grown in off-seasons as well. In a storage experiment, it was found that both ginger and turmeric can be stored under 19 - 20°C up to five months with a 40 - 22% weight loss respectively, with a 16% sprouting percentage and 2% of deteriorate rate. However, it was revealed that the cold storage was the best method compared with other storage media which were soil, sand, coir dust and paddy husk for both ginger and turmeric. The best regime for surface sterilization of rhizome sprouted buds was observed in 30% Clorox for 30 minutes. Highest survival rate of the explants was observed in Chinese ginger while lowest was observed in Local ginger. MS medium supplemented with 2mg l⁻¹ BA and 0.25mg l⁻¹ NAA has shown the best performance for initial multiplication of local ginger buds (8.6 shoots per explants). Half strength MS medium supplemented with 1.5 - 2.0mg l⁻¹ NAA has shown highest induction of roots (Anon, 2012).

Fifty-three ginger accessions were collected from the growers' fields in different districts of Kurunegala, Gampaha, Kalutara, Galle, Matara, Hambantota, Monaragala, Nuwara Eliya, Matale, Kegalle, Jaffna and Ampara. Collected accessions were established in ex-situ conservation at the field of Intercropping and Betel Research Station, Narammala for future crop improvement programmes (Anon, 2016).

Rhizome rot, bacterial wilt and leaf spot are reported as destructive diseases of the crop of ginger and the causal organisms of above diseases were already identified as *Pythium* sp, *Ralstonia* sp and *Phyllosticta zingiberi* respectively. Ginger rhizome fly (*Mimegralla coeruleifrons*), stem borer (*Dichocrocis punctiferalis*), Rhizome scales (*Aspidiella hartii*) and mealy bugs (*Formicococcus* sp.) were reported as economically important insect pests. According to the research findings, an Integrated Pest Management package was already recommended to manage the above pest damages. However, further research is continued to periodically upgrade the control measures.

Technologies developed in the Division to produce the Salted ginger slices, Sweetened ginger slices, Sweet & Sour ginger slices and pickled ginger slices for small-scale industries were tested. These products were introduced to the community and displayed in the exhibitions. Also, another value added products of ginger has been developed in the Division of the Post Harvest Technology. Some of these products are ginger oil, oleoresin, ginger toffee, ginger flavoured jujubes, and ginger flavoured cookies.

Turmeric

Turmeric is grown in wet and intermediate zones of Sri Lanka as a mono crop and an inter crop under coconut. Kandy, Kegalle, Gampaha, Matale and Kurunegala districts are the major turmeric growing districts. With the objective of increasing the productivity of turmeric few researches was initiated in last few years. Sixty seven turmeric accessions having different characters were collected from field surveys in the districts of Kurunegala, Gampaha, Monaragala, Matale, Jaffna and Ampara. Collected accessions were established in a field gene bank at Intercropping and Betel Research Station Narammala for future crop improvement programmes. A protocol was developed for in vitro propagation of turmeric.

The experiment initiated to find out the effect of different types of mulches on growth and yield of turmeric revealed that gliricidia mulch and grass mulch more effective in conserving soil moisture. All organic mulches reduce weed germination and result showed that grass mulch has the strongest influence on the decrease of weed germination.

Ten insect species were recorded including three leaf eating caterpillars, namely *Udaspes folus* Cramer (Lepidoptera: Limacoidae) *Leucoma salicis* L (Lepidoptera: Limacoidae) and *Spodoptera lituralis* Fabricius, (Lepidoptera: Noctuidae), a leaf eating beetle (*Lasioderma serricornis* Fabricius; Coleoptera: Anobiidae) a scale insect (*Aspidiotus distractor* Signoret; Hemiptera: Diaspididae) an aphid (*Pentalonia nigronervosa* Coquerel; Hemiptera: Aphididae), a thrips (*Panchaetothrips indicus* Bagnall; Thysanoptera: Thripidae) a shoot borer (*Dichocrocis punctiferalis* Guen; Lepidoptera : Pyralidae) , a rhizome scale (*Aspidiella hartii* Coquerel; Homoptera : Diaspididae) and a lacewing bug (*Stephanitis typicus* Distant; Homoptera: Tingidae). None of the recorded pests caused economically important damage to the crop except shoot borer thrips and rhizome scale (Dharmadasa *et al.*, 2012).

The experiment conducted to find out the effect of boiling time on drying and colour of turmeric powder revealed that the lowest drying time, the highest curcumin content and the highest yellow colour were obtained in fingers and tubers with blanching for 45 minutes. However, there was no significant difference in the mean curcumin content in the blanching treatments of 45minutes and 30 minutes. The optimum blanching time for turmeric tubers and fingers in order to obtain quality turmeric powder would be 30 minutes.

Cardamom

Cardamom Research Trials Conducted and Outcome

Recommended varieties of cardamom for high & low altitudes

Some accessions of cardamom could be grown satisfactorily at low altitudes (50-150 m AMSL) even under high day temperatures ($> 30^{\circ}\text{C}$).

Recommended varieties for high altitude: The best yielding accessions were Ec 201 (2071 number of capsules/year), Ec 301 (1183 /yr.) and Ec 401 (1051 /yr.) (Vashukka type) and Ec 700 (1061 /yr.) (Mysore type).

Recommended varieties for low altitude: Only Ec 400 (Vashukka type), Ec 100, Ec 101 and Ec 102 (Malabar type) yielded over 500 capsules per clump

Suitable weather conditions for growth & yield of cardamom

- Very high rainfall was not essential, but well distributed showers indicated better clump development.
- With the onset of rainfall or showers, sucker initiations were accelerated and the growth phase continued.
- New sucker initiation was poor after two years of field planting at WL1 and IM3 regions and this may be due to a high temperature effect that shortens the economic life-span of the species.
- Major flowering period was during May – August in the WL1 region, whereas flowering took place in two major seasons, March – May and September – October in IM3 and IU1 regions.
- The time for capsules to mature was 90 –100 days in the WL1 region, but 95 – 105 days in the IM3 and IU1 regions.
- The highest number of panicles and capsules per clump was observed under 50 % shade and both very low and very high shade conditions expressed poor performances.
- Accession Ec 102 showed higher photosynthetic rate, i.e. $5.69 \mu\text{mol m}^{-2} \text{s}^{-1}$ under a wide range of light intensities ($125 - 717 \mu\text{mol m}^{-2} \text{s}^{-1}$) and high temperature ($29 - 32^{\circ}\text{C}$) conditions.

Floral biological & fruit set studies of cardamom

- Anthesis commenced before 4.00 am. Ninety percent of the flowers opened fully by 5.30 am. The peak anthesis was observed between 5.00 am and 5.30 am.
- Anther dehiscence commenced before 5.00 am and completed dehiscence by 9.00 am in the Mysore type at all eco-regions. Peak

anther dehiscence was observed between 6.00 am to 8.00 am and completed before 11.00 am.

- Stigma receptivity of cardamom commenced before 6.00 am, increased rapidly during 7.00 and 9.00 am and decreased after 12 noon to nil at 6.00 pm. Therefore, the stigma remains receptive for about 10 hours.
- Fruit set was very low (< 5.8 %) in self-pollinated flowers and within accessions (10.7 and 15.4 %). Pollination within different types of cardamom gave between 21.3 and 26.2 % fruit set. The best cropping system may be a mixture of accessions at least from same type (if not different types of cardamom).

Growing cardamom under pinus at high elevation: It was observed that the cardamom can be planted successfully under pinus at high elevations

Growing cardamom under Mahogany at low elevation: It was observed that the cardamom can be planted successfully under Mahogany at low elevations

Suitable pit sizes for establishment of cardamom: Results shown that 45 cm x 45 cm x 45 cm pits or 45 cm x 45 cm drains filled with organic matter and top soil could be recommended.

Cardamom multiplication using Tissue Culture Technique

protocol was developed for rapid multiplication of cardamom by adding Benzylaminopurine to the MS medium.

Development of control measures for Cardamom thrips (*Sciothrips cardamomi*): The insecticides namely, Actara 25 WG (Thiamethoxam 25%), Regent (Fipronil 5 g/L SC) and Calypso (Thiaclopride 240 g/L SC) significantly reduced the percentage of pod damage.

Ongoing Research

- Screening of wild types of Cardamom against thrips (*Sciothrips cardamomi*)
- Evaluation of promising Cardamom lines for low elevation under Mahogany (Location: Kiriella)
- Potential of growing cardamom under artificial shade and supplementary irrigation

Cardamom Value Addition

Lanka Green Cardamom is mainly produced. Bleached cardamom cardos.mom seeds oil oleoresins are other main products. Technology has been developed to produce cardamom flavoured toffee.

Spice Trade in SAARC Countries and beyond the SAARC (Intra and Interregional Trade)

Unlike other spice producing countries such as Indonesia, Malaysia and Vietnam, whose bulk of exports are going to Europe and USA, Sri Lankan spice trade is largely concentrated in SAARC region, mainly to India. More over 50% of pepper, clove and nutmeg exports are going to India annually and also India has used to purchase sizable quantity of cinnamon and areca nut. Intra country trade between India and Sri Lanka had considerably increased after India Sri Lanka Free Trade Agreement. The agreement allows Sri Lanka to re-export of imported raw material to India after 35% or more value addition and it was noted more and more cocoa and cardamom are also exported to India under such conditions. Also, an Indian multinational company has invested for spice oil and oleoresin plant in Sri Lanka hence more than 80% of pepper oil and oleoresins are exported back to India. Cinnamon exports to India have significantly increased in past 2-3 years but the quantity never exceeded 500kg.

Other main SAARC trading partner in spice trade is Pakistan and a considerable quantity of pepper and nutmeg are exported by Sri Lanka to Pakistan. On the other hand Pakistan is virtually the only buyer of Sri Lankan betel and 99.9% of local exports are going to Pakistan.

The Maldives is a regular buyer of almost all spices but quantities purchased are relatively small. Bangladesh appears in the spice market time to time, especially purchasing pepper, nutmeg or clove, but it is not a regular buyer. Other SAARC countries, Nepal, Bhutan and the Afghanistan, are not significant buyers of spices from Sri Lanka.

