SYMSAC-V

HARNESSING THE POTENTIAL OF NORTH EASTERN STATES FOR SPICES PRODUCTION THROUGHTECHNOLOGICAL INTERVENTIONS

30-31 October 2009

Central Institute for Horticulture
Medziphema, Nagaland

Organized by

Indian Society for Spices
Calicut, Kerala

Directorate of Arecanut and Spices Development
Calicut, Kerala

Central Institute for Horticulture
Medziphema, Nagaland

In Collaboration with

Indian Institute of Spices Research
Calicut

Indian Council of Agricultural Research
New Delhi

NATIONAL SYMPOSIUM ON SPICES AND AROMATIC CROPS (SYMSAC~V)

Harnessing the Potential of North Eastern States for Spices Production through Technological Interventions

30-31 October 2009
CIH, Medziphema, Nagaland

SOUVENIR & ABSTRACTS

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Indian Society for Spices, Calicut, Kerala
Directorate of Arecanut and Spices Development, Calicut, Kerala
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Souvenir and Abstracts

National Symposium on Spices and Aromatic Crops (SYMSAC-V)
Harnessing the Potential of North Eastern States for Spices Production through Technological Interventions
30-31 October 2009, Central Institute for Horticulture, Medziphema, Nagaland

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CHIEF MINISTER
NAGALAND
KOHIMA

7th September 2009

MESSAGE

It is indeed a matter of immense pleasure to know that Central Institute of Horticulture, Medziphema, Nagaland with Indian Society for Spices, Calicut and Directorate of Arecanut and Spices Development, Calicut is organizing National Seminar on "Harnessing the Potential of NE States for Spices Production through Technological Interventions" at Central Institute of Horticulture, Medziphma, Nagaland during 30th -31st October, 2009.

I congratulate the organizers of the seminar for its maiden venture and sincere effort to take up the noble task of organizing such an important seminar in the State of Nagaland. This will undoubtedly open up opportunities for the region to tap its immense potential in spices production. This National Seminar is a welcome step to congregate a large number of Research and Development officials, Marketing Agencies, NGOs and Progressive Farmers to brainstorm, discuss and conceptualize a meaningful strategy pertaining to spices development in the North East Region in particular and the country at large.

I earnestly hope that this Seminar would spell out the critical issues confronting the farming community of region in context of the spice production and suggest appropriate strategies to accomplish the mission of livelihood security through sustainable farming practices.

I compliment CIH, IISR and DASD and wish the seminar a grand success.

07/9

(NEIPHIU RIO)

MINISTER
Agriculture
Nagaland, Kohima

MESSAGE

I am happy to know that CIH, Medziphema, Dimapur in collaboration with Indian Institute of Spices Research & Directorate of Arecanut and Spices Development, Calicut is organizing a National seminar on "Harnessing the Potential of North Eastern States for Spices Production through Technological Interventions". It is my pleasure to write this message for the souvenir.

With ever-increasing population, technological interventions have become a must to meet with the production-demand gap. Also, wherever possible value addition of agro-produces has become a necessity to promote industrialization of agriculture. However, in seminars many important areas pertaining to the subject are discussed and deliberated. However, sooner than later, things settle down to the same old practices. Could it be because feasible post seminar plan of actions are not formulated? I hope the present seminar will address this issue.

Naga cuisines have exotic aroma and taste due to use of various indigenous herbs and spices which are available only seasonally. Traditional effort in preservation of such spices by smoking and sun drying is associated with loss of potency and many a times such practices are not healthy. If the quantum of domestic requirement and areas of scientific intervention in production and preservation is assessed, I am sure this (local spices) can by itself constitute into a large domestic market.

With regards to common spices, I am made to understand that, Nagaland is suitable for large scale production of many common spices viz., Ginger, Large cardamom, Turmeric and not forgetting the need for a greater rabi campaign for mustard seeds in low lying areas. Technological intervention in production without marketing issues of the produces will be an incomplete exercise.

Lastly, land holding in Nagaland per farming family is small. Motivational factor to convince collection or consortium of such farmers to cultivate commercially viable production target may require a failsafe "buy back policy" with some element of loan system.

I have conjured some setbacks not to project or to infuse negative feelings but with faith that when learned people put together their pro-active minds; progress is in the right perspective. I wish the Seminar participants a meaningful discussion and also wish the visiting researchers a pleasant stay.

23/9/09

(Dr. Chumben Murry)

U K Sangma, IAS
Secretary
North Eastern Council

Dated: 30-09-2009

MESSAGE

I am indeed happy to learn that the Central Institute for Horticulture (CIH), Nagaland is organizing Symposium on "Harnessing the potential of North Eastern States for Spice Production through Technological interventions" in collaboration with the Indian Institute of Spices Research and ICAR. I am confident that the CIH, Nagaland is moving towards the right direction to become a premier institute for propagating good horticultural practices in the North Eastern Region. I wish the Institute and its endeavour all success.

(U K Sangma)

Parliamentary Secretary
Horticulture
Kohima, Nagaland

Date: 17-09-2009

MESSAGE

It gives me immense pleasure to know that the Indian Society for Spices, Calicut; Directorate of Arecanut and Spices Development, Calicut and the Central institute of Horticulture, Medziphema are organizing the fifth National Symposium on Spices and Aromatic Crops (SYMSAC-V) at CIH, Medziphema.

The North East region en bloc is an intact mine of horticultural wealth, imminent to be explored. This symposium I believe will be a revelation to the vast prospects the region holds for spices production. It is also true that most of the spices crops are of low volume with high value and ideally suit our hilly fertile terrain.

I sincerely hope that it will create new ventures above and beyond improving the skills through sharing of ideas and findings among researchers, growers, trades and policy makers. I comprehend the painstaking works of prominent agricultural scientists with special reference to the North East region, instrumental in carving out solutions for spices cultivation, which is a vital segment of our interest for development in the state.

I congratulate the entire members for meticulously organizing this symposium to a grand success.

I wish the coordinators all success.

(R. Khing)

Dr. Mangala Rai
Secretary & Director – General
Government of India
Department of Agricultural Research & Education and
Indian Council of Agricultural Research
Ministry of Agriculture, Krishi Bhavan,
New Delhi – 110 114

MESSAGE

I am happy to know that the fifth National Symposium on Spices and Aromatic Crops is being organized by the Indian Society of Spices at Medziphema, Nagaland at the Central Institute of Horticulture from 30-31 October 2009.

The North Eastern Region of India is known for its vast natural resources and a cauldron of different people, cultures and crops. Agroclimates prevailing at Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura are suitable for cultivation of various spices and also for promoting production of organic spices. Since spices are gaining popularity in the North-Eastern Region, it is a mindful decision to organize this Symposium in the region.

The major issues for spices crops are availability of quality planting materials, transfer of technologies for better post-harvest practices, infrastructure for quality testing, packing and storage and developing organic certification facilities. In addition to concerns, like low yield, biotic and abiotic stresses, IPR measures, marketing and processing that need utmost priority. We need to have appropriate technological interventions for harnessing the potential of these states for spices production.

I hope that the Symposium will focus on consolidating gains, reinforcing strengths and addressing weaknesses of spices production technologies vis-à-vis the north -eastern states

I extend my warm greetings to the organizers and participants and wish the symposium all success.

(Mangala Rai)

Dated the 6 October 2009
New Delhi

Dr. H. P Singh
Deputy Director General
(Horticulture)
Indian Council of Agricultural Research
Krishi Anusandhan Bhavan II
Pusa, New Delhi – 110 012.

MESSAGE

I am happy to learn that the fifth National Symposium on Spices and Aromatic Crops (SYMSAC-V) is being organized by Indian Society for Spices at the Central Institute of Horticulture (CIH), Medziphema, Nagaland from 30-31 October, 2009.

India, the largest producer, consumer and exporter of spices in the world, with a production of 3.95 million tons from an area of about 2.41 million ha has annual growth of 6.2% in production of spices. The total export is 4.45 lakh tones valued at 1101 US $. The NE region in endowed with favourable agro-climatic conditions and produces range of 'niche quality' spices. However, the production continues to be low. Indian Council of Agricultural Research has been striving to harness the potential of spices through research at Indian Institute of Spices Research (IISR)) and All India Coordinated Research Projects. The technologies developed have to be utilized besides, developing new cultivars attuned to NE Region. This organization of the National Symposium is timely to address the issues especially in NE region. I am sure that the deliberations will identify the gaps, provide the solutions to some of the problems and finally develop roadmap to make the spices of NE region more competitive.

I compliment the organizers and wish the Symposium a grand success

(H. P. Singh)

ALEMTEMSHI JAMIR, IAS
Addl. Chief Secretary,
Development Commissioner & APC
Nagaland, Kohima – 797 001

MESSAGE

I am happy to know that Central Institute of Horticulture, Medziphema is taking the initiative to organize a national symposium that will throw more light on the potentials for development of spices as a major agricultural activity.

In the first place, the Director and the faculty of CIH are to be congratulated, that despite being a new institute they are taking this initiative to convene a national symposium. Their efforts are appreciated. The second important issue is that spices and aromatic crops are seen as a fundamental agricultural crop which has the potential to change the economic life of the farmers of the North East region. A symposium focused on technological interventions is therefore a very welcome activity and I am sure that this exercise will definitely add to the growth of the agricultural economy of the region.

(Alemtemshi Jamir)

Dr. Gorakh Singh
Horticulture Commissioner
Government of India
Ministry of Agriculture
(Department of Agriculture & Cooperation)
Krishi Bhawan, New Delhi – 110 001

29th September 2009

MESSAGE

It is indeed a great pleasure to know that Central Institute of Horticulture, Medziphema, Nagaland in collaboration with Indian Society for Spices and Directorate of Arecanut and Spices Development, Calicut is organizing a National Seminar on "Harnessing the potential of North Eastern states for spices production through technological interventions" on 30th and 31st October 2009 at Dimapur, Nagaland.

North Eastern Region, well known for its great potentiality for horticulture crop production with naturally blessed rich resources will be an ideal region for promoting spices production on commercial scale. Hence, this seminar is definitely a step in the right direction to pave the way for boosting spice industry in the region. I hope that during this seminar, there will be elaborate deliberations on key issues relating to spice production by eminent subject experts of spices and thereby, bring about comprehensive recommendations for the policy makers to be adopted.

Bringing out the souvenir on this occasion with valuable contribution on the subject matter by renowned personalities in the spices sector will definitely be useful for all the stake holders of this important sector of horticulture. Therefore, I am glad the organizers are putting their efforts to bring out the Souvenir.

I wish the organizers of this seminar best of luck and a grand success of the program.

(Gorakh Singh)

Chief Secretary
Government of Nagaland
Kohima

23rd September 2009

MESSAGE

I am glad to know that the Central Institute of Horticulture, Medziphema, in collaboration with the Indian Institute of Spices Research, Calicut and the Directorate of Arecanut and Spices Development, Calicut is organizing a national seminar on "Harnessing the potential of North Eastern states for spices production through technological interventions", on 30-31 October, 2009 at Dimapur.

Throughout the ages, spices have always added spice to life. Many of the international trades in the older days were triggered by the desires of men to taste the newest of the spices. It may be recalled that the first Europeans who came to India were in search of the famous Indian Spices. Spices are low volume–high value commodities that are evidently suitable for commercial scale cultivation in the North East Region.

There is no doubt that the North Eastern Region of India is rich in spices, both the cultivated and the wild varieties. The most well known is the Naga King Chilly recorded by the Guinness Book of World Records as the hottest chilly in the world. During the seminar, we could discuss how to improve the quality and North-Eastern Region can become the hub of spice productions in India, and contribute not only in the export earnings of the country, but also in adding spice to the lives of mankind.

I wish the seminar all success.

23.09.09

(Lalthara)

COMMISSIONER & SECRETARY
DEPARTMENT OF HORTICULTURE
KOHIMA, NAGALAND

MESSAGE

I am delighted that the Central Institute of Horticulture, Medziphema, Nagaland in collaboration with Indian Society for Spices and Directorate of Arecanut and Spices Development, Calicut is organizing a National seminar on ***"Harnessing the Potential of North Eastern States for Spices Production through Technological Interventions"*** on 30th and 31st of October, 2009 at Dimapur, Nagaland. I thank the organizers for choosing the state of Nagaland as the venue for this important Seminar which I hope will give the required impetus to production of spices in the region benefiting the people, especially the farming community.

This seminar will not only serve as a platform for exchange of views and ideas from experts drawn from across the country but also deliberate on the various problems confronting the spices sector in the region. I hope that from the deliberations, a blue print for development of a strong and vibrant spices sector for the North-East will be formulated and implemented.

I convey my best wishes to the organizers and wish the seminar all success.

(Sentiyanger Imchen)

Dr. S. N. Puri, FNAAS
Vice –Chancellor
Central Agricultural University
Post Box No. 23, Lamphel
(P.O) Imphal – 795 004,
Manipur (India)

MESSAGE

I am happy to know that the Central Institute of Horticulture, Medziphema, Nagaland with Indian Society for Spices, Calicut and Directorate of Arecanut and Spices Development, Calicut is publishing a souvenir on the occasion of the National Seminar on "Harnessing the Potential of NE states for Spices Production through Technological Interventions" being organized from 30-31st October, 2009 at Dimapur, Nagaland.

I am sure this seminar will provide the right platform for fruitful interaction among horticulturists, entrepreneurs and other stakeholders, which will boost spice industry in the region, which is the need of the hour.

I hope this seminar will adequately highlight the various issues confronting the spices production and come up with proper strategies to enhance the spice production in the region. This souvenir will definitely form as a good source of material for information to various sections of the people concerned with the development of this important sector of horticulture.

I wish the organizers of the seminar a grand success.

3/10/09

Dated: 03-10-2009

(S N Puri)

VICE CHANCELLOR
NAGALAND UNIVERSITY
(HEADQUARTERS: LUMAMI)
KOHIMA CAMPUS, KOHIMA - 707 001

Date: 31st August 09

MESSAGE

It gives me great pleasure to know that the Central Institute of Horticulture, Government of India, Medziphema in collaboration with the Indian Institute of Spices Research, Calicut and Directorate of Arecanut and Spices Development, Calicut is organizing a National Seminar on the subject of “Harnessing the Potential of North Eastern States for Spices Production through Technological Interventions” on 30^{th} and 31^{st} October 2009 and bringing out souvenir on the occasion. I am sure the souvenir will provide a good platform to all concerned to express their opinion on the potential of spices cultivation in the NE regions of India. Quality articles in this field are the need of the hour.

I convey my best wishes for the successful conduct of the symposium.

K. Kannan

(K. Kannan)

CONTENTS

Scope and constraints for spices development in Nagaland

Rongsentemjen Ao

Director of Horticulture
Nagaland, Kohima

Nagaland has a geographical area of 16579 sq km located at altitudes ranging from 100 m to 3840 m and climatic condition varying from sub-tropical to sub temperate. The isolated geographical location owing to its hilly terrains and varied climatic condition have all contributed to the state's unique ecosystem making it the home of numerous endemic and endangered species of flora and fauna which is perhaps one of the most diverse in terms of agro-biodiversity in the country. Nagaland is favorably situated, bounded by Myanmar in the East, Assam in the North west, Arunachal Pradesh in the North east and Manipur in the South indicating a good scope for export of spices in this region. Then again, the soil status is very much ideal being rich in organic matter that can be tapped to the fullest advantage. The state is also basically an agrarian state, Jhum forms an intrinsic part of the Naga culture embedded deep in the mind set of the people. Spice crops like ginger, Naga King chilli, turmeric, besides other indigenous spices like zanthoxylum, Naga garlic, indigenous leek varieties *etc.* are extensively grown in the Jhum fields either as mono or mixed crop.

Spices can play a pivotal role in changing the practice of the Naga whose aspiration has gone beyond the earlier subsistence livelihood to income generation. Naga King chilli which is indigenous to the state with the state having already acquired the registration for geographical indication, holds tremendous scope for export to the national as well as international market as the demands for this chilli is growing enormously, giving a boost to the socio-economic level of the farmers.

Agriculture in Nagaland is organic by default owing to which the Government of Nagaland has declared some crops as organic during 2006-07. This facet of cultivation can be turned into a boon, knowing that the ill-hazards of the use of inorganic chemicals have become a matter of global issue. Incidentally, the state has already tied with the ICCOA, Bangalore, for certification of organic ginger with more in the offing, which apparently holds a bright promise for spices in the state.

In the employment scenario, nevertheless, cultivation of spices has facilitated in creating more avenues for employment through cultivation of selected spice crops which are economically viable in the state, given the fact that private industries and other such institutions are inadequate and employment in the public sector becoming an issue of concern aligned with proliferation of educated natives.

Over the past few years, the zeal and enthusiasm of the farmers for taking up cultivation of spices like large cardamom, ginger, turmeric, black pepper, betel vine, indigenous spice crops *etc.* has been overwhelming following the motivation from the successful implementation of the Horticulture Technology Mission since 2001-02. This is evident from the increase in the number of farmers' keenness for information regarding quality seeds, technical knowhow, marketing linkages, increased production and any other assistance available from the department. Thus, there is a huge scope for bringing more area under spices thereby increasing the production which can bring about landmark changes in the spice graph of the state. Besides, the Nagas are quite innovative in their field of work. New innovations like portable dryer manufactured by progressive local farmer called SAWO has turned out to be very successful in drying large cardamom, Naga chilli, *etc*. while retaining its color and flavor vis-à-vis the conventional method of drying.

Cultivation of spices holds the key to the much needed stimulus required for establishment of processing units in the state since spices can be developed as valuable processed products beside their raw use, which can motivate more people in taking up spices cultivation with positive outcome.

Indigenous spices like zanthoxylum and Naga garlic have their own unique flavor and properties that can be explored for more extensive cultivation and purpose of exports to other non producing regions which assures to be a sunrise industry for the Nagas attracting lucrative business in the market today. In the field of development of zanthoxylum, progressive farmers of Tuensang with the initiatives of the Department of Horticulture has emerged with an innovative technique for raising seedlings in nurseries before transplanting in the main field, hitherto unknown. The practice of direct sowing was limiting the uniform germination and other technical aspects. However, this package is in its infancy confined to some pockets which is expected to proliferate as a new boulevard of commerce in the state.

In spite of all these scope for their cultivation, it is felt that though some progress has been made in the development of spices in Nagaland over the past few years; there still remains much to be achieved. The availability and use of quality planting materials remains a lacuna in the production of spices, even though a large number of farmers are cultivating, most of them have no access to quality planting materials which is sine qua non for enhancing the production of spices in the state. Furthermore, lack of sufficient knowledge about plant protection measures and inadequate state-of-the-art technologies hampers the development of spices in the state. Many of the farmers are still rooted in the traditional system of cultivation and restricted in their own belief and capacity, wherein no appropriate measures are adopted by the farmers to exclude, control or eradicate diseases and pest thereby losing a large mass of the production to these factors resulting in very low productivity.

Seasonality in production remains one main reason as to why farmers are reluctant to exclusively take up spices cultivation drastically affecting their development in the state. And even if they do take up the cultivation, discouragement takes the form of post harvest losses owing to the lack of adequate storage facilities and processing units which results in huge losses to the farmers.

Another bottleneck is the lack of grading and standardization facilities due to which farmers are unable to sort out their produce ultimately leading to poor prices in the market and distress sale. It has also been observed that the farmers in the state are unable to profitably sell off their spices in the market due to unorganized growers association and ignorance of market intelligence which leave them at the hands of the unscrupulous traders who cheat them of their fair share in the sale of the produce, thus the farmers are unable to get the deserved prices for their produce thereby affecting the development of spices. Though the farmers have keen interest in the development of spices, transportation becomes another predicament which may be attributed to far flung farm locations, high cost of transportation due to kuccha road, poor connectivity, and inadequate collection hubs.

Many of the enthusiastic growers own a small inherited land where the harvest may be just enough for local markets leaving limited space for large scale production. This has affected the cost benefit ratio by and large, leading to high cost of cultivation and low proceeds. Besides, this has seriously hampered the magnitude of attraction of renowned private companies into the state for large scale procurement.

While speaking of ground reality, many of the farmers are ignorant of different credit facilities, plans and schemes offered by different institutions of the state which would otherwise have given a lift to development of spices in coordination with the various schemes allotted to the department. Refinancing of various credit schemes with minimum rate of interest and proper pay back policies would tremendously benefit the farmers align with the policies of the department for commercial production. However, many genuine farmers are uneducated and require proper guidance to take such credit schemes in concurrence with the scheme guidelines of implementation thereby the farmers are benefited as well as the pay back is accomplished.

It has also been observed that there is no definite package for development of spices processing industries in the state which leads to low morale of the farmers in taking up spices cultivation. This package will not only add values to the produce but generate technical and non technical employment, reduce post harvest losses, longer shelf life, better quality and advanced remunerations. Nagaland is far behind other neighboring states in the spices segment due to lack of strict coordination between the growers and the technical personnel which evidently leads to distortion of technical knowledge and the feedback of ground realities, which directly affects the decision of the policy makers in framing out policies for the state, many of which may be unwarranted in view of the farmers aspirations and requirements.

In accordance to these scope and constraints for development of spices in the state, certain area of thrust needs to be undertaken which would provide impetus for development in this sector so as to put the state on the global spice map. For instance, policy makers should come out with certain policies which would provide interest free subsidies to the progressive farmers that would definitely assist them for mass scale production. Initiation of proper marketing linkages with buy back policies, adequate market shed or collections centers at appropriate locations etc. Mass scale production through crop zoning and establishment of "*Spice Villages*" in pre-determined potential areas can manifest the state into a leading spice producer. Proper identification and classification of potential spice varieties in line with the State Agriculture Universities, Central Horticulture Institute, ICAR and other research stations to motivate and encourage farmers for minimum cost of cultivation and higher remuneration is imperative.

Private as well as public sector companies should be encouraged increasing their investment in the state which would automatically increase cultivation of spices in the state. Besides farmers-on-the-field experiences and problems should be taken into account and considered seriously and sincerely in all future policies if development of spices in the state is to be achieved.

Thorough and periodical training along with exposure trips on sustainable agriculture such as conservation of soil moisture, use of water, soil fertility, diseases and pest management, system of cultivation, *etc* should be imparted to the farmers as well as technical personnel with the advanced good agriculture practices. Besides, other infrastructure like pack houses, proper storage facilities and drying units should be provided adequately so as to avoid any post harvest losses which can aid in increasing the economic returns.

The vision of development of spices can be realized through proper strategies framed with better coordination between the different sectors of the people, including the local masses to popularize the spices trade. To sum up it is worthwhile to mention that the hilly state of Nagaland ever rich in its agro-biodiversity urgently deserves concerted attention from the planners, policy makers, research scientists and traders so that this area of development can flourish and contribute more for the socio-economic development of the state and the country as a whole.

Potential for spices in North East India including present status and future production strategies

R. K. Bhattacharyya

Professor, Horticulture
Assam Agricultural University
Jorhat – 13, Assam

India has a long history of producing and exporting spices. The 'King' (black pepper) and 'Queen' (cardamom) of spices hail from India. India grows as many as 75 different kinds of spices and only some eight per cent of the total spices production is being exported to more than 150 countries. The establishment of WTO in 1995 had a vast impact on Indian spice industry. Indian Government has enacted the 'Geographical Indication Good Registration and Protection Act' in 1999. As a major producer and exporter of spices, India has to gain from this act.

Kerala being the leading producer of spices in India is popular as 'land of spice'. The North eastern states also contribute to some extent to the production pool of spices.

Strength

Vast land resources are available for horizontal expansion both in hills as well as plains.

State wise area and production of spices in North East India (2004-2005)

State/ Spice	Chilli		Ginger		Turmeric	
	Area (ha)	Production (t)	Area (ha)	Production (t)	Area (ha)	Production (t)
Arunachal Pradesh	1650	2640	4450	32880	510	1790
Manipur	10140	6160	1270	2100	330	230
Meghalaya	1840	1340	9230	47140	1670	9440
Mizoram	1400	1190	4530	38070	200	1650
Nagaland	810	7290	1820	12730	30	650
Tripura	1590	5560	1360	5450	1510	6600
State total	6537	39266	6719	42243	6587	36651

Anonymous (2009a)

Area & Production of spices in Assam (2006-07)

Chilli		Ginger		Turmeric	
Area (ha)	Production (t)	Area (ha)	Production (t)	Area (ha)	Production (t)
15453	9975	18855	128817	11741	8538

(Barooah, 2009)

There is tremendous scope for horizontal expansion covering the arecanut, coconut and other tree standards in homestead gardens (*bari)* and shade trees in tea gardens including the plantations of small tea growers. Shade tolerant high yielding varieties of black pepper like Panniyur-2, Panniyur-4 and Panniyur-5 may be introduced to suit the shady conditions of *bari*. Ginger has also a vast potential in the *bari*s.

Prevalence of suitable agro-climate

All the North eastern states fall under three agro-ecological regions. The climate of the region varying from temperate to tropical with hilly terrain offer tremendous scope for growing horticultural crops particularly spices. The spice cultivation in the North eastern region may be categorized according to the growing conditions as given below:

Spice crops in NE India according to Agro-climatic situation

Sl. No.	Agro-climatic situation	Crop
A. Existing spices		
1.	Hills	Large cardamom, bay leaf (tejpat), ginger, turmeric, chilli (Birds' eye chilli, Naga chilli), *etc.*
2.	Plains	Ginger, black pepper, turmeric, chilli, *etc.*
3.	Char Area/ riverine tracts	All seed spices - black cumin, coriander, fennel, fenugreek, *etc.* (Annon., 2001)
B. Emerging		
1.	Plains	Vanilla

Soil and climatic conditions of North eastern region are suitable for large scale cultivation of a variety of spices like -

a. Rhizomatous spices: ginger, turmeric
b. Seed spices: Black cumin, fennel, fenugreek, coriander (Annon., 2001)
c. Perennial spices: Black pepper
d. Tree spices: Cinnamon, bay leaf
e. Annual spices: Chilli

Rich genetic diversity and abundance of promising cultivars

Rich genetic diversity is present in the region more particularly in ginger, turmeric and chilli. The family Zingiberaceae is represented by 50 genera and 1400 species distributed throughout the tropics but is predominantly Asian. India has rich diversity of Zingiberaceae with about 22 genera and 170 species. The North eastern region, a distinct part of Indo-Burma hotspot has the largest concentration of Zingiberaceae with 19 genera and 88 species.

Local cultivars of spices in NE India are given below:

Ginger cultivars:

- Low fibre yield: Dibong Collection, Tura
- High oil and oleoresin: Maran
- High yielding: Thingpui, Thinglaidum, Karlai, Maran

Turmeric cultivars:

- High cucurmin: Lakadong

Chilli cultivars:

- High capsaicin (pungency): Bihjalakia/ Bhutjalakia
- High capsaicin with suitability of drying: Birds eye chilli (Kanjalakia, Memjalakia)

Integral component of agricultural production system especially in the hill farming

Spices like ginger, turmeric and black pepper are integral part of hill farming traditionally practiced in the North East.

Higher regional productivity compared to the national average

In some of the spices like ginger the production per unit area is more in the North eastern region compared to national average.

Productivity comparison of some spices of NE India with national average (2002 – 03)

Sl. No.	Crop	Productivity (q ha^{-1})	
		NE India	National average
1	Ginger	56.34	35.96
2	Chilli	10.40	10.16

Anonymous (2005)

Strong technological back-up from the research functionaries of the region

Assam Agricultural University, Jorhat and ICAR Research Complex for NEH Region, Umium and Gangtok, Nagaland University, Medziphema and Central Agricultural University, Imphal, Mizoram University Aizawl are the main centres.

Weakness

- Lack of an integrated plan for the all round development of spices sector in the North East India
- Lack of vital statistics for strategic planning

- Scattered production pockets, transport bottleneck, weak communication and absence of organized cultivation
- Weak transport system, heavy postharvest losses and lack of organized collection system
- Lack of adequate storage facility and postharvest management practices like cleaning, grading, packaging *etc.*
- Low volume of internal market for the spices
- Long transport channel from Arunachal to Delhi or Mizoram to Kolkata and excessive middlemen involvement
- Infant stage of processing sector
- Lack of adequate attention of the State as well as Central government till recently towards growth of spice sector of the North East

Opportunity

Opening of new horizon for traditional spice cultivation of NER in context of growing demand for organic spices

The North eastern states of India possesses unique advantage of production and supply of highly valued organic spices since the cultivation of the spices in this part of the country particularly in the hills is done without much dependence on chemical fertilizers and pesticides. The existing system which is regarded as organic by default can well be transformed into a systematic organic production venture for capitalizing the fast growing world organic market for higher economic gain without distributing the nature and ecological balance. It should be adequately backed up by a location specific full proof organic production technology developed in accordance with the principles and guidelines of the world authorities of organic agriculture like International Federation of Organic Agriculture Movement (IFOAM).

Special drive from the Spice Board, India for expansion of organic spices cultivation in North eastern region

Export of organic spices from India has started in the right earnest. The country at present exports around 50 tons of various cultivars of organic spices. Exports will get a significant boost in the coming years as more farmers switch to organic methods. Spices Board, India has prepared a document on production of organic spices. It features the organic concepts, principles, basic standards, production guidelines, documentation, inspection and certification. Research programmes on organic cultivation of important spices have commenced. The work is carried out at the Spices Board's Indian Cardamom Research Institute at Idukki District in Kerala. Besides organizing demonstrations to educate and motivate prospective organic spice growers, the Board is simultaneously involved in training programmes to existing spice growers on organic principles and practices.

Similar line of research and extension programmes is to be initiated in the North eastern region of India to produce export quality spices. Streamlining the production in the light of national organic standards shall help in acquiring the certification necessary for export.

Value addition to North eastern spices

a. Better post harvest management.

b. Practices of proper harvest, cleaning, sorting, grading, packing, storage and transportation.

c. Storage in fresh form e.g., technology for storage of fresh ginger in bamboo rack system in sand media standardized by AAU (AICRP-PHT)

d. Development of product from fresh spices without dehydration e.g., salted ginger, ginger paste, ginger cubes *etc.*

e. Development of product from dry spices e.g., ginger powder, oleoresin of ginger, black pepper, turmeric and chilli, oil of ginger and black pepper.

f. Special schemes of the Ministry of Food and Processing Industries (MPFI), Govt. of India for establishment of spice processing industry in NER.

Implementation of Agri Export Zone for ginger in Assam and Sikkim

Recent establishment of Agri Export Zone (AEZ) in Assam especially for ginger has created enormous scope for streamlining the production and processing of ginger. A lot of subsidy schemes are available. The AEZ for ginger in Sikkim should also be exploited to the fullest.

Establishment of industrial park near Guwahati

An industrial park has been established at Amingaon where all facilities for development of processing unit shall be available.

Market promotion activities

- Revitalization and accelerated activities of North Eastern Regional Marketing Cooperation (NERAMAC)
- Acceleration of the functioning of Agricultural and Processed Food Products Export Development Authority (APEDA) in NER

Credit support

- Increasing credit support from NEDFi, NABARD *etc.*
- Extension of Crop Insurance Scheme
- Care and Support from DONER

Establishment of Agriclinics and Agribusiness Centres

Unified effort of Ministry of Agriculture, GOI, NABARD, SFAC and MANAGE for training and financial support to establish Agri-clinics and Agribusiness Centres.

Extension support

- Special emphasis on development and extension of spices in the entire North East under centrally sponsored scheme on Technology Mission for Integrated Development of Horticulture
- Proliferation of activities of VA(s) and NGO(s) in the region
- Fast proliferation of information technology

Other opportunities

- Extensive planning of the National Horticultural Board (NHB), for production, postharvest and capital investment in agriculture sector

- Development of Gopinath Bordoloi International Airport at Guwahati
- Emphasis on border trade with Bangladesh and Myanmar

Threat

Unstoppable jhuming in the region

Shifting cultivation *i.e.*, *jhuming* is prevalent in all the North eastern states. It was noted in the studies carried out by the Forest Survey of India that loss in forest cover in the North eastern states was mainly due to the shifting cultivation. The area under natural forest has declined. Besides, the fragmentation of habitat, local disappearance of native species and invasion by exotic weeds and other plants are some of the other ecological consequences of *jhuming*.

Frequent fluctuation of prices of spices in the terminal markets

Lack of regulated market leads to price fluctuation for spices in the terminal market. The farmers may face loss due to sudden reduction in prices.

Interference of unsocial elements in transportation and marketing of spices

Unsocial elements present in the North East India also create hindrance in transport and marketing of spices by collecting undue taxes.

Inflow of foreign produces at cheaper rate especially in ginger and black pepper

Many countries are competing with the North eastern states and India as a whole in production and export of major spices.

Competing countries with India in production and export of major spices

Spice	Competing country
Black pepper	Indonesia, Brazil, Malaysia, Thailand, Sri Lanka, Vietnam, China, Madagascar and Mexico
Cardamom (S)	Guatemala, El Salvador, Indonesia, Malaysia, Papua New Guinea and Sri Lanka
Ginger	China (PR), Thailand, Japan, Bangladesh, South Korea, Malaysia, Fiji and Philippines
Turmeric	China (PR), Pakistan, Bangladesh, Thailand, Peru, Jamaica and Spain
Clove	China (PR), Pakistan, Bangladesh, Thailand, Peru, Jamaica and Spain
Nutmeg and Mace	Grenada, Guatemala, Mexico, Sri Lanka and Nicaragua
Cassia	China, Indonesia, Madagascar, Malaysia, Thailand, Vietnam and Sri Lanka
Cinnamon	Madagascar, Papua New Guinea and Seychellis

Peter and Nybe (2004)

Future production strategies

- Variety is an important criterion for enhancing production and productivity of spices in the North eastern states. The following points to be considered for variety -
  - Selection of superior type from the local type
  - Introduction of elite varieties
- Quality seed and planting material is essential for improvement of production of spices and to promote the 'Spice Village' concept.
- Development of foolproof technology to combat critical production problems of spices need to be addressed properly.
- Integrated Regional Spice Development Plan for production and post harvest management is of utmost importance.
- Promotion of concepts of Good Agricultural Practices (GAP) especially to overcome non-tariff barrier is essential.
- Proper conservation and exploration of abundant germplasm resources of spices in North eastern states is of urgent need.
- A large area in the region is virgin, which should be explored for area expansion programme for spices through mini-kit programmes.
- Quality assurance of value added products is an absolute necessity if one is to produce value added products for domestic and global markets for human consumption in view of growing awareness.
- The issue of spice marketing to be addressed seriously in collaboration with NERAMAC, APEDA and other related agencies.
- Establishment of Agri Export Zones in the line of APEDA's Agri Export Zone for ginger in Sikkim and Agri Export Zone for fresh and processed ginger in Assam.
- Human resource development and capacity building in the North eastern states is of urgent need.
- Socio-economic development of local people to be taken up to attract farmers to grow spice crops ensuring better incomes through co-operatives higher than the traders.

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IPR in spices-Indian scenario

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Introduction

Intellectual Property Rights (IPRs) are property right in the domain of intellectual activities related to innovations intellectual property is also referred to as 'Information with Commercial Value'. Though the intellectual property refers to creations of human mind, the value of resultant innovation is a pre condition to be termed as intellectual property (Sivakumar, 2006). Since innovations, by and large, form the basis of human progress, it is imperative to protect the intellectual property associated with the innovation by exacting rights over the creative idea. Since innovations are the basis of growth and development in agriculture, IP protection is of crucial importance. Globalization in agriculture demands protection for all kinds of IPs in agriculture in order to protect the nation's agricultural sector from increased competition at international level and to take advantage of emerging opportunities like market for traditional products. Spices require special mention here, since they are traded in international markets most frequently and historically. India, the home of the spices, has particular responsibility to deal with IPRs in spices. In this context, this paper focuses on scenario of IPRs in Indian agriculture with particular reference to spices. It describes relevant IPRs in Indian spices, their implementation and the present status.

Intellectual property rights (IPRs)

Intellectual properties, as defined by the World Intellectual Property Organization (WIPO) are the creations of the mind like inventions, images, designs, literary and artistic work etc. In the TRIPS agreement[1], IPRs are defined as the rights given to persons over the creations of their mind. They are legal and exclusionary rights offered to the inventor against any misappropriation or use without permission of the creator.

Intellectual property rights are usually divided into two main areas.

1. Copyrights and rights related to copyright
2. Industrial property

Industrial property is divided into two main areas

1. Protection of distinctive signs –Trademarks and geographical indications
2. Protection to stimulate creation of technology-patents, designs, trade secrets, layout designs of integrated circuits, breeders right.

WIPO and World Trade Organization (WTO) are the important organizations at International level involved in intellectual property protection. WIPO acts as a forum for its member states to create and protect intellectual property rights through the provision of legal and technical assistance. WTO's agreement on Trade

[1] http://www.wto.org/english/tratop_E/trips_e/intel1_e.htm

Related Aspects of Intellectual Property Rights has established minimum level of protection that each government has to give to the intellectual property of the fellow WTO members. Apart from WIPO and WTO, there are some other agreements at various international forums like UPOV (International Union for the Protection of New Varieties of Plants), CBD (The Convention on Biological Diversity), and ITPGRFA (The International treaty on Plant Genetic Resources for Food and Agriculture of FAO) etc. These are particularly relevant to IP protection in agriculture. India has undertaken various measures to comply with the specifications of international IP agreements including amendment of Patent Act (1970) in 1999, 2002 and 2005, The Geographical Indications (Registration and Protection) Act, 1999 and the Protection of Plant Varieties and Farmers' Rights Act, 2001.

IPR in spices –Indian scenario

India is known as the land of spices. Spices are mainly used for flavoring and preservation of food. Other than their use as food additives, spices are used in pharmaceutical, perfumery and cosmetic industries. India has vast traditional wisdom on medicinal and aromatic properties of spices and a long history of production and trade in spices and occupies the positions of largest producer, consumer and exporter of spices in the world. India has its own natural comparative advantages with respect to spices production mainly due to diverse agro climatic conditions. International demand for natural plant products including spices are increasing steadily. This booming international spices market is posing opportunities and challenges to Indian spice industry. Protection of intellectual properties is thus essential to strive in the regime of free trade.

All forms of IPR as applicable to agriculture are relevant to spices also. Patents have wide spread possibility like patenting of agrochemicals, growth promoters, micro propagation techniques etc. Trade marks and geographical indications are important in the case of natural and processed agricultural products. Designs and IC lay outs as applicable to agricultural engineering and undisclosed information in the case of parentage of hybrids. In the Indian National Agricultural Research System, the earlier strategy to administer IPs was on case to case approach taking cue from few documented rules and guidelines. Recently it has started the process of developing IPR management strategies for effective transfer of IP protected technologies. ICAR has developed guidelines for intellectual property management and technology transfer/ commercialization in all its institutes. ICAR has also delegated powers to all its Directors for their institute to execute protection, maintenance and transfer of the IP in the ICAR's research result for the benefits of farmers and farm enterprises (Kalpana, 2009). The Protection of Plant Varieties and Farmers' Right Act, 2001 provide protection to newly bred varieties, extant varieties, farmer's varieties, essentially derived varieties and transgenic varieties (Parthasarathy *et. al.,* 2008). Government of India has also ratified Biological Diversity Act 2002, which has many provisions to protect nation's traditional knowledge and genetic resource base. A detailed assessment revealed that major IP forms relevant to Indian spices are patents, trademarks, geographical indications and plant varieties.

Patents

A patent is a statutory right for an invention granted for a limited period of time to the patentee by the Government, in exchange of full disclosure of his invention for excluding others, from making, using, selling, importing the patented product or process for producing that product for those purposes without his consent[2]. Patentability is decided by novelty, inventiveness and industrial applicability. TRIPS agreement demands patent protection for 20 years[3] and must be available for both product and processes. Government can refuse to issue a patent, in following cases[4].

2 http://ipindia.nic.in/ipr/patent/patents.htm
3 TRIPS- PART II — Standards concerning the availability, scope and use of Intellectual Property Rights, Section 5, Article 33
4 Section 5, Article 27

1. If its commercial exploitation is prohibited for the reasons of morality
2. Diagnostic, therapeutic and surgical method
3. Plants and animals (other than micro organisms) and biological processes for the production of plants and animals.

Indian patent administration is governed by Indian Patent Act, 1970 which came into force in 1972. The Act was further amended in the years 1999, 2002 and 2005. Indian patent office in Kolkata and branch offices in Delhi, Mumbai and Chennai look after the patent related issues in India. Varieties of spices developed using modern plant breeding techniques cannot be patented as such as per the Indian patent law. But the process of developing such varieties can be protected through patents. Similarly, processes of extraction of active ingredients, product developments by using spices and their usages for new purposes are patentable as per the national law provided they meet the standards of novelty, inventive steps and industrial applicability.

There are almost 87 patents registered in India related to spices.[5] Post harvest processes and products occupy as many as 19 patents. Others are related to product improvement (17), therapeutic and pharmaceutical use (17), derivation of different bio chemical components and active ingredients (16), colorants (3), bioavailability enhancing factors (2), crop improvement (2) and extraction of oleoresin, oil or pigments (9).

A list of approved patents in the major spices is given in Table 1. A number of patents are there in other spices also. Indian Council for Scientific and Industrial Research (CSIR) has registered almost 40 patents related to spices in India. DRDO, TBGRI, BARC and Bose Institute have one patent each. Among the private firms, Johnson and Johnson Health Care has got two patents related to medicinal properties of turmeric.

Table 1. Approved patents in major spices of India

Crop/ Sl.No	Title	Organization	Year of application
Black pepper			
1.	A process for the preparation of stable green natural colourant from the skin of fresh green pepper berries	CSIR	2001
2.	A process for preparing white pepper	Biocon India Ltd	2001
3.	An improved process for making white pepper from fresh green pepper *Piper Nigrum* L.	CSIR	2000
4.	An improved process for preparing white pepper	CSIR	2002
5.	An improved process for preparation of white pepper	CSIR	2000
6.	A process for preparing dehydrated green pepper without using chemicals	CSIR	1998
7.	An improved process for the production of dehydrated green pepper	CSIR	1998
8.	An improved process for the production of sterilized		

5 Patent infos: Database on Indian Patents

	spices particularly green pepper	CSIR	1993
9.	An improved process for the preparation of enriched spice oleoresin such as turmeric and pepper	CSIR	1994
10.	An improved process for the production of ball shaped unwrinkled pepper	CSIR	1991
11.	An improved process for the preparation of white pepper	CSIR	1989
12.	A process of preparation of a novel anti pyretic herbal drug from the plants *Andrographis paniculata*, *Piper nigrum* and *Piper betle*	TBGRI	1998
Cardamo (small)			
1.	A process and device for curing green cardamom	Individual	1982
Ginger			
1.	A process for the production of oil and oleoresin from fresh ginger rhizome	CSIR	2001
2.	An improved process for the extraction of oleoresin from ginger	CSIR	1993
3.	Bioavailability enhancing activity of *Zingiber officinale* Linn and extract/ fractions thereof	CSIR	2004
Turmeric			
1.	A process for the isolation of ar- tumeron oil from turmeric oleoresin industry waste	CSIR	2001
2.	A process for the preparation of water soluble turmeric colorant useful as yellow colour in food and beverages	CSIR	2001
3.	Process of recovery of pure curcumin from turmeric rhizomes	Godavari Sugar Mills Ltd.	2004
4.	A process for the preparation of curcuminoid mixture from spent turmeric oleoresin	CSIR	2002
5.	A method of making a turmeric based bandage	Johnson and Johnson Ltd.	2000
6.	A process for producing therapeutically active pure curcumin from *Curcuma longa* Linn.	Individual	2001
7.	The process of isolation of anticancer isoflavanoids from the rhizome of *Curcuma longa* Linn.	Individual	1999
8.	A process for the extraction of an immunomodulating fraction from *Curcuma longa* mainly containing (a) ar-tumerone (b) dihydro tumerone in the ratio of 1:15 to 1:2	CSIR	1994

Maximum numbers of patents are registered for tamarind (17), of which six patents are related to preparation of processed products like paste, powder, jam etc. Extraction of different bio chemical components like tartaric acid, pectin, tanning materials also have six patents. In case of pepper, methods of production of white pepper, dehydrated green pepper and sterilized pepper have four, two and one patents respectively. Nutmeg and cinnamon have two patents each, which are related to their medicinal properties. There are five patents for medicinal properties out of ten patents in turmeric. In case of fenugreek[6], there are two patents for medicinal properties. There are three patents each in ginger and chilli. Cardamom, mustard, saffron, sesame and onion have two patents each. Those spices with single patent include coriander, cumin, kokum, pepper mint, dill, bergamond and *Piper longum*. A patent each in chilli and *Piper longum* with respect to micro propagation also exists.

The stakes for India are high as far as patenting of spice related goods are concerned mainly due to the fact that out of the 109 spices available worldwide, 75 are grown in India. An immediate need to counter the threat from the West is felt in case of spices as evident from the patents gained by US based firms on curcumin and piperine from turmeric and pepper, for their pharmaceutical properties. For contesting and pre-empting such patents, the Spices Board is preparing a compendium on the spices and spice products relating to major spices of India.

Trademarks

A trademark is an IP in the form of a visual symbol. This may be a word, signature, name, device, label, numerals or combination of colors on goods or services or other articles of commerce to distinguish the goods and services of one undertaking from those of other undertakings. As per the provisions of TRIPS agreement, initial registration and each renewal of registration of trademark shall be for a term of no less than seven years. The registration of trademark shall be renewable indefinitely[6]. Indian Trademark Act, 1999 is administered by the trademark registry. The registry was established in 1940 with head quarters in Mumbai and branch offices in Delhi, Kolkata, Ahmedabad and Chennai.

Assessing the trade mark registration status of spices in India has some intricacies. Trade marks are registered for different spices products. Registration is sought either for spices of all kind or for a number of products including spices. Following list will give an idea about trade mark registration in spices[7].

1. Registering a single trade mark for all the goods included in a class (class 30), though only one or two products are really marketed. Spices, mustard and pepper always figure out in these lists. These types of trade marks are most common.
2. Spices registered with one or few other goods (eg: rice and spices, spices and nuts *etc.*)
3. Spices of all kind (whole and ground).
4. Registering spices like mustard, pepper, cardamom, jeera, tamarind, fennel, methi *etc.* separately
5. Spice powders (turmeric powder, chilli powder, coriander powder etc singly or together).
6. Masalas, curry powders and pickle powder (garam masala, meat masala, chicken masala, sambar masal *etc.*)
7. Mustard oil

6 Section 2, Article 15, Article 18

7 Trademark Journals, Various issues

8. Saffron
9. Spice extract
10. Vanilla essence

Trademarks aim to minimize consumer confusion by clearly identifying the origin of a product and maximize consumer satisfaction by quality control. Since a lot of firms are operating in Indian spice industry dealing with the trade of various spices and their value added products, trademark registration is essential. In the absence of a registered trademark, the goodwill earned by a company may be encashed by some fraudulent enterprises. Infringement of any form can be effectively counteracted only when the brand is legally registered. The issue is of significance in spices, since unfair practices especially adulterants have been a major threat to reputed brands of spice products. A lot of trademarks are already being registered by different firms.

Geographical indications

Geographical Indications are defined as goods originating in the territory of a country, or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographical origin[8]. Thus, this definition specifies that the quality, reputation or other characteristics of a good can each be a sufficient basis for eligibility as a geographical indication, where they are essentially attributable to the geographical origin of the goods. TRIPS provisions (Article 22) require that member countries should prevent the use of designation for any other product and any unfair competition within the meaning of the Article 10 bis of the Paris convention.

In India the Geographical Indications of Goods (Registration and Protection) Act, 1999 came in force with effect from September 2003. The Act defines geographical indication, provides a mechanism for registration of GIs, establishes a GI Registry, and elaborates the concept of authorized user and registered proprietor, higher level of protection for notified goods and remedies for infringements. The Controller-General of Patents, Designs and Trade Marks is the registrar of geographical indications. The Geographical Indication Registry located at Chennai has all India jurisdictions. The Registry maintains a Register of GI which contains details of distinguishing characteristics of the goods, the *registered proprietor* and particulars of *'authorized users'*.

Geographical indications can play vital role in promoting India's spices industry. India is always hailed as major producer of spice, but off late it is facing stiff competition from countries like Indonesia, Malaysia and Madagascar etc. India can overcome the challenges posed by the cheap produces from other countries only by highlighting the superior quality of Indian spices and its age old tradition in spices farming and trade. Geographical indication, by signaling the unique characteristics and quality by virtue of its area of origin will help to fetch premium price in the international market. Parthasarathy and Prasath (2008) have outlined the benefits of GI registration in spices. It provides legal protection to Indian spices and prevents unauthorized use by others. Consequently it promotes export of Indian spices and hence the economic prosperity of producers. Also it enables seeking legal protection in other WTO member countries.

Status of Geographical indications (spices) registered in India are given in Table 2. Spices Board is the main agency initiating and applying for GI registration in spices. But it does not mean that GI in spices can be registered only under the auspices of Spices Board. Any association or person, producer, organization, or any authority established under law can apply for a GI. GI registration for Naga Mirchi is for Department of Horticulture Government of Nagaland.

[8] Section3, Article 22

Table 2. List of Geographical indications (Spices) registered in India[9]

S.No	G.I Application No	Name of G.I	Applicant
1	49	Malabar Pepper	Spices Board
2	72	Alleppey Green Cardamom	Spices Board
3	78	Coorg Green Cardamom	Spices Board
4	109	Naga Mircha Nagaland	The Government of

The registration process for Byadgi chilli and Guntur Sanam chilli is in the final stage. The Spices Board proposes to apply for GI registration of some other promising Indian spice varieties, which include

- Alleppey Finger Turmeric
- Cochin Ginger
- Sikkim Cardamom
- Erode Turmeric
- Ramanadu Mundu Chilli
- Kanpur Coriander.

Many other spices have potential for GI registration like

- Wayanadan Manjal
- Erode Local Turmeric
- Rajapuri Turmeric
- Salem Turmeric
- Ghorakhpur Turmeric
- Lakadang Turmeric
- Kurupambady chukku (Dried ginger)
- Mizoram Ginger
- Arunachal Thippali
- Tezpur Chilli
- Kashmiri Saffron
- Konkan Kokum syrup

The foregoing discussion on GI in spices reveal that the concept of geographical indication is yet to be acclimatized in Indian spices industry. The importance of legal protection which can be attained by the traditional Indian spices and the economic benefits thereof have to be given adequate priority. On the other hand,

[9] GI Journals, Various Issues

plurality of GI registrations leading to non differentiated product profile and less profit is also expected. At present, lack of international system for GI registration is a lacuna, since most of the Indian spices are traded in the international markets and legal protection is restricted to Indian territory only.

Protection of plant varieties[10]

The protection of plant varieties around the world is guided by Article 27(3) (b) of TRIPS agreement. Plant variety rights are a form of intellectual property protection granted to breeders of new varieties of plant. For a plant variety to be protected, it must produce the same type of the plant in every generation, and should be distinct in appearance and distinguishable from others. TRIPS allow the member countries to choose between a pure patent system, a *sui generis* system or a combination of the two. (Kalpana, 2009). India has adopted a *sui generic* system. The sui generic PPV&FR (Protection of Plant Varieties and Farmers' Right) Act, 2001 is a delicate amalgam of provisions in the TRIPS agreement, UPOV, ITPGRFA and the privileges already available to Indian farmers. Unique provisions in PPV&FR[11] Act (Sudipta Basu *et al*. 2008) include:

Protection by registration to all categories of plants except micro organisms, covering new variety, exant variety and farmers' variety, essentially derived varieties and transgenic varieties.

New variety: A variety is new when the propagating or harvested material of such variety has not been sold in India, earlier than an year and outside India, earlier than six years for vines or trees and four years for all others.

Extant varieties: Extant varieties include previously notified varieties under the seed law and other varieties of the common knowledge or in public domain.

Farmers' varieties: Variety that has been traditionally cultivated and evolved by the farmers in their fields; or is a wild relative or land race of a variety about which the farmers possess the common knowledge.

Essentially derived varieties (EDVs): A variety shall be essentially derived with respect to initial variety when

- It is predominantly derived from such initial variety while retaining the expressions of the essential characteristics that results from the genotypes or combination of genotype of the initial variety
- It is clearly distinguishable from such initial variety
- It conform to such initial variety in the expression of the result from the genotype or such initial variety

The EDVs may be developed by the selection of natural or induced variations, somaclonal variations, back crossing derivatives, point mutations, transformations, ploidy changes, gene insertion/deletion.

Transgenic varieties: All transgenic varieties can be registered for protection after conduct of special tests for the detection of transgenes in the variety.

The act also recognizes different rights like farmers' right, community's right, plant breeder's right and researcher's right

Farmer's rights: It recognizes the farmers as conservers and providers of genetic resources, breeders of new varieties and the users of the protected varieties. Farmers shall be entitled to save, use, sow, re-sow, exchange and share or sell his farm produce including seed of a variety protected under this act in the same

10 http://www.plantauthority.gov.in/about-authority.htm
11 (PPV&FR Act, 2001. Chapter VI-Section 39(1) i-iv)

manner as he was entitled before the coming into force of this act provided that the farmer shall not be entitled to sell branded seed of variety protected under the act.

Community's right: The act recognizes the contribution of a local community in the evolution of a variety and recommends compensation for that. The compensation shall be determined by the PPV authority and deposited in gene fund.

Plant Breeder's right (PBR): PBR is an exclusive right on the breeder, his successor, agent or licensee to produce, sell, market, distribute, import or export the variety.

Researcher's right: Any variety registered under these Act could be freely accessed and used for conducting experiment or research by any person, except for commercial production of new varieties.

Under the act, Any new variety should conform to Novelty and DUS (distinctiveness, uniformity and stability) for registration. The examination of a variety for DUS generates a description of a variety, using its relevant characteristics by which it can be described as a variety in terms of the Act. At present, the Central Government has notified 12 crops with their genera as eligible for protection which include rice, wheat, maize, sorghum, pear millet, chick pea, pigeon pea, green gram, black gram, lentil, field pea and kidney bean. Spices are not included in the present list of protection. Many varieties with exceptional qualities, developed by Indian Institute of Spices Research and different State Agricultural Universities are not yet registered with PPV&FR authority. However, as per the PPV & FR act, spice crops that are in cultivation, which are farmers' varieties can be safe guarded from piracy by registration. But, much benefit cannot be achieved in spice crops by the farmers because the rule states that all the extant varieties are to be registered within three years from the date of enforcement of this act. According to the act, extant varieties include farmers' varieties also. Only possibility left now is to register the farmers' variety as new variety since provision is available for the farmers also to register new varieties.

However, draft guidelines for the conduct of DUS testing have been published in the case of ginger, turmeric, Indian mustard and sesame. Guidelines are about to be published in the case of black pepper and small cardamom. Indian Institute Spices Research, Calicut is the proposed DUS test centre for ginger, turmeric, black pepper and cardamom. Test centre for mustard is NRC on Rapeseed and Mustard, Bharatpur.

It is always to be remembered that new varieties are developed by farmers or researchers to improve some desirable characteristics like yield, disease tolerance, active ingredient content *etc*. Consequently they will have key role in boosting the economic prosperity micro level and attaining self sufficiency at macro level. In case of spices, the assumption is quite valid for India. So, substantial effort has to be taken for the protection of different varieties of spices.

Biodiversity and traditional knowledge

Spice crops constitute the countries biological diversity and its usages have been recognized by the Biodiversity Act, 2002. Even after developing IP by using the country's spice crop bio-resources through proper legal permission, one has also to take approval from the National Biodiversity Authority (NBA) for filling an application for any form of IPR. This provision will take care of benefit sharing that will emerge due to utilization of our BR.

Our country has rich in traditional knowledge base. Since the time immemorial, folk medicines are using either fresh or dried spices like black pepper, turmeric, nutmeg, ginger, fennel, coriander, garlic, mentha, and a variety of others in their preparations. This knowledge is transferred across generations through practice without any proper documentation. There is no particular legislation enacted to protect this knowledge base. Instances of alleged bio piracy have demanded proper documentation of our indigenous knowledge.

Traditional knowledge digital library (TKDL): Collection, compilation and validation of various folk medicines, in addition to traditional knowledge have been initiated by National Institute of Science Communication and Information Resources of Council of Scientific and Industrial Research and also by a few other NGOs. This documentation will help in opposing any piracy of patent as experienced in case of turmeric and pepper.

Institute's initiatives on IPR in spices: Indian Institute of Spices Research

Indian Institute of Spices Research, Calicut is a major constituent body of Indian Council of Agricultural Research involved in research on various aspects of spices. IISR is playing the lead role in undertaking the IPR issues in spices. The institute is the DUS testing centre for spices under plant variety protection authority. The institute technology management unit (ITMU) has been established in the institute under the ICAR scheme "Intellectual Property Management and Transfer/ Commercialization of Agricultural Technology Scheme". Major activities undertaken by IISR in the recent period in relation to IPR in spices are listed below

1. Identification of research projects of the institute with IPR relevance, identifying areas where IPR rights can be achieved.
2. Applied for patents for white pepper production technology developed by scientists of the institute
3. Assistance for securing GI registration for spices: Assisted the Spices Board in securing GI for Malabar pepper by providing appropriate geographical indicator details and scientific data for proving identity of Malabar pepper. Information on biochemical and molecular analysis to be collected and given to Spices Board, Ministry of Commerce, Kochi for filing GI registration application for Indian cardamom. Also Assisting in securing GI for Lakadang turmeric
4. Optimization of appropriate techniques for developing finger prints through molecular methods with a view to securing IPR rights
5. Identified 26 spices (Table 3) that have the potential for GI registration and the name submitted to ICAR for further necessary action to secure GI
6. Assisting some local voluntary organization in obtaining trademark registration
7. Assisted 20 scientists for availing training in various aspects of IPR like GI, patenting, IPR and WTO related issues, IPR rights etc. Delivered several lectures on IPR to students and farmers and provided consultancy services to farmers.

Table 3. Varieties released from IISR with potential for registration under PPV&FR Act

Black pepper	Subhakara, Sreekara, Panchami, Pournami, PLD-2, IISR - Thevam, IISR - Girimunda, IISR - Malabar Excel, IISR - Shakthi
Cardamom	IISR - Kodagu Suvasini, IISR - Avinash, IISR - Vijetha-1
Ginger	IISR - Varada, IISR - Mahima, IISR - Rejatha
Turmeric	Suvarna, Suguna, Sudarshana, Prabha, Prathibha, IISR - Kedaram, IISR - Alleppey Supreme
Cinnamon	Nithyasree, Navasree
Nutmeg	IISR - Viswasree

Conclusion

India is a signatory of WTO and enactment of requirements of TRIPS agreement is mandatory in our country. IP laws and rules are already established in our country. Nobody can be an exception. Innovators who are IP illiterate or averse to IP protection will be the losers. A review of intellectual property rights in spices in India points to the vast unexploited possibilities. Though India has more than 50 percentage of the cultivated spices in the world and occupies the position of largest producer and exporter of spices, arena for IP protection is poorly exploited.

Researches have been carried out or ongoing on various aspects of spices production, processing and extraction of useful components at research institutes and individual levels. Most of these researches are quite expensive and hence the outcomes should be patented to reward the inventers. Central research councils like ICAR and CSIR have already initiated efforts in this regard. Technical and financial constraints exist at individual level. Agencies like National Research Development Council (NRDC) have to assume responsibility in such cases. Large numbers of trademarks have been registered on spices. Simplified procedures and awareness of business community regarding benefits of registration might be the reasons for proliferation of trademarks in spices. Very limited numbers of GIs are registered on Indian spices. Procedural requirements, like proof for unique characteristics and its correlation with geographical origin, demands more time and effort. A modern biotechnology tool like molecular profiling has been found useful in proving the uniqueness of the product. Moreover, except in the case of Naga Mircha, Spices Board is the sole agency involved in the GI registration of spices. Since the GIs are the sort of community rights, concerned communities should be involved in the GI registration of spices by forming producer associations or other forms of institutions. A serious concern exist with regard to protection of spices varieties. Spices are not yet notified as eligible for protection under PPV&FR Act. This issue is to be taken care, since registration is necessary to protect the promising varieties of spices.

From the preceding discussions it can be comprehended that a lot of opportunities and challenges exist in the sphere of intellectual property rights in spices. They can be managed with existing institutional mechanisms, assuming widespread IP awareness among all sections of the society.

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Approach and strategy for spices development in the North East

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Agricultural pattern of spices

In the North Eastern Region (NER), comprising of eight states (Arunachal Pradesh, Assam, Manipur, Mizoram, Meghalaya, Nagaland, Tripura, Sikkim) no sign of green revolution is visible. The agricultural production system is predominantly rainfed and monocropped at subsistence level. Shifting cultivation (Jhum) is practiced in all the states, except Sikkim, with shifting cycle of 2-3 years. Crop production practice falls under two broader categories *viz.,* (a) settled farming in plains, valleys and terraced slopes (b) shifting cultivation in unterraced hill slopes with slash & burn method.

The NER has diverse and favourable agroclimatic conditions with abundant rainfall, which offer immense scope for horticultural development, including spices. Among the various spice crops, the region is known for high quality ginger, turmeric, chillies and large cardamom. Black pepper is also showing some promise in a few pockets. The crop wise area and productivity of major spices at pre-Horticulture Technology Mission (HTM) period are tabulated below (Table 1).

Table 1. Area and productivity of major spices in NER and India in 1997-98

North eastern region			India	
Crops	Area (000' ha)	Productivity (t ha^{-1})	Area (000' ha)	Productivity (t ha^{-1})
Ginger	16.4	6.4	67.2	3.5
Turmeric	13.6	1.5	124.6	3.9
Chilli	29.7	0.8	831.5	0.98

Source: National Horticulture Board Yearbook (2002)

Impact of Horticulture Technology Mission (HTM) on spice development

The technology mission launched by the DAC of Ministry of Agriculture in 2001-02 in its programme gave due emphasis on the development of important spices grown in the region and till 2006-07 in terms of additional area expansion status, spices enjoyed second position after fruit crops ahead of vegetable crops. The major achievements in different Mini Missions (MM) are presented briefly below.

Mini Mission I (research)

Under MM I, promising varieties of important crops were identified, limited quantity of planting material of elite varieties multiplied and distributed as base materials and training organized for state extension functionaries. The consolidated report of MM I for the period 2001-2008 indicates the following major achievements.

i) Planting material production

- Ginger cvs. Nadia, Thinglaidon, Gorubathan/ Bhaisay – 48 Q
- Turmeric cvs. Lakadong, Megha Turmeric 1- 94 Q
- Black pepper vars. Panniyur 1, Karimunda - 16000 cuttings

ii) Production technologies covering organic production and disease control in selected spices developed

iii) Training imparted to field extension workers of different NE states imparted to a great extent

Mini Mission II (production including area expansion)

During the period 2001-02 to 2006-07, a total of 3,34,720 ha has been additionally brought under spices in the NER. Among the NE states area expansion was highest in Tripura (9133 ha), followed by Arunachal Pradesh (6370 ha). The state wise additional area brought under spices (Table 2) amply demonstrate that due emphasis has been given to major spice crops like ginger, turmeric, chilli and large cardamom. The total area under ginger and turmeric in the region is reported to be 33,240 ha and 16,225 ha respectively. Considering the area coverage figures of ginger as shown in Table 1 (pre-HTM period), the total area in ginger has almost doubled mainly due to HTM intervention.