Table 2. Spice Exports to SAARC Countries (MT)

Year		India	Pakistan	Bangladesh	Maldives	Nepal
2016	Pepper	4801	39	41	32	-
	Clove	493	7	20	9	-
	Nutmeg	154	196	89	0.18	-
	Cinnamon	483	184	-	0.73	-
	Cardamom	663	-	-	0.79	-
	Oleoresin	93	-	-	0.01	-
2015	Paper	9068	1556	54	11.05	26.50
	Clove	1869	174	50	7	-
	Nutmeg	192	267	127	0.12	-
	Cinnamon	444	266		0.65	-
	Cardamom	100	-		0.28	-
	Oleoresin	40	-			-

Source: Sri Lanka Customs, 2016

In the intra-regional trade of spices Latin American countries, USA and some European countries are significant buyers but except for cinnamon, it never reached to SAARC level. In export trade of cinnamon Mexico is the main buyer historically and every year Mexico purchases around 40-50% of cinnamon. Altogether 60%-70% of cinnamon is exported to Latin American countries. USA is a significant regular buyer of cinnamon from Sri Lanka and had purchased over 1000mt. in past five years. Republic of Germany, UK, the Netherlands, Spain and Italy are main European buyers of pepper, cinnamon and spice oils who appeared in the spice market very frequently. In the Middle East Region Egypt is a significant buyer of pepper in many years and UAE, Saudi Arabia, Bahrain and Qatar are significant buyers of Nutmeg, Clove and Pepper

Table 3. Spice Exports to non SAARC Countries (MT)

Year		USA	France	Germany	Mexico	UAE	Egypt	Japan	Australia &Newzealand
2015	Pepper	367	17	643.47	266	46.39	41.00	18.49	15.43
	Clove	167	3.94	105.72		0.10	25.15	11.96	26.56
	Nutmeg	34	2.35	128.10		209.28	37.17	14.77	3.24
	Cinnamon	2170	40.55	221.54	5946	58.76	-	33.57	125.52
	Cardamom	0.0	0.66	1.25	-	10.11	-	0.18	0.46
	Oleoresin	92.47	6.76	71.65	3.70	-	11.20	-	1.70
2016	Pepper	563	34.75	783.82	74.00	497.15	728.30	8.14	19.57
	Clove	174	1.58	167.66	29.50	1008.92	53	2.57	11.28
	Nutmeg	57	2.26	46.05	2.50	205.05	9.55		4.22
	Cinnamon	1607	57.68	172.63	5578.25	6.68	1.80	27.32	119.48
	Cardamom	-	1.77	1.80	-	10.03	-	0.15	0.39
	Oleoresin	77	6.15	73.76	5.80	-	5.50	-	1.71

Source: Sri Lanka Customs, 2016

Key Policy Inputs for Deploying Strategies aimed at Strengthening of Value Chain and Enhancing the International Trade

Typical spice related value chain within Sri Lanka is relatively long comprising, producers, a number of intermediary traders (or collectors) and exporters. However, some other players such as VA producers, processors, brokers etc. too acting at different levels. Comparative to other export crops in the country such as tea and rubber, spice value chain is relatively weak and have many problems to be solved. Key government policies with regard to spice value chain are to increase spice production and high value exports thereby to improve the spice sector to a competitive level domestically and internationally. To reach those policies Sri Lankan government has implemented numerous programs and projects through many government agencies to strengthen

different segments of spice value chain.

Following diagram shows spice value chain in Sri Lanka and tasks to be fulfilled by each segment or group of segments.

Table 4. Spice Value chain in Sri Lanka

Producers	intermediary traders /collectors /processors	Exporters Packers/brokers/ shipping agents etc
Increase production	Ensure product quality	adequate supply
Increase productivity	Proper storage and market infrastructure	VA products
Ensure optimum price	Market information and IT	Branding /GI
Hygienic processing	Value addition facilities	Market information
Ensure product quality links/exposure Taxation	Transport/ packing material etc. Knowledge/training Trade facilitation/Logistics	Market
Testing facilities		

Source: Department of Export Agriculture, 2016

The government has implemented several assistance schemes to support farmers, through the Department of Export Agriculture, for new planting and increase productivity of existing lands. For new spice cultivations technical advice and planting material at subsidized price are provided by the government. More awareness programs through farmer training and mass media are conducted to increase knowledge of farmers about benefits of increased spice productivity. The research division of DEA work on generating new technologies such as, remedies for pest and disease problems, low cost PIP and IPM packages, machineries and VA products and disseminate those information through DEA field officers, mass media or by direct farmer training.

Government assists in numerous ways to farmers, traders and exporters to upgrade processing facilities to increase quality of products as well as to establish and upgrade value addition facilities. Department of Export Agriculture, Export Development Board, Industrial Development Board and Ministry of Industry and Commerce has implemented a number of assistance schemes and provide cash grants and needed technical advice. Many local banks to operate soft loan schemes to assist new cultivations of spices and to upgrade quality of processing facilities and VA facilities. Also there are other local and international NGO support farmers, traders and processors in numerous ways. However it was noted that only a small percentage of traders and collectors take the advantage of such schemes and they prefer to work on traditional way.

The Export Development Board and Ministry of Primary Industries organize different programs to increase market exposure of exporters and to establish market links. For that they organize trade exhibitions and facilitate exporters to attend international trade exhibitions and trade forums.

With all such mechanisms there are inherited problems in Sri Lankan spice Industry which affect on hindering expected growth. Unlike other export crops in Sri Lanka there is no proper regulatory mechanism and players in value chain have the freedom to act individually with their own desires. It has become a problem to implement quality assurance mechanism in the country and assure traceability and transparency of the trade. Since the value chain players have responsibility to any agency they are scattered and no strong links have been established, resulting a weak value chain with poor forward and backward linkages. Because of that dynamic market information is not adequately passing to low level segments such as farmers and traders and they have poor knowledge on international market requirements

Key developments and Strategies for Benefitting Spice Crop Economy in the Respective Country and South Asia

World Bank project/EU project

The World Bank has offered a concessionary loan to strengthen value chains of primary industries in Sri Lanka and under that two projects are implemented by Ministry of Primary Industries and Ministry of Agriculture. The project implemented by the Ministry of primary Industries support farmers traders, processors and Value Added Product producers in Spice sector through cash grants and giving bank guarantees for soft Loans.

European Union has approved a grant to facilitate export trade in Sri Lanka and it has supported Sri Lankan spice exporters through cash grants, market exposure and foreign training directly, through trade Chambers and Export development Board.

National Export Strategy of EDB

Under the directive of the government, the Export development Board is in the process of formulating a National Export Strategy, including spices, to reach 10 billion export earnings by 2020. It has addresses all fundamental problems ranging from production to exports and suggests government needed actions within a given time frame.

Trade agreements with India/Pakistan and more to come (discussions are on the way for FTA with China and Vietnam)

Sri Lanka has already have signed Free Trade Agreements with India and Pakistan and benefitting in numerous ways with regard to spices. Also SL government is planning to sign a free trade agreement with China in future and expecting to reap huge benefits from such giant country. It was expected huge benefits for spice sector by opening up of Chinese market where a large high and middle level population who enjoys spicy foods.

Way Forward

- Ginger - to become self sufficient by 2016
- Turmeric - to become self sufficient by 2018
- Pepper - to become the second largest exporter in the world by 2020
- Introduce EACs to plantation sector in a large scale
 - Year 2016 – “Year of Coffee”
- Introduction of EACs to non-traditional areas.
- Need to revise Standards to comply with the international market requirements and standards
- Strengthen market promotion activities and giving due recognition for the Sri Lankan quality
- Investment assistance for the stakeholders to invest in cultivation, processing and value addition. Ex; soft loans, tax concessions etc.
- Strengthen public & private sector partnership

Conclusion

The major aim of this spice sector in SAARC countries is enhancement of export earnings through productivity improvement, quality improvement and value addition. At present this sector has become more risky due to climatic change and extreme weather conditions. In this context most important factor is to diversify the value addition.

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Successful Spice Value Chain Development Technologies in South Asia: Strategies for Achieving SDGs

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Abstract

International Standard Organizations (ISO) has defined spices as "Any of the aromatic vegetable products used in cooking, seasoning and preserving the foods". In a simple definition "Spices are natural products of plant origin, used primarily for flavoring, seasoning or adding pungency and flavor to foods and beverages (Ferrell, 1985). Dry parts of aromatic plants such as bark (cinnamon), rhizome (ginger, turmeric), leaf (cinnamon leaf and mint), berry (black pepper), flower bud (clove), stigma (saffron), fruit (Nutmeg), seed (cumin) and resinous exudates (asafetida, hing) are the representative examples and have been considered as spices in the international spice trade. Majority of spices are grown in tropical to sub-tropical but some spices (saffron, black cumin and *Allium hysistum* (Jimmu) are grown in temperate climates. Of the 109 spices listed by the ISO, India grows 52 spices (Ravindran, 2006) and about 31 spices grow in Nepal either *in-situ* or in cultivated conditions (Sharma, 2013 and Pandey, 2017). Bangladesh grows 20, Bhutan 20, Pakistan 52, Maldives 8 and Sri-Lanka more than 10. Afghanistan leads only in Saffron. South Asia has diverse soil and climate & several agro- ecological regions from Sri-Lanka to Nepal and Bhutan which provides the Opportunities to grow a variety of spice crops. Both monsoon and Mediterranean winter rain favors South Asia for varieties of spice production. Charaka, and Susrutha mentioned the use of pepper in 1550-600 BC as medicine. The ancient Epic Ramayana mentions about cloves. The cinnamon and black pepper trade trace back to 2000 BC between South Asia and Middle East. Black pepper trade with China from Malabar Coast between 8th to 12th centuries. Vasco de Gama discovered the sea route to India and arrived at Calicut India in 1498 and traded spices. Alvares Cabral landed in Calicut and established spice trade with Portugal in 15th century. British East India Company started spice trading in 16th century and the French came for spices trade 1700-1800 and America entered the pepper trade 1795-1800. Presently, spices from South Asia gaining popularity especially from India, Pakistan, Bangladesh and Sri-Lanka in the western world and branded and high quality spices are in demand. South Asia has great opportunities to increase production and marketing of spices, however SAARC have to make certain policy change and strategies for joint and collaborated development. Center for

Environmental and Agricultural Policy Research, Extension and Development (CEAPRED)¹ has been contributing in spice crop development since its establishment during nineties.

Keywords: Ginger, cardamom, chili, in-situ, spices, ecology, sea route, spice trade

Introduction

International Standard Organizations (ISO) has defined spices as "Any of the aromatic vegetable products used in cooking, seasoning and preserving the foods". In a simple definition "Spices are natural products of plant origin, used primarily for flavoring, seasoning or adding pungency and flavor to foods and beverages (Ferrell, 1985). Dry parts of aromatic plants such as bark (cinnamon), rhizome (ginger, turmeric), leaf (mint), berry (black pepper), flower bud (clove), stigma (saffron), fruit (Nutmeg), seed (cumin) and resinous exudates (asafetida, hing) are the representative examples and have been considered as spices in the international spice trade. Majority of spices are grown in tropical to sub-tropical but some spices (saffron, black cumin and *Allium hypsistum* (Jimmu) are grown in temperate climates.

Spices in South Asian Agriculture

South Asian Association for Regional Cooperation (SAARC) includes eight countries (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri-Lanka). All these eight countries together have a land of extreme and wonder with their topography and agro-climatic variability and cultural diversity. Among them Afghanistan, Bhutan and Nepal are land locked; all other countries have opened to sea route. Altitude varies from seashore to Mount Everest 8848 Meter in Nepal. Almost all types of world climate and a wide range of bio-diversity exist in south Asia. The International Standard Organization (ISO) listed 109 types of spices grown in the world. Among them almost all types of spices are grown in one or other south Asian countries. The major spices and total number of spices grown in SAARC countries is presented in Table 1.

¹ Center for Environmental and Agricultural Policy Research, Extension and Development (CEAPRED) is a NGO (civil society) established in April 23, 1991. It works for poverty reduction and for economic development with National and International partners of public and private sectors. CEAPRED's objectives are to contribute to reduce poverty, enhance food security, and empower women, deprived and disadvantaged communities in Nepal. Its areas of actions include; Poverty Reduction and Livelihood Enhancement, Sustainable Ecosystem and Environment Management and Action/Policy research CEAPRED involved in spice crop development since its establishment in 1990. During 1992 to 94 it promoted cardamom and ginger cultivation in Eastern Nepal. It also promoted and integrated onion, garlic, chili and turmeric as spice in commercial vegetable production in Central and Western Nepal. It promoted ginger and *Zanthoxylum armatum* (Timmur) in mid-western region for export promotion. Presently it is promoting safe production of ginger, turmeric, onion, garlic, chili etc. for climate resilience adaptation in Central region of Nepal

Table1. Number of Spice Crops Grown in SAARC countries

Countries	# of spices grown	Major spices
Afghanistan	4	(1) Saffron
Bangladesh	20	(6) Onion, Chili, Turmeric, Ginger, Garlic and Coriander
Bhutan	20	(4) Cardamom, Chili, Ginger and Turmeric
India	52	(30) Cardamom (Large and Small), Black Pepper, Chili, Ginger Turmeric, Coriander Cumin, Fennel, Fenugreek Celery , Aniseed , Ajowan, Cinnamon, Garlic, Curry leaf, Mint, Mustard, Saffron , Vanilla, Tejpat, Pepper Long , Clove, Asafoetida, Nutmeg, Mace, Basil, Horse Radish, Star Anise, Bay Leaf and Tamarind.
Maldives	8	chili
Nepal	31	Ginger, Large Cardamom, Turmeric, Onion, Garlic, Chilies, Coriander, Fennel,
Pakistan	52	NA
Sri-Lanka	20	(10) Cinnamon, Black Pepper, Cardamom (Large and Small), Chili, Clove, Nutmeg, Vanilla, Turmeric, Ginger,

Source: Papers presented by respective countries in Regional Expert Consultation Meeting at Kerala, India September 2017

From the above table it is evident that Saffron and dry fruits are the major spices grown in Afghanistan, Bangladesh grows 20 spices with six majors, Bhutan grows 20 with cardamom and ginger major, India grows 52 types (Detail in Annex 1) with 30 major, Maldives grows eight types with chili major, Nepal grows 31 types with eight majors (Details in Annex 2), Pakistan also grows 52 types similar to India and Sri-Lanka grows 20 with 10 majors.

In South Asia the existence of spices are in conditions 1) under naturally grown as *in-situ*, 2) *in* back yard for home consumption and 3) commercial cultivation for domestic and export market. Cereal food crops are the main sources of carbohydrates and priority has been given to the cereals and other alternative carbohydrate sources like vegetables, pulses and fruits in SAARC countries. Production area, production volume and productivity compared to cereals spices have very low, however, amount of spices in our daily foods which provides high calories and health care. Area and production of spice crops in SAARC countries during 2016-17 is presented in Table 2.

Table 2. Area and production of spice crops in SAARC countries during 2016-17

Countries	Areas (ha) % of Total cultivated area	Production (MT)
Afghanistan	2588 (0.03%)	6.08
Bangladesh	374,000 (0.3%)	2,410,000
Bhutan	5509 (3.36%)	10,873
India	3,535,680 (1.6%)	7,075,880
Maldives	NA	NA
Nepal	81,807 (1.7)	738,489
Pakistan	NA	NA
Sri-Lanka	118,670 (NA)	83069

Source: Papers presented by respective countries in Regional Expert Consultation Meeting at Kerala, India September 2017

Though, area allotted to spices is very small compared to cereals and other horticultural crops, the value of spices are quite high compared to cereals and other horticultural crops.

Spices in South Asian Food Culture

Consumption of spices is increasing with the increase in population and improvement of livelihoods and wellbeing of the people. South Asian people use many indigenous and imported spices on daily basis. Some special spices are used at week's intervals or at special social functions as a part of food culture. Spices are used in various forms and ways, pickles (peppers, garlic, ginger, chilies), as preservatives (Clove, black pepper, mustard seeds/powder), for coloring agent and for special taste (turmeric, chili, saffron), spice oils (ginger oils) for the preparation of soft drinks and the oleoresins obtained from black pepper, ginger, capsicum, turmeric, fenugreek and cardamom are used for pungency, flavor and aroma in both vegetative and non-vegetative food items and food processing industries. The main flavoring effect in many spices is aroma, flavor special taste and pungency. The use and methods of use differs in different castes and ethnic groups. Whatever the differences, it is clear that spices are indispensable to the South Asian way of life. Spices are the important ingredients in continental food preparation consumed by all classes of people in one or another way. Many spices have antimicrobial properties and used to prevent food items from bacterial attack. This may explain why spices are more commonly used in warmer climates which have more infectious diseases, and why the use of spices are more prominent in meat, which is particularly

susceptible to spoiling. Spices are sometimes used in medicine, religious rituals, cosmetics or perfume production. Some spices like onion, garlic and chili used as vegetables also.

Common Spices of South Asia

The common spices used by most South Asian kitchen include as primary spices are turmeric and chili powder and added salt. Among spices chili, ginger, onion and garlic are mostly indigenous. Inter-traded spices include fenugreek, cumin seed, black pepper, nutmeg, saffron etc. Among many seasoning varieties of spices at hand is the popular and favorites Garam Masala (A pack of hot spices), a mixture of a dozen of spices used to flavor many dishes, especially meat. Garam Masala contains equal quantities of cumin seeds, coriander, black pepper, small and large cardamom and cinnamon, bay leaf, clove and nutmeg. It is popular in all SAARC countries (Annex 3).

Traditionally, Nepalese households used to by whole spices separately and used to grind in the kitchen itself depending on the types of curries. The separate spice ingredients in a common kitchen kit is kept and used in curries and meat as per the family taste. The spice market in South Asia also resembles each other except some local specialties. Four major countries, India, Pakistan, Bangladesh and Sri-Lanka have large spice market within SAARC and even in abroad.

Agro-climatic Diversity to Grow Various Spices in South Asia

As South Asian countries have highly diversified soil and several agro-ecological regions from Sri-Lanka to Nepal, such different micro climates are favorable to grow several species of spices. As a result of climatic diversification, diversified spice species are grown and can be promoted for international trade. Different countries have Opportunities to grow low volume and high value spice crops to bulky ginger and turmeric, e.g. high rain falls and humid areas of Bangladesh, Bhutan, India (North east) and Nepal for ginger, cardamom, and turmeric production. Mild temperature and medium rainfall areas are for chili, onion, garlic and cinnamon leaf production. Similarly hot tropical areas south India and Sri-Lanka are more suitable for black pepper, cinnamon, cumin, nutmeg production. Cool dry area of Afghanistan and North West India for saffron cultivation.

Production Technologies of Major Spices in SAARC countries

Area and production status of commonly use spice crops (Cardamom (small and large), Ginger, Turmeric, Black pepper, and Cinnamon are described in detailed in respective country papers including production technology, post-harvest handling, processing, value addition and storage

of spices. This paper is general policy paper and need not to repeat all technologies here.

History of Spice Trade in SAARC Countries

Charaka, Samhita and Susrutha Samhita mentioned the use of pepper in 1550-600 BC as medicine. The ancient Epic Ramayana mentions about cloves as medicine. The cinnamon and black pepper trade between South Asia (especially Sri-Lanka and India) and Middle East trace back to 2000 BC. The recorded history of Black pepper trade with China from Malabar Coast between 8th to 12th centuries is also available. Vasco de Gama discovered the sea route to India and arrived at Calicut India in 1498 and traded spices with Spain and other European countries. Alvares Cabral landed in Calicut and established spice trade with Portugal in 15th century. British East India Company started spice trading in 16th century and the French came for spices trade between 1700-1800 century and America entered in the pepper trade during 1795-1800. These are the historic evidences of black pepper trading from south Indian continent to the middle-east, China and European countries. There was also trade with Tibet from Nepal, Bhutan and the then Skkim for chili, garlic and other spices imported from South Asia.