Table 2. Area expansion with spice crops under HTM during 2001-02 to 2006-07 in NE states

State	Area (ha)
Arunachal Pradesh	6370
Assam	4088
Manipur	3133
Meghalaya	2225
Mizoram	2366
Nagaland	5640
Tripura	9133
Sikkim	1765

Mini Mission IV (processing)

Till April-May 2005, three processing units were established and upgraded with HTM funding support of about Rs. 104 lakhs. The three units are

1) Spices oil and oleoresin unit at Brnihat, Meghalaya by J.P. Spices Ltd.
2) Ginger processing unit at Byrnihat, Meghalaya by NERAMAC and
3) Ginger processing unit, Imphal East District, Manipur by United Development Agency

Success stories under MM II - Case studies in Nagaland

- Healthy planting materials of ginger cv. Nadia were supplied to a group of farmers of Phek District in February 2005. By cultivating ginger the farmers earned Rs. Ten thousand in October 2005 by selling ginger flowers and Rs. four lakhs in January 2006 by selling seed rhizomes. The 'Nadia ginger' has become very popular in the district.
- At Ponglwa and Galia village in Paren District (35 km from Dimapur) about 450 farmers cultivate Nadia variety of ginger in 80 ha land and harvested about 500-550 tons of rhizome. The crop is grown

organically and it is reported that the two villages generated about Rs. 15-20 lakhs income every year from ginger crop.

- Since 2001, about 60 ha have been brought under large cardamom in the Khonoma village of Kohima District involving 163 households. It is reported that dry capsule yield of about 100 kg ha^{-1} and average income of Rs. 60 thousand per ha could be realized by growing large cardamom.

Strategies for further growth

Ginger

Raised bed ginger production in hill slopes allows good drainage and slow burning process of the raised bed soil helps in destroying some soil borne pathogens. Burning, however, is not a very desirable practice as it affects soil fertility levels. Since bio-control agents are to be encouraged it is reported that some local isolates of *Trichoderma* sp. are effective against soft root disease both in Assam and Sikkim. Seed treatment before planting with such beneficial microorganisms should be made mandatory.

Since ginger rhizome productivity is high in Assam (Karbi Anglong area) and Arunachal Pradesh, area expansion with low fibre varieties is to be planned. Processing support provided under HTM need to be further extended. Good quantity of fresh ginger is exported from Sikkim for long distant market. APEDA report shows that in 2001-02 about 1640 tons of ginger was exported from NER, while NERAMAC report shows that ginger oil/ oleoresin production is gaining momentum in the North east. APEDA has identified AEZ for ginger in Sikkim and this is the right time for creating infrastructure for value addition of ginger.

The Spices Board plans that by 2012 organic ginger production will be expanded by covering at least one district in all the NE states. Present practice of organic ginger production is nothing but natural farming and hardly any scientific input to address balanced nutrition and plant protection is provided. The science component of organic production must be considered in the Spices Board programme for long term sustainability.

Turmeric

High curcumin containing varieties/ selections like Lakadong and Mega Turmeric-1 need to be mass multiplied for area expansion. Curcumin content being a location specific phenomenon, selection of suitable sites (eg. Jowai of Jaintia hills of Meghalaya, parts of Nagaland) is to be undertaken for saturating with high curcumin containing varieties.

Increasing productivity of turmeric to at least 4 t ha^{-1} is essential and should be possible. Foot hills and mid-hills of Arunachal Pradesh, Nagaland, Meghalaya and Karbi Anglong experiencing more than 1500 mm annual rainfall and with well drained sandy to clayey loam soil are better suited for turmeric area expansion.

High curcumin containing turmeric and organic turmeric are preferred for export outside India. Turmeric having more than 7% curcumin on dry weight basis is produced in NER and such produce will fit well in meeting international quality standards. Turmeric processing (drying, powdering, packaging etc.) also need organized support.

Large cardamom

Large cardamom farming as an under-storey crop in the hill slopes of Sikkim is an unique traditional production system. Prior to launching of HTM, cardamom area was reported to be around 23,000 ha and an additional area expansion of 3775 ha was reported under HTM till 2003-04. Cardamom is considered a high value commodity in Sikkim and generates employment for 80-100 days per ha. Spices Board, should plan to expand large cardamom area in other states as 'forest floor farming' under the shade of natural forests or under nitrogen fixing Alder afforestaion.

Dehydration / drying and packaging of cardamom capsules need to be improved. Improved small scale cardamom dehydration plant/ machineries need to be supplied to cardamom farmers with HTM assistance.

Black pepper

Black pepper can be grown in wide range of soil with pH range 4.5 to 6.0. Eastern part of Assam and adjoining areas in Arunachal Pradesh; southern part of Assam adjoining Nagaland; Karbi Anglong District of Assam; Parts of Tripura in the rubber plantation zone are well suited for black pepper. Healthy rooted cuttings of promising varieties (Panniyur 1, Karimunda) are to be supplied, preferably after treating with bio-control agents reported to be affective against root wilt pathogens.

Under arecanut based HDMSCS, yield of areacanut, black pepper and citrus were recorded as higher at 2/3rd of the recommended fertilizer dose. Also, employment generation of 450-475 person days per ha was recorded under this mixed cropping practice, as compared to 250 – 275 person days in arecanut mono cropping practice. Black pepper farming in arecanut stands is recommended in NER experiencing 1250 to 2000 mm annual rainfall.

Chillies

Chilli is a well adapted crop of North eastern states. In addition to common chillies, traditional 'Naga chilli' and 'Bird eye chilli' are unique to this region. Humid to sub-humid climate with 600 to 1250 mm rainfall and temperature range of 16 to 24^{o} C during growing period are ideal for production of good quality chillies. Excessive rainfall, water logging are harmful and such areas are to be avoided.

'Char' area of Assam, valleys between tillas in Tripura and Manipur valleys are better suited areas for chilli production. Hottest chilli is reported form certain pockets of Tezpur of Assam. Area expansion should take place in such niches. The ITC has already entered with an agreement with Nagaland government for production of organic chilli. Greater focus in needed for larger scale use of bio-fertilizers and bio-pesticides for organic production of chilli, for which the demand is growing.

Organic production of spices

To achieve further economic growth from spice crops of NER, the following intervention are suggested. Funding support from HTM, NABARD, NEDFI and others should be possible.

- Ginger and turmeric varieties identified for having better processing qualities to be multiplied for further area expansion in newer area. The production packages for maximization of yield both under normal and organic farming situations need to be suggested by the R & D institutions under the leadership of ICAR Research Complex of NEH Region and the MM 1 of HTM. The past successful model/ mechanism of production and distribution of planting material of Nadia variety of ginger to different NE states may be replicated with desired modifications.
- Standardization of post harvest handling practices for the tribal farmers and value chain development through public-private partnership as attempted in case of seed spices under NAIP of ICAR should receive priority attention of research organizations of NER.
- Value addition and product diversification have not received much attention, mainly due to slow entrepreneurship development in the region. Up scaling of technologies for packaging of turmeric and ginger products, extraction of oleoresin/ oil from chilli and, ginger mechanical drying of cardamom, black pepper, chilli and suitable refinements to suit the local conditions are suggested.

Spices production in India-
Potential of North eastern states in spices production

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India with its varied agro-climatic region produces about 63 spices, of which the economically important ones are chillies, black pepper, ginger, turmeric, cardamom, coriander, cumin, fennel, fenugreek, ajwan seed, dill seed, cloves, nutmeg, cinnamon, saffron, vanilla *etc.* Spices are low-volume and high value commercial crops, playing an important role in agricultural economy of the country. Almost all states in the country produce one spice or other. During the year 2007-08, our country produced 4.1 million tonnes of spices from an estimated area of 2.6 million ha. About 8 -10% of total spices produced in the country are exported which form 49 % of the global spices trade, in terms of quantity, and 44 % in terms of value, as sourced from Spices Board .

The increasing trend towards eating ethnic or oriental foods in the developed countries and the increasing affluence of consumers in Asian and Latin American & Middle eastern developing countries have lead to the increase in world spices consumption. As a result, the world import of spices recorded a 6% annual growth rate during the last decade. This increase in world spice consumption holds good promise in the coming years for the spice industry both domestic as well as international.

Over the past decade, the Indian Spices industry has made quality, the cutting edge of its global game plan. The present trend in export of spices shows that, India can take over the world market, which seemed to be slipping out of its hand in the recent past. One of the major causes for worry for domestic spices industry is the low farm productivity in the majority of spices grown leading to higher cost of production.

Present status

The area and production of spices in India shows an annual growth rate of 1.5% and 5.3%, respectively during the last decade. The present spices production in the country is in the order of 4.10 million tonnes from an estimated area of 2.60 million ha. Chilli is the major spice crop occupying about 29 percent of area under cultivation and contributing about 30.4 percent of total spices production in the country. Turmeric accounts for 20% of production and 7 % of area, garlic accounts for 20% of production and 7% of area. Seed spices 13% of production and 37% of area, pepper, 2 % of production and 9 % of area of the total spices in the country. Crop wise area, production and productivity of spices in India for the last two years is given in Table 1.

Table 1. Crop-wise area and production of spices in India for the last 2 years

(Area:'000 ha, Production:'000 tons)

Crop	2006-07 (Revised)			2007-08		
	Area	Prod.	Yield	Area	Prod.	Yield
Black pepper	236.59	68.81	291	241.80	67.52	279
Ginger	106.13	376.90	3551	105.99	375.85	3546
Chillies	761.24	1233.41	1620	764.88	1243.55	1626
Turmeric	185.20	836.43	4516	180.01	829.53	4608
Cardamom	104.17	17.07	164	100.23	16.10	161
Garlic	150.81	710.40	4711	167.95	810.38	4825
Coriander	321.34	232.84	725	397.51	242.84	611
Cumin	363.72	129.77	357	429.38	172.47	402
Fennel	48.47	65.51	1352	48.53	62.25	1283
Fenugreek	45.86	53.76	1172	55.17	55.45	1005
Ajwan	16.49	9.87	599	3.24	1.63	503
Other seed spices (1)	17.71	10.71	605	17.71	10.71	605
Clove	2.12	1.02	481	2.12	1.02	481
Nutmeg	13.83	11.52	833	13.83	11.52	833
Tamarind	58.11	184.78	3180	59.74	192.12	3216
Cinnamon	0.86	1.67	1932	0.86	1.67	1942
Tejpat	3.77	8.29	2199	3.69	7.72	2092
Others (2)	10.32	0.27	26	10.32	0.27	26
Total	2446.74	3953.03	1616	2602.96	4102.59	1576

Rajasthan occupies the major area under spices owing to seed spices cultivation in the country followed by Andhra Pradesh, Kerala, Karnataka, Madhya Pradesh and Gujarat. Andhra Pradesh, which is the foremost state producing chilli and turmeric in the country, ranks first in terms of production followed by Rajasthan, Madhya Pradesh, Tamil Nadu, Orissa, Karnataka and Kerala. Major spices grown in different states are given in Table 2.

Table. 2. Major spices produced in different states

State Spices Produced

Andhra Pradesh	Chilli, Turmeric, Coriander, Ginger, Black pepper, Garlic
Arunachal Pradesh	Ginger, Turmeric, Chilli
Assam	Chilli, Turmeric, Black Pepper
Bihar	Chilli, Garlic, Turmeric, Ginger, Seed spices

Chhattisgarh	Garlic, Chilli, Seed spices, Ginger
Gujarat	Garlic, Seed spices, Ginger, Turmeric
Haryana	Garlic, Chilli, Seed spices
Himachal Pradesh	Ginger, Chilli, Turmeric, Saffron, Seed spices
Jammu & Kashmir	Saffron, Chilli, Seed spices
Karnataka	Chilli, Turmeric, Ginger, Black pepper, Garlic, Tree spices, Seed spices, Vanilla
Kerala	Black Pepper, Ginger, Turmeric, Garlic, Tree spices, Chilli, Vanilla, Cardamom
Madhya Pradesh	Garlic, Chilli, Seed spices, Ginger, Black pepper, Turmeric
Maharashtra	Chilli, Garlic, Ginger, Turmeric, Seed spices, Black pepper, Tree spices
Manipur	Chilli, Ginger
Meghalaya	Ginger, Turmeric, Chilli, Black pepper, Tree spices
Mizoram	Ginger, Chilli, Turmeric, Black pepper
Nagaland	Ginger, Chilli, Black pepper
Orissa	Garlic, Chilli, Ginger, Turmeric, Seed spices
Punjab	Garlic, Chilli, Seed spices
Rajasthan	Seed spices, Chilli, Ginger, Turmeric, Garlic
Sikkim	Ginger, Turmeric, Large Cardamom, Tree spices
Tamil Nadu	Turmeric, Seed spices, Garlic, Ginger, Black pepper, Vanilla
Tripura	Ginger, Turmeric, Chilli
Uttar Pradesh	Ginger, Turmeric, Chilli, Garlic, Seed spices,
Uttaranchal	Ginger, Chilli, Garlic, Seed spices,
West Bengal	Chilli, Ginger, Turmeric, Large Cardamom
Pondicherry	Black Pepper, Chilli, Tree spices, Turmeric
Andaman & Nicobar	Black Pepper, Tree spices, Ginger
Delhi	Chilli, Seed spices

India exported 0.44 million tons of spices valued at US $1101.8 million (Rs 4435.5 crores) during the year 2007-08, to more than 150 countries around the world. The Indian spice export which was to the tune of 2.25 lakh tons valued at Rs 1231 crores during 1996-97 rose to the all time high of 4.44 lakh metric tons valued at Rs 4435.5 crores during 2007-08, which registered an annual growth rate of 6% in quantity and 12% in value. Export of various spices and spice products from India during the last three years is given in Table 3.

Table 3. Item-wise export of spices from India during the last three years

	2005-06		2006-07		2007-08	
Spices	Quantity (tons)	Value (Rs in lakhs)	Quantity (tons)	Value (Rs in lakhs)	Quantity (tons)	Value (Rs in lakhs)
Black pepper	17,363	15,095	28,750	30,620	35,000	51,950
Cardamom (S)	863	2,682	650	2,236	500	2,475
Cardamom (L)	1,046	1,155	1,500	1,695	1,325	1,500
Chilli	113,174	40,301	148,500	80,775	209,000	109,750
Ginger	9,411	4,296	7,500	3,975	6,700	2,800
Turmeric	46,405	15,286	51,500	16,480	49,250	15,700
Coriander	23,756	6,771	20,500	7,462	26,000	11,025
Cumin	12,879	9,819	26,000	20,150	28,000	29,150
Celery	4,165	1,501	3,550	1,321	2,900	1,325
Fennel	5,725	2,782	3,575	2,380	5,250	2,850
Fenugreek	15,525	3,403	8,500	2,699	11,100	3,300
Other seeds (1)	12,670	3,322	8,000	2,240	8,850	3,125
Garlic	34,688	4,798	11,500	2,128	675	400
Nutmeg & Mace	1,530	3,117	2,100	4,274	1,300	2,875
Vanilla	72	1,227	125	1,996	200	1,775
Other spices (2)	21,134	7,493	19,500	7,280	19,000	8,100
Curry powder/paste	9,340	7,838	9,500	8,693	11,500	11,100
Mint products (3)	14,544	81,321	16,250	110,095	21,100	128,050
Oils and oleoresins	6,074	50,557	6,250	51,079	6,600	56,300
Total	**350,363**	**262,762**	**373,750**	**357,575**	**444,250**	**443,550**

(1) Includes Ajwan seed, Dill seed, Poppy seed, Aniseed, Mustrad etc. (2) Includes Asafoetida, Cinnamon, Cassia, Cambodege, Saffron, Spices (NES) etc (3) Includes menthol, menthol crystals and mint oils

According to Spices Board, India commands a formidable position in the world spice trade with 49% share in volume and 44% in value.

The major constraint faced by India in exporting spices is the fall in unit prices of spices in the international markets. This is due to the increased supply from newly emerged competitors like Vietnam, Thailand, China, Guatemala *etc*. These producers have no domestic market which makes them to push their entire produce to the international market, making the traditional exporters like India to bear the brunt. India though a major producer of spices, exports only around 8-10% of its production as it has a strong domestic market. The major constraints in export of spices are the lack of surpluses at international competitive prices for export, quality issues, port congestions, lack of infrastructure and credit. This situation is gradually changing India to become one of the major importers of spices also. In some traditional item like pepper, where India was once a major player, the situation has drastically changed to make India a major importer.

Before 2001-2002, Indian spice industry was protected from import of spices from outside. Due to WTO agreement, India has removed quantitative restrictions on import of spices and other agricultural products since 1999-2000. Due to similar agro-climatic conditions prevailing in other countries and also very high price realized for selected spices new countries are emerging as major producers of spices. Lack of adequate domestic demand and lower cost of production in these new emerging countries poses a major threat to Indian spice industry. Hence, import of spices into India has gone up since 2001-02. Table 4 shows an increase in import of spices from 2000-01 to 2007-08.

Table 4. Import of spices in India in the recent years

Year	Quantity ('000 tons)	Value (Rs. in lakhs)
2000-01	44.14	25509.38
2001-02	86.34	50507.65
2002-03	121.37	58873.11
2003-04	126.24	56363.72
2004-05	99.10	54023.93
2005-06	90.41	53924.00
2006-07	95.41	60386.70
2007-08	90.00	64550.00

Table 5. Item-wise import of spices in India

Spice	2005-06		2006-07		2007-08	
	Quantity (tons)	Value (Rs in lakhs)	Quantity (tons)	Value (Rs in lakhs)	Quantity (tons)	Value (Rs in lakhs)
Black pepper	16,870	10,358	15,750	13,642	13,500	19,389
Cardamom (Small)	437	432	625	570	875	868
Cardamom (Large)	4,935	4,003	6,275	5,468	5,850	4,635
Chilli/Paprika	933	444	1,250	803	475	361
Ginger Fresh/Dry	23,680	4,663	20,700	2,450	22,500	3,275
Turmeric	4,022	1,676	6,700	2,391	4,650	1,227
Coriander	1,838	814	1,660	720	1,000	620
Cumin black/white	906	624	1,000	879	2,000	1,850
Mustard Seed	3,095	641	3,320	740	2,520	636
Poppy seed	5,798	2,106	8,250	3,758	5,300	3,616
Garlic	2,771	587	1,080	193	4,050	552
Clove	7,721	13,117	7,250	11,285	8,450	11,910
Nutmeg	862	1,244	940	1,369	950	1,625
Mace	525	1,481	695	1,868	300	790

Cassia	9,721	2,763	11,100	3,362	8,900	3,035
Star anise	2,232	1,218	2,210	1,253	1,725	950
Other spices (1)	3,697	6,039	6,200	7,598	6,575	6,435
Oils & oleoresins (2)	367	1,713	400	2,036	380	2,775
Total	**90,412**	**53,924**	**95,405**	**60,387**	**90,000**	**64,550**

(1) Includes Aniseed, Asafoetida, Cinnamon, Pepper long, Cambodge, Herbal spices and Spices NES
(2) Includes Spice oils & oleoresins and Mint products (Source: Spices Board, Cochin)

Constraints in spices production

1. One of the major constraints in most of the spice production system is the low farm productivity and consequent high cost of production
2. Crop loss due to severe disease and pest incidence.
3. Non-availability of quality planting materials
4. Inadequate extension network
5. Price instability

To keep ourselves afloat as a major player in the world spice market, a well concerted effort is required from research, development and marketing agencies working in spice sector. Development of varieties resistant to major pests and diseases and production oriented technological packages workable at the farm level is the need of the hour to boost the productivity and bring down the cost of production. Development of infrastructure for multiplication and distribution of quality planting material of improved varieties for easy access to the farmers should be given the priority. Investment in processing sector to develop new end products and to increase the range of uses of Indian spices / spice products has to be considered seriously. Entrepreneurs in processing and marketing field should be adequately supported.

Emphasis should also be given for organic spice production and its marketing as the demand for organic spices in the world market is reported to be increasing at a very high rate.

National Horticulture Mission

The National Horticulture Mission (NHM) launched by the Ministry of Agriculture, Government of India during 2005-06 aims at doubling the production of horticultural crops including spices by the end of eleventh plan, primarily focusing on increase in crop productivity.

Following are the major development programmes under National Horticulture Mission.

- Production and productivity improvement
- Production & distribution of planting material
- Model nurseries
- Small nurseries
- Tissue culture units
- Seed infrastructure
- Rejuvenation / Replacement of senile plantations
- Promotion of integrated nutrient management/Integrated pest management
    - Disease forecasting units

- Plant health clinics
- Biocontrol labs
- Leaf/tissue analysis labs.

- Technology dissemination through demonstrations/ front line demonstration
- Post harvest management

Potential of North-eastern states in spices production

North-eastern region of India, comprising of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim harbours a rich flora on account of its varied topography, climate and altitudes and has great potential for the development of horticulture crops including spices.

The land utilization pattern in the NE region shows that only about 50% of the area is under forest and only 16.4% land comes under net area sown category. It is thus apparent that almost one-third land area in the region remains unutilized and the proposition for expansion of horticultural crops holds good promise.

In so far as spices crops are concerned, vast scope exists for development, particularly for ginger, turmeric, chillies, black pepper, tree spices like clove and cinnamon, and aromatic crops.

Ginger is one of the important spice crops grown in North-eastern states particularly in the states of Meghalaya, Mizoram, Arunachal Pradesh, Nagaland *etc*. It is estimated that 50% of the national production ginger comes from the North-eastern States. The variety of ginger mainly grown is Nadia and Rio-de-Janeiro. Of these, Nadia has been found to give higher yield upto about 10 t per ha. This variety also has least fibre content. The volatile oil content (oleoresin) in dry ginger powder of this variety varies between 1.2 to 1.5%.

Lakadong turmeric obtained from Meghalaya has the highest content of curcumin and has lot of industrial demand. Similarly, Naga chillies has the credit of having highest pungency of all the varieties in the world.

With the best efforts put into in the past plan periods, introduction of different cultivars/ varieties of black pepper was done and their cultivation is however gaining momentum. As adequate rainfall, high humidity and warm climate are ideal for its growth, the cultivation of black pepper can further be extended to the plains and near foot hills in the entire region. It can also be encouraged to be grown as a backyard plant by the tribals as the produce could be dried and marketed without difficulty.

The region is well suited for development of a good number of tree spices particularly clove and cinnamon. There are quite a number of suitable pockets where high humidity, good rainfall (150-250 cm annually) optimum elevation (up to 900 m) equable temperature and laterite or loamy soils rich in humus ideal for tree spices are available. The clove can very well be grown in association with existing fruit trees which provide necessary shade.

There are two types of cinnamon *viz*. C. *zeylanicum* and C.*tamala,* grown in the region. The former is mainly grown for its bark which gives cinnamon of commerce. For leaf oil the later is preferred. Oil extracted from the bark and leaf is of great commercial value, domestic demand for which is on the increase.

To strengthen the horticulture sector in North-East, well coordinated and concerted efforts should be made by all development and research agencies involved in the sector with the following strategies in mind.

i) Strengthening the infrastructure set up
ii) Self sufficiency in planting materials
iii) Effective transfer of technology
iv) Encouragement for scientific cultivation and soil and water management
v) Organized marketing, scientific storage and value addition

Following development efforts should be given priority to popularize the cultivation of spices crops among the farmers.

1. Demonstration cum progeny gardens of spices established in North eastern States to be strengthened so as to serve as centres of excellence in spices cultivation, as progeny gardens for planting material production, as a demonstration centre for transfer of technology, training centre for farmers and extension workers *etc.*
2. Extension machinery of the state horticulture department to be strengthened with adequate technical support and infrastructure facilities.
3. Self sufficiency for various planting materials of spices by setting up of progeny gardens and nursery centres in all the potential centres of cultivation. Transfer of technology by field demonstrations, method demonstrations, farmers training programmes, field visits and farmers exchange programme in association with the traditional centres of cultivation.
4. Co-operative marketing to be streamlined with adequate procurement, storage and processing centres so as to avoid glut in the market and post harvest facilities to facilitate value addition.

Centrally sponsored schemes in North eastern states

Development activities in horticulture in the North-eastern states are covered under the centrally sponsored scheme, the Technology Mission for Integrated Development of Horticulture in North eastern region including Sikkim (TMNE). The scheme aims at establishing convergence and synergy among numerous ongoing governmental programmes in the field of horticulture development to achieve horizontal and vertical integration of these programmes which will ensure adequate, appropriate, timely and concurrent attention to all the links in the production, post harvest and consumption chain. The Small Farmer's Agribusiness Consortium (SFAC) is involved in coordinating the scheme.

The Technology Mission through its four Mini Missions addresses all the aspects of horticulture development with an end-to-end approach. Mini Mission-I involving research is coordinated and implemented by the Indian Council of Agricultural Research (ICAR). Mini Mission-II covering production and productivity improvement activities is coordinated by the Department of Agriculture & Cooperation and implemented by the Agriculture/ Horticulture Departments of the States. Mini Mission- III involving post harvest management, marketing and export is coordinated by National Horticulture Board and Mini Mission-IV involving processing is coordinated and implemented by the Ministry of Food Processing Industries. State level SFACs have also been constituted in most of the implementing States for monitoring and implementing the programme at the grass-root level.

During the years 2001-02 to 2008-09, an amount of Rs 1055.73 crores have been released under the Mission, for the integrated development of horticulture in NE states. Under the scheme, 58,443 ha has been brought under spices cultivation.

Conclusion

With globalization and free trade it becomes imperative that India produce its spices at a competitive price and with quality standards as prescribed by the importing countries so as to compete with other producing countries in the world market. Lots of expectations are pinned on to the centrally sponsored schemes under National Horticulture Mission and Technology Mission on Integrated Development of Horticulture in North east. There are also enough funds earmarked for the same. However, to achieve the objective as envisaged in it there should be a concerted effort from the research, development and marketing agencies working in the sector. They should work in tandem and mobilize a farming community to achieve the broader objective of making India a global power in spices.

Genetic diversity in large cardamom and its suitability to North eastern states

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Introduction

Cardamoms are the dried seed capsules of a small group of species of plants belonging to the family Zingiberaceae which contain seeds possessing a pleasant characteristic aroma and flavour. These are broadly grouped in to two categories:

- Small cardamom- popularly known as 'Chota Elaichi' (*Elettaria cardamomum*) or the true cardamom. It is also known as "Queen of Spices'.
- Large cardamom – 'Bada Elaichi' (*Aframomum* and *Amomum* species)

Amomum subulatum Roxb. is the greater Indian or Nepal cardamom which is also called large cardamom. The presence of several wild relatives and the tremendous variability within the cultivated species support the view of its origin in Sikkim (Subba, 1984; Rao *et al.,* 1993a; Singh and Singh, 1996). The order Zingiberales (formerly known as Scitamineae) to which the family Zingiberaceae belongs appears to have originated as wild plants in the tropical evergreen forests. Zingiberaceae, the largest family of this order, is found throughout the tropics.

The North eastern India has largest concentration of Zingiberaceous flora (next to Malaysia) especially in number of genera. The family is represented here by 19 genera and 88 species out of 22 genera and about 170 species reported from India (Ved Prakash and Mehrotra, 1996). This family has provided important aromatic spices that are widely used. The important spices of this family are *Zingiber* (ginger), *Curcuma* (turmeric), *Alpinia* (galangal), *Kaemferia*, all representing rhizomatous spices and *Elettaria* (small cardamom), *Amomum* and *Aframomum* (large cardamoms) representing seed spices (Anonymous, 1977). Earlier explorers like Baker (1890) have listed eight species of Amomums from eastern tropical Himalayan region (North eastern states) *viz., A. aromaticum* Roxb., *A. corynostachium* Wall. ,*A. costatum* Benth., *A. dealbatum* Roxb., *A .kingii* Baker, *A. pauciflorum* Baker, *A. linguiforme* Benth. and *A. subulatum* Roxburgh. However, later workers like Ved Prakash and Mehrotra (1996) listed only six species of Amomums, out of which the occurrence of *A. fulviceps* in North East India is yet to be confirmed. Hence, only five species are recorded and the occurrence of *A. costatum*, *A. linguiforme* and *A. kingii* have not been confirmed in recent times.

Large cardamom (*Amomum subulatum* Roxb.) is a perennial cash crop grown in the hills of Nepal, Darjeeling hills, Sikkim and Bhutan. Generally the cardamom is grown under agro-forestry system in the Himalayas either under the Himalayan alder (*Alnus nepalensis*) or mixed forest tree species. This has proved to be a sustainable land use practice supporting multiple functions and ecosystems. This system helps in the management of slope land and helps in conserving soil and water and maintaining soil fertility by organic recycling. The area under this crop is about 26,000 ha with an annual production of 4500 to 5000 tons (Anonymous 2007). The area, production and productivity are given in the Table 1. This crop thrives well in 6C to 25°C with well distributed annual rainfall of 200-350 cm. It is well adapted to the hilly forest ecosystem where the fertility status is high due to natural nutrient recycling. However, the area and production of large cardamom has been decreasing in the recent years. The production in Sikkim during 2004-05 was 24,000 ha with an annual production of 6500 t and has come down to 12,500 ha with an annual production of 3000 t during 2006-07. Apart from Sikkim and Darjeeling District of West Bengal, large cardamom is also cultivated to a limited extent in some of the other North Eastern states. The area and production in the North eastern states are given in Table 2. There is tremendous potential to increase the area, production and productivity in other NE states.

Table 1. Area and Production of large cardamom

Year	Sikkim			West Bengal		
	Area (ha)	Production (t)	Productivity (kg ha^{-1})	Area (ha)	Production (t)	Productivity (kg ha^{-1})
2002-03	26,734	4650	205	3274	650	241
2003-04	26,734	5401	242	3305	753	279
2004-05	26,734	4980	223	3305	793	292
2005-06	26,734	4477	200	3305	708	261
2006-07	26,734	3910	202	3305	510	210
2007-08	26,734	4,358	225	3,305	614	226

Source: Annual Report, Spices Board

Table 2. Area and production of large cardamom in other NE states (2006-07)

State	Area (ha)	Production (t)
Arunachal Pradesh	3542	532
Nagaland	550	50
Mizoram	35	NA
Meghalaya	35	NA
Manipur	65	7.5

North Eastern Hill Region (NER)

The North Eastern Hill Region comprises states of Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura, constitute 5.6 % of India's geographical area (1,83,741 sq.km) and supports 1.2% of India's population (1.23 crores). The region is characterized by difficult terrain, wide variations in slopes and altitude, fragility, inaccessibility, cultural heterogeneity, ethnicity and rich biodiversity. Land tenure systems and cultivation practices are also quite diverse. Including Assam, around 56% of the total area is under low altitude (270-1500 m msl), 33% mid altitude (1500-2000 m msl) and the rest (11%) under high altitude (2000-3000 m msl). The climate varies from sub-tropical to temperate. The annual rainfall is 2000 to 4000 mm. The region receives 12.1% of India's precipitation. The soil pH is acidic to strongly acidic (4.5 to 6.5) but rich in organic matter. Agriculture is the mainstay of the region and 82 % of the people depend on it. Farming is predominantly rain fed, rice-based with exception of Sikkim where maize is a dominant crop. The system is characterized by low cropping intensity (114%), subsistence level and mono-cropping. Over 60 % of the population is cultivators, 9.28% are agricultural labourers and nearly 8% depends on livestock, forestry, plantation and orchard *etc*. The average landholding is 2.7 ha/person but the entire holding is not cultivable due to rugged topography. The net sown area is about 1.2 m ha *i.e.,* 7 % of NER total area . The net sown area is the highest in Tripura and lowest in Mizoram. Mixed farming system is the order as most of the farmers want to meet his household food and nutritional need without having dependency on outside resources. The system supports a large number of horticultural crops and animal husbandry partly due to their complementary role in agriculture and partly to meet their animal protein requirement as all the tribal communities are non-vegetarian.