Spice Trade among SAARC Countries and Abroad

Diverse food and spices use depending on ethnicity and climate within SAARC countries is increasing. Due to globalization, food diversity and spices use is increasing within SAARC countries also. Nepal exports ginger, cardamom, turmeric and cinnamon leaves mainly to India and other SAARC countries. Bhutan exports her cardamom and ginger to India and Bangladesh. Nepal imports clove, nutmegs, saffron, cumin seed, black pepper etc. mainly from India, Bangladesh, Pakistan and Sri-Lanka. Some dried spices imported from India and other SAARC countries.

Presently, branded and high quality spices from South Asia especially from India, Pakistan, Bangladesh and Sri-Lanka gaining popularity in the western world and are in demand. South Asia has great opportunities to increase production and marketing of spices. Dried ginger, cardamom, ginger oil and many other spices from SAARC countries exported to EU, USA, Arabian countries and Japan, however SAARC have to make certain policy change and strategies for joint and collaborated development of all member countries. Thus, Spices play important roles in intra, inter and International trade among SAARC and beyond SAARC countries.

Constraints of Spice Production in SAARC

There are different types of constraints in quality spice production in SAARC countries. These can be summarized as follows:

Biotic Constraints:

- Many diseases and pests e.g. Foot rot disease of black pepper, Rhizome rot of ginger, viral diseases of Cardamom etc. are impeding the quality production and also reducing the yield.
- Spices like cardamom, ginger, and turmeric are vegetative propagated limiting the genetic variability in varieties. However India has succeeded in sexually propagation and hybrid breeding in turmeric and other important spices.
- Some spices like nutmeg are dioecious and need both male and female plants to be planted maintaining proper ration and spacing. Farmers of new area if not informed properly the expected yield may not be obtained.
- Similarly in vanilla artificial pollination is needed and which is cumbersome job.

Abiotic Constraints

- Spices are delicate plants. Exogenous natural factors such as drought, flood, fire, storm, soil toxicity may affect both growth and yield drastically.

Socio-economic Constraints

There are some socio-economic constraints in spice crop promotion such as:

- Quality control during production, harvesting and post-harvest handling.
- High cost of production with greater risk of crop failure.
- Competition with other economic crops or synthetics in the markets.
- Lack of labor and low capital investment in spice researches in member countries are also constraining to develop spices to the desired extent in some member countries like Nepal.

Technological Constraints

In technological constraint, there are following conditions:

- First, whatever the technologies are developed in research stations are not properly transferred to the farmer's field.

- Second lack of technologies itself e.g. development of superior varieties, improved cultural practices and processing technology etc.

Key Policy Input for Enhancing Domestic Production and International Trade of Spices in South Asia

SAARC was established for regional cooperation to combat the poverty and backwardness of the region jointly. The one of the aim of the SAARC is in the field of agriculture also to share the knowledge and technology of one member state with another member state. Some progress has been made in this direction, however still not sufficient. That is the endeavors are on. There are still some policy issues those have to be resolved politically for the common benefit of the SAARC countries. Favorable and conducive policies in the following aspects must be agreed and adopt among the members countries;

- Collaborative and coordinated technology generation research and germplasm exchange freely among SAARC members.
- Harmonization in import and export taxing policy among members to promote international trade of spices of South Asia.
- Common and better Sanitary and Phytosanitary (SPS) compliance and export promotion of spices.
- Each country prepares authentic documentation of indigenous spice bio-diversity and conserve them preventing misuse of bio-diversity of one country by other countries.
- Adequate attention on Intellectual Property Rights and Traditional Knowledge related to indigenous spices must be agreed upon.
- SAARC Member States must stand jointly maintaining national identity for international trade of SAARC spices to developed countries

Key Development Strategies for Benefitting SAARC Countries through Spice Crop Industry

To harness the full benefit from spice industry by SAARC member countries the regional complementarities and collaborations must be enhanced with the following strategies;

- Sharing of Good Agricultural Practices and knowledge gained and developed by one member country with others through a common information center which could be established as one unit in SAARC Agriculture Center (SAC).
- There are established spice related institutional set up in each member countries, strengthen and harmonize the existing mechanisms for better collaboration.

- Conduction of coordinated research among member countries to exploit the agro-ecological advantages and develop suitable technology has to be implemented to harness common benefit.
- Exchange of experts and sharing of technologies developed in respective countries for common benefit.
- Enhance SAARC spice economy developing special SAARC brand of respective member countries and sale to the developed countries.

Common Challenges in Spice Crop Development

There are several common challenges in spice crop development in the region which can be tackled jointly.

- Climate change is a global phenomenon (erratic weather conditions) and SAARC countries may work together to resilient climate change impact.
- Fragmented land, small holdings, steep slopes increases the cost of production and pose marketing challenge to be cost competitive.
- Assembling spices to make marketable volume from a large number of small holder producers make difficult to maintain quality and to adopt branding and continue sustainability. For this grouping of producers and affiliate them to cooperatives and adopt internal quality control mechanism by producer themselves may be adopted.
- Third party guarantee to check adulteration is another challenge.
- In SAARC countries agriculture in general is considered as low dignity job and educated people go away from agriculture and production is left with poor and uneducated persons.
- Competition from growing imports of cheaper items is another challenge.

Opportunities of SAARC in Spice Crops

Spices have high value compared to traditional crops and play important and unique role in SAARC countries to improve the income of the rural people and also marginal farmers. It is a labor intensive crop and generates lot of employment opportunities. On the other hand, the demands of spices are increasing in domestic market as urban population is increasing with higher disposable income. In other countries (USA, Australia, UK, and EU) also the demand of SAARC spices are increasing. Migrants from South Asia are promoting spices in abroad. They are carrying SAARC taste to those countries where food preparations are dull and plain. Hence SAARC has good scope to meet the world demand by increasing production and post-harvest management and improving quality and packaging with SAARC brand.

Technologies are available for enhancing production (crop intensity, yield) & reducing post-production losses). Commercialization in areas with high potential can be increased by increasing investments in irrigation & farm mechanization. The opportunities are also high for promoting Organic Farming, Branding for premium price. Engaging and increasing private sector involvement – Contract farming, PPP & international collaboration. Exploiting huge export potential – assured market in abroad as their food habit is changing towards spicy food of SAARC taste

Way Forward

The following 10 action points have been identified as way forward

1. Data on area, production, yield and production cost of most spices crops in SAARC countries are misleading; each member country should updated these basic data based on ground reality using modern tools and technology.
2. Joint venture, increased investment on variety development, production technology generation, post-harvest management in coordination among member countries.
3. Production and distribution of quality planting materials and improvement in service delivery for commercialization.
4. To promote international trade as SAARC product explore possibilities of value-addition and agri-business promotion of SAARC spices.
5. Protect farmers with minimum support price based on cost of production.
6. Develop inventory of all in-situ and ex-situ spices of respective countries jointly and Analyze DND printing and maintain record in common portfolio at SAC.
7. Assess quality and medicinal aspect of all spices of SAARC and share among member countries.
8. Establish common gene bank of SAARC spices and assessable to research institutions of both public and private sectors.
9. Conduct collaborative and coordinated R&D among SAARC both in Public and private sector.
10. India is the lead in research and technology generation in spices and should lead and continue cooperation to the prosperity of SAARC spices in all member countries.

Strategies for Achieving Sustainable Development Goal through Spices in South Asia

The Sustainable Development Goals (SDGs), otherwise known as the Global Goals, are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. There are 17 Goals build on the successes of the Sustainable Development Goals, while including new areas such as climate change, economic inequality, innovation, sustainable consumption, peace and justice, among other priorities. The goals are interconnected – often the key to success on one will involve tackling issues more commonly associated with another.

The SDGs work in the spirit of partnership and pragmatism to make the right choices now to improve life, in a sustainable way, for future generations. They provide clear guidelines and targets for all countries to adopt in accordance with their own priorities and the environmental challenges of the world at large. The SDGs are an inclusive agenda. They tackle the root causes of poverty and unite us together to make a positive change for both people and planet. “Poverty eradication is at the heart of the 2030 Agenda, and so is the commitment to leave no-one behind.” The Agenda offers a unique Opportunities to put the whole world on a more prosperous and sustainable development path.

Out of 17 SDGs the four major goals; No Poverty (Goal 1) Zero Hunger (Goal 2), Climate Action (Goal 13) Life on Land (Goal 15) and Partnerships for the Goals (the Goal 17) are the prime goals related to agriculture and livelihood.

End of Poverty in all its Forms- Everywhere by 2030 is the main target of this goal. Extreme poverty has been cut by more than half since 1990, however; more than 1 in 5 people live on less than \$1.25 a day. Increase the income and improve food security and quality of life or improve livelihood are the basic target of SDG Goal 1 and Goal 2. The root cause of poverty is not only lack of income or resources- it includes lack of basic services, such as education, hunger, social discrimination and exclusion, and lack of participation in decision making. Gender inequality plays a large role in the perpetuation of poverty and its risks. They then face potentially life-threatening risks from early pregnancy, and often lost hopes for an education and a better income. Age groups are affected differently when struck with poverty; its most devastating effects are on children, to whom it poses a great threat. It affects their education, health, nutrition, and security. It also negatively affects the emotional and spiritual development of children through the environment it creates

How can spice crop production and marketing contribute in alleviating poverty and increase food security and eradicate hunger is the basic concern. As we know, the spices are high value crops and fetches better price compared to traditional crops and increase income at least by 3 fold. This increased income can buy food items stuffiest for family for a year and also save money for health, education and other family welfare.

However, urgent action on Goal 13 to combat climate change and its impacts by regulating emissions and promoting developments in renewable energy and increasing is another task associated with poverty reduction and food security. Annual, biannual and perennial spices planted in systematic way can contribute to reduce climate change effect and also help in increasing income and protect environment.