More than 80% of people in NER are living in remote places and their problems, needs and resources vary from state to state. They are often unable to adopt modern technologies because of inaccessibility and or non-availability of inputs, technologies and other reasons. About 126 tribal communities constituting 60% of NEH population inhabit the region. They have their own culture and indigenous methods of cultivation. Some of the traditional system of cultivation are the *jhum* system or shifting cultivation (practiced in seven states), *bun* system (in Meghalaya), *jabo* system (by Chakhesang tribe of Nagaland), *tilla* system (in Tripura and Assam), *panikheti* system (by Apatani tribe of Arunachal Pradesh), alder based farming system (by Angami, Chakhesang and Konyak tribe of Nagaland) and large cardamom based agroforestry system (by Lepcha, Bhutias of Sikkim). These systems are prevalent since ancient time and it is said to overcome the problems of heavy rain, high humidity and low temperature. The major spice crops cultivated in these regions are large cardamom, pepper, ginger, turmeric, chillies (highly pungent varieties), garlic and tejpat. Area and production of spices in NE states are given in Table 3.

Table 3. Area and production of spices in NER

State	Spice	Area ('000 ha)	Production (t)
Arunachal Pradesh, 2005-06	Ginger	8.71	37399
	Large cardamom	4.52	583
	Black pepper	1.61	135
Assam, 2006-07	Black pepper	3.23	5000
	Chillies	15.45	9980
	Turmeric	11.74	8540
	Ginger	18.75	128900
	Onion	6.87	16780
	Garlic	6.71	22180
Manipur, 2005-06	Chillies	6.49	NA

	Ginger	2.24	NA
	Onion	1.76	NA
	Turmeric	0.2	NA
	Total spices	11.01	5300
Meghalaya, 2004-05	Chillies	1.84	1303
	Ginger	9.22	47138
	Turmeric	1.63	8752
	Tejpat	5.95	13924
Mizoram, 2007-08	Chillies (Birdeye)	0.10	200
	Turmeric	4.17	83500
	Ginger	3.589	57010
Nagaland,2004-05	Chillies	0.810	1365
	Turmeric	1.10	4200
	Ginger	1.21	4730
	Black pepper	0.370	360
	Large cardamom	0.55	550
Tripura, 2006-07	Chillies	1.83	2085
	Turmeric dry	1.15	3381
	Ginger	1.42	4170
Sikkim,2006-07	Turmeric	0.61	2070
	Ginger	6.70	35980
	Large cardamom	12.50	2740

Source: Statistical Handbook of NER: NEDFi Databank; NA- Not available

Genetic diversity of large cardamom

Large cardamom is essentially a cross-pollinated crop, insect pollination is the rule. The flower morphology is adapted for such a mode of pollination. Each spike consists of about 40-50 flowers, which open in the acropetal sequence over a period of about 15-25 days. Flower opening starts in the early morning hours, *i.e.* 3-4 AM, anthers dehisce almost simultaneously whereas stigma receptivity starts an hour later and lasts for 24 hours. The stigma was found to be receptive even after 36 hours from the time of flower opening during rain-free days (Gupta and John, 1987).

Bumble bees (*Bombus* sp.) are the main pollinators, through a variety of honeybees and other insects do pollinate the flowers. Bumble bees are effective pollinators due to its compatible size with the flowers and is having brush-like hairy structures on its dorsal thorax which helps in carrying pollen mass and depositing it on stigmatic surface while entering the flowers. The highest foraging activity of bumble bees is seen during 6-7 AM, but becomes slow or dull in rainy conditions.

Large cardamom seedling population has large variability due to cross pollination and hence very rich in its genetic diversity. It grows from about 800 m altitude to about 2000 m altitude in the eastern Himalayas.

Because of the wide range of altitudes it inhabits, there are different cultivars adapted to different altitudes and agro-climatic conditions. Explorations for collection of germplasm of large cardamom was carried out by Indian Cardamom Research Institute (ICRI), Regional Station, Gangtok at various tracts and a gene bank consisting of 220 accessions is established at Pangthang (East Sikkim). Based on the evaluation of the high yielding accessions, two selections ICRI Sikkim-1 and ICRI Sikkim-2, have been released for cultivation in Sikkim and Darjeeling District of West Bengal. Both the selections are from cultivar Sawney.

There are mainly six cultivars of large cardamom viz., *Ramsey, Ramla, Sawney, Golsey, Varlangey (Bharlangey*) and *Bebo* (Gyatso *et al*., 1980). In addition, sub-cultivars of the above ones like *Ramnag, Madhusey, Mongney* are also seen in cultivation in small areas in Sikkim State. Another cultivar *Seremna or Lephrakey* is also getting importance and is spreading to more areas in lower altitudes (Upadhyaya and Ghosh, 1983).

There are distinct cultivars suited to different altitudes and diverse agro-climatic situations, hence increasing the scope of introduction and area expansion of suitable cultivars in the NE states. Cultivars suited for high altitudes (>1515 m msl) are *Ramsey*, *Varlangey* and *Ramla*. *Sawney* is suited for mid (975 – 1515 m msl) altitudes and cultivars *Golsey* and *Seremna* are suited for low (< 975 m msl) altitude areas. The characteristic features of important cultivars are as follows.

Ramsey

The name *Ramsey* was derived from two Bhutia words – '*Ram*' meaning mother and 'sey' for gold (yellow). This cultivar is well suited for higher altitudes, on steep slopes. Grown up clumps of 8-10 years age group possesses 60-140 tillers. The tillers colour is maroonish green to maroon. Second half of May is the peak flowering season. Capsules are small, the average being 2.27 cm in length with 2.5 cm diameter, with 30-35 capsules in a spike, each containing 16-30 seeds. The harvest is during October-November. Peak bearing of capsules is noticed in alternate years.

This cultivar is more susceptible to viral diseases like *foorkey* and *chirke* especially if planted at lower altitudes. It occupies a major area under large cardamom in Sikkim and Darjeeling District of West Bengal. Two strains of this cultivar *viz., Kopringe* and *Garadey* from Darjeeling District having stripes on leaf sheath, are reported to be tolerant to *chirke* virus (Karibasappa *et al*., 1987).

Ramla

The plants are tall and vigorous like *Ramsey* and have capsule characters like *Dzongu Golsey*; the colour of tiller is pink like *Ramsey* and Sawney. The leaves of *Ramla* are very broad compared to all other cultivars. Cultivation is restricted to a few mid-high altitude plantations in North Sikkim. The capsules are medium sized, dark pink with 25-38 seeds per capsule. They are susceptible to *foorkey* but are moderately tolerant to *chirke* disease.

Varlangey

This cultivar grows medium and high altitude areas in South Regu (East Sikkim) and at high altitudes at Gortak (Kalimpong sub-division in Darjeeling District of West Bengal). Its yield performance is exceptionally high at higher altitude areas i.e.1500 m and above. It is a robust type and total tillers may range from 60 to 150. Colour of tillers is like that in *Ramsey i.e.*, maroonish-green to maroon towards collar zone; girth of tillers is more than that of *Ramsey*. Each productive tiller on an average produces almost three spikes with an average of 20 capsules per spike. Size of capsules is bigger and bold with 50-65 seeds. Harvest begins in last week of October. This cultivar is also susceptible to *foorkey* and *chirke* diseases.

Sawney

This cultivar got the name from *Sawan* in Nepali, corresponds to August by which month this becomes ready for harvest at low and mid altitudes. This cultivar is widely adaptable, especially suited for mid and high altitudes *i.e.*, around 975-1500 m. It is robust in nature and consists of 60-90 tillers in each clump. Colour of tillers maroon. Each productive tiller on an average produces two spikes. Average length and diameter of a spike is 6 and 11 cm. Flowers are longer (6.23 mm) and yellow in colour with pink veins. Second half of May is the peak flowering time (Rao *et al*., 1993b).

Capsules are medium to bold and number of seeds in each capsule is more (35). Harvest begins in September-October and may extend up to November in high-altitude areas. This cultivar is susceptible to both *chirke* and *foorkey* viral diseases. Cultivars such as *Red sawney* and *Green Sawney* derived their names from capsule colour. *Mongney*, a strain found in south and west districts of Sikkim, is a non-robust type with its small round capsules resembling mostly that of *Ramsey*.

Golsey (Dzongu Golsey)

The name has derived from Hindi and Bhutia words; '*Gol*' means round and '*sey*' means gold. This cultivar is suitable to low altitude areas below 975 m msl especially in Dzongu area in North Sikkim. Plants are not robust like other cultivars, and consist of 20-50 straight tillers with erect leaves. Alternate, prominent veins are extended to the edges of leaves (Biswas *et al*, 1986). Unlike *Ramsey* and *Sawney,* tillers are green in colour. Each productive tiller on an average produces two spikes. Flowers are bright yellow. On an average each spike is 5.3 cm long with 9.5 cm diameter and contains an average of seven capsules. Capsules are big and bold, and contain about 60-62 seeds. This cultivar becomes ready for harvest in August-September.

Golsey is tolerant to chirke and susceptible to foorkey and leaf streak diseases. The cultivar is known for its consistent performance though not a heavy yielder. Many local cultivars are known in different locations such as Ramnag from North Sikkim. Ram meaning 'mother' and Nag for black, which refers to its dark pink capsules. Seto-Golsey is from west district of Sikkim with robust leafy stems/tillers and green capsules. Madhusey with elliptic and pink coloured capsules is having robust leafy stem and has sweet seeds compared to other cultivars (Rao *et al.*, 1993b).

Seremna (Lephrakey)

This cultivar is grown in a small pocket at Hee-Gaon in West Sikkim at low altitude and is known for its high yield potential. Plant features are almost similar to Dzongu Golsey but the leaves are mostly dropping, hence named as *Sharmney*. Total tillers range from 30 to 49 and is not robust in nature. On an average 2-3 spikes emerge from each productive tiller with an average of 10.5 capsules per spike, each having 65-70 seeds. This cultivar is having narrow adaptability as it is not performing well in other low altitude areas.

Babo

This cultivar is grown in Siang district of Arunachal Pradesh. The plant is medium tall, herbaceous perennial. Flowers are yellowish red. Spikes bear 10-12 capsules, capsules are deep brown, medium sized. Capsules mature in October and weigh 1.3-1.4 g with 80-85 seeds. Apart from this, five species of Amomums also grow wild in the hilly region of Arunachal Pradesh. Some of these are used for medicinal purpose by the local tribes. These are locally called Tali, Jaker, Belak and Boklok. The Tali variety is very interesting because the fruits mature early in June-July months where as the large cardamom matures only after August-September months (Upadhyaya and Ghosh, 1983).

Prospects

Apart from Sikkim, large cardamom cultivation has been attempted in NER especially in Arunachal Pradesh, Manipur, Meghalaya, Mizoram and Nagaland states. Arunachal Pradesh and Nagaland states have large area with suitable agro-climatic conditions for the cultivation large cardamom. However, establishment, production and productivity are limited in Manipur, Meghalaya and Mizoram due to prolonged dry periods during winter and summer months. Hence introduction of hardy varieties along with provision for irrigation during dry months may be necessary for the successful cultivation of large cardamom in these states. Introduction of cultivars from the states of Sikkim and Darjeeling District of West Bengal, which are having wide adaptability, could help in area expansion programmes in NER.

Production of quality planting material is a prerequisite for the area expansion. Large cardamom is affected by two serious viral disease and a devastating fungal blight disease, hence due care should be taken in plant quarantine, sanitation and establishment of certified nurseries in the respective states. Viability of use of tissue culture technology in mass multiplication of disease free planting material of large cardamom and their successful cultivation in the field has been demonstrated by the Indian Cardamom Research Institute, with the financial assistance of DBT, New Delhi. Hence, this technology could be used for the generation of disease free planting material. TERI in collaboration with DBT is multiplying large cardamom material through tissue culture for distribution in the NER. Spices Board provides financial assistance of Rs. 17,500/- per ha for establishment of large cardamom plantations in NER. There is very good scope for production of organic large cardamom in NER as most of the states use very little or no chemicals. The rich genetic diversity available in large cardamom could be effectively put to use by introducing appropriate varieties in the NER.

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Genetic diversity of black pepper and its suitability to North eastern states

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Introduction

Black pepper (*Piper nigrum* L.) is an important spice with medicinal properties valued all over the world. At present it is grown in about 26 countries with an annual production of 369587 t from 467708 ha, the average yield being 790.2 kg/ha. Though India had a virtual supremacy in black pepper production till recently, since last two three years, Vietnam is leading in production. Apart from India and Vietnam, the other major black pepper producing countries are Indonesia, Malaysia, Brazil, Sri Lanka and China. In India, North Eastern states have great potential for area expansion under horticulture. Black pepper can be an important component in the crop diversification programmes, where it can be cultivated along with other perennial crops like coconut and arecanut. The rainfall pattern and other climatic conditions are also very much favorable for the cultivation of this crop in the region. Diversity for *Piper* species in India and the improved varieties of black pepper suitable to the region are also discussed.

Black pepper- Global scenario

Vietnam, Indonesia, Malaysia and Brazil are the major black pepper producing countries besides India at present. The area and production vary among countries (Table 1). Area varied from 100 ha to more that 2,00,000 ha. Production also varies between less than 100 t to more than 90,000 t. The global production of pepper fluctuates between 3-3.5 lakhs tons. Till 1999, India was the main producer and exporter of pepper in the world followed by Indonesia. But Vietnam emerged as the top producing and exporting country from 1999 onwards.

Table 1. Black pepper production capacities of countries in the world

Countries producing < 1000 t	Countries producing 1000 to 10 000 t	Countries producing > 10 000 t
Benin, Brunei Darussalam, Cameroon, Costa Rica, Côte d'Ivoire, Ethiopia, Fiji Islands, Guatemala, Honduras, Kenya, Kyrgyzstan, Saint Lucia, Tajikistan, Uzbekistan, Zambia	Cambodia, Ghana, Madagascar, Malawi, Mexico, Niger, Thailand, Uganda, Zimbabwe	Brazil, China, India, Indonesia, Malaysia, Sri Lanka, Vietnam

Global pepper demand in terms of export is estimated between 200,000- 225,000 ton/year. The main suppliers to the world market are Vietnam, India, Indonesia and Brazil. Exports of pepper form producing countries have increased constantly form 141,767 tons in 1997 to the maximum of 2,23,003 tons in 2006. However during the year 2007 there was a decline in the export to 2,01,700 tons (Sreekumar, 2008). While Vietnam continued to be the largest exporter in the world, increase in export from Brazil, Indonesia, Sri Lanka and Malaysia have also been significant, but the exports from India have declined. During the year 2008-09, India has exported a total quantity of 25,250 tons of pepper valued Rs.413.74 crores as against 35,000 tons valued Rs. 519.50 crores of last year, registering a decline of 28% in volume and 20% in value. Major buyers of black pepper are the US, Europe, Japan and Australia.

Indian scenario

Black pepper is a native of Western Ghats, India. India accounts more than 40% share of world area under pepper, contributes about 23% of the world output and is also a one of the largest consumers. During 2006-07 the area under black pepper cultivation in India was 2,45,970 ha with a production of 69000 t and a productivity of 281 kg ha^{-1} (Table 2). In India, black pepper is cultivated in Kerala, Karnataka and Tamil Nadu. Kerala is the largest producer of pepper accounting for over 95% of India's total production. In recent years, other states like Andhra Pradesh, Orissa, West Bengal, Assam, Tripura, Meghalaya etc have also started cultivation of black pepper.

Table 2. State-wise area, production and yield of black pepper in India

(Area:'000 ha, Production:'000 tons, Yield: kg ha^{-1})

	2005-06			2006-07		
State	**Area**	**Production**	**Yield**	**Area**	**Production**	**Yield**
Goa	0.63	0.14	222.0	0.65	0.17	262.0
Karnataka	14.8	3.24	219.0	14.0	3.0	214.0
Kerala	238.0	87.6	368.0	226.1	64.3	284.0
Meghalaya	0.90	0.68	754.0	0.90	0.68	753.0
Tamil Nadu	5.23	1.14	218.0	3.70	0.84	227.0
Pondicherry	0.01	0.01	1000.0	0.01	0.01	1000.0
Andaman & Nicobar	0.66	0.12	182.0	0.61	0.04	66.0
All India	260.23	92.94	35.7	245.97	69.00	281.0

Source: DASD, 2008

The future demand for black pepper is predicted at 1, 27, 902 tons for the year 2026-27 (Table 3). The projection on black pepper demand showed that a 12% growth rate is needed for each forth coming five year plans to achieve a production target of 1.28 lakh tones in 2025. To reap the benefit of this demand, it will be prudent to concentrate the black pepper production in the nontraditional sectors like North Eastern states along with strengthening of production from the traditional tracts by using improved varieties with high yield, quality traits and disease/pest resistance.

Table 3. Future demand of black pepper production and productivity

Year	Total demand (t)	Qty. to beproduced (t)	Area under the crop (ha)	Targeted productivity (t ha^{-1})
2011-12	91375	92658	233520	0.397
2016-17	102701	103733	233520	0.444
2021-22	114531	115362	233520	0.494
2026-27	127902	128570	233520	0.551

Source: Parthasarathy et al. (2008)

The non traditional areas

The North eastern India, Andaman & Nicobar Islands, Orissa, West Bengal etc are then non traditional areas having potential for black pepper cultivation in India. The North eastern region lying between 21.5^{o} N-29.5^{o} N 1atitudes and 85.5^{o} E – 97.3^{o} E longitudes comprises of eight states *viz.,* Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, Tripura and Sikkim. The total geographic area of NE region is 262, 180 km^2 which is nearly 8% of the total geographic area of the country (Yadav *et al*. 2003). The rainfall ranges from 200 to 400 cm. The major soil groups are brown hill, red and yellow, alluvial and acidic laterites. It is endowed with rich evergreen forests. Black pepper is cultivated in a small scale in the homestead gardens at North eastern India at present. Organized cultivation is yet to gain momentum in the region. The vast areas of hills, interspersed with fertile valleys and diverse agro-climatic conditions in North eastern region offers a vast potential for cultivation of black pepper in this region.

The diverse agro climatic conditions, varied soil types and abundance of rainfall offer immense scope for cultivation of different types of horticultural crops including fruits vegetables, flowers, plantation crops, spices like ginger, cardamom, turmeric, black pepper, tree spices etc. Black pepper cultivation in the North eastern region contributes about 1.9% in area and 6.5% in production of India's share (Table 4).

Table 4. Area, production and productivity of black pepper in North eastern states

State	Area ('000 ha)	Production ('000 t)	Productivity (t ha^{-1})
Assam	2.7	3.7	1.36
Arunachal	0.90	0.68	0.75
Manipur	0.612	0.13	0.212
Meghalaya	0.9	0.68	0.756
% of the country	1.9	6.51	—

In the North East region of India, Panniyur -1 and Karimunda are found to perform well with consistently good yield. However other varieties developed by the research organizations like Indian Institute of Spices Research, Calicut, Kerala (ICAR) and Pepper Research Station, Panniyur (KAU) also have to be popularized in these regions for better production and productivity. Among the eight states, Assam, Tripura, and Arunachal

Pradesh besides part of West Bengal have more potential for black pepper production either as monocrop or inter crop in coconut/arecanut/tea gardens.

The arecanut plantation in Garo hills of Meghalaya and Assam offers a tremendous scope for black pepper cultivation in these regions (Mathew, 2007; Hazarika, 2007).

Further, there is a great scope for growing pepper in tea gardens using shade trees as standards. It is estimated that about 3 lakhs ha land is available in NE States along with North Bengal as tea gardens. The shade trees of the tea estates are at present under exploited. Tea estates in North east can accommodate more than one million pepper stands. If at least 30-50 shade trees per ha is planted with pepper, the country will be able to meet the international requirement (Parthasarathy *et al.,* 2008). As per a conservative estimate one kg black pepper (dry) at the fifth year per standard is realizable. However, varieties of pepper suitable to high elevation area need to be identified and popularized for the states/region.

Biodiversity and distribution of *Piper*

Piper nigrum belongs to the family Piperaceae. The *Piper* species are mostly woody perennial climbers, herbs or shrubs and are distributed pantropically. The International Plant Name Index (www.ipni.org) has recorded 6704 *Piper* species in their website. Maximum diversity of *Piper* species occurs in American tropics (700 spp.) followed by southern Asia (300 spp.), where the economically important species *Piper nigrum* L. (black pepper) and *P. betle* L. (betel vine) have originated (Jaramillo and Manos, 2001). Ridley (1924) documented 75 *Piper* species from the Peninsular Malaya region. De Candole (1910) enumerated 133 species of *Piper* occurring in Philippines. Later Quisumbing (1930) conducted systematic study of the Philippine Piperaceae and he documented only 87 species from Philippines.

The distribution of *Piper* species ranges from sea level to the high ranges of Andes to the sub Himalayas (Royle, 1839). North eastern region and the south Deccan are considered to be the two independent centers of origin of the genus *Piper* in India (Hooker, 1886).

The *Piper* species originated from Southern Asia are of more importance since the economically important species like *P. nigrum* (Black pepper), *P. betle* (Betel vine), *P. longum* (Long pepper), *P. chaba* (Java long pepper), *P. cubeba* (Cubeb) *etc.* have originated from this region. The most important species of the genus, *Piper nigrum* is believed to be originated from the wet humid regions of the Western Ghats of South India. The sub - mountainous tracts of Western Ghats are believed to be the center of origin of black pepper – *Piper nigrum* Linn. About 111species are reported from India which are more common to Western Ghats of South India and the Eastern Himalaya of North eastern India from Sikkim to Arunachal Pradesh (Table 5) (Index Kewensis, 1906-1970; Hooker, 1886; Naithani, 1990, Gajurel *et al.*, 2002). Eastern Himalayas and the neighbouring areas *viz.,* Sikkim, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Tripura and Nagaland form a mega biodiversity area for *Piper* species in North east India. About 65 species are reported from this region (Gajurel *et al.*, 1999). Even though ecosystem diversity does not contribute much to biodiversity of black pepper, species diversity and varietal diversity are considerable (Hooker, 1886; Gamble, 1925; Rahiman, 1981; Ibrahim *et. al.*, 1985; Sasikumar *et. al.*, 1999).

Table 5. Important *Piper* species occurring in North eastern India

Species	Remark
P. acutistigmum C. DC.	A stout woody climber. Main stem and branches are glabrous. Spike length upto 20 cm. Drupe loosely aggregated, turn yellow to red while ripening.Distribution: Arunachal Pradesh

P. attenuatum Ham *ex* Miq.	The common wild pepper occurring in low and medium elevations. Leaves seven ribbed from the base, the outer pair reaching only half to two third of the leaf.Distribution: Distributed in all NE states
P. arunachalensis Gajurel *et* Rethy	A small dioecious glabrous shrubby climber. Fruiting spike short, cylindric 0.5 cm; bract peltate orbicular. Reported from Arunachal Pradesh
P. aurantiacum Wall.	Stout glabrous climber. Leaves ovate, thinly coriaceous, bracts peltate. Distributed in Assam and Meghalaya
P. betle L.	The common betel vine used for chewing along with arecanutDistribution: Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland & Tripura
P. betleoides C. DC.	A scandent much branched climber. Bracts orbicular peltate. Fruiting spike swollen. Leaves are used as a substitute for betel leaf and also have medicinal value.Distribution: Arunachal Pradesh, Assam & Sikkim.
P. boemeriaefolium (Miq.) C. DC.	A tall, glabrous, scandent or creeping shrub. Bract orbicular peltate. Fruiting spike lengthening upto 15 cm. Drupe black on ripening.Distribution: Arunachal Pradesh, Assam, Meghalaya, Mizoram, Nagaland, Tripura & Sikkim
P. diffusum Vahl, Enum.	Small glabrous climber. Bracts orbicular peltate. Drupe turn on black on ripening.Distribution: Arunachal Pradesh, Assam & Meghalaya
P. griffithi C. DC.	A large stout woody climber. Leaves membranous with round base and glabrous. Drupes pedicellate, black on ripeningDistribution: Arunachal Pradesh, Assam & Meghalaya
P. hamiltonii C. DC.	A small glabrous climber often creeping on the ground. Leaves small, elliptic, sub acute, coriaceous. Bracts orbicular peltate.Distribution: Assam & Manipur
P. haridasanii Gajurel, Rethy et Kumar	A new species reported. Small climber. Stem and leaves pubescent. Drupe black on ripeningDistribution: Arunachal Pradesh
P. khasianum C. DC.	Small climber, leaves membranous, petiole and underneath of the leaves finely pubescentDistribution: Arunachal Pradesh, Assam, Meghalaya, Tripura & Sikkim
P. lonchitis Roem. *et* Sch.	A small erect glabrous shrub 2-4 feet in height, bract orbicular peltate, spikes erect; drupe turn orange to red on ripening.

P. longum L.	The common long pepper. Creeping habit, spikes are erect, cylindrical and fused laterally.Distribution: All over in NE states
P. makruense C. DC.	A low creeping or climbing shrub. Plant parts pubescent. Bract orbicular peltate. Drupe turn purple and red while ripening. Endemic to North East IndiaDistribution: Arunachal Pradesh, Manipur & Tripura
P. mullesua Ham *ex* C. DC	A slender climber found at high elevations. Spikes erect, globose and fused laterallyDistribution: Arunachal Pradesh, Assam, Meghalaya & Sikkim
P. nepalense Miq.	A small climber. The petiole and lower surface of leaves finely pubescent. Bract ovate and adnate to the rachis. Drupe turn black on ripeningDistribution: Assam, Manipur & Tripura
P. pedicellatum C. DC.	An erect glabrous shrub. Fruiting spike cylindric, bract orbicular peltate, drupe yellow then deep red on ripening. Distribution: Arunachal Pradesh, Sikkim & Tripura
P. peepuloides Roxb.	Glabrous climber. Leaves elliptic- oblong, membranous. Male spikes slender. Fruiting spike dense, cylindric. Bracts peltate orbicular. Fruits very smallDistribution: Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Tripura and Sikkim
P. potheforme Wall. *ex.* C. DC.	A climbing shrub. Spikes pedent swollen with thick rachis. Drupe sunken on the rachis.Distribution: Arunachal Pradesh
P. sylvaticum Roxb.	A low creeping or climbing pubescent shrub. Fruiting spike short cylindric, drupe turn black on ripening
P. thomsonii Hook.	Scandent, half woodyglabrous species. Leaves ovate-oblong or elliptic oblong. Fruiting spike sub globose. Bracts peltate orbicularDistribution: Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Tripura and Sikkim
P. wallichii Miq.	A large climber with plant parts pubescent. Young shoot tip dark purple with prominent hairs. Spikes bright yellow in colour. Drupe yellow to red while ripening. Used by the local people for cough and cold. Distribution: Arunachal Pradesh, Assam, Meghalaya & Sikkim

Source: Kanjilal, 1940; Haridasan, 1987; Gajurel et al 1999.

Domesticated diversity of black pepper

Cultivar diversity (Table 6) is one of the principal components of diversity in black pepper. The cultivars are evolved directly from the wild *P. nigrum*. Natural selection and conscious selection by man over years for various traits have created diversity in cultivars. More than 100 cultivars are known today. About 60-65 of them are prevalent in cultivation. At least some of the cultivars may be 'duplicates' as the cultivar identity is linked to some vernacular names denoting a particular feature of the vine, a place or a person's name. Some of the local varieties are confined to only in small pockets and are considered as cultivars of less importance. Cultivar diversity is maximum in Kerala followed by Karnataka. The important black pepper varieties cultivated in India is listed below.

Table 6. Black pepper diversity occurring in India

Sl. No	Name of the cultivar	Remark
1.	Aimpiriyan	High yielding, performance excellent in higher elevations, good in quality. But late maturing, vigorous vines.
2.	Arakkulammunda	Moderate and regular bearer, medium in quality, well adapted
3.	Balankotta	Cultivar with large droopy leaves, moderate and irregular bearing.
4.	Bilimallegesara	Moderate yielder with light green spikes
5.	Chengannurkodi	Moderate yielder from South Kerala, medium in quality.
6.	Cheppakulamundi	Moderate yielder from Central Kerala, medium in quality
7.	Jeerakamundi	Cultivar with small leaves and short spikes, alternate bearing nature, small berries.
8.	Karimalligesara	Moderate yielder with dark green spikes
9.	Karimaratta	A moderate yielder with uniform bearing
10.	Karimunda	Most popular cultivar suitable for most of the black pepper growing areas, high yielder and medium in quality, shade tolerant.
11.	Kottanadan	A high yielding cultivar from South Kerala, drought tolerant type.
12.	Kurimalai	A cultivar from Karnataka, moderate yielder with medium quality.
13.	Kuthiravally	A cultivar with long spikes, high yield and good quality.
14.	Kuttianikodi	A moderate yielder from Central Kerala with relatively long spikes and good spiking intensity.
15.	Malamundi	A moderate yielder, medium in quality
16.	Malligesara	A common cultivar from Karnataka, relatively good in yield.
17.	Narayakodi	Popular in South Kerala, moderate yielder with medium quality. Not easily affected by foot rot.
18.	Neelamundi	A good yielder from central Kerala medium in quality, tolerant to *Phytophthora* infection

19.	Nedumchola	A cultivar with small leaves and short spikes, moderate yielder.
20.	Neyyattinkaramundi	A cultivar from Central Kerala, medium in quality and yield.
21.	Perumkodi	A cultivar from Central Kerala, moderate in yield and quality.
22.	Poonjaranmunda	A cultivar originally from Central Kerala, sporadically found in gardens of North Kerala. Moderately good in yield and quality.
23.	Thommankodi	A cultivar from central Kerala, moderately good in yield and quality.
24.	Thulamundi	A Central Kerala cultivar, medium in yield and quality.
25.	Vattamundi	A moderate yielder from Central Kerala.
26.	Vellanamban	Relatively moderate yielder and medium in quality characterized by the light green colour of the young shoot tip.
27.	Cheriyakaniakadan	Popular in North Kerala, moderate and early bearing variety.
28.	Kalluvally	A promising North Kerala cultivar, good yielder, medium in quality with high dry recovery, drought tolerant.
29.	Kottan	A cultivar found in North Kerala, moderate in yield and medium in quality
30.	Manjamundi	A moderate yielder from North Kerala, medium in quality.
31.	Perambramunda	A cultivar from North Kerala, moderate yielder with medium quality.
32.	Vadakkan	A cultivar from North Kerala, medium in quality and yield with relatively large berries.
33.	Valliyakaniyakadan	A cultivar with larger leaves, medium in yield and quality.
34.	Uddagara	A popular cultivar of Karnataka, good in yield and medium in quality.

Varieties suited to North eastern region

There are 16 black pepper varieties released for cultivation by IISR and SAU's (Table 7) that had a great impact in increasing the production and productivity of black pepper in the country. Black pepper varieties released from IISR are Sreekara (Yield: 2677 kg dry ha^{-1}), Subhakara (2352 kg dry ha^{-1}), Pournami (2333 kg dry ha^{-1}), Panchami (2828 kg dry ha^{-1}), IISR Shakthi, (2253 kg dry ha^{-1}), IISR Thevam (2481 kg dry ha^{-1}), IISR Girimunda (2880 kg dry ha^{-1}) and IISR Malabar Excel (1440 kg dry ha^{-1}). Almost all these varieties are suited for cultivation in NE regions. However varieties bred for high altitude areas will be more ideal for these regions and it can be grown either as a monocrop or as an intercrop on coconut, arecanut or the shade trees of tea estates. Apart from cultivated black pepper other economically important species such as *P. betle, P. chaba. P. cubeba, P. peepuloides* and *P. longum* are also suited to North eastern states.

Table 7. Improved varieties/ hybrids of black pepper and their salient features

Name	Pedigree	Released from	Oleo-resin (%)	Pip-erine (%)	E. oil (%)	Remarks
Panniyur-1	F_1 of 'Uthirankotta' x 'Cheriyakaniy-akadan'	Black pepper Research Station, Panniyur, Kerala Agriucultural University (KAU),	11.8	5.3	3.5	Suited to all black pepper growing regions. Not suited to heavily shaded areas.
Panniyur-2	Open pollinated progeny selection of 'Balankotta'	-do-	10.9	6.6	3.4	Shade tolerant.
Panniyur-3	F_1 of 'Uthirankotta' x 'Cheriyakaniy - akadan'	-do-	12.7	5.2	3.1	Late maturing. Suited to all black pepper growing regions.
Panniyur-4	Clonal selection from 'Kuthiravally'	-do-	9.2	4.4	2.1	Performs well under a variety of conditions. Stable yielder.
Panniyur-5	Open pollinated progeny selection of 'Perumkodi'	-do-	12.3	5.5	3.8	Tolerant to nursery diseases and shade.
Panniyur-6	Clonal selection of 'Karimunda'	-do-	8.3	4.9	1.3	Suited to all black pepper tracts.
Panniyur-7	Open pollinated progeny of 'Kalluvally'	-do-	10.6	5.6	1.5	Suited to all black pepper tracts.

Subhakara	Clonal selection from 'Karimunda'	Indian Institute of Spices Research, Calicut	12.4	3.4	6.0	Suited to all black pepper growing regions.
Sreekara	Clonal selection from 'Karimunda'	-do-	13.0	5.1	7.0	Suited to all black pepper growing regions.
Panchami	Germplasm selection	-do-	12.5	4.7	3.4	Late maturing type suited to all black pepper growing areas.
Pournami	Germplasm selection	-do-	13.8	4.1	3.4	Tolerant to root knot nematode (*M. incognita*).
IISR Thevam	Clonal selection of 'Thevanmundi'	Indian Institute of Spices Research, Calicut	8.15	1.6	3.1	Tolerant to *Phytophthora* foot rot disease. Suited to high altitudes and plains.
IISR Malabar Excel	F_1 of 'Cholamundi' x Panniyur-1	-do-	13.5	2.96	3.2	Suited to high altitudes and rich in oleoresin.
IISR Girimunda	F_1 of 'Narayakodi' x 'Neelamundi'	-do-	9.65	2.2	3.4	Suited to high altitudes
IISR Shakthi	Open pollinated progeny of 'Perambramundi'	-do	10.2	3.3	3.7	Tolerant to *Phytophthora* foot rot disease

Conclusion

Blessed with suitable climate and other production parameters the North eastern states have good potential to expand black pepper production. Efforts must be focused on production of quality planting material of the improved varieties besides disseminating the information on scientific cultivation among the farming community. The SAUs/CAUs located in the region may take up research on black pepper right at the earnest, especially for evolving varieties specifically suited to the local condition along with the location specific agro techniques. All these will augment the efforts for greater production and productivity of the crop in the region and thereby improving the financial conditions of North eastern farming community.

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Genetic diversity in ginger and its suitability to North eastern states

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The genus *Zingiber* consists of 80-90 species. Among these *Z. zerumbet* and Z. *cassumunar* are medicinal species and *Z. officinale* is the cultivated one. The chromosome number of *Z. officinale* is 2n=22

In India, survey for collection of elite germplasms of ginger was initiated in 1976-77 by the Central Plantation Crops Research Institute, National Bureau of Plant Genetic Resources and Himachal Pradesh Agricultural University. Later on, the AICRP centers on spices selected and conserved 659 ginger germplasm (Table1). These germplasm are now being evaluated at Chintapalle, Andhra Pradesh; Dholi, Bihar; Kumarganj, Uttar Pradesh; Pottangi, Orissa; Pundibari, West Bengal; Raigarh, Chhattisgarh and Solan, Himachal Pradesh. The Indian Institute of Spices Research, Calicut also has conserved more than 700 germplasm of ginger. Ginger is grown in all most all the states of India and several cultivars are grown in these states. They are generally named after the localities where they are grown. Some of the prominent indigenous cultivars are Maran, Kuruppampadi, Ernad, Waynad, Himachal, Gorubathan and Nadia. Exotic cultivars such as Rio-de-Janeiro have also become very popular among cultivars. The ginger cultivars grown in different states are presented in Table 2. Indian Institute of Spices Research in collaboration with National Bureau of Plant Genetic Resources and AICRP Centres (YSPHUF, O.U.A.T and KAU) on spices has characterized cultivars for rhizome size, pungency, flavours and fibre content. Characters of some important exotic and indigenous cultivars are presented in Table 3.

Status of ginger in North eastern region

The area under ginger in the North eastern region is about 35 thousand ha and an average productivity in this region is about 5.8 t ha^{-1}. The major producer in the region is Meghalaya (19.6% of India's production) followed by Mizoram and Arunachal Pradesh. However, the productivity is highest in Arunachal Pradesh (Table 4). The agro-climate and soils of North eastern region is ideally suited for ginger cultivation and there is tremendous scope to increase the productivity and production of ginger in the North eastern region.

Genetic resources of ginger in the North eastern region

The North eastern region is considered as the treasure house of ginger germplasm. There are many varieties grown in different states, mostly indigenous germplasm with local names are popular.

In Arunachal Pradesh, the main growing regions are East Siang, West Siang, Debang and Xeroh. The variety Basar Local is very popular due to high productivity. Cachar, Dibrugarh, Guwahati, Goalpara, Jorhat and North Laximpur are the main ginger growing regions of Assam. Maran, Nadia and Jorhat Local are the popular varieties of Assam. In Manipur, Central, East, North and South regions combined have about 2300 ha of ginger cultivation. Thingpui is the preferred variety in the hills. Garo and Khasi hills are the main ginger growing regions of Meghalaya. In addition to local types namely Khasi Local and Tura Local, considerable area has been brought under selected type Nadia in Meghalaya. In Mizoram, local types Thingpui and Thinglaidon are grown commercially. Black ginger having bluish black tinge inside the rhizomes is reported have medicinal properties and is grown by the inhabitants of Mizoram for their own use. In Nagaland, the main growing regions are Dimapur, Kohima, Phek and Wokha. A variety having very high pungency but smaller in size is commonly grown by the tribals in Nagaland. The variety Nadia and Rio-de-Janeiro are also grown in an around Dimapur and Kohima. In Tripura, a local selection Tripura Local performed better compared with other types. In Sikkim, Bhainse and Gorubathan are grown commercially due to their high yield potential and big size rhizomes. Many other varieties namely Nadia, Rio-de-Janeiro, Sikkim Selection-1, Thingpuri *etc.* are also grown in east and south of Sikkim. However, the variety Nadia is very much popular in all the states of North eastern region due to its low fibre content.

The average yield of variety Nadia in this region is about 30.0 t ha^{-1} with crude fibre content of 4.1 per cent (Yadav *et al*, 2004). In terms of yield (t ha^{-1}) Nadia proved superior to other improved varieties like IISR-Varada (22.66 t ha^{-1}), Suprabha (16.6 t ha^{-1}), Suruchi (11.6 t ha^{-1}), Suravi (17.5 t ha^{-1}), Himagiri (13.5 t ha^{-1}), IISR Mahima (23.2 t ha^{-1}), IISR Rejatha (22.4 t ha^{-1}), Maran (25.2 t ha^{-1}) and Rio-de-Janeiro (17.7 t ha^{-1}). However, in terms of oleoresin and essential oil content (Anon, 2006, Table 5 and 6) the varieties Suruchi (10.0% oleoresin and 2.0% essential oil) and Suravi (10.2% oleoresin and 2.1% essential oil) are superior than Nadia (5.4% oleoresin and 1.4% essential oil). The oleoresin and oil are known as high value and low volume products, which have great demand in international market. Therefore, more emphasis should be given for cultivation of varieties with less fibre, high dry matter recovery, and high oil and oleoresin contents in the North eastern states. However, quality production following the international market requirements should be the target for the ginger growers of the region. In International market several grades are available and on the basis of that ginger has been categorized in different grades (Table 7).

Table 1. Ginger germplasm collection of AICRP on spices

Centre	Indigenous	Exotic	Total
Chintapalle	06	-	06
Dholi	47	-	47
Kumarganj	58	-	58
Pottangi	174	3	177
Pundibari	48	-	48
Raigarh	44	-	44
Solan	279	-	279
Total	656	3	659

Source : Annual Report 2007-08, AICRP on spices

Table 2. Ginger growing areas and cultivars grown

State	Cultivar
Andhra Pradesh	Medak, Tuni
Arunachal Pradesh	Shillon Local
Assam	Maran, Nadia
Bihar	Darbhanga Desi
Gujarat	Boriyavi, Shamlaji
Haryana	Ambala Local
Himachal Pradesh	Dharija Local, Himachal Selection – I
Jammu & Kashmir	Himachal Selection – I
Karnataka	Mananttodi, Narasapattam, Thaiguppa, Wynad Local
Kerala	Ernad, Chemad, Jamaica, Kuruppampadi, Maran, Nadia, Rio-de-Janeiro, Suprabha, Suruchi, Valluvanod, Vengar, Wynad Local, Wynad Mananthody
Madhya Pradesh	Chindwara Local, Bastar Local, Tikkamgarh Local
Maharashtra	Satara Local
Manipur	Shing Shingtam, Thingpuri
Meghalaya	China, Maran, Nadia, Rio-de-Janeiro, Thingpuri, Poona, Wynad Local
Mizoram	Maran, Rio-de-Janeiro, Thingpuri
Nagaland	Rio-de-Janeiro
Orissa	Anamika, Bhitarkatta, Daringbadi, Janagarh, Kunduli Local, Kotagarh, Laxmipur, Raikia, Suprabha, Surchi, Thingpuri, Vengar
Rajasthan	Dungarpur Local
Sikkim	Gurubathan, Nadia, Rio-de-Janeiro, Sikkim Selection–1, Thingpuri
Tamilnadu	Maran, Nadia, Reo-de-Janeiro
Tripura	Himachal – 1
Uttar Pradesh	Barua sagar, China, Wynad Mananthody, Nadia, Narasapattam, U.P. Local, Wynad Local
West Bengal	Gurubathan, Malli, Maran, Rio-de-Janeiro, Sambak-A, Thingpuri, Tura, Taruk Sadan

Table 3. Rhizome characters of some exotic and indigenous cultivars

Cultivar	Rhizome	Skin	Pungency	Fibre	Uses
Exotic					
Bangkok	Bold	Fare	Pungent	Less	Green
China (PG-54)	Extra bold	Yellowish-white	Very pungent	Fibrous	Green & dry
Jamaica (PG-128)	Bold	White	Moderate	Fibrous	Green & dry
Rio-de-Janeiro (PG 49)	Bold	Buff	Very pungent	Fibrous	Green & dry
Sierra-Leone	Slender	Buff	Pungent	Fibrous	Green & dry
Taiwan	Bold	Buff	Pungent	Fibrous	Green & dry
Indigenous					
Anamika (PG-17)	Bold	Light brown	Pungent	Fibrous	Green & dry
Boriyavi	Bold	Brown	Pungent	Less	Dry
Gorubathan (PG-106)	Bold	Buff	Pungent	Fibrous	Dry
Himachal Pradesh (PG-61)	Bold	Light-yellow	Pungent	Fibrous	Dry
Jorhat	Bold	Buff	Pungent	Fibrous	Green
Laxmipur (PG-53)	Slender	Light-brown	Pungent	Fibrous	Green & dry
Medak (PG-93)	Slender	Buff	Pungent	Less	Green
Nadia (PG-62)	Slender	Buff	Pungent	Less	Green & dry
Shillong (PG-92)	Bold	Buff	Pungent	Less	Green
Shingtam (PG-119)	Slender	Buff	Pungent	Fibrous	Green & dry
Sikkim	Bold	Buff	Pungent	Fibrous	Green
Suprabha (PG-96)	Bold	Light-brown	Pungent	Fibrous	Green & dry
Suruchi (PG-3)	Slender	Buff	Pungent	Less	Green & dry
Tura (PG-51)	Slender	Whitish-grey	Pungent	Less	Green & dry
Waynad Local (PG-16)	Bold	Buff	Pungent	Fibrous	Green & dry
Zahirabad (PG-89)	Bold	Buff	Pungent	Fibrous	Green & dry

Table 4: State-wise area, production and productivity of ginger in North eastern region

State	Area (ha)	Production (t)	Productivity (t ha^{-1})
Arunachal Pradesh	4610	38020	8.24
Assam	4200	32100	7.64
Manipur	2140	3530	1.65

Meghalaya	8400	46590	5.5
Mizoram	7290	45000	6.1
Nagaland	500	400	0.8
Tripura	1000	1400	1.4
Sikkim	5100	24000	4.7
NEH region	33240	191040	5.8
India	67200	233900	3.5

(Source: Basic statistic of NER, 2002)

Table 5. Yield and quality of improved varieties of ginger

Variety	Mean yield (fresh)(t ha^{-1})	Maturity (days)	Dry recovery (%)	Crude fibre (%)	Oleoresin (%)	Essential oil (%)
IISR –Varada	22.66	200	20.7	4.7	6.7	1.8
Suprabha	16.60	229	20.5	4.4	8.9	1.9
Suruchi	11.60	218	23.5	3.8	10.0	2.0
Suravi	17.50	225	23.5	4.0	10.2	2.7
Himagiri	13.50	230	20.6	6.4	4.3	1.6
IISR Mahima	23.20	200	23.0	3.3	4.5	1.7
IISR Rejatha	22.40	200	19.0	4.0	6.3	2.4

**Anon (2006)*

Table 6: Yield and quality of local cultivars/land races of ginger

Variety	Mean yield (fresh) (t ha^{-1})	Maturity (days)	Dry recovery (%)	Crude fibre (%)	Oleoresin (%)	Essential oil (%)
China	9.50	200	21.0	3.4	7.0	1.9
Assam	11.78	210	18.0	5.8	7.9	2.2
Maran	25.21	200	20.0	6.1	10.0	1.9
Himachal	7.27	200	22.1	3.8	5.3	0.5
Nadia	28.55	200	22.6	3.9	5.4	1.4
Rio-de-Janeiro	17.65	190	20.0	5.6	10.5	2.3

**Anon (2006)*

Table 7. The quality characteristics of different grades in ginger

Quality Character		Limits	
	Grade 1	Grade II	Grade III
1 Extraneous matter % by mass (max.)	2.0	3.0	5.0
2 Insect damaged matter, % by mass (max)	1.0	3.0	5.0
3 Pieces less than 25 mm, % by mass (max.)	0.5	1.0	2.0
4 Decayed pieces, % by mass (max.)	Nil	0.5	1.0
5 Dry matter, % by mass (min.)	22.0	20.0	18.0
6 Volatile oil as ml/100 gm (min.)	0.7	0.5	0.3
7 Crude fibre content of the dry matter % by mass (max)	8.0	10.0	12.0
8 Non-volatile ether extract content of the dry matter % by mass (min.)	5.0	3.0	2.0

(Source: Spice India, February, 2004)

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Biodiversity in tree spices and its suitability to North eastern India

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Introduction

The biological diversity of the Indian subcontinent is one of the richest in the world owing to its vast geographical area, varied topography and climate. Of the 25 hotspots recognized in the world, Eastern Himalayas and Western Ghats are in India. Lying between 22-30^0 N latitude and 89-97^0 E longitude, North east India comprises of 8 states *viz.,* Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim and Tripura and has a wide range of physiography and eco-climatic conditions. To increase agricultural development and to change the socio-economic status of the people in North eastern India the inclusion of horticulture crops like fruits, vegetables, spices, plantation crops, medicinal plants, aromatic plants, and floriculture in the local farming systems is essential and emphasis has to be given to increase the per hectare productivity of important agri-horti crops as part of a farming system. Spices like black pepper, ginger, turmeric, chillies, cardamom and seed spices are grown in North eastern states of India. At present no tree spices are commercially grown in North east India, though there is a tremendous potential for growing these crops. The climatic conditions prevailing in North eastern states are ideal for cultivation of some of the tree spices. This paper deals with the biodiversity of tree spices and the potential of growing tree spices in North east India.

Biodiversity in tree spices

North east region of the country is one of the richest reservoir of genetic variability and diversity of different crops like fruits, vegetables, spices, ornamental plants and medicinal and aromatic plants. Among the tree spices, large number of species in *Cinnamomum*, *Garcinia* and *Myristica* occur in North East India. The biodiversity of these crops are detailed below.

Cinnamomum species

Species diversity

The family Lauraceae consists of 11 genus namely Cryptocarya, Apollonias, Beilschmiedia, Cinnamomum, Alseodaphne, Machilus, Phoebe, Actinodaphne, Litsea, Neolitsea and Cassytha (Gamble 1925). The genus *Cinnamomum* Schaeffer (Lauraceae) comprises about 250 species of trees and shrubs of tropics and subtropics. In India, it is represented by 26 species [Hooker 1886). Kostermans (1983) reported 12 species from South India. Many of the species of *Cinnamomum* have medicinal and spice value and are of great demand commercially. *C. verum* Bercht. & Presl (true or Ceylon cinnamon), *C. cassia* Presl. (Chinese cinnamon, *Cassia lignea*), *C. burmannii* Blume (Indonesian cassia), *C. loureirii* Nees (Vietnamese cassia), *C. tamala* (Buch-Ham.) Nees & Eberm. (Indian cassia, Indian bay leaf or tejpat), *C. camphora* (camphor tree) etc. are a few of the economically important species of the genus. The diversity in *Cinnamomum* is mainly species diversity. As most of the species occur only in the wild, semi-domesticated gene pools of *Cinnamomum* do not occur.

Sri Lanka is considered as the primary center of origin of *Cinnamomum* and several species of related taxa occur in Sri Lanka. The *Cinnamomum* species distributed in the two centers of diversity in India are distinctly different. The South Indian species and the north Indian species are also distinctly different. A few species are reported to occur in both the places. False cinnamon is obtained from *C. cassia* (L) Brecht. & Presl. (syn. *C. aromaticum* Nees). The other sources of cassia are *C. loureirri* Nees., *C. burmannii* Blume and *C. tamala Nees*. *C. cassia* (Chinese cassia) is indigenous to China- Vietnam region and *C. burmannii* (Indonesian cassia) is native to Sumatara and Java regions of Indonesia. *C. tamala* (Indian cassia) is found in the forests of North India and Nepal. *C. tamala*, occurring mostly in the tropical and subtropical Himalayas and extending to North East India up to an altitude of 2000 m, is the main source of the spice tejpat. It also grows in Nepal, Bangladesh and Myanmar. It is a moderate sized evergreen tree which is the source of *tejpat*, *tejpat* oil and Indian cassia bark. Tejpat is the dried leaf of *C. tamala* and tejpat oil is the oil obtained by distillation of the leaves. The dried bark of the stem is the Indian cassia bark. *C. tamala* is listed as a threatened species as the plant population is declining day by day due to over exploitation and habitat destruction in India (Kumar *et al*. 1997). List of *Cinnamomum* species found in North eastern India is given in Table 1. *C. tamala* is native to India and is reported to have originated in the Himalayas. It is distributed in the Indian sub continent, Indo-China region, Bangladesh and Nepal. In tropical and sub-tropical Himalayas, it is distributed upto an altitude of 900-2500 m (Ahmed *et al*. 2000). It occurs in the North western, eastern and Sikkim Himalayas. It is also found in Meghalaya (Khasi Hills and Jaintia Hills), Assam (North Cachar Hills); Jammu and Kashmir (Basantgarh and Rajouri); Himachal Pradesh (Drang Forest in Dauladhar ranges, Hamirpur, Shimla, Kangra, Chamba, Mandi, Solan, Nahan, Palampur) and Uttar Pradesh (Jaunsar, Tehri Garwal and Kumaon).

C. camphora (camphor tree) are evergreen aromatic medium to large sized trees growing naturally in China, Japan, Taiwan and in the adjoining regions of South east Asia. In India, it is grown in a few plantations. *Cinnamomum camphora* and its variants have been reported from North east India. It is used commercially for production of camphor which is used in the perfume industry. Hirota and Hiroli (1967) and Wan -Yang *et al.* (1989) recognized five chemical races among Chinese camphor trees. Khein *et al.* (1998) recognized eight chemovarieties among camphor trees in Vietnam. Various chemotypes occur in camphor, yielding camphor, linalool, safrole and cineole as the major constituent (Wan-Yang *et al.* 1989).

Diversity analysis

In a cluster analysis of the South Indian species, *C. verum* was found to be more closely related to *C. malabatrum* (Shylaja 1984). Cluster analysis of the taxa using centroid linkage led to the grouping of *C. verum* with some collections of *C. malabatrum* while *C. cassia* and *C. camphora* formed unique groups. *C. camphora* formed a separate group from other species based on the bud type, stomatal type, phyllotaxy and epidermal thickness. Species such as *C. camphora, C. cassia, C. riparium*, *C. macrocarpum* and *C. perrottettii* remained independent entities with respect to the principal component studied, thereby indicating their taxonomic independence. Phenetic analysis of a large number of *Cinnamomum* spp. was carried out by Bakker *et al.* (1992) indicating ten clusters. According to this indication *C. burmannii* and *C. verum* are in cluster 1, together with many other species. Within this cluster *C. burmannii* occupies an independent sub-cluster position, while *C. verum* is in another sub-cluster together with 21 other species (including *C. tamala, C. culitlawan*, *C. keralaense, C. sintok*, etc.). *C. cassia* formed a separate cluster.

Chemotaxonomy

Chemotaxonomical studies on *C. verum* and some of its related taxa occurring in the Western Ghats of Kerala, were carried out by Shylaja (1984) and Ravindran *et al*. (1992). *C. verum, C. camphora, C. cassia* and *C. riparium* are chemically very distinct among themselves and from other species. Much infraspecific chemical variability was noticed in *C. malabatrum*. They also found that Sri Lankan and Indian accessions of *C. verum* were chemically identical.

The chemical composition of *C. tamala* leaf oils of both wild and cultivated sources it was found that various chemotypes exist. The various chemotypes are eugenol type (Gulati 1979, Hussain *et al* 1988), cinnamaldehyde type (Bradu and Sobti 1988), cinnamaldehyde-linalool type (Nigam and Ahmed 1990, Sood *et al*. 1979) and linalool type (Nath *et al*. 1994). The above analysis indicates that either different chemotypes exist or the species used for chemical analysis was taxonomically misclassified. The population of *C. tamala* growing in North east India has been classified into four distinct variants based on the leaf morphology and leaves of many related species are being sold in the market as tejpat (Baruah and Nath 2000). Nath *et al.* (1999) analyzed the four variants of *C. tamala* and reported the chemical composition of the leaf oil.

Cultivar diversity

In India, high coefficient of variation for dry and fresh bark yield per plant, bark oleoresin, leaf oil, leaf size index and percentage recovery of bark was observed in cinnamon. Association analysis for nine characters in cinnamon revealed significant correlation of fresh weight of bark and leaf oil with dry; bark yield. Bark oil was negatively correlated with leaf oil (Krishnamoorthy *et al*., 1992). Correlation and path analysis studies conducted by Joy *et al.* (1998) indicated that the economic yield characters namely fresh leaf yield, leaf oil yield and eugenol yield were highly correlated among themselves. Plant height and canopy spread were highly and positively correlated with the yield component (Joy *et al*. 1998).

Rare and endangered species

Owing to severe deforestation there is every possibility of some species becoming extinct in the near future. The wild population of *Cinnamomum* is in real threat due to indiscriminate bark extraction from them. *C. tamala* is listed as nearly threatened as the crop is facing over exploitation and habitat destruction in India, such that the plant populations are considerably reduced. However, *C. sulphuratum*, which was listed as red listed spices in found in abundance in Kemmangundi (Western Ghats) (Aravind *et al.* 2005*)*.

Garcinia species

Garcinia belongs to the botanical family Clusiaceae and according to old botanical classification, *Garcinia* is placed within the family Guttiferae which includes about 1300 species. Guttiferae is further divided into 42 genera and five sub-families namely, Kielmeroideae, Hypericoideae, Calopylloideae, Moronbeioideae and Clusioideae. Of these, the subfamily Clusioideae consists of two tribes *viz.,* Clusieae and Garcinieae and Garcinieae in turn has two genera namely, *Garcinia* and *Mammea* (Muhammed *et al.* 1994).

Species diversity

The genus *Garcinia* (Cluciaceae) includes more than 200 species of trees and shrubs, distributed in the tropics of the world chiefly in Asia and Africa. About 35 species are reported to exist in India including some exotic ones (Rodrigues, 2001) many of which are economically important. Out of 35 species reported to exist in India, seven are endemic to Western Ghats, 6 in Adaman and Nicobar Islands and four in North east India (Rodrigues, 2001). Some of these are detailed in Table 2. The genus *Garcinia* includes *Garcinia* *atroviridis, G. dulcis, G. echinocarpa, G. gummi-gutta, G. hombroniana, G. indica, G. lanceaefolia, G. livingstoneii, G. mangostana, G. microstigma, G. morella, G. paniculata, G. pedunculata etc*. (Roberts 1984). These species can be useful as sources of gamboges, dyes, hydroxyl citric acid (HCA), as good rootstock or for breeding purpose. Among the commercially important species, *G.gummi-gutta* (cambodge) and *G. indica* (kokum) are cultivated mainly for their spice, which is obtained from the dried rind. *G. mangostana* and *G. morella* are also cultivated to a certain extent for their fruit and gamboges respectively. However, little attention has been given to document and conserve the other economically important species of this genus in the era of intellectual *property rights and biodiversity conservation.*

Cultivar diversity

Kokum: Good variability in vegetative and reproductive characters has been reported in kokum. This variability is of great use in the improvement of the crop in the coming years. Shinde *et al*. (2001) have reported the occurrence of early maturing types (February- March) and in fruit characters like fruit colour, size and rind thickness. The colour varies from bright red, dark purple, white or even lemon yellow. However only the red forms have commercial value. The rind is quite thin (5 mm) whereas thick skinned types (> 50mm) are preferred and are available. Gawanker *et al.* (2001) reported a promising thick rind type MLDK-5, which is under evaluation, out of five selections made at Ratnagiri.

Cambodge: Trees differ in size, shape and bearing habit. Some trees bearing fruits through out the year have been observed. The trees vary with regard to the flowering habit also. Dioecious and hermaphrodite types are seen. Lot of variation exists with regard to number of fruits, fruit size, shape, number of seeds per fruit and weight of fruit and seed. Seedless types are also observed rarely. The hydroxycitric acid content in the cultivars also vary significantly.

Rare and endangered species

Garcinia mestonii Bailey found in Australia has been identified as a rare species (Hammer and Khoshbakht, 2005) and *G. indica* which was listed in the red list in Charmandi (Western Ghats) is at present found in abundance there (Aravind *et al.,* 2005).

Myristica species

Species diversity

The primitive family Myristicaceae, has about 18 genera and 300 species. The members of the family are pantropical, being associated with the rainforests of Asia, Africa, Madagascar, South America and Polynesia. India has four genera namely *Horsfieldia, Gymnacranthera, Knema* and *Myristica* and altogether 15 species which occur in the evergreen forests of Andaman and Nicobar Islands, Meghalaya and the Western Ghats. Table.3 indicates the wild and related spices of Myristicaceae occurring in North eastern India. Nutmeg is indigenous to the Moluccas islands in Indonesia. Semi-domesticated gene pools of *Myristica* species do not exist as most of these species occur in the wild.

Ecosystem diversity

The Myristica swamps are dominated by members of Myristicaceae. Krishnamoorthy (1960) reported Myristica swamp, for the first time, as a special type of habitat from Travancore. The northernmost swamp known is associated with a sacred grove in the Satari taluk of Goa. Myristica swamps are also reported from New Guinea (Corner, 1976). The Western Ghats have three genera and five species of Myristicaceae; all of them are trees associated with evergreen to semi-evergreen forests. Of these *Gymnacranthera canarica* and *Myristica fatua* var. *magnifica* are exclusive to the swamps. *M. malabarica* is occasional in the swamps and more frequent in the evergreen forests. No Myristica swamps have been reported from North eastern India.

Cultivar diversity

M. fragrans (nutmeg) is typically dioecious, with male and female flowers on different trees. Occasionally, male trees carrying a few female flowers are observed. Hermaphrodite trees having bisexual flowers are rarely noticed. male inflorescence has more number of flowers (up to 10) while female is less (up to 3). In a study to identify the sex segregation in nutmeg, it was observed that out of 90 progenies, 40 were males, 45 females and 5 bisexuals. Correlation analysis in nutmeg revealed a significant negative correlation of fruit number per tree and mace weight. However, seed weight had a significant positive correlation with mace weight (Krishnamoorthy *et al*., 1991).

Rare/threatened species

Myristica swamps are considered as an endangered habitat. The species *M. magnifica* var *fatua, M. malabarica* and *G. canarica* are reported to be rare/ threatened and need to be conserved. *M. malabarica* has been reported as endangered crop plant (Hammer and Khoshbakht, 2005). *M dactyloides* included as red listed species from Charmadi and Kemmangundi (Western Ghats) is now found widely distributed in those areas (Aravind *et al.,* 2005). None of the species which occur in North eastern India is considered as endangered at present.

Potential for tree spices in North East India

Spices like black pepper, ginger, turmeric, chillies, cardamom and seed spices are grown in North eastern states of India. No tree spices are grown commercially in these states. Among the commercially important tree spices, tejpat is grown as homestead crop in North eastern states and also forms as part of agro forestry in certain parts of the country. Few plantations of tejpat are reported to occur in Manipur and Arunachal Pradesh. Many wild species of *Garcinia* are reported from Assam, Manipur, Meghalaya and Arunachal Pradesh. The fruit is used as a spice locally for flavouring curries. Except tejpat which is grown in very limited scale no other tree spice is commercially cultivated in North east India. The climate of the North eastern region varies from sub-tropical to extreme alpine type. North east India has a predominantly humid sub-tropical climate with hot humid summer, severe monsoons and mild winter. The states of Arunachal Pradesh and Sikkim have mild summers and snowy winters.

At present no tree spices are commercially grown in North east India, though there is a tremendous potential for growing these crops. The climatic conditions prevailing in North eastern states are ideal for cultivation of some of the tree spices. There are about 17 tree spices grown in the country (Table 4) and among them cinnamon, cassia, tejpat, cambodge, kokum and nutmeg can be grown in parts of NE states where the temperature do not go below 15^0C.

Conclusions

Our biotic resources are under increasing pressure due to over exploitation of plant resources, changing land use, habitat loss and fragmentation, growing pollution of soil, water and air and the green house effect. In addition, the increasing population, development pressures on the land resources, deforestation changes in land use pattern and natural disasters contribute to the genetic wipe out of promising diversity and loss of genetic resources. Now with increasing importance of plant genetic resources especially in the context of

Intellectual Property Rights, Plant Breeders' Rights and Biodiversity Convention, there is an urgent need to conserve the biodiversity. Identification and documentation of rare, threatened and endemic species is important in the conservation of biodiversity. These species usually have specific ecological niches, edaphic gradients, and vulnerable habitats. *In situ* conservation is the best way to conserve plants, including the varied germplasm of different species. The hot spots have to be safe guarded so as to save the species under risk or that have found a place in the red data book.