The Goal 15 states to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss. This can be achieved by collaborating in huge plantation of economic spices wherever possible in the member countries.

The SDG Goal 17 is the most important and imperative to the SAARC countries for strengthen the means of implementation and revitalize the regional partnership for sustainable development.

To achieve the Sustainable Development Goals mobilizing the vast number of farmers and stakeholders involve in spice production and trade; the following three pronged strategies adopted by CEAPRED in Nepal are suggested among SAARC countries.

1. Prepare and aware farmers about spice economy through strong and practical Social Mobilization.
2. Develop the capacity of farmers and stakeholders to undertake and adopt the developed technology.
3. Institutionalize sustainable spice crop development at farm and farmers level promoting group/cooperative actions for volume production and quality assurance introducing internal quality control system and technology led development. As a regional cooperation;
 - The climate change and the resultant impact is tackled jointly
 - The global and regional economic differences are addressed judicially
 - Promote coordinated approach at national and regional level for economic strength in the sense of “stability” increasing investment

Conclusion

SAARC member countries have developed many successful value chains in major spice crops. Let us adopt, share and spread Good Agricultural Practices and technology developed by each member country among ourselves. Let us work with the motto of, “Each for all and all for each”.

While forming SAARC during 1985, some westerners commented it as **“Poor men's Club”**. However, now we are able to answer them with our strong collaboration and cooperation and let us send them high quality spices proving our prosperity. Greeting them standing on equal footing and conveying that SAARC has come up from “Poor men's club” to prosperous club.

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Annex 1: Spices Grown In India
(Spices under the Purview of The Spices Board)

English Common Name	Botanical Name	Family Name	Partused As Spice
1. Cardamom (Small)	<i>Elettaria cardamomum</i> Maton	Zingiberaceae	Fruit,Seed
Cardamom (Large)	<i>Amomum subulatum</i> Roxb.	Zingiberaceae	Fruit,Seed
2. Pepper	<i>Piper nigrum</i> L.	Piperaceae	Fruit
3. Chilli,			
Bird's Eye	<i>Capsicum frutescens</i> L.	Solanaceae	Fruit
Capsicum	<i>Capsicum annuum</i> L.	Solanaceae	Fruit
Chilli	<i>Capsicum annuum</i> L.	Solanaceae	Fruit
Paprika	<i>Capsicum annuum</i> L.	Solanaceae	Fruit
4. Ginger	<i>Zingiber officinale</i> Rosc.	Zingiberaceae	Rhizome
5. Turmeric	<i>Curcuma longa</i> L.	Zingiberaceae	Rhizome
6. Coriander	<i>Coriandrum sativum</i> L.	Apiaceae	Leaf & Fruit
7. Cumin	<i>Cuminum cyminum</i> L.	Apiaceae	Fruit
8. Fennel	<i>Foeniculum vulgare</i> Mill.	Apiaceae	Fruit
9. Fenugreek	<i>Trigonella foenum-graecum</i> L.	Fabaceae	Seed
10. Celery	<i>Apium graveolens</i> L.	Apiaceae	LeafFruit,&Stem
11. Aniseed	<i>Pimpinella anisum</i> L.	Apiaceae	Fruit
12. Ajowan	<i>Trachyspermum ammi</i> L.	Apiaceae	Fruit
13. Caraway	<i>Carum carvi</i> L.	Apiaceae	Fruit
14. Dill	<i>Anethum graveolens</i> L.	Apiaceae	Fruit
15. Cinnamon	<i>Cinnamomum zeylanicum</i> Breyn	Lauraceae	Bark
16. Cassia	<i>Cinnamomum cassia</i> .Blume	Lauraceae	Bark
17. Garlic	<i>Allium sativum</i> L.	Alliaceae	Bulb
18. Curry leaf	<i>Murraya koenigii</i> (L) Sprengel	Rutaceae	Leaf
19. Kokam	<i>Garcinia indica</i> Choisy	Clusiaceae	Rind
20. Mint	<i>Mentha piperita</i> L.	Lamiaceae	Leaf
21. Mustard	<i>Brassica juncea</i> L.Czern	Brassicaceae	Seed
22. Parsley	<i>Petroselinum crispum</i> Mill.	Apiaceae	Leaf
23. Pomegranate	<i>Punica granatum</i> L.	Punicaceae	Seed
24. Saffron	<i>Crocus sativus</i> L.	Iridaceae	Stigma
25. Vanilla	<i>Vanilla planifolia</i> Andr.	Orchidaceae	Pod
26. Tejpat	<i>Cinnamomum tamala</i> (Buch Ham)	Lauraceae	Bark &Leaf
	Nees & Eberum		
27. Pepper Long	<i>Piper longum</i> L.	Piperaceae	Fruit

English Common Name	Botanical Name	Family Name	Partused As Spice
28. Star Anise	<i>Illicium verum</i> Hook.	Illiciaceae	Fruit
29. Sweet flag	<i>Acorus calamus</i> L.	Araceae	Rhizome
30. Greater Galanga	<i>Alpinia galanga</i> Willd.	Zingiberaceae Rhizome	
31. Horse Radish	<i>Armoracia rusticana</i> Gaertn.	Brassicaceae	Root
32. Caper	<i>Capparis spinosa</i> L.	Capparidaceae	Flower buds
33. Clove	<i>Syzygium aromaticum</i> (L) Merr.& Perry	Myrtaceae Unopened	
34. Asafoetida	<i>Ferula asafoetida</i> L	Apiaceae	Flower bud Oleogum resin from rhizome and thickened root
35. Camboge	<i>Garcinia cambogia</i> (Gaertn).Desr	Clusiaceae	Rind
36. Hyssop	<i>Hyssopus officinalis</i> L.	Lamiaceae	Leaf
37. Juniper berry	<i>Juniperus communis</i> L.	Cupressaceae	Berry
38. Bay Leaf	<i>Laurus nobilis</i> L.	Lauraceae	Leaf
39. Lovage	<i>Levisticum officinale</i> Koth.	Apiaceae	Leaf&Stem
40. Marjoram	<i>Marjorana hortensis</i> Moench.	Lamiaceae	Leaf
41. Nutmeg	<i>Myristica fragrans</i> Houtt.	Myristicaceae	Seed
42. Mace	<i>Myristica fragrans</i> Houtt.	Myristicaceae	Aril
43. Basil	<i>Ocimum basilicum</i> L.	Lamiaceae	Leaf
44. Poppy seed	<i>Papaver somniferum</i> L.	Papaveraceae	Seed
45. Allspice	<i>Pimenta dioica</i> (L) Merr.	Myrtaceae	Fruit & Leaf
46. Rosemary	<i>Rosmarinus officinalis</i> L.	Lamiaceae	Leaf
47. Sage	<i>Salvia officinalis</i> L.	Lamiaceae	Leaf
48. Savory	<i>Satureja hortensis</i> L.	Lamiaceae	Leaf
49. Thyme	<i>Thymus vulgaris</i> L.	Lamiaceae	Leaf
50. Oregano	<i>Origanum vulgare</i> L.	Lamiaceae	Leaf
51. Tarragon	<i>Artemisia dracunculus</i> L.	Asteraceae	Leaf
52. Tamarind	<i>Tamarindus indica</i> L.	Caesalpiniaceae	Fruit

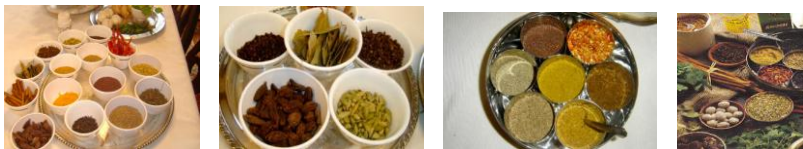
Annex 2: List of spices Crops Grown in Nepal and Parts used as Spices

S. No	English Name	Nepalese Name	Scientific Name	Parts used
1	Ajoin/Lavage/	Jwano	<i>Trachyspermum ammi L</i>	seed
2	Asafetida	Hing	<i>Ferula asafoetida L</i>	exudate
3	Black Caraway	Himalijeera	<i>Bunium persicum Boss</i>	seed
4	Cardamom (large)	Alainchi	<i>Amomum aromaticum Roxb</i>	seed
5	Cardamom (Small)	Sukumel	<i>Elettaria cardamomum Roxb</i>	seed
6	Cumin seed	Jeera	<i>Cuminum cyminum</i>	seed
7	Cumin (Black)	Kalojeera	<i>Nigella sativa L</i>	seed
8	Cinnamon bark	Dalchini/Tejpat	<i>Cinnamom tamala Nees&Ebern</i>	leaves & bark
9	Coriander	Dhaniya	<i>coriandrum sativum</i>	leaves & seed
10	Coriander (wild)	Barmeli dhaniya	<i>Eryngium foetidum L</i>	leaves
11	Chili	Khursani	<i>Capsicum frutesense L</i>	fruits
12	Clove	lwang	<i>Syzygium aromaticum L</i>	flower bud
13	Dill	Nepali sonf	<i>Anethum graveolens L</i>	seed
14	Fennel	Madhesi sonf	<i>Foeniculum vulgare Mill</i>	Seed
15	Fenugreek	Methi	<i>Trigonella foenumgraecum L</i>	seed
16	Garlic	Lasun	<i>Allium sativum L</i>	clove
17	Ginger	Aduwa	<i>Gingiber officinale Posc</i>	Rhizome
21	Himalayan caraway	Bhotejeera	<i>Carum bulbocastanum</i>	Seed
22	Mint (common)	Pudina	<i>Mentha aquatic L</i>	leaves
23	Nepal Pepper	Timur	<i>Zanthuzylun armatum DC</i>	Fruit
24	Onion	Pyaj	<i>Allium cepa L</i>	bulb
25	Pepper (black)	Marich	<i>Piper nigrum L</i>	Seed
26	Pepper (long)	Pipla	<i>Piper longum L</i>	seed
27	Pepper (Betel)	Pan	<i>Piper betel L</i>	leave
28	Perilla	Silam	<i>Perrila frutescens L</i>	Seed
29	Purple timur	Nepali timur	<i>Zanthoxylum nitidum L</i>	seed
30	Saffron	Keshar	<i>Crocus sativus L</i>	stigma
31	Turmeric	Besar	<i>Curcuma longa L</i>	Rhizome