The huge wasteland of rural areas in North east India can be utilized for the purpose of spice cultivation. The cultivation of tree spices like cinnamon, cassia, tejpat, cambodge, kokum and nutmeg would not only help in the economic upliftment of rural people but would also help in the utilization of wastelands and solving unemployed problem to a great extent. Besides, as there is a growing demand for organic spices and as the area is ideally suitable for growing tree spices organically there is an excellent scope for organic farming in this region through the use of bio-fertilizer and organic compost, coupled with integrated management of insect pests and diseases.

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Table 1. *Cinnamomum* species available in North eastern India

Species	Distribution	Major constituent
C. assamicum	North east India	-
C. bejolghota (Buch-Ham)	Eastern Himalayas, Myanmar	1, 8- cineole, Linalool
C. camphora (L.) Bercht & Presl.	Sub-Himalayan region	Camphor
C. cassia (L.) Brecht & Presl.	Mizoram	Cinnamaldehyde
C. cecidodaphne Meissner	Eastern Himalayas	Cineole, Methyl cinnamate
C. glanduliferum Nees	Himalayas, Khasi Hills	Cineole, Terpineol, Camphor
C. impressinervium Meissner.	North east India	Eugenol
C. iners	Assam	-
C. parthenoxylon	Shillong, Meghalaya	-
C. pauciflorum Nees	North east India	Cinnamaldehyde
C. sulphuratum Nees	North Cachar hills, Assam,	
	Western Ghats	Linalool, Citral, Cinnamaldehyde
C. tamala Nees	North east India, Assam	
C. verum	North east India	Cinnamaldehyde

Table 2. Important *Garcinia* species available in India

Species	Distribution
Garcinia andamanica King	Andaman Islands
G. anomala Planc.	Khasi Hills
G. atroviridis Griff.	North eastern districts of Assam
G. cornea L.	Bengal
G. cowa Roxb. Andaman	Eastern parts of India, Assam, Bihar Bengal, Orissa,
G. dulcis (Roxb.) Kurz	Introduced into India from Malaysia
G. echinocarpa Thw.	Tirunelveli forests
G. gummi-gutta (L). Robsmall *[G. cambogi (Gaetn)* Desr.*]*	Western Ghats, Maharashtra, Goa, Karnataka, Kerala, Shola forests of Nilgiris.

G. hanburyii Hook.	South India
G. hombroniana Pierre	Nicobar Islands
G. imbertti Bourd	South India
G. kydia Roxb.	Andman Islands, North eastern India
G. lanceaefolia Roxb.	Assam, Khasi Hills
G. livingstonei T.Anders.	Introduced to India from East Africa
G. malabarica Talbot	South India
G. mangostana L.	Introduced to South India
G. microstigma Kurz	Andaman Islands
G. morella Desr.	Assam, Khasi Hills, Western Ghats
G. paniculata Roxb.	Foot hills of Himalayas, Assam, Khasi Hills
G. pedunculata Roxb.	Assam, Manipur
G. speciosa Wall.	Andaman Islands
G. spictata Hook. [*G. ovalifolia* Hook. f.]	Western Ghats from Konkan Southwards
G. stipulate T. Anders.	Eastern Himalayas
G. succifolia Kurz	South India
G. travancorica Beddome	Western Ghats
G. wightii T. Anders.	South Indian Forests
G. xanthochymus Hook. [*G. tinctoria* Wight *G. pictorius* Roxb.]	Eastern Himalayas, Assam,Western Ghats, Andaman Islands

Table 3. Members of *Myristicaceae* occurring in North eastern India

Members of Myristicaceae	**Distribution**
M. gibbosa Hook. f. & Thoms.	Khasia mountains
M. glabra Blume	Silhet (Assam), Tirunelveli (Tamil Nadu), Andaman Islands
M. kingii hook. F.	Sikkim, Himalaya
M. longifolia Wall.	Sikkim, Himalaya, Assam, Khasi Hills

Table 4. Tree spices grown in India

Botanical name	**Family**	**Common name**	**Part used as spice**
Averrhoa bilimbi L.	Averrhoaceae	Bilimbi	Fruit
A.carambola L.	Averrhoaceae	Carambola	Fruit
Cinnamomum aromaticum Nees	Lauraceae	Chinese cassia	Fruit

C.tamala Nees	Lauraceae	Tejpet, Indian cassia	Leaf, bark
C.verum Bercht &Presl.	Lauraceae	Cinnamon	Bark, leaf
Garcinia gummi-gutta (L.) Robs.	Clusiaceae	*Garcinia cambogia*	Pericarp of fruit
G. indica (Thouras) Choisy	Clusiaceae	Garcinia, Kokam	Pericarp of fruit
Illicum verum Hook.	Illiciaceae	Star anise	Fruit
Juniperus communis L.	Cupressaceae	Juniper	Fruit
Laurus nobilis L.	Lauraceae	Bay leaf	Leaf
Mangifera indica L.	Anacardiaceae	Mango	Rind of immature fruit
Murraya koenigii (L.) Sprengel	Rutaceae	Curry leaf	Leaf
Myristica fragrans Houtt.	Myristicaceae	Nutmeg	Kernel, aril
Pimenta dioica (L.)Merr.	Myrtaceae	Allspice, Jamaica pepper	Immature fruit, leaf
Punica granatum L.	Punicaceace	Pomegranate	Dried seed (with flesh)
Syzygium aromaticum (L.) Merr. & Perry	Myrtaceae	Clove	Flower bud
Tamarindus indica L.	Caesalpiniaceae	Tamarind	Fruit

Potential for herbal spices cultivation in North eastern states of India

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Introduction

The North east India is the land of rising sun in the Indian sub-continent. The green belt of India, so called land of forests and tribals, the entire North eastern region is very rich in its natural resources, minerals and most importantly for valuable forests. The region is influenced predominantly by unique physiographic, edaphic, climatic and altitude gradients. The diverse hill ecosystems covering more than two third of total geographical area at different elevations from tropical to temperate and alpine zones provides rich resource base. It is one among the ten bio-geographic zones in India and is the treasure house of species and genetic diversity. The diverse agro climatic conditions favor the cultivation of a wide range of crops making agriculture as one of dominant economic activities in the region. A variety of spice crops are cultivated commercially and it includes *ginger, turmeric, amomum cardamom, black pepper, chilli ,tejpatta* and *herbs.* There is an ample scope for commercial cultivation of exotic herbal spices owing to many favourable factors particularly their amenability to organic system of cultivation practiced in the North eastern states of India.

Centre of origin and global scenario

Herbal spices are probably the most widely grown aromatic group of plants all over the world today. The botanical definition of the herb is a plant with no persistent stem above ground and for all practical purposes; herbs are those plants with aromatic or perfumed parts, whether they are leaves, roots, flowers or fruits which are used in cooking, medicine or cosmetics. Based on the life span, herbs are categorized in to annuals, biennials and perennial herbs and they are also broadly grouped into three classes such as culinary, flavouring and medicinal based mainly on their uses. Most of the culinary herbs belong to the families of Umbelliferae and Labiatae. The Mediterranean areas including North Africa and Middle East are considered to be the centre origin of most of the culinary herbs including bay leaves, cumin, coriander, mustard, rosemary, sage etc. The colder regions of north Europe and Asia have supplied only few herbs like caraway seed and horse radish. Now many herbs are extensively cultivated in countries like France, Egypt, Hungary, Indonesia, USA, UK, Turkey, Algeria etc. The total consumption of the dried herbal spices is estimated as 30000 – 32000 t/annum in the international market. The major suppliers are France, Germany, Netherlands, Turkey, Mexico, Greece, Israel, Egypt, Hungary, Albania, Yugoslavia, Spain, Morocco etc. The major markets are West Europe and USA importing about 12000 - 13000 t each year.

Indian scenario

The cultivation of herbal spices is confined to a few pockets at higher elevations of Tamil Nadu, Jammu and Kashmir, Rajasthan and Delhi. Many of the herbs are cultivated on small holdings and are scattered, accurate information on area of cultivation, production and productivity are not available. Green house cultivation is also practiced on commercial scale. However, field grown organically produced herbs are widely preferred in the market. It is estimated that India requires 200 tons of herbal spices annually, out of which around 65 tons are produced, The bulk of the consumption is accounted by the metropolitan cities like Delhi, Mumbai, Calcutta and Chennai. In recent years the cultivation of herbs is in the increasing trend. However, the domestic demand is met through the imports. The import cost of herbs is very high in India and this warrants its large scale cultivation. Since the Indian sub continent is blessed with congenial climatic conditions suitable for the cultivation of herbs through out the year, its cultivation shall be extended to large areas in North eastern states of India.

Variability

An array of variability has been encountered in the growth habit and morphology of the useful part. Some are succulents (parsley, celery), bulbs (leek, chives), small creepers (marjoram, thyme), root tuber (Horse radish), hardy shrubs (rosemary, lemon thyme) and even woody tree (bay tree). The morphology of the useful parts varies with the herb. It can be root (horse radish), stem (sweet marjoram), leaf (bay, oregano, mint, parsley, thyme, and tarragon), flower (hyssop) and seed (caraway, anise, poppy).

Quality

The intrinsic quality of herbs, i.e, aroma and flavour is due to essential oils and other constituents. Fragrance is due to the presence of volatile compounds in the essential oil, which belongs to a group of chemical compounds like alcohols, aldehydes, ethers, esters, ketones, sesquiterpenes, terpenes, lactones, phenols and phenol ethers. The type and intensity of these constituents vary with individual herb.The essential oil content is very low in many of the herbs which vary from 0.15 (parsley) to 3 (bay leaf) percent. The essential oil content in turn depends on the factors like nutrition, growing conditions, stage of harvest, harvesting, methods of drying and conditions like temperature, light and humidity during drying and storage. Knowledge of these factors, which vary with individual herb, is very essential to maintain commercial quality.

Processing and uses

Air drying by hanging under shade or keeping at hot surfaces, steaming followed by sun drying at controlled temperature (21-32^{0}C), storing under refrigerated condition (deep freezing) in plastic containers, cleaning etc., are some of the common post harvest processing practices adopted for these herbs. The recovery percent of these spices on drying varies from 20 (horse radish) to 7 (basil). Moisture content level is optimum at six percent. Many types of equipment are used for cleaning these herbs as cleanliness specifications are very stringent.

Spices are one of the indispensable factors of Indian cooking system. Spices and herbs are employed as adjuncts to flavours and aroma. Herbs are used mainly for natural living, nutrition and health healing and gardening. The fresh herbs are preferred for culinary use. As soon as they are harvested, the produce is cleaned and packed in baskets and transported at the earliest since their storage life is very short. Hence, dehydration or freeze storing is essential. It is also needed for meeting the off-season requirement. Vacuum sealed packing or use of air tight dark containers with 50 to 250 g net weights is ideal for herbs. Packing in glass bottles with sprinkler system is also preferred for dehydrated powdered/ semi powdered herbs. Repacking after one month enhances shelf life for flavour. Storing is to be done in a cool place in dark cupboards as light destroys the essential oils. Frequent opening of storage jars is to be avoided or else the absorption of atmospheric moisture and deterioration will be quick.

Herbal spices are widely used in food preparations, cosmetic and beauty-aid and in medicine. In cuisine they are mainly used for flavouring many dishes, salads, sauces, soups, vinegars, juices, butter, sweets, salt, sugar, jellies, tea, wines, chutnies, cheeses, breads, biscuits etc. They figure in a number of cosmetics *viz.,* soap, hair tonic, face cream, shampoo, chewing gum, tooth paste, nail polish, lipstick, body fresheners, deodorants, mouth washes, aftershave lotions, candies, perfumes, toilet preparations etc as aromatic. Their pharmaceutical properties are as expectorant, antispasmodic carminative, chloretic, hypotensive, antiseptic, diuretic, stomachic, skin tonic and appetite stimulant. Besides the herbs can also be developed in garden by planting in hedges, edgings, rows, pavements, paths, and lawns and for ground cover, as also as decorative foliage plants, flowering plants *etc*. Their use in making of renounced 'port-purri' is also well known.

Scope and cultivation constraints

Herbal spices are reported to have excellent scope for exports both in raw and in value added forms. Considering their importance, Spices Board has conducted a domestic survey to the feasibility of exotic herbs cultivation in the country. There is a tremendous potential for export of these spices from India particularly in value added form. Some of the spices are commercially cultivated and others are on trial basis at various locations. However, their extensive cultivation in India is beset by many constraints. It includes lack of adequate good quality planting materials, good agricultural practices (GAP) for quality commodity production, inadequate storage facilities for upkeeping the quality of raw as well as processed products, lack of market linked production and unawareness of their potential and suitability under Indian conditions *etc*.

Potential herbs

The rich resources reservoir and ideal climatic conditions prevailing in the North east region of India provides a favourable niche for the growth and commercial cultivation of herbal spices. Some of the economically viable and those suitable for large scale cultivation are described.

Majoram (*Majorana hortensis* Moench)

Majoram, the perennial aromatic herb is a native of Mediterranean region and extensively cultivated in India. Its leaves and seeds are astringent and are used in flavouring liver preparations and polish sausage and cheese, in soaps, salads, egg and vegetable dishes. Its leaves are used for seasoning food. It yields 3.5% volatile oil. It is propagated through both seeds and cuttings. The plant has also been employed in the treatment of cancer and also exhibited antifungal activity.

Mint (*Mentha piperita* L.)

Mint is a native of Europe and Asia and introduced throughout the world due to its wide adaptability. It is a tropical perennial herb used in flavouring meat, fish soups etc. Pepper mint oil is used in conconfectionary and liquors, pharmaceuticals and dental preparations. The oil and dried plant parts are antiseptic, carminative, stimulant and diuretic. It is propagated through runners and rooted cuttings and through divisions of stolons.

Origanum (*Origanum vulgare* Linn.)

This is a perennial plant indigenous to the Mediterranean region particularly Greece, Italy and Spain. It grows well on sunny, slopping hilly areas surrounding the Mediterranean. In India, it is produced on a small scale and grown in the Simla hills, Kashmir valley and Nilgiris. It is a perennial plant. The dried herb is pale grayish green in colour. The crop is harvested when in full bloom. It has a strong aromatic, camphoraceous flavour. The dried leaves, stalks and floral parts all constitute the spice. It is propagated through seeds and cuttings.

Parsley (*Peeroselium eripsum* (*P. milles*)

Parsley is a most expensive culinary spice indigenous to the Mediterranean. Parsley is a dried, aromatic leaf of a low growing biennial herb with dense foliage and white flowers. The bright green leaves are finely divided and cured. It has a warm, fresh herbaceous flavour. It contains vitamins A, B and C and many other nutrients. Dried parsley flakes are used for seasoning a variety of food. It also finds use in beverages and medicines and dried roots and leaves are used as insecticides. Parsley is propagated through seeds.

Rosemary (*Rosemarinus officinalis* Linn.)

Rosemary is indigenous to European countries bordering the Mediterranean. In India rosemary is grown in the homesteads. Rosemary is the leaf of densely branched, small, evergreen aromatic shrub that may grown up to height of two meters. The shrub produces linear, leathery, dark green leaves with light sky-blue flowers. When dry the leaves have a rolled up appearance, dark green color and tea like fragrance. It is propagated by cuttings. Commercial Rosemary production was first commenced in the Nilgiri District of Tamil Nadu in India.

Sage (*Salvia officinalis* Linn.)

Sage is native of southern Europe and it is a bushy perennial shrub. Sage has been widely used in the food industry as a standard spice in marketing stuffing of fowl, meat and sausages. It is used as a mild tonic, astringent and carminative and in toothpaste, mouthwash, toothpowder, hair tonics *etc*. Sage has been prescribed to cure female disorders since ancient times. Sage oil is used in perfumes as a deodorant apart from insecticide preparations. It is harvested top growth before flowering and it yields 2.5% essential oil. It is propagated through stem cuttings.

Savory (*Satureia horttensis* Linn.)

Savory is one of the most fragrant spices. It is an erect pubescent annual herb native of southern Europe. It is propagated through seeds. Savory is used in flavouring of soups and sauces, egg and salad dishes apart from poultry dressing. Savory is of two types, winter savory and summer savory (*Satureia montana)*. It contains 1% volatile oil. The herb is reported to have carminative and stimulating properties and it also possesses anti-oxidant property.

Tarragon (*Artemisia draccunculus* Linn)

The dried leaves and flowering tops of *Artemisia draccunculus* form the tarragon of commerce. It is a perennial herb native to West Asia and Southern Europe. Tarragon is used for flavouring vinegar, pickles and to a limited extent for the flavouring of soups, salads and vegetables. The aromatic leaves are employed in the preparations of the medicine. Harvest young leaves and shoots before flower buds develop and it yields 0.3 to 1.3% of oil. Its aroma is warming aromatic and reminiscent of anise. It is vegetatively propagated through cuttings

Thyme (*Thymus vulgaris*)

It is indigenous to the Mediterranean region. In India, thyme grows wild along the Western Himalaya region, from Kashmir to Kumaon. It is also grown as homestead gardens in Ooty. Thyme is flourishes in sub-tropical and temperate climates. Thyme has a pungent, mint like odour. Thyme is small, creeping shrub like perennial. It has dense, whitish branches bearing narrow leaves and clusters of purple leaves. The leaves and flowering tops are used as spice, but the entire plant, excluding the roots yield oils and oleoresins. Propagation is by means of seeds and cuttings.

Basil or sweet flag (*Ocimum basilicum* Linn.)

Basil is the dried leaf of a tropical annual, erect glabrous herbaceous plant, native of North west India and Persia. In India, there is a wide spread belief that if planted around home and temple, it ensures happiness. Polymorphism and cross pollination under cultivation have given rise to number of sub – species, varieties and races. The leaves have numerous dot like oil glands in which the volatile oil of the herb is contained. Basil contain protein, volatile oil, fixed oil, cellulose pigment, minerals and vitamin. It is propagated through seeds. The essential oil has found important application in perfumery and leaves are used in flavouring food. It is a very safe insect controlling agent.

Organic farming of herbal spices – A case study

Spices Board has taken up a UNDP financed project on '*Integrated Development of Spice Industry*'. Organic farming of spices was identified as one of the components in which pepper, ginger, turmeric, vanilla etc and herbal spices like rosemary, thyme, parsley. Non Governmental Organizations (NGOs) such as Peermade Development Society (PDS); Wayanad Social Service Society, Kerala; HOPE, Nilgiris, Tamil Nadu were entrusted to implement the scheme on participatory mode approach. The activities envisaged were 1) quality improvement and technical upgradation of spices production and post harvest techniques and 2) promotion of environmental and eco friendly cultivation of spices.

During the IX Plan, Spices Board has implemented a pilot project for development of herbal spices with the support of NGO *viz.,* HOPE in Nilgiris, Tamilnadu. The project has successfully demonstrated the commercial cultivation of herbal spices *viz.,* rosemary, thyme *etc.* by the beneficiaries. Prior to implementation of the project the cultivation of herbs in Nilgiris was limited to a small area (few cents) mainly for supply of fresh herbs to star hotels in major cities. Apart from the standardization of production technology, the project could demonstrate post harvest practices such as scientific processing and value addition. Rosemary and thyme oils were extracted and made available in the domestic and export market. The programme has become very successful.

Considering the successful outcome of the project, the Board has implemented the herbal spices development programme during X plan with the active support of NGOs / farmers groups to cover 50 ha by meeting 40 % of the cost of planting materials as subsidy. Under this scheme, the cultivation of rosemary was extended to Burgur hills in Erode District of Tamil Nadu covering 38 ha covering 105 small and marginal growers with the support of HOPE, farmers group, Myrada KVK, DRDA. The facilities for drying as well as oil extraction were provided. The dried herbs and oil well were sold to the exporters. It has revealed that rosemary cultivation in Nilgiris and Erode districts of Tamil Nadu became economically viable under organic system of cultivation. Further, it helped in the promotion of group farming by small and marginal growers. The successful model involving grower - exporter partnership with support of NGOs will provide benefit to the entrepreneurs interested in herbal spices cultivation.

Conclusion

There is tremendous scope for cultivation of exotic spices in North eastern states of India as the region is blessed with ideal soil and climatic conditions. These spices are amenable to organic farming which results in chemical residue free commodity for domestic as well as export market.

Prospects of seed spices cultivation in North eastern India

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India is a leader in spices. The export data presented in 'Spices India' (July 2009) further consolidates this position that Indian spices are in great demand despite increasing competition from newer entrants into spices production and trade. However we cannot be complacent on this account. Just like in any other crop, the productivity of many a spices are either stagnant or showing a decreasing trend. This needs to be reversed. Major issues that daunt the spices cultivation are the pestilences. Even with utmost efforts, successes in generating resistant varieties against myriad of diseases and pests that affect spices cultivation is limited. Further, changing weather pattern is complicating the growth and cultivation of the spices. One way to counter this problem is to explore newer areas for cultivation. North eastern India therefore appears to be promising in this direction. Nothe eastern states are unique and have their own special place in the cultivation of spices. These states are famous for the large cardamom, unique types of chillies. Important spice crops that are grown in the North eastern states of India are presented in Table 1. As can be seen almost all the states grow major spices. Data with regard to minor spices is not available. Can seed spices be grown in North east? Let us explore the issue.

Seed spices have originated in Mediterranean region, where from they were introduced into our country. Major areas of cultivation of seed spices are the western states namely Rajasthan and Gujarat. Nearly all the acreage of cumin is found in these two states. More than 70% acreage of the three major spices is also located in these two states. Coriander and fenugreek have pan India presence, although commercial production for seed is taken in Madhya Pradesh, Uttar Pradesh, Andhra Pradesh and Tamil Nadu for coriander. Coriander for leaves is cultivated on a limited scale around urban areas or domestic kitchen gardens in all the places. Similarly fenugreek is also cultivated on limited scale in several of the states. Major spice growing regions of Gujarat and Rajasthan have dry climate, with clearly defined seasons, where the spices are grown mostly in the cool season. All the crops are susceptible to frost, hence frost free zones give high yields.

Let us broadly analyze the climate and soil types of North eastern states for their suitability to seed spices cultivation. A brief account of the weather conditions of the NE states is given below.

Assam: The climate of Assam is depicted by its extreme humidity. Its most distinguishing feature is the abundant rainfall between March and May at a time when rain in upper India is at its minimum. Climate wise the year in Assam can be divided into the cold season and the rainy. The cold weather lasts from October to February and the rest of the year is rainy. The South West monsoon begins in Assam from middle of June.

Arunachal Pradesh: The weather and the climate of Arunachal Pradesh are quite unique from the rest of India. The climate of Arunachal is governed by the Himalayan system and the altitudinal differences. The climate here is highly hot and humid at the lower altitudes and in the valleys wrapped by marshy thick forest particularly in the eastern region, while it becomes too cold in the higher altitudes. Average temperature during the winter months range from 15 to 21 ^{0}C and 22 to 30 ^{0}Cs during monsoon. Between June and August the temperature sometimes goes up to 40 to 42 ^{0}C. The rainfall of Arunachal Pradesh is amongst the heaviest in the country. The annual average rainfall in Arunachal Pradesh is more than 350 cm.

Meghalaya: Meghalaya is subject to vagaries of the monsoon. The climate varies with altitude. The climate of Khasi and Jaintia Hills is uniquely pleasant and bracing. It is neither too warm in summer nor too cold in winter, but over the plains of Garo Hills, the climate is warm and humid, except in winter. The Meghalayan sky seldom remains free of clouds.

Mizoram: The Tropic of Cancer runs through the middle of Mizoram. The climate therefore is temperate with cool summers and not-so-cold winters. The state experiences heavy rains from May to September. Winter is very pleasant; the skies are wonderfully blue and the sunshine is immensely enjoyable. Annual rainfall is 250 cm. Average temperatures are 11°-21° C in winter and 20°-29° C in summer.

Nagaland: Rains are heavy in Nagaland. The average rainfall is between 175 cm to 250 cm. Most of the heavy rainfall is during the four months from June to September. The rain during April to May is low. Strong winds blow from the North West in February and March. The climate is pleasant.

Sikkim: The climate of the state has been roughly divided into the tropical, temperature and alpine zones. For most of the period in a year, the climate is cold and humid as rainfall occurs in each month. The area experiences a heavy rainfall due to its proximity to the Bay of Bengal. The rainfall in North district is comparatively less than of the other districts. The general trend of decrease in temperature with increase in altitude holds good every where. Pre-monsoon rain occurs in April-May and monsoon (South West) operates normally from the month of May and continues up to early October.

Tripura: Tripura enjoys a typical monsoonal climate with differences ranging from sub-tropical to temperate conditions in hilly areas. The rapid change in topography results in significant climate changes within a short time. The climate of Tripura displays a strong seasonal rhythm. The terrain, soil and climate of Tripura are ideally suited for rain-fed horticulture. The year being divisible to four characteristic seasons namely winter (Dec - Feb), premonsoon (March - April), monsoon (May - September) and post monsoon (Oct - Nov). The monsoon period lasts for about five months from May to September, which is the longest season of the state. June is the wettest month followed by July and May. Temperature varies between 10 to 35^{0}C, average annual rain fall is 2100 mm, highest rain fall is 2855 mm (Kamalpur); lowest rain fall is 1811 mm (Sonamura).

In general, the topography of North east is undulating and mountainous. Humidity is high with high rainfall and even distribution all through the year in comparison to western states or even from the place where most of the seed spices have originated. Wide variation in temperature is seen with very cool to very warm areas. Seasonal differences are noted. One notable feature is the presence of cloudy days. In the cooler regions frost is not a problem. These conditions are ideal for the cultivation of fennel, fenugreek and coriander but not for cumin which requires a drier climate. High humidity of North east would be ideal to explore commercial cultivation of the said seed spices in these regions. Since rains are uniform with above average humidity, the seed spices tend to overgrow leading to lodging; hence, it is ideal if dwarf varieties are explored. Cloudy weather is detrimental for seed spice cultivation as they induce disease development, hence may not be suitable for cumin cultivation. The other major spices can tolerate the cloudy weather and humidity.

Ajowain: It is a cool season crop and the production of ajowain required cool and dry climate. At present this crop is largely grown in UP, Bihar, MP, Punjab, Rajasthan, Gujarat, West Bengal, Tamil Nadu and Andhra Pradesh. Higher moisture in the air will attract diseases and insects. Higher moisture particularly after anthesis will be detrimental for the crop productivity. The number of improved varieities are still limited and with the availability of varieties, this may be tried in NE in the rabi season.

Aniseed: Also called anise, is a constituent of traditional medicine for time immemorial. Because of its close resemblance it is often confused with fennel and many a times referred to as Indian aniseed. It has also originated from East Mediterranean region covering Greece, Egypt and Asia Minor. It is grown on a small scale in Rajasthan, Punjab, UP and Orissa. It is cool season crop hence is grown in rabi season. Warm and sunny days and well distributed rainfall is best for its growth, hence it is generally grown as summer crop in temperate climates while as winter crop in North Indian Plains. This crop may tried for adoption in NE as at present most of the aniseed consumed in India is imported from France, Spain and other European countries.

Caraway: It is also a cool season crop which has its origin in North and Central Europe. It has limited distribution in India and the cultivation limited to J&K, Himachal Pradesh and Uttaranchal and is found growing in temperate areas at an altitude of 1800-3500 msl. During winter growing areas are covered with heavy snow. Snowfall after sprouting is very injurious to the crop and therefore cultivated areas should be free from snowfall or frost during cropping season. While this crop is generally cultivated as rainfed crop, a little rain at the time of flowering is very conducive for seed formation. This can, therefore, be tried in Arunachal Pradesh as it has good export potential.

Celery: Celery is native to Mediterranean region but finds distribution all through the Europe and North of Africa as well as in India. It is cultivated both for salad as well as for seed. The celery seed is in great demand both in India and abroad. It is a biennial crop with the seed produced in the second year in the cooler climate of Himalayas while it becomes annual in the plains with the seed produced in the first year itself. It is a moisture loving plant. It can be successfully cultivated in areas which are free from severe frost and with low relative humidity during February- March when the crop flowers. Thus, this can be tried in NE in the mountains where the temperature is not too low or too high with good drainage. This will be a good salad crop in protected cultivation.

Coriander: This is a very popular crop which is grown in all most all the states on small or large scale either for leaves or seeds or both. Commercial cultivation for seed is more prominent in the western and central states as well as in southern states of Tamil Nadu and Andhra Pradesh. This crop requires frost free cool environment when grown for seed, however for leaves it can be cultivated practically in any environment. In fact, Directorate of Arecanut and spices Development statistics show that when cultivated on a limited area, the productivity is highest among all the states in India. The commercial cultivation should be tried in NE states which receive good rainfall and have cooler climate and are frost free. Several varieties are available which should be tried. False coriander is common to Manipur and neighboring areas which is grown for the leaves and its peculiar taste. This is virtually unknown to rest of country.

Cumin: This crop originated in Mediterranean region, and is a popular in western states namely Rajasthan and Gujarat. Like other cereals, it is also cool season crop requiring cool and dry atmosphere for proper growth. Higher moisture during growth period is detrimental as it will induce diseases. This is a delicate crop requiring utmost care in cultivation. Since disease resistant varieties are limited, the prospect of cumin cultivation in NE states is questionable.

Black cumin: Also called Kalonji, it is a native of the Mediterranean. It occurs wild in India and is used as condiment from the ancient time. It is at present cultivated on commercial scale in MP, Bihar, Punjab and Assam. It is a cool season crop and is cultivated during rabi in North India. Cold weather is congenial for early growth and crop requires warm sunny weather during seed formation and maturity. It appears to be a promising crop for NE.

Fennel: Fennel is again a cool season long duration crop and is cultivated for the seed by most of the European countries as well as India. Gujarat and Rajasthan are the largest producers in India. In India bitter type fennel is cultivated, while in Europe both sweet type (also known as Florence fennel)and bitter types are grown. It requires cool climate and frost free environment. High winds at the time of maturity can cause shattering and very hot winds at flowering reduce seed setting. Thus the NE climate particularly in the upper reaches appears ideal. In very cool climate of Arunachal Pradesh the cultivation of Florence type fennel for the export market may be tried.

Fenugreek: This crop is grown for its dried ripe fruit the seeds have pleasantly bitter taste and a peculiar odor and flavor of its own. It is cultivated on large scale in the western states of India, although on small scale it has pan India presence. Around urban areas, the young plants are harvested for the use as leafy vegetable. This is therefore a common vegetable and can be propagated as such in NE states.

Table 1. Important spices grown in North eastern states

State	Spice	Important areas of cultivation
Arunachal Pradesh	Black pepper	Changlang, Siang, Subansiri
	Large cardamom West Siang	Khonsa, East Kameng, Lower Subansiri,
	Chillies	East Siang, Lower Subansiri,
	Ginger	East Garo hills
	Turmeric	Jaintia hills
	Garlic	
	Bay leaf	
Assam	Chillies Kokrajhar, Darrang	Barpeta, Dhubri, Nagaon, Kamrup,
	Ginger	NC Hills, Karbi-Anglong
	Turmeric Sonitpur	NagaonBarpeta, Kamrup, Darrang,
Meghalaya	Black pepper West Garo Hills	East and West Khasi Hills,
	Chillies	East and West Garo Hills
	Ginger	East and West Garo Hills
	Turmeric	Jaintia Hills, West Garo Hills
Mizoram	Chillies	Aizawl
	Ginger	Aizawl

	Large cardmom Chillies Ginger	Senapati, Churachandpur,Ukhrul Churachandpur
Nagaland	Ginger Chillies Garlic	Kohima, Phek, Mokokchung, Wokha Kohima, Phek, Mokokchung, Wokha Kohima, Phek, Zunheboto,Tuensang
Sikkim	Large cardamom Ginger Ginger Turmeric Chillies	East-West-South and North Sikkim East-West-South and North Sikkim North and South Tripura North and South Tripura North and South Tripura

Technologies for cultivation of spices in North eastern region

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The North eastern region occupies about 1.40 lakh hectare area among major spices *viz.*, chillies, ginger, turmeric, large cardamom and black pepper with production of 1.81 lakh tons (Table 1). Besides, the region also grows on a limited scale several other spices like garlic, coriander, *etc*. and several indigenous spices for local consumption. Among the tree spices, cassia and cinnamon are growing as wild habitant. Some of the exotic commercial spices like black pepper have been introduced in integrated farming system in the warmer parts of different hill states. Sikkim is an important state for large cardamom production and other states like Arunachal Pradesh, Nagaland and Meghalaya are also moving in the positive direction. The region is coming forward in production of organic spices like ginger (cv. Nadia) and turmeric (cv. Lakadong) and exporting about 60 to 70 per cent produce outside the region and neighboring countries.

Table 1. Area (000' ha) and production (000't) of spices in NE region

State	Chilli		Ginger		Turmeric		Large cardamom		Black pepper	
	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.
Arunachal Pradesh	1.2	1.6	4.34	31.09	0.40	1.50	3.84	0.56	1.32	-
Assam	14.7	0.97	-	-	10.10	7.00	-	-	-	-
Manipur	8.8	5.3	5.9	9.7	-	-	-	-	-	-
Nagaland	1.2	9.6	7.60	6.69	0.6	3.59	1.46	0.15	3.7	2.6
Mizoram	2.8	3.3	7.60	20.50	0.4	3.60	-	-	-	-
Meghalaya	1.8	1.1	4.10	49.06	1.50	8.2	-	-	-	-
Sikkim	-	-	9.55	4.32	0.4	1.5	15.48	8.0	-	-
Tripura	2.0	1.2	4.90	6.41	1.5	2.8	-	-	9.15	1.3
Total	32.8	23.07	37.46	127.47	27.5	27.49	10.78	8.71	14.17	3.9
All India	81.31	113.1	86.16	317.8	163.0	552.3	11.65	12.10	216.5	79.1

Source: Directorate of Economics and Statistics, Ministry of Agriculture (2006-07)

Since the inception of HTM, an additional area of 12,895 ha has been brought under various spices crops between 2001-02 to 2003-04 (Table 2). By visualizing the importance of traditional crops, maximum emphasis is given to large cardamom and ginger besides low volume and high price crop like black pepper. Sikkim is a leading state in area expansion followed by Arunachal Pradesh.

Table 2. Additional area brought under spices in HTM

Crops	Area (ha)	State	Area (ha)
Large cardamom	3775	Arunachal Pradesh	3240
Cinnamon	145	Assam	1350
Turmeric	843	Manipur	768
Black pepper	2773	Mizoram	1355
Chillies	850	Meghalaya	810
Ginger	3356	Nagaland	1625
Garlic	150	Sikkim	3773
Other spices	1003	Tripura	604
Total	12895		

Identification of constraints

The problem in successful production varies with location and crop. For evolving workable strategies to increase the productivity of spices, analysis of reasons for low productivity and identification of constraints in production under a particular agro climatic condition is essential. Productivity is particularly low in most of the spices (Table 3) and it is below the average national productivity. The factors that limited productivity in spice crops in the NE region are,

- Inadequate supply of quality seed/planting materials of improved varieties
- Lesser fertilizer inputs, low fertilizer use efficiency and micro nutrients deficiency
- Biotic factors limiting the yields like soft rot of ginger, wilt of black pepper, *Taphrina* in turmeric, *chirki-foorkey* in large cardamom, *etc*.
- Abiotic stresses like winter drought and low sunshine during harvesting and drying period of ginger and turmeric
- Lack of availability of eco-friendly technologies of production and protection for organic farming
- Poor basic infrastructure like rural roads, transport and communication, *etc*.
- Poor post harvest handling, processing and inadequate storage facilities
- Market fluctuations and lack of organized marketing system
- Lack of agro-based industry in field of spices for value addition
- Poor linkage between producers, R&D and marketing agencies
- Inadequate database facilities and lack of growers association in the field of spices

Table 3. Productivity status of spices in NE region

Crop	National productivity	NER productivity (t ha^{-1})	Gap in productivity (t ha^{-1})	Share in national production(%)	
				Prod.	Area
Ginger	3.8	3.40	0.4	40%	43.5%
Turmeric	3.4	2.0	-2.4	11.9%	16.87%
Chillies	1.2	0.7	-0.5	3.72	2.07%
Large cardamom	0.72	0.72	-	90%	83.25%
Black pepper	0.36	0.27	-0.09	4.9%	6.5%

Strategies to improve productivity of spices

Inspite of the fact that Indian spices are known for their intrinsic quality, flavour and aroma, Indian spices industry has been facing competition from other spice producing countries. There has been an alarming growth in consumption pattern of spices in India itself. As the international market becomes increasingly competitive, it is imperative to enhance the production and bring down cost of cultivation to make spices nationally and globally competitive.

Salient features of research findings and technologies evolved and transferred by various research organizations are briefly furnished.

Spices varieties

Farmers traditionally used local varieties. The research efforts made by ICAR and SAUs have resulted in many improved varieties to boost productivity (Table 4).

Table 4. Varieties of Spices

Crop	Varieties
Black pepper	P_1, P_4 and Sreekara suited for NEH region (Singh, 2006)
Ginger	Thinglaidum, Nadia, Khasi Local (higher yielder), Thinglaidum, Rio-de-Janeiro, China, Nagaland pungent (rich in oil & oleoresin), Nadia, Manran, China(Less fibre) good for national & international market (Anon, 1996; Singh *et al.,*2000), Baisey [350 g] (Anon, 2009)
Turmeric	Lakadong [curcumin 7%](Singh *et al.*, 2009) & PCT-13 [curcumin 5.6%] (Bendangsenla *et al.,* 2006) best suited for NE region; Waiphai [6.8% curcumin] (Anon, 2009)
Cinnamon	Navasree (Anon, 2006)
Onion	N-53 and Agri Found Dark Red variety from NHR&DF, Nashik, best suited for summer season (off season) under Nagaland condition (Singh, 2006 and Ethel *et al.,* 2009)
Large cardamom	Ramsey, Sawney, Varlangey, Dzongu Golsey & Seremna. Released varieties by ICAR are ICRI Sikkim-1 and ICRI Sikkim-2 (Biswas and Deka, 2006)

Production technologies

Black pepper

Propagation	▪ Production of disease free planting materials in the nursery through soil solarization and use of bio control agents like *Trichoderma viride* and VAM incorporation in nursery ▪ Pit method for single node cuttings ▪ Bamboo method for production of rooted cuttings with multiplication ratio of 1.40 per annum was developed at IISR, Calicut, followed in NE region also
Cropping system	▪ Silver oak is most suitable standard. ▪ Coconut, arecanut, jackfruit are also suitable standards for mixed plantation (Singh, 2006) ▪ Indian gooseberry, Naga neem and other forest and avenue plantations can be used in NE region as standards (Singh, 2006)
Nutrient management	▪ Fertilizers schedule (N, P, K) for obtaining optimum yield in black pepper has been standardized by IISR @ 140:50-170 g/year in laterite soil. Application of phosphorus as Mussoorie rock phosphate @ 100g/year is recommended ▪ Field trials showed that neem coated urea (1%) increased the release of N in the soil and productivity of black pepper enhanced by 50% ▪ Neem oil cake given @ 30g or NPK 1: 0.5: 0.5g/10kg of soil at 60 days interval increased spiking intensity. ▪ Under organic farming system, application of 10 kg FYM or 6 kg pig manure and leaf mulch together with 0.5 kg groundnut cake, 2.5 kg neem cake, 200g rock phosphate and 2 kg wood dust with 20g biofertilizer per vine per year is the best dose for higher yield.
Post harvest technology	▪ Techniques for preparation of white pepper and green pepper in brine has been standardized.
Plant protection	▪ For root rot or wilt, *Trichogramma viride* @ 50 g/vine with neem cake 1 kg/vine is recommended. Similarly, IPM schedule was developed for pollu beetle, scale insects. Spraying insecticides and commercial neem products and selected application of pesticides and bio control agents like *Chilocorus* sp., *Encarsia lounsburyi*, *Pseudoscymnus* sp., for leaf curl is recommended. Bio control agents have also been identified for top shoot borer like *Hexamermis* sp., *Apanteles cypress.* For leaf gall thrips of black pepper the biocontrol agents identified are *Montandoniola moraguesi* and *Androthrips flavipes*.

Ginger

Ginger is an important cash crop among the spices for NE region and the region contributes about 40% in national production. The NE region grows ginger in organic system even though there is only 0.4 t ha^{-1} gap in productivity in comparison to national production. By systematic nutrient and pest management, productivity level could be enhanced to appreciable level.

Crop management	■ Crop management practices *viz.*, planting season, seed rate, systems of planting, nutrition, mulching, shade tolerance, mixed cropping, post harvest handling and storage has been worked by ICAR and SAUs. ■ Planting of 20-25g rhizome pieces (5-7 cm in length) as seed material, the best planting material identified is that of cv. Nadia (Singh and Thasiama, 1991). ■ Inorganic system of nutrient management involves application of FYM @ 25 t ha^{-1} and pig manure @ 15 t ha^{-1} under Nagaland conditions (Lalramthara *et al.,* 2001). ■ Fertilizer doses can be effectively reduced by 25-30% by application or treatment of planting material/ soil with bio fertilizer. Under Nagaland condition, *Azospirillium* was found to be much more effective in comparison to *Azotobacter*, Phosphotica can be also used to enhance the availability of phosphorus in the soil. Application of 75 kg K ha^{-1} + Azospirillum was found to be more economical in terms of net profit and cost benefit ratio (Singh *et al.,* 2004). ■ Zn and B improve the yield of ginger at 0.4% spray (Lalramthara, 2001). ■ Among different organic manures, pig manure is found to be much more effective in enhancing the yield and quality of ginger, followed by FYM, poultry manure and vermi compost under Nagaland condition (Singh and Singh, 2007). ■ Chemical nitrogen fertilizer can be given in 2 split doses, 30 DAP and 60 DAP for effective utilization. ■ Mulching with dry grass leaves, paddy straw or green leaves in early stage is found to be beneficial in enhancing the germination and conservation of moisture besides adding organic manures after decomposition ■ Second mulching may be given in the month of September so that it can conserve the moisture and help in better accumulation of nutrients in developing rhizome
Pest and disease management	■ Integrated pest management technology for rhizome rot disease has been standardized by soil solarization and use of bio control agents including chemicals

	■ Seed treatment with Indofil 0.25% + Bavistin (0.1%) for 60 minutes and drying in shade for 24 hours before sowing is recommended. Bio control agents like *T. harzianum*, *T. harnatium*, *T. viride* are found to give effective control of rhizome rot of ginger and turmeric (Anon, 2001). ■ Bi-monthly spray of Rogor 0.01% is found to give effective control of shoot borer. For shoot borer bio control agent like *Heramermin* sp and *Heripteran, Peresitios* have also been identified.

Turmeric

Turmeric is second important spice of the North east region contributing about 12% share in national market. Average productivity of turmeric is about 1 t ha^{-1}, which is below the national productivity (3.4 t ha^{-1}). In most of the hill states, turmeric is cultivated with zero production inputs. Hence, production gap of 2.4 t ha^{-1} can be easily overcome by proper nutrient management.

Inspite of favourable agro-climatic conditions, production is so less that 80 per cent market requirement of turmeric is being met from Andhra Pradesh. Hence, by systematic nutrient and pest management and area expansion, the productivity level could be enhanced.

Crop management	■ Planting season – April-May ■ Govind and Gupta (1989) observed that 20-30 g of rhizome is the optimum weight of planting material for commercial production of turmeric. They further observed that 60 kg N ha^{-1} was the optimum dose of nitrogen for turmeric cv. Lakadong under Barapani condition of Meghalaya. ■ Singh *et al.* (2008) observed that under Nagaland conditions, mother rhizome and half cut mother rhizome were the best planting materials with regard to yield and quality of turmeric. Application of 80 kg N ha^{-1} under foothill conditions of Nagaland was optimum dose for increasing the productivity of turmeric. The accumulation of macro and micro nutrient and curcumin in rhizome were found to be optimum at 80 kg N ha^{-1}. ■ Fanai *et al.,* (2006) reported that maize and turmeric in 1:2 row ratios under weed free treatment was found to be the best combination for obtaining optimum yield and the most profitable combination under foothill conditions of Nagaland. ■ Sanwal *et al.* (2007) reported from field experiments that the application of FYM @ 18 t ha^{-1} which was statistically at par with 10 t ha^{-1} poultry manure. Application of various organic sources *viz.,* FYM, poultry manure, pig manure, neem shield, rabbit manure and bioplus resulted in 16-103 per cent higher rhizome yield over control and also improved the quality parameters *viz.,* dry matter, curcumin, oleoresin, oil and protein content in cured rhizome.

	■ A fertilizer dose of NPK 60:40:40 kg ha^{-1} with N & K in two split doses after 45 days interval and P as basal is recommended for maximum yield (Govind and Gupta, 1989). ■ To reduce the fertilizer quantity and cost, seed and soil should be treated with biofertilizers like *Azotobacter* and Phosphotica ■ Application Zn + B @ 5 kg ha^{-1} improved the yield by 2.5%
Plant protection	■ Seed treatment with Indofil N-45 (0.25%) + Bavistin (0.1%) for 60 minutes and drying in shade for 24 hours before sowing/ storage was effective against soft rot or rhizome rot. ■ Bi-monthly spray of Rogar (0.01%) against shoot borer is recommended.· To avoid incidence of *Taphrina* half cut mother rhizome can be used as biological control (Singh and Kar, 1989).

Onion

Off season or rainy season onion production techniques have been standardized by Department of Horticulture, Nagaland University in collaboration with NHR & DF, Nasik. However, the technology needs to be tested in other hill states of North eastern regions.

Crop management	■ Flat or terraced land up to 500 m altitude may be selected and cultivated area should be free from shade. ■ Main field may be prepared by applying 2.5-3 t FYM or pig manure before 20 days of planting on an area of 1000 sq mt (1 bigha). Main field should be treated with *Trichoderma* 1 kg mixed in 100 kg of FYM ■ Ethel *et al.* (2009) recorded highest yield of onion by application of 30 t FYM ha^{-1} followed by 20 t pig manure. Whereas, Yeptho *et al.* (2008) observed highest yield of rainfed onion by application of poultry manure (20 t ha^{-1} + *Azotobacter*) followed by FYM (30 t ha^{-1} + *Azotobacter*) under Nagaland condition· 6-8 weeks old seedlings or bulblets are planted at spacing of 20 x 10 cm during August after treatment with *Azotobacter* and Phosphotica ■ Mulching with dry thatch grass or wood ash may be done during later part of rainy season to conserve the moisture. For better growth and yield about 25-30 kg of urea/ bigha may be given in two split doses *i.e.,* first at the time of planting and second after 25-30 days after planting
Plant protection	■ Kharif season crop generally suffers from *Stemphylium* blight and purple blotch diseases. It can be controlled by application of mocojel 0.25% and chloroperolin 0.2%.

Harvesting and curing	■ Kharif crop planted in August may be ready for harvesting in November-December. After harvesting, plants are left for 2 days along with leaves and then leaves are cut 2.5-3 cm above the neck and further allowed to be cured for 5-7 days before being marketed
Source of availability of seed and techniques	■ NHR & DF, Nashik, 11-HSNEI, Department of Horticulture, Nagaland University

Large cardamom

Large cardamom is important cash crop of Sikkim and now its systematic plantation has spread to other hill states like Nagaland, Arunachal Pradesh and Meghalaya. However, proper attention is required during selection of site, cultivar and package of practices.

Selection of varieties	■ Altitude range 1000-2000m higher altitude (1200-2000m): Ramsey, Sawney and Varlangey (robusta type) ■ Mid hills (975-1500): Dzongu Golsey and Seremma (non-robusta type)
Planting	■ Disease free materials suckers/rhizomes are planted at 1.25 x 1.25 m and 1.5 x 1.5 m for robust; Non-robusts are planted in a pit size of 25 or 30 cm^3 filled with FYM and top soil during May-June
Shade plant	■ Utis (*Alnus nepelensis*)· Panisaj, Malato, Argili, Asare, Bilounee, Kharana, Dhurpis, Khasi Cherry, Faledo, Thingani
Crop management	■ 2 kg FYM/ pit in April-May fertilizer @ 20:30:40 kg N, P & K/ ha in two splits with full P in April and half N & K in September.
Disease management	■ Roughing of Chirke and Foorkey viral infected plants during April to September. Use of disease free planting materials ■ Spray copper oxychloride (0.3%) at 15 days interval during Feb-March & Sept-Oct for leaf streak disease ■ Proper sanitation and control of vectors of viral diseases

Conclusion

Though research and development bases of spices are very strong at the national level, the North eastern region is far behind. Hence, R & D on spices needs to be strengthened for faster development of spices industry. The state Directorate of Horticulture is also required to come forward to set-up research wings besides developmental activities. The Department of Horticulture or relevant Departments of Universities of North eastern hill states has to be brought under AICRP on Spices to overcome the impasse in production and processing of spices. By development of improved package of practices for these cash crops and through proper transfer of technology to the growers, spices production and productivity will certainly increase in the coming years. Now emphasis has to be shifted from produce to products and value addition. Therefore, there is an urgent need to establish close linkage between production, post harvest handling and marketing.

Organic production technologies for spices – Potentials in the North eastern states

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Introduction

The excessive use of chemical fertilizers, a characteristic of modern farming creates soil fertility problems and pollution of surface water bodies. Increasing quantities of external inputs such as chemical fertilizers and plant protective chemicals have been used with little reliance on the maintenance of soil organic matter. In recent years, organic agriculture has been gaining considerable importance and many farmers are switching to this traditional method of cultivation as a means to produce safe foodstuffs and preserve the environment. Organic farming favors lower input costs, conserves nonrenewable resources, high-value markets and boosts farm income. According to Lampkin (1990) organic agriculture or farming is a production system, which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators and livestock feed additives and relies on crop rotations, crop-residues, animal manures, legumes, green manures, off-farm organic wastes and aspects of biological pest control to maintain soil productivity and tilth to supply plant nutrients and to control insects, weeds and other pests.

In India the area under certified organic agriculture is around 28.0 lakh ha of which 24.3 lakh ha falls under forest area of Madhya Pradesh and Uttar Pradesh (www.apeda.com). Agricultural and Processed Food Products Export Development Authority (APEDA) estimate shows that India has 4.5 lakh ha under certified organic cropping producing agricultural crops like plantation, spices, pulses, fruits, vegetables and oil seeds *etc*. The current production of organic crops (Table 1) is around 9.7 lakh tons of which 37,533 t worth of Rs. 498 crores is exported.

From India, the export of organic products expanded from 700 t in 2002-03 to 6800 t valued at Rs. 2010 lakhs in 2007-08 making around 85% of total organic crop production. Spices Board has targeted an export market of 250 crores by 2012. The main organic spices traded by volume are pepper (39 percent), ginger (19 percent), turmeric (11 percent), cardamom (8 percent), chilli (7 percent), cloves (7 percent), nutmeg (7 percent), vanilla (1 percent) and others (7 percent)(Parthasarathy *et al*. 2008). Major export market for Indian organic producers are Australia, Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Singapore, South Africa, Saudi Arabia, UAE, UK, and USA. The current estimated share of organic foods in these countries is approximately 1 to 1.5%. Organic pepper has established its market share better than other pepper products like dehydrated green pepper, pepper in brine, freeze-dried pepper or frozen pepper and is produced and exported to these international markets by India, Indonesia and Sri Lanka. Since organic foods are free from chemical contaminants, the demand for these products should steadily increase in the coming years.

Table: 1 Major products produced in India by organic farming

Type of Product	Products
Commodity	Tea, Coffee, Rice, Wheat
Spices	Cardamom, Black pepper, white pepper, Ginger, Turmeric, Vanilla, Tamarind, Clove, Cinnamon, Nutmeg, Mace, Chili, Peppermint
Pulses	Red gram, Black gram
Fruits Walnut	Mango, Banana, Pineapple, Passion fruit, Sugarcane, Orange, Cashew nut,
Vegetables	Okra, Brinjal, Garlic, Onion, Tomato, Potato
Oil seeds	Mustard, Sesame, Castor, Sunflower
Others	Cotton, Herbal extracts

Source: Garibay and Jyoti, 2003

Potentials for organic spices in the North East

Farmers in our country have always been practicing traditional ways of using indigenous technologies and inputs mostly in line with modern organic farming principles. India, in particular NE states has great potential to capture the expanding global organic spice market as per capita consumption of fertilizers and pesticides is far below that of developed countries and it is very easy for the farmers to embrace organic spice farming in its true sense. With global retail sales of organic products fast picking up, India could emerge as a major player by exploiting its own strengths like traditionally followed agriculture systems, diverse agro-climatic regions with self sustaining agriculture systems.

Most of the NE states are having virgin land without any commercial cultivation that is very much suitable for organic cultivation of spices and major spices like black pepper, ginger, turmeric and chillies have larger area in this tract. Most of these spices are cultivated under shade trees, which are available naturally as evergreen forest and left out Jhum land. The NE states *viz.,* Meghalaya and Arunachal Pradesh ranks 2^{nd} and 3^{rd} in production of ginger in the country, Assam holds 4^{th} position in area of turmeric in the country. Besides, large cardamom is cultivated in Arunachal Pradesh in an area of 2,192 ha with a production of 512 tons and productivity of 500 kg/ha.

In the world map of large cardamom production, India shares 54%, in which 87% is contributed by Sikkim and the remaining 13% by Darjeeling (West Bengal). In large cardamom, Sikkim claims the major share in the country with an area and production of 26734 ha and 5401 tons, respectively with a productivity of 242 kg/ha. India is the leader in large cardamom in the world market and there is a vast scope to produce organic large cardamom as well as to export it (Parthasarathy *et al*. 2007).

Mixed cropping systems

Multiple cropping or farming systems helps efficient use of natural resources, buffer against price fluctuations, generates more employment opportunities and production of commodities for varied end uses and thus ensures crop diversity. Unlike other field crops, spices are highly amenable for intercropping owing to their ecological niche. As the pressure on land under cropping is increasing, area expansion for spice cultivation is questioned. The best alternative would be cultivation of spices as a component crop in the existing coffee, tea, coconut and arecanut plantations. Mixed cropping of black pepper with rubber, cocoa, orange *etc*. are common in other countries like Brazil.

Vines like black pepper and vanilla and rhizomatous crops like ginger, turmeric, cardamom and galangal are ideally suited for mixed/ inter cropping under tree plantations with partial light. In West Bengal, ginger was found to be highly remunerative as intercrop in coconut. The profit was Rs. 40,250/ha whereas, it was Rs. 23,450/ha from turmeric. An increase in net returns to the tune of Rs. 13, 300/ha can be obtained in mixed cropping black pepper in coconut gardens (Sarma *et al*. 2003). In a cropping system the addition of organics due to litter fall would also result in organic matter build up and enhanced nutrient availability in soils (Khan *et al*. 2002). The minimum tillage practice would ensure no or minimum damage to root systems and the associated microbial load would be ideal.

It is reported that there is great scope of bringing tea and coffee estates under black pepper production by covering all the shade trees with pepper. Area under tea in NE states can accommodate considerable area for pepper, respectively and can result in additional production.

Recycling organic wastes

Most of the spices are perennial in nature and explore a limited volume of soil continuously throughout its lifespan. It is important that a source rich environment is provided in the root zone to realize sustainable yield. The nutrient supply from organic sources is steady besides its minimal loss. The effect on physical properties and improved micro nutrient availability are additional profits.

Plantation crops including black pepper and cardamom being perennial in nature contribute large quantities of waste by-products, which by composting and recycling will meet the nitrogen requirement of crop and partly other nutrients. Leaves and bunch wastes of coconut, arecanut, oil palm, coffee husk and tea spent have been found to give very high bioconversion efficiency. The multiple cropping system results in the continuous uptake, addition of biomass and higher level of nutrient recycling that would lead to a positive influence on the physico-chemical and biological properties of soil.

The microbial biomass, the organic content, total N, P and K would be higher in the root region soils of multistoried cropping system when compared to the monocrop. The beneficial effects are reflected through enhanced soil fertility status, enhanced microbial activity and better utilization of natural resources for the benefit of plant growth and sustainable crop productivity.

The organic addition brought through leaf litter recycling and microbial activity would lead to integrated nutrient management for enhanced system productivity. In south India where coconut is a major plantation crop, abundance of waste materials, about 7.5 million tons of coir dust annually from coir based industries provides a good scope for recycling the organic materials into the system. Composts made out of leaf and sheath wastes and husks of these plantation crops are valuable sources of plant nutrients (Table 2).

Biofertilizers and beneficial microbes

Although organic farming is better than conventional chemical farming systems, its crop yield is observed to be much lower in the developing countries as compared to that of the latter. Therefore, for enhancing the yield potential technologies like inoculating soils and plants with beneficial microorganisms for creating a favorable micro environment for plant growth are being promoted. The presence of *Azospirillum* reported in the spices based cropping is of great relevance and needs to be exploited. So also the P solubilisers present in several perennial cropping systems. Combination of bio fertilizers *viz*., *Azospirillum*, Phosphobacteria and

VAM in the nursery mixture has enhanced the root and shoot growth of nursery cuttings, significantly. Field application of *Azospirillum* @ 20g along with coir compost and FYM has significantly increased the yield of black pepper, ginger and turmeric.

Table 2. Nutrient content of different organic farm wastes

Organic waste	N	P	K	Zn (mg kg^{-1})
	(g /100g)			
Composted coffee pulp	3.20	0.16	2.3	12
Arecanut leaf	2.13	0.12	0.88	17
Cardamom dried leaves	1.85	0.11	1.80	18
Shade tree leaves	1.68	0.07	1.10	19
Leaf compost	1.10	0.84	0.78	76
Coir compost	1.20	0.60	1.20	16
Vermi compost	2.00	0.80	1.20	44

Several PGPRs (plant growth promoting rhizobacteria) isolated from the rhizosphere of black pepper and other spice crops were found growth productive, disease suppressive and incidentally are efficient P solubilizers. The role of *Pseudomonas fluorescens* mediated nutrient flux in the soil microcosm in plant growth promotion was studied with the higher uptake of nutrients by the bacterized plants. Significant uptake of nitrogen (N) and potassium (K) was noticed in the treated black pepper (Diby *et al*, 2003).

The research on PGPRs in spice crops like black pepper, ginger and vanilla (which becomes a part of the perennial cropping system) have proved their potential in growth promotion and disease suppression, their effects on other crops in the cropping systems are warranted. PGPRs and their effectiveness has been established on foot rot and slow decline of black pepper and rhizome rot of ginger and clump rot of cardamom. The efficient isolates from black pepper with high rhizosphere competency and adaptability can be used in a cropping system involving black pepper, ginger and cardamom. Either a single organism or a group of organisms (consortia) which have potential to ensure optimum root health and higher root regeneration need to be identified. This becomes all the more important in coconut / arecanut based cropping systems where several crops like cocoa and black pepper are grown successfully.

The use of EMs (Effective Microorganisms) that contain a consortium of beneficial microbes act as microbial inoculants and antioxidants in the soil thus improving the soil health and promoting healthy environment for plant growth. The benefits of using EMs in agriculture are as follows (Unnikrishnan Nair, 2006):

- Promotes germination, flowering, fruiting and ripening.
- Improves physical, chemical and biological environments of the soil and suppresses soil borne pathogens.
- Enhances photosynthetic capacity of crops.
- Increases the efficacy of organic matter as fertilizers.

Organic farming strategies

Definite principles, basic standards of production, documentation, inspection and certification guidelines are approved by the National Standards Committee constituted by the members of IFOAM in India.

- Organic production systems are based on farm management practices that maintain long-term soil fertility and biological activity and conserve bio diversity to attain a sustainable eco system.
  - For existing plantations - minimum of 3 years under organic cultivation - Ginger & turmeric – general period of 2 years
  - In intercropping, the component crop should also be grown as organic
  - For a new or replanted area - the first year yield itself is organic provided no chemicals are used in the previous cropping history.
- Buffer zone – suitable physical/ tree barriers or buffer crops all around the organic plantation to avoid contamination by drift from neighboring conventional plantations and produce from buffer zone cannot be sold as organic.
- Usage of approved materials – farm inputs including seeds - for at least 2-3 years.
  - Traditional varieties adapted to the local soil and climate
  - GMO not allowed
  - Conventional seed materials that are not been treated with pesticides are not permitted by standards
- Should meet local, state and federal regulations on quality, adequately certified by an independent agency

Research support

Nutrient management

Experiments conducted at IISR revealed that application of composts *viz.,* leaf and vermi composts and FYM improved the soil physico-chemical properties and nutrient availability significantly in black pepper and cardamom. The FYM and vermicompost application increased the yield by 119% and 74% respectively, in Panniyur-1 and 91% and 88% in Karimunda varieties of black pepper. In cardamom, the yield increase was 140% higher in neem cake and vermicompost treatments over application of chemical fertilizers alone and the important quality attributes namely 1, 8 cineol and α-terpinyl acetate contents (33 and 33.4%) were found to be significantly highest in FYM and vermicompost applications. Leaf compost and vermicompost treatments supported significantly highest population of free-living N-fixing bacteria and phosphate solublizing bacteria populations.

Converting coir dust to enriched coir pith compost and applying it to the spice basins helped in increasing the production and quality of spices and also reduced the amount of chemical fertilizer need in to half. Coir pith compost application @ 2.5 t/ha along with FYM and biofertilizer significantly increased the yield and quality of major spices. Trials conducted through AICRP on spices at various locations revealed that sustainable yield up to 6.5 kg vine^{-1} could be achieved in black pepper by application of FYM (10 kg) + rock phosphate (40g) + wood ash (2 kg) per vine along with *Azospirillum* on par to the conventional practice in nutrient supplementation.

Similarly in ginger and turmeric, combined application of different organic sources like FYM + pongamia oil cake + neem oil cake + stera meal + rock phosphate + wood ash has yielded on par to the conventional practice in addition to high quality. But research results during initial years showed 15-20% reduction in yield in ginger and turmeric under organic system as compared to integrated management. The quality parameters of ginger (high oleoresin and low fibre) and turmeric (curcumin and starch) were found to be high under organic farming (IISR annual report, 2004-05).

Pest and disease control

In black pepper, *Phytophthora* foot rot caused by *Phytophthora capsici* and 'slow decline' caused by plant parasitic nematodes in association with *P.capsici* are major diseases leading to death of several pepper vines every year in Kerala and Karnataka. Pollu beetle is a major pest of black pepper and under severe infestation the yields may be reduced by 40%, since the insect causes direct damage to pepper berries. Eco-friendly management schedules have been developed at IISR, Calicut using biological control of pathogens and pests that have great significance especially in the concept of organic farming.