Annex 3: Photographs



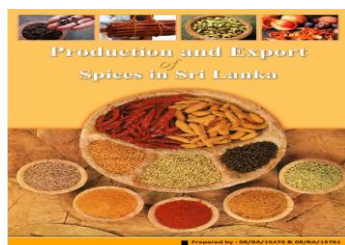
Picture 1: A scene of readymade spices selling in the common Nepalese market
(Source: Google search)



Picture 2: A scene of ready to use spices in the normal kitchen
of Nepalese households
(Source: Google search)



Picture 3: A scene of readymade spices selling in the common Indian market
(Source: Google search)



Picture 4: A scene of readymade Sri-Lankan spices
(Source: Google search)



Picture 5: A scene of spices selling in the common Bangladesh market
(Source: google search)

Available form of spices in Bangladesh



- Raw and dust are common form for the end user
- Recent days some company introduced in the packet form, also exporting

18



Picture 6: Spices in Bhutan market and kitchen (Google search)

Proceedings of the SAARC Consultative Meeting on Technology Sharing of Spice Crops held during 11- 13th September 2017 in Kerala, India

Background

Agriculture has played a central role in the economies of South Asian countries. Over two-thirds of the population still depends on it for a living, and it accounts for nearly one-third of the region's exports. Such major problems as food shortages, rural unemployment, and social, economic and political discontent are directly related to the agricultural systems. In statistical terms, the region occupies a major position in the world in several agricultural commodities including with spice crops.

Spices are important essential condiments in the SAARC countries. There are many spice crops commonly grown in the region. Among the crops, onion, garlic, ginger, chilies, turmeric, coriander, cumin, cardamom, cinnamon, black pepper etc. are more important. The total demands of these spices are increasing among the SAARC countries as well as outside the SAARC countries. Among the SAARC Countries, India holds an important position in the production of such commercial crops as spices, bananas, tobacco, oil seeds, and cotton. Significant progresses in Research and Development on these crops have been made by SAARC member countries. In addition to domestic consumption, these crops also have high export potential. Sharing of production and post-harvest technologies are important for development, improvement and marketing of these crops. Thus, documentation of production and post-harvest handling, processing and storage of spices would be mutually beneficial to each member country. Considering these aforementioned facts, three days Regional Expert Consultation Meeting for Technology sharing of spice crops in SAARC Countries was held during 11 to 13 September 2017 with following objectives.

Objectives of the Meeting

1. Sharing of information on production technology, post-harvest handling, processing, value addition and storage of spices for mutual benefit of SAARC Member Countries.
2. Key policy input for deploying strategies aimed at strengthening of spice value chains and enhancing international trade.
3. To document and collate key developments and strategies in the member states for benefitting spice crop economy in south Asia.

Methodology of the Meeting

The country status paper on production, post harvest technologies and marketing of major spices of SAARC countries were prepared based on the information provided by the respective country focal points (resource persons).

Expected outputs of the Meeting

1. Publication on commonly grown Spices crops and providing policy input for Research, Agro-industry, agribusiness and trade.
2. Explore intra and inter regional spice trade and value chain development strategy among the SAARC Countries.
3. Recommendation of value chain development technology and cross border issues of spice crops and way forward for the future strategies.

Inagural Session of the Meeting

The inaugural session of the Regional Expert Consultation Meeting on “Technology Sharing of Spice Crops in SAARC Countries” started with the ICAR song. Dr. K Nirmal Babu, Director, ICAR-Indian Institute of Spices Research welcomed the august gathering of delegates from the member countries, invited guest and the participant institutions and industry representatives.

The concept, purpose and objectives of the meeting were explained by Dr. Pradyumna Raj Pandey, Senior Programme Specialist (Crops), SAARC Agriculture Centre (SAC), Dhaka, Bangladesh. In ort introduction to the programme he explained the mandate of SAC, which works in crop science, horticulture, fisheries and NRM with the mandate of giving training, capacity building and solution for challenges in Agriculture in SAARC region. In his opening remarks, he mentioned that farmers/agricultural entrepreneurs of SAARC countries have made tremendous contributions for the health and wealth of their countries. The total demand for spices is increasing among SAARC countries. India holds an important position in spice production among SAARC countries.

SAARC Agriculture Centre, Dhaka in collaboration with ICAR-IISR, India has initiated this consultation meeting for sharing of technologies of spices production and value chain management with an objective of benefitting the economy of SAARC countries by spices production and developing inter and intra regional spice trade among SAARC countries. He appreciated the efforts of Government of India, Indian council of Agricultural Research and IISR for organizing the meeting which will be beneficial for SAARC countries.

Dr. Homey Cheriyan, Director, Directorate of Arecanut and Spices Development, Ministry of Agriculture and Farmers Welfare, Government of India, in his presidential address gave a glimpse of spices scenario in India. Around 63 spices are documented in India, of which 20 are commercialized. Spices contribute 6 % of total GDP and 50 % of foreign exchange from export of horticulture produce. Other than its culinary value, he also emphasised the importance of spices as pharmaceuticals and nutraceuticals. There is an increase in productivity of spices due to improved varieties and technological interventions for the management of pest and diseases, micro irrigation etc. Though 90 % of spices are consumed domestically, the export of late has increased tremendously owing to price competitiveness and quality produce which were addressed by technologies.

In Inaugural address the Chief Guest, Dr. P Rajendran, Hon'ble Vice Chancellor Kerala Agricultural University emphasized that spices, apart from earning foreign exchange, they are the livelihood for many farmers in the country and many industries are supported directly or indirectly by spices. The issues with spices are low productivity and price volatility. Low productivity can be addressed by developing improved varieties using the strong genetic pool and biodiversity available with us. To address the issue of price volatility, farm insurance by state government, complete procurement or procurement at fair price by the government need to be set up. Varieties to address climate change, to tackle pest and diseases need to be promoted among farmers and farmers need to be empowered and trained in value addition and product diversification. He also emphasized the need to speed up policy decisions on sharing good quality planting materials among SAARC countries. Creation of seed bank, provision for exchange of planting material and corpus fund for trade issues among SAARC countries are also urgently required. The meeting ended with vote of thanks by Dr. Lijo Thomas, Scientist, ICAR- Indian Institute of Spices Research.

The first Technical Session, "Technology and Institutional Perspectives in Spices Development" was set apart for invited presentations from institutional (private sector) participants in the meeting. The objective was to sensitize the delegates and participants about latest advances in spices production, processing and value addition technologies and to introduce innovations in aggregation and institutional developments in the sector.

Likewise, second technical Session was for Country Presentations (Afghanistan, Bangladesh and Bhutan). Mr. Ferdaws Bromand, Agriculture Research Stations Coordinator, Ministry of Agriculture, Irrigation and Livestock, Afghanistan explained the possibility of introducing potential spices like large cardamom, ginger, turmeric and

cinnamon; value chain development and Research and Development on spice crops; promotion of developmental programmes in traditional spices like black cumin, asafoetida, garlic etc.; and initiation of promotional programmes on saffron cultivation.

Mr. Md. Iqbal Haque, Senior Scientific Officer (Horticulture), Regional Spices Research Centre, Bangladesh Agriculture Research Institute, Gazipur stated that, Bangladesh is a country with a very high cropping intensity of about 200% with a predominance of subsistence farming system. Ginger and Turmeric are the only major spice crops in spite of good potential of other spice crops like large cardamom and cinnamon. As well as, Ms. Tanka Maya Pulami, Senior Agriculture Officer, Agriculture Research and development Centre, Bajo, Bhutan identified critical gaps at all levels of the value chain of two major spice crops grown in the country, large cardamom and ginger and suggested interventions at different levels.

In third Technical Session, there were three Country presentations from India, Nepal, Sri Lanka and one presentation on Successful spice value chain technologies in South Asia. Dr. K. Nirmal Babu, Director ICAR Indian Institute of Spices Research spoke about the germplasm wealth of different spice crops in India, varieties released, technologies commercialized, protected cultivation, site specific nutrient management, irrigation, value addition and processing machineries. He also emphasized on adoption of high density multi species cropping system for ensuring farmers income. Likewise, Mr. Anisur Rahman Ansari, Director, Nepal Agricultural Research Council (NARC), Kathmandu, Nepal presented the status of major spice crops of Nepal like ginger and large cardamom. He explained about the local practices like removal of mother seed rhizome of ginger (Bruni) and value added product like Sutho/ dried ginger. He also urged the necessity of skill development training on tissue culture for the production of virus free planting materials in Nepal. As well as Dr. A. P. Heenkende, Additional Director General (Research) Department of Export Agriculture, Sri Lanka presented the initiatives in value chain development of spice crops like black pepper, cinnamon, ginger and turmeric. He also outlined the difference between Ceylon cinnamon and Cassia cinnamon. Pruning the black pepper standard Glyricidia four times/ year improved the black pepper yield in Sri Lanka. At the last as an independent presenter from the civil society, Mr. Indra Raj Pandey, Senior Horticulturist, Center for Environmental, Agricultural Policy Research, Extension and Development (CEAPRED) illustrated about different spice crops grown in SAARC countries. He emphasized on germplasm exchange, development of common gene bank of spices for SAARC countries and generation of collaborated and coordinated technologies. He emphasized

the need for maintaining a dynamic and current database of spice crops in SAARC countries. He expressed hope that collaborative project can be prepared between CEAPRED and ICAR-IISR for exploring the possibilities of value addition and agri business promotion in SAARC region.

During the brainstorming session all the focal point experts from member countries, invited experts from abroad, scientists from ICAR Indian Institute of Spices Research and representatives from selected private organizations and Non-governmental agencies. The participants were requested by the moderators to freely air their concerns, ideas and suggestions for improvement of the spices sector in the SAARC region. The points raised were noted down for further discussion and prioritization. Some of the key issues and suggestions aired in the brainstorming session were:

- Exchange of germplasm within SAARC countries need to be made easier through strong policy support.
- Spice crop network to be created at SAARC regional level.
- Need to involve private entrepreneurs in value chain development initiatives and research.
- The promotion of solar power in processing of spices.
- Networking and strengthening of human resource development in spices technology and research capability in SAARC countries.
- Identification of elite germplasm across all spices in SAARC countries.
- Creation of a strong spice trade network amongst SAARC nations with provision for information sharing cooperation and trade facilitation.
- Establishment of scholarships for promoting research in spices.
- Strengthening germplasm exchange between SAARC countries through mutually binding MoU's for exchange of germplasm.
- Developing common testing and research approaches against major diseases and pest in spice crops and SAC to play a more proactive role for harnessing synergies among member countries.
- Establishment of expert exchange program (more than 3 months) for the technology sharing for the SAARC countries.
- Standards of production standards need to be harmonized.
- Spice Board of India can help to establishing quality testing lab and standards among SAARC countries.

- Spice Board of India is the member of CODEX and has to leverage its expertise to develop common standards of production, processing and trade of spices and related value added products.
- More emphasis needs to be given to business planning and development for small farmers and small holder production systems.
- Value addition in small pockets through appropriate sized processing units suited to requirements.
- The need to create awareness on the necessity to maintain the hygiene and safety in the entire production process.

The issues discussed in the country presentations and the brainstorming sessions were summarized to develop actionable recommendations.

At the final stage of the brainstorming session “Policy and Technological Interventions for Spice Value Chain Development in South Asia: Priorities and Challenges” enabled the delegates to chalk out a clear strategic map and to elucidate the key elements for comprehensive improvement of spices economy in the SAARC region. While emphasizing the clear strategic advantage of SAARC region with regard to spices production in the global scenario, the meeting also identified certain concern which needs speedy redressal through creative strategies and cooperation among the SAARC Member States.

Spices Technology Exhibition

A focused spices technology exhibition was organized on the sidelines of Regional Expert Consultation Meeting on Technology Sharing of Spice Crops in SAARC Countries. The technology exhibition pavilions were housed in a fully covered structure with state of the art display facilities and stalls. The spices technology exhibition showcased the state of the art technology in spices production and processing available in the country in the focus crops. The exhibition gave equal importance to the crop production aspects and post harvest production and value chain innovations. The ICAR Indian Institute of Spices Research along with its technology licensees displayed the latest technologies available for commercialization and dissemination. The exhibition had pavilions from invited participants from private sector, cooperative sector and non-governmental organizations.

The delegates spent considerable time in the exhibition pavilions learning about the technologies and its potential applications in their respective countries. The commercial potential for expanding the user base for the technologies developed within the country, both in the public sector and private sector can create a win-win situation for the spice farmers in the SAARC region and the technology developers. The public

sector was represented in the exhibition by ICAR Indian Institute of Spices Research and Spices Board of India. Selected successful technology dissemination and value addition models were introduced to the participant delegates during the exhibition. The exhibition highlighted the potential impact of technology adoption in enhancing the quality of spice products and extracting more value out of the farm production process through creative strategies in product aggregation, marketing and value addition. The press and media gave excellent coverage for the technology exhibition and associated events.

Key Recommendation of Policy & Technological Interventions for Improvement of Spices in SAARC Countries

Goal

To develop an integrated and holistic value chain in all member countries through need based technological interventions in spices sector.

Policy

- The SAARC Member States should have a unified stand on food safety and sustainability which need to be codified through frequent dialogues and interaction.
- A spice knowledge portal needs to be set up for information and knowledge management pertaining to spices.
- Integration and harmonization of GAPs and trade policies among member countries.

Research

- Country specific researchable issues in spices need to be identified, prioritized and shared among member states to realize spill over benefits from spices research in the entire SAARC region.
- Create a research platform to address common problems in member countries and facilitate visit of experts across the SAARC countries to share their expertise.
- Pilot studies on feasibility of introducing newer spices to member countries should be undertaken.
- Immediate efforts should be taken to identify and document the intrinsic qualities of ethnic spice varieties to fetch premium price to growers.
- New research initiatives should be undertaken to establish the superiority of natural spices over synthetic ones.
- An integrated research and development project may be prepared and submitted for external funding.

Linkage

- A spice task force on technology sharing and sorting out trade related issues may be set up.
- A technology hub needs to be created for creating awareness and sharing of technologies including varieties among member countries.
- Mechanism for developing creative partnership models with industry and private sector in contract farming, value addition and processing to be promoted.
- Harmonization of Standard Operating Practices (SOP) in quality evaluation and processing.

Human Resource Development

- A Centre of Excellence in Spices may be established for human resource development and skill enhancement in a suitable location.
- Institute scholarships for post graduate and doctoral studies in spices for scholars from SAARC member countries need to be established.

Meeting Agenda

Day 1: 11 September 2017 (Monday)

Inaugural Session: Silver Jubilee Hall, ICAR-Indian Institute of Spices Research

Rapporteurs: Dr. C M Senthil Kumar/ Ms. S. Aarthi

09:30	Registration	
10:00	ICAR Song	
10:05	Welcome	Dr. K Nirmal Babu, Director, ICAR-Indian Institute of Spices Research
10:15	Concept, purpose and objectives of the meeting	Dr. Pradyumna Raj Pandey, Senior Programme Specialist (Crops), SAARC Agriculture Centre, Dhaka, Bangladesh
10:30	Presidential address	Dr. Homey Cheriyan, Director, Directorate of Arecanut and Spices Development, Ministry of Agriculture and Farmers Welfare, Government of India.
10:45	Inauguration (Lighting of lamp)	All Dignitaries
10:50	Inaugural address by the Chief Guest	<i>Dr. P Rajendran, Hon'ble Vice Chancellor Kerala Agricultural University</i>
11:10	Vote of thanks	Dr. Lijo Thomas, Scientist, ICAR-Indian Institute of Spices Research

11: 20: Inauguration of Technology Exhibition Pavilion – Smt Geetha, Principal Agricultural Officer, Government of Kerala

Group Photo Session

11:30 Tea Break

Technical Session- I: Technology and Institutional Perspectives in Spices Development

Venue: Silver Jubilee Hall

Moderators: Dr. P Rajendran, Associate Director, RARS, KAU/Dr. T John Zachariah, Principal Scientist, ICAR -IISR

Rapporteurs: Dr. N K Leela/Ms.P.Umadevi

Invited presentations from select organizations (5-10 min each)

12:00-12:45	- Spices Board- Dr. A B Remasree, Director-Research, Spices Board - Synthite Industries Ltd- Mr.Silvin/Rishal - Sami Labs Pvt Ltd- Dr. Benny Daniel - Kancor- Dr. V Shaju
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- WSSS- Fr John Choorapuzhayil

12:45 – Discussion and closing remarks

13:00

Lunch 13:00 – 14:00

Technical Session- II: Country Presentations – Set A

Venue: Committee Room, ICAR IISR

Moderators: Dr. B Remasree, Director, Research, ICRI and Dr. B Sasikumar, Head, Crop Improvement and Biotechnology, ICAR -IISR

Rapporteurs: Dr P Rajeev/Dr. E. Jayasree

14:00	Country presentation (Afghanistan)	Mr. Ferdaws Bromand Agriculture Research Stations Coordinator Ministry of Agriculture, Irrigation and Livestock Afghanistan
14:30	Country presentation (Bangladesh)	Mr. Md Iqbal Haque Senior Scientific Officer (Horticulture) Regional Spices Research Centre, Bangladesh Agriculture Research Institute , Gazipur,
15:30	Country presentation (Bhutan)	Ms. Tanka Maya Pulami, Senior Agriculture Officer, Agriculture Research & Development Centre Bajo, Bhutan
15:30	Discussion and closing remarks	

Day 2: 12 September 2017 (Tuesday)

Technical Session-III: Country Presentations - Set B

Venue: Committee Room, ICAR IISR

Moderators: Dr. S J Anke Gowda, Head, ICAR IISR Regional Station/ Dr. C K Thankamani, Head, Division of Crop Production, ICAR IISR

Rapporteurs: Dr.Sharon Aravind/ Dr. A Jeevalatha

09:30	Country presentation (India)	Dr. Kantipudi Nirmal Babu Director, Indian Institute of Spices Research Kozhikode , Kerala, India
10:00	Country presentation (Nepal)	Dr. Anisur Rahman Ansari Director Nepal Agricultural Research Council (NARC) Kathmandu, Nepal

10:30	Country presentation (Sri Lanka)	Dr. A.P. Heenkende Additional Director General (Research) Department of Export Agriculture, Sri Lanka
11:00	Successful Spice Value chain Technologies in South Asia: Strategies for Achieving SDGs	Mr. Indra Raj Pandey, Senior Horticulturist, Center for Environmental, Agricultural Policy Research, Extension and Development (CEAPRED/Nepal)
11:20	Discussion and closing remarks	
11:30	Tea break	
Brainstorming session: Policy and Technological Interventions for Spice Value Chain Development in South Asia: Priorities and Challenges		
Moderator: Dr. K. Nirmal Babu, Director, ICAR-IISR		
Facilitators: Dr. Santhosh J Eapen/Dr. J Rema/ Dr. A I Bhat/ Dr. Pradyumna R. Pandey		
Rapporteurs: Dr.C N Biju/ Dr C Sarathambal		
Lunch: 13:45 – 14:30		
Closing Session		
Chair: Dr. Homey Cheriyan, Director, Directorate of Arecanut and Spices Development, Ministry of Agriculture and Farmers Welfare, Government of India		
14:30	Welcome Summary of Technical and Brainstorming session	Dr. Santhosh J Eapen, Head, Div. of Crop Protection, ICAR-IISR
14:45	Remarks by participants	
15:00	Remarks by Chief Guest	Dr. Homey Cheriyan, Director, DASD
15:15	Certificate awarding	Dr. Homey Cheriyan, Director, DASD
15:30	Vote of thanks	Dr. Pradyumna Raj Pandey, SPS (Crops)
	High Tea/ Social Networking and sideline meetings	
19:00	Cultural Programme - <i>Flavours of the South</i>	
20:00	Conference Dinner	

Day 3 (13 September, 2017) Wednesday

07:00-18:00 hrs: Visit to spice fields and processing facilities

Field visit was in Wayanad District of Kerala, India. Wayanad is about 100 km away from Kozhikode, the host city. The participants returned to Kozhikode in the evening. Travel to Wayanad had been taken about 3 hours.

Participant List

Sl No	Name	
1	Mr. Ferdaws Bromand	Agriculture Research Stations Coordinator, Ministry of Agriculture, Irrigation and Livestock, Afghanistan
2	Mr. Md. Iqbal Haque	Senior Scientific Officer (Horticulture) Regional Spices Research Centre Bangladesh Agriculture Research Institute , Bangladesh
3	Ms. Tanka Maya Pulami	Senior Agriculture Officer, Agriculture Research & Development Centre Bhutan
4	Dr. Kantipudi Nirmal Babu	Director, ICAR Indian Institute of Spices Research Kozhikode , India
5	Dr. Anisur Rahman Ansari	Director, Nepal Agricultural Research Council Kathmandu, Nepal
6	Dr. A.P. Heenkende	Additional Director General (Research) Department of Export Agriculture, Sri Lanka
7	Dr. Pradyumna Raj Pandey	Senior Program Specialist (Crops) SAARC Agricultural Centre, Dhaka Bangladesh
8	Mr. Indra Raj Pandey	Senior Horticulturist (Vegetable and Spice Crop specialist), CEAPRED Foundation, Kathmandu, Nepal

Coordinators:

1. Dr. Pradyumna Raj Pandey, Senior Program Specialist (Crops), SAARC Agriculture Centre, Dhaka, Bangladesh, (E-mail: pandeypr4@gmail.com, Cell: +880-1763708514)
2. Dr. Lijo Thomas, Scientist, Indian Institute of Spices Research (IISR), Kozhikode (Calicut), Kerala, India. (E-mail: lijo.iari@ gmail.com Cell: 91-8589902677)
3. Dr. A I Bhat, Principal Scientist, ICAR Indian Institute of Spices Research, Kozhikode India, (Mob: +91 94463 14506 E mail: aibhat65@gmail.com)

Selected Press Clippings





The New Indian Express



Malayala Manorama



കോഴിക്കോട്ടെ ഇന്ത്യൻ ഇൻസ്റ്റിറ്റ്യൂട്ട് ഓഫ് സ്പൈസസ് റിസർച്ച് സെന്ററിൽ നടന്ന സുഗന്ധവിള ശാസ്ത്രജ്ഞരുടെ സമ്മേളനം ഉദ്ഘാടനം ചെയ്ത ശേഷം കാർഷിക സർവകലാശാല വിസി ഡോ. പി. രാജേന്ദ്രൻ സുഗന്ധവിള പ്രദർശനം കാണുന്നു

-റിവിക

സുഗന്ധവിള കൃഷി ശാസ്ത്രജ്ഞരുടെ സമ്മേളനം തുടങ്ങി

സാർക്ക് രാജ്യങ്ങൾ സുഗന്ധവിള സീഡ് ബാങ്ക് തുടങ്ങണമെന്ന് കാർഷിക സർവകലാശാല വിസി

കോഴിക്കോട്: സുഗന്ധവിള ശാസ്ത്രജ്ഞരുടെ ത്രിദിന സമ്മേളനം മുഴിക്കൽ ഇന്ത്യൻ ഇൻസ്റ്റിറ്റ്യൂട്ട് ഓഫ് സ്പൈസസ് റിസർച്ച് സെന്ററിൽ തുടങ്ങി.

സുഗന്ധവിളകളുടെ മികച്ച വിത്തുകളും നടയിൽ വസ്തുക്കളും സാങ്കേതിക വിദ്യകളും പരസ്പരം പങ്കുവയ്ക്കുന്ന ഒരു സീഡ് ബാങ്ക് സാർക്ക് രാജ്യങ്ങൾ ചേർന്ന് ആരംഭിക്കണമെന്ന് സമ്മേളനം ഉദ്ഘാടനം ചെയ്തു കൊണ്ട് കാർഷിക സർവകലാശാല വിസി ഡോ. പി. രാജേന്ദ്രൻ പറഞ്ഞു. അത് ഉത്പാദനവും ലഭ്യവും വർദ്ധിപ്പിക്കാൻ സഹായിക്കും. ഇന്ത്യൻ ജീഡിപി യുടെ ആറു ശതമാനം സുഗന്ധവിളകളിലൂടെയാണ് ലഭിക്കുന്നത്. രണ്ട് വർഷമായി സുഗന്ധവിളകളുടെ ഉത്പാദനം ഇന്ത്യയിൽ മൊത്തത്തിൽ ഉയർന്നിട്ടുണ്ടെങ്കിലും കേരളത്തിൽ കുറഞ്ഞിരിക്കുകയാണ്. ഉയർന്ന ഉത്പാദന ചിലവും കാലാവസ്ഥാ വ്യതിയാനവും ഭൂപ്രദേശങ്ങളിൽ വന്ന മാറ്റവുമാണ് ഉത്പാദനം കുറയാൻ കാരണം. മിശ്രവർഗ കൃഷിക്ക് പകരം വിദേശ രാജ്യങ്ങളിലെ പോലെ ഏകവർഗ കൃഷി ചെയ്യുന്നത് ഉത്പാദനം വർദ്ധിപ്പിക്കാൻ സഹായിക്കുമെന്ന് അദ്ദേഹം പറഞ്ഞു. ഗുണമേന്മ കുടിയേറ്റം അന്താരാഷ്ട്ര നിലവാരത്തിലുള്ളതുമായ വിത്തുകൾ വിതരണം ചെയ്യണമെന്നും കർഷകർക്ക് ഇൻഷുറൻസ് സും മറ്റു സഹായങ്ങളും നൽകണമെന്നും അദ്ദേഹം കൂട്ടിച്ചേർത്തു.

പുതിയ ഇനം വിളകൾ കൊണ്ട് ഉത്പാദനം കൂടിയിട്ടുണ്ടെങ്കിലും ഇപ്പോഴുള്ള പ്രശ്നങ്ങൾ പരിഹരിക്കാൻ പുതിയ പദ്ധതികൾ കൊണ്ടുവരേണ്ടത് അത്യാവശ്യമാണെന്ന് സുഗന്ധവിള വികസന കേന്ദ്ര ഡയറക്ടർ ഡോ. ഹോമി ചെറിയാൻ അധ്യക്ഷ പ്രസംഗത്തിൽ പറഞ്ഞു.

സാർക്ക് രാജ്യങ്ങളിലെ സുഗന്ധവിള ഉത്പാദനത്തിന്റെ സാങ്കേതിക വിദ്യകൾ പരസ്പരം പങ്കുവെക്കുന്നതിനെ പറ്റിയുള്ള ചർച്ചയാണ് സമ്മേളനത്തിന്റെ പ്രധാന ലക്ഷ്യം.

ഇതിനായി സാർക്ക് രാജ്യങ്ങളായ അഫ്ഗാനിസ്ഥാൻ, ബംഗ്ലാദേശ്, ശ്രീലങ്ക, ഭൂട്ടാൻ, നേപ്പാൾ എന്നിവടങ്ങളിൽ നിന്ന് ശാസ്ത്രജ്ഞന്മാരും നയതന്ത്രജ്ഞരും എത്തിയിട്ടുണ്ട്. ധാർക്കയിലെ സാർക്ക് അഗ്രികൾച്ചറൽ സെന്ററിന്റെ സഹകരണത്തോടെയാണ് സമ്മേളനം.

സാങ്കേതിക വിദ്യകളുടെയും സുഗന്ധവിളകളുടെയും പ്രദർശനം പ്രിൻസിപ്പൽ അഗ്രികൾച്ചർ ഓഫീസർ വി.ഗീത ഉദ്ഘാടനം ചെയ്തു. ഇന്ത്യൻ ഇൻസ്റ്റിറ്റ്യൂട്ട് ഓഫ് സ്പൈസസ് റിസർച്ച് സെന്റർ ഉത്പാദിപ്പിച്ച സുഗന്ധവിളകളും ഉപോൽപ്പന്നങ്ങളും വിളകൾ സംസ്കരിക്കുന്ന സങ്കേതിക വിദ്യകളും പ്രദർശനത്തിനുണ്ട്. പരിപാടിയിൽ ഡോ.കെ. നിർമ്മൽ ബാബു, ഡോ.പ്രദ്യുംന രാജ് പാണ്ടയ്, ഡോ.ലിജോ തോമസ് എന്നിവർ പ്രസംഗിച്ചു. സമ്മേളനം നാളെ സമാപിക്കും.



Tue, 12 September 2017
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Deepika

Photo Gallery



Dr. P Rajendran, Hon'ble Vice Chancellor, Kerala Agricultural University
inaugurating the meeting



Dr. P Rajendran, Hon'ble Vice Chancellor, Kerala Agricultural University
delivering the inaugural address



Inauguration of Spices Technology Exhibition Pavilion



The chief guest and delegates visiting the exhibition



Country representatives from Afghanistan, Bangladesh, Bhutan, India, Nepal and Sri Lanka (from left to right) with Senior Programme Specialist (crops) from SAARC Agriculture Centre, Dhaka (in centre)



Presentation by Mr. Iqbal Haque Bangladesh representative



Presentation by Ms. Tanka Palami, Research Officer, Bhutan



Visit to the Biowin Agro Research Centre, Wayanad



Visit to the Biowin Agro Research Centre, Wayanad



Delegates at the Regional Agricultural Research Station, KAU, Ambalavayal