Soil solarization and fortifying the nursery mixture with *Trichoderma harzianum* and VAM to raise the nursery rooted cuttings of black pepper and cardamom gives protection from foot rot pathogen *P. capsici* and nematodes *R. similis* and *M. incognita*. Organic manures such as a neem cake, coffee husk, FYM and tea waste can be effectively used to mass multiply biocontrol agents for better field establishment and serve as nutrient supplement. Effective control of the foot rot disease under field condition can be achieved by adopting cultural practices like phytosanitation, minimum tillage and better drainage and application of biocontrol agent *T. harzianum* @ 50 g/ vine mixed with 1 kg of neem cake or 5 kg of FYM in the basin of black pepper vines.

Field evaluation trials with *T. harzianum* against rhizome rot of cardamom, applied during pre- and post-monsoon periods @ 100-150 g of mass cultured material on decomposed coffee husk was consistently effective in controlling the disease. Efficient strains of VAM isolated from black pepper rhizosphere (*Glomus* sp. and *Gigaspora* sp.) are very efficient in suppression of root knot nematode infesting back pepper. Other biocontrol agents namely *Paecilomyces lilacinus* and *Verticillium chlamydosporium* are also found to be effective in suppressing nematode infestation in black pepper. Leaf extracts of *Strychnos nux-vomica, Azadirachta indica, Lantana camara* and allspice plant also showed good nematicidal activity at 1% concentrations.

Various plant products like leaf extracts of *Chromolaena odorata* and *Strychnos nux-vomica* and seed extracts of *Azadirachta indica* and *Anona squamosa* are promising against pollu beetle. Trials conducted at IISR, Calicut indicated that neem oil 0.3%, neemgold 0.6% and fish oil rosin 3% were on par with the insecticides for the control of scale insect (*Lepidosaphes piperis)*, a major pest of black pepper at high altitudes.

The biocontrol agents of major insect pests of black pepper, ginger and turmeric were documented to develop biocontrol strategies for the management of these insect pests. Soil solarization combined with application of biocontrol agents *T. harzianum* and *Pseudomonas fluorescens* effectively controls rhizome rot disease of ginger. Spraying twice and seed treatment with neem oil @ 5 ml/ lit to check scales, shoot borer and soil drenching with *Trichoderma* @ 4 g/ lit of water + *Pseudomonas* @ 3 g/ lit to check leaf spot and rhizome rot diseases is adopted in Orissa (Mishra and Gopalakrishnan, 2006).

Certification

The most significant factor distinguishing organic farming from eco-farming or perma culture is the existence of production standards and certification procedures. Quality of the produce is of the prime importance. Quality parameters follows stringent standards like microbiologically clean, absolutely residue free with authentic analytical data from approved laboratory.

Certification and labeling is usually done by an independent body to provide a guarantee that the production standards are met. The certification bodies existing globally under the guidance of IFOAM, Germany charge higher amount for certification that may not be able to bear by our small and medium farmers. In this view the Government of India has taken steps to have indigenous certification system to help small and marginal growers and to issue valid organic certificates through certifying agencies accredited by APEDA.

Any grower who has inclination for organic farming can apply for organic certification. The tariff on inspection and certification varies between agencies and between the types of farmers. The farmer has to keep all the details with respect to cultivation like input-output details, farm map and organic system plan and reports *etc*. documented. Similarly, processing/ packing and exporting units are also need to be certified before they deal with organically certified exports. Group certification programmes are also in vogue for organized group of producers, processors and exporters with similar production systems located in geographical proximity. The criteria used for group certification is (Kithu, 2005):

Marginal farmers	-	below one hectare
Small farmers	-	between 1 - 1.99 ha
Semi medium farmers	-	between 2 – 3.99 ha
Medium farmers	-	between 4 – 9.99 ha
Large farmers	-	above 10 ha

The certifying agencies operating or intending to operate in India may apply for accreditation to Spices Board and the accreditation certificate issued is valid for a period of three years only. Guidelines for organic production of export oriented spices have also been developed and published by Spices Board, Cochin.

Spices Board also launched a brand '*Flavourit'* for commercially marketing a range of high quality, organically produced premium spices.

National Programme for Organic Production (NPOP) having standards for products and labeling as '*India Organic*' was started in May 2000 and the following accreditated certifying agencies are in operation.

1. M/s. Indian Organic Certification Agency (INDOCERT),

   Thottumugham, Alwaye, Kochi, Kerala – 683 105. (info@indocert.org)

2. LACON GMBH, Germany

   C/o Renewable energy center, Chunanganveli, Alwaye – 683 105, Kerala

   (laconindia@indiatimes.com)

3. M/s Stitching SKAL, Stationplein 5, P.O. box 384, 8000 AJ Zwolle, Netherlands.

   Skal Inspection and Certification Agency, 191, Ist main road, Mahalaxmi layout, Bangalore – 560 086. (skalindia@vsnl.com).

4. M/s. IMO Control (P) Ltd., 26, 17th Main, HAL 2nd A stage, Bangalore – 560 008.

5. M/s. Ecocert International, Forster Str. 87, D- 37520, Osterode, Germany.

   Ecocert SA Branch office, 54A, Kanchan Nagar, Nakshetrawadi, Aurangabad, Maharashtra – 431 002. (ecocert@sancharnet.in)

6. APOF Organic Certification Agency (AOCA), Veterinary college campus, UAS, Hebbal, Bangalore – 560 024. (aporganic@yahoo.com)

7. SGS India Pvt. Ltd., 250, Udyog vihar, Phase IV, Gurgaon – 122 015.

8. Indian Society for Certification (ISCOP), 162/163, Rasi building, Ponnairajapuram, Coimbatore – 641 001.

Constraints

Obstacles to adoption of organic farming by farmers include,

a) Huge managerial costs (for certification) and risks of shifting to a new way of farming

b) Limited awareness of organic farming systems

c) Inability to capture marketing economies

d) Insufficient numbers of processors, distributors and marketing channels for organic spices and

e) Complete and up-to-date maintenance of records by small farmers is often not easy as some may be illiterate and not convinced of the need to maintain onerous records

The techniques and potential problems in practicing organic farming can differ greatly from location to location. As in areas where organic materials are in abundance and labour is cheap, using compost as a way to maintain soil fertility may be more logical than using green manure in the rotation. Determination of suitability of organic farming must include agro-ecological, economic and social and institutional considerations.

Future strategies

The main strategies for organic farming should be on

- Promoting proper land use management with concentrated soil and water conservation measures
- Promoting adoption of biofertilizers, biocontrol agents, cover crops and ecofriendly inputs
- Adhering to strict phyto-sanitary measures and upgradation of post harvest technology
- Incentives to the growers in the initial years of shifting to organic farming
- Strengthening research base on the economic viability of the system
- Creating awareness among the farmers about benefits, market promotion and adequate publicity for increasing the demand for organic pepper even in the local market
- Popularization of National level certification scheme & accreditation agencies

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Organic management of insect pests of ginger and turmeric

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Introduction

Organic agriculture as defined by Codex Alimentarius Commission is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, wherever possible, cultural, biological and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system. Management of insect pests through organic means is a key element in organic agriculture.

Organic pest management - General principles

Organic management of insect pests includes cultivating resistant cultivars, biological control, cultural control and use of organic pesticides. Use of resistant crop cultivars to suppress insect pest damage is generally used in conjunction with other control tactics. A major advantage in the use of insect-resistant crop cultivars is its compatibility with other direct control tactics. Insect-resistant cultivars also synergize the effects of natural, biological, and cultural insect pest-suppression tactics. Biological control is the regulation of insect populations by natural enemies, which keeps them in a state of balance in an ecosystem. The natural enemies (predators, parasitoids and pathogens) are conserved, multiplied by artificial means and disseminated in the field to bring down the population of insect pests. The control of insect pests through adoption of farm practices in such a way that insect pest populations are reduced in the field is called cultural control. These practices are generally adopted in such a way so as to affect the life history or host adaptation of an insect. This method of control is generally more economical in homestead farms where the cost of labour is low. Cultural control includes crop rotation, trap crops, tillage operations such as earthing-up and deep ploughing, crop sanitation, and alteration in time of sowing and harvesting operations. Several pesticides approved for use in organic agriculture have been called green pesticides such as neem formulations, soap solutions and plant extracts. Generally, organic pesticides are safer and more environmentally friendly than synthetic pesticides.

Insect pests of ginger and turmeric

Infestation by insect pests is a major factor responsible for the low productivity of spice crops including ginger (*Zingiber officinale* Rosc.) and turmeric (*Curcuma longa* L.) in India. Ginger and turmeric are infested by many species of insect pests, among which the shoot borer and root grubs cause severe crop losses in the field especially in the north eastern region. The rhizome scale causes severe damage to ginger and turmeric rhizomes in storage. The other insect pests that can occasionally become serious include leaf roller and leaf beetles. Ginger and turmeric are high-value crops and their products are export-oriented in nature. Pesticide residues are the most important non-tariff barriers on trade in these produces; hence adoption of organic pest management strategies is more relevant in these crops. There has been a renewed interest during the past decade in developing environment–friendly organic crop management schedules in sustainable agriculture including spice crops like ginger and turmeric, reflecting the increasing concern over pesticide misuse. The nature and symptoms of damage, brief descriptions of adult and juvenile stages, and the strategies that can be adopted for the organic management of insect pests of ginger and turmeric are highlighted here.

Shoot borer (*Conogethes punctiferalis* Guen.)

The shoot borer *(Conogethes punctiferalis)* (Pyralidae: Lepidoptera) is the most serious insect pest of ginger and turmeric. The larvae bore into shoots and feed on the internal tissues resulting in yellowing and drying of infested shoots. The presence of bore-holes on the shoots through which frass is extruded and the withered central shoot is a characteristic symptom of the pest infestation. The adult is a medium-sized moth with a wing span of about 20 mm; the wings and body are orange-yellow with minute black spots. The eggs are laid on the topmost unopened leaf and the newly hatched larva feeds on the unopened leaf and later they bore into the shoots. Fully grown larvae are light brown with sparse hairs and measure 15–25 mm in length. Pupation occurs within the larval tunnel in the shoot. The pest is observed in the field throughout the crop season when new shoots are produced. The shoot borer is highly polyphagous and has been recorded on more than 30 host plants including several economically important plants in India.

Management

An integrated schedule including mulching of ginger beds with neem leaves @ 10 t/ha and spraying NSKE 5% has been recommended for the management of the pest on ginger. Pruning and destruction of freshly infested shoots (as indicated by the extrusion of frass) at fortnightly intervals during the first two months of crop stand and spraying neem oil 0.5% at fortnightly intervals during the remaining period of crop stand is also effective in controlling the pest infestation on ginger. In turmeric spraying neem oil 0.5% at fortnightly intervals during crop stand is effective for the management of the pest at low infestation levels. Various predators and parasites have been documented on the pest in the field among which the entomophagous nematode *Hexamermis* sp. and the hymenopteran parasitoid *Apanteles* sp. are the major natural enemies. Conservation of natural enemies also plays a crucial role in reducing the population of the pest in the field.

Root grubs (*Holotrichia* spp.)

Root grubs (*Holotrichia* spp.) (Scarabaeidae: Coleoptera) cause serious damage to ginger plants especially in Sikkim and other north eastern regions. The eggs are laid by the adults in the soil near the rhizomes and the grubs feed on roots and newly formed rhizomes. The pest infestation leads to yellowing of leaves and stunting of plants and in severe infestations the pseudostems may be cut at the basal region. The entire crop may be lost in severely infested gardens. The adults of *H. seticollis* commonly occurring in Sikkim are dark brown beetles measuring about 2.5 x 1.5 cm in size. The adults feed on leaves of *Ficus* sp. seen in the vicinity of ginger gardens. The larvae are creamy white with a brown head and 'C' shaped. Pupation occurs in the soil in an earthen cell. The adults emerge in large numbers with the receipt of summer showers during April-May.

Management

Mechanical collection and destruction of adults during their peak periods of emergence and application of the entomophagous fungus *Metarhizium anisopliae* mixed with fine cowdung in the soil is effective for the management of root grubs.

Rhizome scale (*Aspidiella hartii* Sign.)

The rhizome scale (*Aspidiella hartii*) (Coccidae: Hemiptera) infests rhizomes of ginger and turmeric in the field (especially at later stages) and storage. The pest feeds on plant sap and when the rhizomes are severely infested, they become shriveled and desiccated and fail to germinate. Adult (female) scales are minute (about 1 mm in diameter), circular and light brown to grey and appear as encrustations on the rhizomes. Scale insects reproduce parthenogenetically leading to heavy infestations within a short period. The rhizome scale also infests yams, taro and tannia.

Management

Timely harvest of rhizomes is important for preventing carry-over of the pest infestation from the field to storage. Severely infested rhizomes are to be discarded and the healthy rhizomes stored in dried leaves of *Strychnos nux-vomica* (or *Glycosmis pentaphylla*) + sawdust in 1:1 proportion in a cool dry place. The rhizomes are to be checked at regular intervals and scale infested rhizomes are to be removed and discarded. Three species of hymenopterous parasitoids have been recorded on the pest among which *Physcus comperei* is a major natural enemy.

Leaf roller (*Udaspes folus* Cram.)

The larvae of the leaf roller (*Udaspes folus*) (Hesperidae: Lepidoptera) cut and fold the leaves of ginger and turmeric, remain within and feed on them. The pest is generally observed in the field during the monsoon season. The adults are medium-sized butterflies with brownish black wings with white spots on the fore wings and a large patch on the hind wing. Fully grown larvae are dark green with a conspicuous head and measure about 40 mm in length. Pupation occurs within the leaf fold. The pest also breeds on a few other Zingiberaceous plants seen around ginger and turmeric gardens.

Management

The leaf roller can be controlled by regular handpicking and destruction of larvae. A few hymenopterous parasitoids that have been recorded on the leaf roller and other general predators and parasitoids observed in the field are to be conserved for reducing the population of the pest.

Leaf beetles (*Lema* spp.)

Adults and larvae of leaf feeding beetles belonging to *Lema* spp. (Chrysomelidae: Coleoptera) feed on turmeric leaves especially during the monsoon season and form elongated parallel feeding marks on the leaves. The adults are small beetles measuring about 6.0 x 2.5 mm in size; the larvae are stout with a humped posterior and greyish brown and carry faecal matter over their dorsal body surface. Pupation occurs in the soil. *Lema* spp. also feed on cucurbits and solanaceous crops such as brinjal in the field.

Management

The leaf beetles can be controlled by mechanical collection of adults and regular handpicking and destruction of larvae. The general predators and parasitoids observed in the field are to be conserved for reducing the population of the pest.

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Disease management in ginger and turmeric

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Introduction

India is one of the major spice producing countries of the world and spice crops are cultivated for both internal consumption and export. India produces about 4 million tons of spice and exports around 180 spice products to more than 150 countries. The world export of spices during 2005 was 3.59 million tons and import was 3.45 million tons (FAO database, 2007). In 2007-08, Indian share of the world trade in spices is about 35% in volume and 37% in value. The production and productivity of spice crops are limited by several pests and pathogens. The major diseases affecting ginger and turmeric and their management strategies are described in this article. With growing concern about environment pollution globally and the health hazards of chemical pesticides, there is a great demand for pesticide free products and that are grown organically. Keeping this in view, the research efforts at research institutes are concentrated on developing eco-friendly management strategies.

The science and art of pest management

The Integrated disease management strategies involve phytosanitation, cultural practices, biological and chemical control. Meticulous adoption of each of the component is essential for a successful management of the diseases. The rationale for adoption of each component is described in brief below.

Phytosanitation

Disease causing organisms (pathogens) are part of the ecosystem and cannot be eliminated from the environment. In nature microbial organisms both beneficial and harmful exist in the soil in an equilibrium governed by physical and biological factors. Once that delicate balance is shifted, it results in build up of inoculum (pathogen population) and cause the disease. The initial occurrence of disease in a field is at random for several soil borne diseases. Subsequently these affected plants serve both as source and focus of secondary spread. The best example is the rhizome rot diseases of ginger and turmeric. Phytosanitation plays an important role in the management of diseases in a field.

Cultural practices

Drainage: Most of the diseases of spices are soil borne and occur during the wet period. Once the soil moisture is abundant the population builds up and causes damage to the root system, which gradually leads to the killing of the entire plant. The rhizome rot of ginger and turmeric are severe under water logged conditions and hence the recommendation is to avoid water stagnation and to plant ginger and turmeric on raised beds. Providing drainage is one of the important cultural practices that prevents the favourable conditions for disease development.

Application of organic manures: The garden soil is rich in microbial populations. There is a plethora of microbial communities in the soil that are acting to convert the organic matter in to the available form of nutrients necessary for plant growth. These are native to most soils and help in nutrient cycling and also prevent build up of harmful organisms, which attack the living crops. The population of these organisms depends up on organic matter. By applying organic matter the native saprophytic micro-flora are increased which in turn regulate the build up of pathogens. While applying organic matter one has to exercise caution on the choice of material. It is safer to apply organics in the form of compost.

Soil solarization: One simple method to reduce pathogen load is by sterilizing by use of heat obtained from sunlight. It is important to raise disease free planting material. Raised beds for planting of ginger and turmeric are prepared and covered with a clear polythene sheet and the sides are sealed and left in the sunlight for 40-45 days. During this period due to alternate heating and cooling most of the fungal spores germinate and are killed due to heat. So also the nematodes and weed seeds. This process of heating the soil with the help of sunlight is known as soil solarization. Immediately after solarization the soil has to be fortified with beneficial organisms such as antagonists like *Trichoderma.*

Biological control

Biological control is an attempt to mimic the natural situation by using one organism or a material derived from one organism to regulate the population of another usually the harmful disease causing organisms. In natural habitats both pathogens and their biocontrol agents live in harmonious balance. But in agricultural soils due to preferential cultivation of desired plants there is a disturbance to the soil ecology and the fluctuation in the microbial communities. At research stations conscious attempts are made to collect soil and root samples from the rhizosphere (root zone) of different spice crops like black pepper, cardamom, ginger, turmeric and several other plants through random surveys undertaken spice growing areas. Organisms such as fungi and bacteria residing in the rhizosphere soil and roots are isolated, screened, evaluated for their efficacy and recommended. A large collection of repository of biocontrol agents that includes *Trichoderma*, *Paecilomyces, Verticillium, Aspergillus, Fusarium,* fluorescent pseudomonads and *Bacillus* is being maintained at Indian Institute of Spices Research, Calicut. There are certain bacteria, which are associated with the root system of crop plants thriving on the root exudates and at times gaining entry in to the root system through growth cracks and reside inside the tissues (endogenously). They help the plants in mobilizing nutrients, suppressing pathogens and induce the plants to grow. These are called plant growth promoting rhizobacteria (PGPR). There is a tremendous impetus the world over to exploit their potential both for plant growth promotion and disease suppression.

Mechanism of disease suppression by biological control agents

The biological control agents follow one or many of the following methods namely, competition, antibiosis and hyper parasitism. In the soil environment both pathogens and biocontrol agents compete for space and nutrition. Biocontrol agents being more adapted to saprophytic survival have better enzyme system for colonizing organic matter and have an edge over pathogens in saprophytic colonization. Once organic matter is added to the soil there will be a spurt in their population. A population level of 10^6 colony-forming units (cfu) of biocontrol agent is required to suppress the pathogen populations. Hence if biocontrol has to be effective, it is essential to apply and maintain high organic matter content of the soil.

Competition for nutrition in bacteria is brought about by producing certain proteins called as siderophore, which selectively bind to elemental iron and renders it unavailable to other competing microbes resulting in the starvation for iron nutrition. Yet another method is by producing peptide antibiotics with antimicrobial properties, which in turn prevent the population build up of pathogens. The antibiotics produced are; pyoluteorin, pyrrolnitrin, 2,4 - diacetophloroglucinol, bacillomycins, phenazine *etc*. Direct parasitization is also prevalent in some of the antagonists by producing cell wall dissolving enzymes such as cellulases, glucanases and lipases.

The antagonistic fungi are also evaluated for their ability to parasitize various life stages of the nematode *viz.* eggs, juveniles, females and egg masses. Three isolates of *Verticillium chlamydosporium* and one each of *V. lecanii* and *V. tenerum* were studied for their parasitic ability on different stages of root-knot nematodes. All the fungi, though colonized the egg masses, varied in colonizing eggs and juveniles of root-knot nematodes. None of them was able to colonize on second-stage larvae. However, higher degree of nematode suppression was observed with all the isolates, indicating the involvement of mechanisms other than direct parasitism.

Growth promotion

In addition to suppressing pathogen populations, biocontrol agents also promote growth of crop plants. The enhanced growth is the result of several factors. The primary factor being preventing minor pathogens that colonize the roots and cause invisible damage to crops and reduce the productivity. Other factors include enhanced uptake of nutrition and growth. Most of the PGPR belonging to fluorescent pseudomonas and bacillus are proven solubilizer of phosphorus and other nutrients such as potash, manganese *etc.*

The enhanced growth is often manifested in the form of height and number of nodes, size of leaves *etc.* The increase in the growth is also due the secretion of growth regulators such as auxins, gibberellins and cytokinins by the PGPR. Thus the beneficial effect of PGPR is two fold, disease suppression and growth enhancement.

Induced systemic resistance

Plants have natural inherent mechanisms to defend themselves against pests and pathogens. This includes structural barriers such as thickened cell wall, presence of toxic substances and also synthesis of chemicals up on infection. As soon as the pathogen attacks, the inherent mechanisms swing in to action. Cascades of genes controlling defenses are activated. If the defense put forth by the plant is not sufficient, the invading pathogens over power the defenses and the plant succumbs to infection. Human interventions are required to reinforce the defenses either by reducing pathogen populations or supplementing the defenses by added chemicals. The PGPR strains used to manage diseases are not only capable of acting directly against pathogens but also trigger the defense mechanism of host plants. Such is their potential that they could be used in immunizing the plants by activating the defense genes.

Chemical control

Chemical is used as one of the options for the management of soilborne diseases. The choice of chemical depends up on the cropping system. Copper is an approved chemical in organic cultivation and Bordeaux mixture could be applied taking care not to spill too much of the chemical to soil where biocontrol organisms are applied. Alternatively, potassium phosphonate and metalaxyl could be used. These two chemicals are specific to *Phytophthora* and *Pythium* and are also compatible with biocontrol agents at the recommended levels.

Diseases of ginger and turmeric

Ginger and turmeric are cultivated for their rhizomes which are used both for internal consumption and for export. They are cultivated in a wide range of soils such as sandy loam, clay loam, black rich clay and laterite and climates ranging from tropical to subtropical conditions. The disease causing organisms also vary from place to place and about thirty nine organisms are recorded on ginger. The major diseases that occur on ginger in the field in India and the organisms associated with them are listed in Table 1. The term rhizome rot is used to denote both soft rot caused by *Pythium* and bacterial wilt in ginger caused by *Ralstonia solanacearum*. In both the cases the ultimate result is the rotting of the economic part, the rhizome. However, it is easy to differentiate the two based on initial symptoms. In case of bacterial wilt, the wilting symptoms are manifested early by the inward curling of leaflets followed by yellowing. In soft rot the yellowing starts on the lower leaflet and gradually move upwards. Bacterial ooze could be detected when the affected pseudostem is cut and placed in a glass of water. Ginger and turmeric being vegetatively propagated crops, the rhizomes of one crop season is stored till the next season. Some of the diseases being seed borne are perpetuated through contaminated seed rhizomes. The pathogens that occur on the rhizomes of ginger during storage and cause damage are presented in Table 2.

Turmeric being regarded as a plant possessing antimicrobial properties is affected by several pathogens. The pathogens occurring on turmeric both in the field and storage are listed in Table 3.

Table 1. Diseases of ginger and the causal organisms

Disease	Pathogen	Distribution
Soft rot	*Pythium* species *P. aphanidermatum (Edson)* Fitz *(*syn: *P. butleri* Subram *I, P.gracile* *(*deBary) Schrent *P. delience* *P. myriotylum, P. ultimum P. pleroticum,* *P. vexans*	 Andhra Pradesh, Assam, Bihar, Gujarat, Kerala, Karnataka, Maharashtra, Madhya Pradesh, West BengalMadhya PradeshHimachal Pradesh, Kerala, Maharashtra, RajasthanHimachal Pradesh
Bacterial wilt	*Ralstonia solanacearum*	All over the country
Yellows	*Fusarium* spp *F. oxysporumf.sp.zingiberi* *F. solani,F. moniliforme* *F. graminearum, F. equiseti*	Himachal Pradesh, Rajasthan
Leaf spots	*Phyllosticta zingiberi* *Helminthosporium maydis* *Colletotrichum zingiberi* *Pyricularia zingiberi* *Leptosphaeria zingiberi* *Coniothyrium zingiberi* *Curvularia lunata* *Vermicularia zingiberi* *Septoria zingiberi*	Kerala, Karnataka, Himachal Pradesh Bihar Andhra Pradesh Assam Meghalaya Assam Bihar Andhra Pradesh Andhra Pradesh
Leaf blight/ Dry rot	*Rhizoctonia solani* *R. bataticola*	Himachal Pradesh Haryana, Kerala

Thread blight	*Pellicularia filamentosa*	Kerala
Basal rot	*Sclerotium rolfsii (Corticium rolfsii)*	Maharashtra
Sheath rot	*Fusarium* sp.	Maharashtra
Viral diseases	*Cucumber mosaic virus* (CMV) *Chlorotic Fleck virus* (GCFV) Chirke virus	Kerala Assam

Table 2. Organisms associated with storage rot in ginger

Name	Nature of colonization
Fusarium oxysporumPythium delience, P.myriotylum Aspergillus flavusCladosporium lennissium,	Pathogens
Gliocladium reseum,Graphiumalbum, Mucor racemosus,Stachyobotyrs sansveriae	Saprophytes
Thanetophorus cucumerisVerticillium chlamydosporiumGeotrichum candidum	Pathogenic during storage

Table 3. Diseases of turmeric and their causal organisms

Disease		Organism
1	Rhizome rot	*Pythium graminicolum, P. aphanidermatum, P. myriotylum*
2	Leaf blotch	*Taphrina maculans*
3	Leaf spot	*Colletotrichum capsici* *Thirumalacharia curcumae* *Phaeodactylum alpinae* *Phyllosticta zingiberi* *Pestalotiopsis* sp. *Fusarium solani* *Pyriculariae curcumae*
4	Leaf blight	*Corticium sasaki*
5	Storage rots	*Aspergillus* spp *A. flavus* *Macrophomina phaseolina* *Cladosporium cladosporiodes* *Fusarium* sp *Rhizoctonia* sp *Sclerotium* sp

Nematodes associated with ginger and turmeric

Among various nematodes reported on ginger and turmeric, *Meloidogyne* spp., *Radopholus similis* and *Pratylenchus* spp. cause damage to the root system and they interact with soil borne pathogen and aggravate the disease problem.

Management of storage rot

During the period of storage the rhizomes are invaded by many microorganisms, some of which are pathogens and cause deterioration of the seed rhizomes. As the rhizomes are stored during summer some amount of moisture loss is also anticipated. To prevent the moisture loss and invasion of microorganisms the seed rhizomes are treated with chemicals such as mancozeb 0.3% (Dithane M-45) or carbendazim 0.3% (Bavistin) for 30 minutes and dried in shade before storing. While storing shallow pits are made under thatched sheds and saw dust, paddy husk or sand is used as lining material. The seed rhizomes and lining material are used in alternate layers and the pits are covered with wooden planks. During storage scale insects (*Aspidiella hartii*) infest the rhizome and cause shriveling and desiccation. Soaking rhizomes in quinolphos (0.1%) is recommended to prevent the damage. In organic production systems the permitted chemicals only are used. Biocontrol agents such as *Trichoderma* may be used as seed treatment to protect against fungal pathogens during storage.

Soft rot

The initial symptoms are yellowing of the lower leaves at the margins which gradually spread to the entire lamina. The yellowing later spreads to other leaves and water-soaked lesion appear on the pseudostem. By the time the symptom appear all the leaves of the pseudostem and the rhizome rot and become a putrefied mass. At initial stages when the plants are uprooted rotting of roots and the extension of rotting to the rhizome could be seen. Three species of *Pythium, viz. P. aphanidermatum, P. myriotylum,* and *P. vexans* have been reported to be associated in this disease.

In turmeric also, the symptoms are similar and is caused by *P. aphanidermatum* and *P. graminicolum.*

Bacterial wilt

The first visible symptoms are curling of the leaves followed by yellowing and withering. The affected pseudostems and rhizomes when cut transversely and pressed, a milky exudates ooze out. This is caused by the bacterium *Ralstonia solanacearum.* Both soft rot and bacterial wilt are soil as well as seed borne and severe in ill drained soils.

Management of rhizome rots of ginger and turmeric

Cultural methods

- Avoid water stagnation and provide adequate drainage. A raised bed of 30 cm height and 1m width and convenient length is recommended.
- Select healthy seed material from disease-free areas.
- Phytosanitary measures have to be adopted strictly in order to reduce the inoculum. Infected plants should be removed and destroyed taking care to prevent falling of soil particles from infected plant to new area.
- Crop rotation with non-hosts of ginger and turmeric may be followed.

Soil treatment

- The infested soil is fumigated with methyl bromide or formalin before planting.
- Soil solarization of the beds is suggested to reduce the inoculum. Soil solarization is reported to increase the soil temperature up to 12.2°C above ambient in Kerala and from 37.7°C to 45 °C in Rajasthan.

Seed treatment

- A new ecofriendly technique of rhizome solarization is developed where the rhizomes are covered with polyethylene sheets and exposed to sunlight for a period of 2 h in order to raise the rhizome temperature to 48°C and retained for 30 m. This eliminates the bacteria present on the rhizome and inactivates the fungal pathogens present on the rhizome.

Chemical control

- Treat the seed rhizomes for 30 minutes with Dithane M-45 (0.3%) or Bavistin (0.3%) in case of soft rot and with 200 ppm of streptocycline for bacterial wilt, prior to storing and planting. The seed treatment should be based on the prevalence of soft rot or bacterial wilt.
- Drench the beds with Dithane M-45 (0.3%) or Cheshunt compound for controlling soft rot and spray with 100 ppm streptocycline or agrimycin 100 for bacterial wilt control.
- Metalaxyl (Ridomil) 500 ppm as a soil drench was found to reduce the soft rot incidence. Metalaxyl in combination with copper or biocontrol organisms have been successfully used to reduce crop losses
- Carbendazim alone or in combination with mancozeb is also used to prevent the seed borne inoculum of both *Pythium* and *Fusarium*

Biological control

- Antagonistic fungi namely, *Trichoderma harzianum, T. hamatum, T. virens* and bacterial isolates *Bacillus* and *Pseudomonas fluorescens* have been reported to be suppressive to soil borne pathogens of ginger and turmeric.
- These organisms are applied along with organic amendments such as oilcakes, pine needles *etc.*

Botanicals

- The efficacy of plant extracts such as garlic extracts against foliar pathogens is reported. An extract of asafetida, turmeric and water is reported to prevent several plant pathogens including nematodes.

Rhizome rot diseases of ginger and turmeric being soil and seed borne the key to the management rests with use of disease free planting material. Recent studies have shown that bacterial wilt of ginger is perpetuated mainly through the contaminated seed material and the pathogen moves along with planting material. Sensitive tests based on ELISA and PCR have been developed to detect the pathogens both in soil and rhizomes. Strict compliance of quarantine regulations in the movement of planting material within a region would go a long way in preventing introduction of bacterial wilt to newer areas. An integrated approach involving healthy pathogen free seed, management of soil inoculum by solarization coupled with biological agents that promote growth and suppress pathogens have to be adopted.

Leaf spot of ginger

Small oval spots appear on the tender leaves which become white and papery later with a dark brown margin and yellow halo. This is caused by the fungus *Phyllosticta zingiberi* and spreads through rain splashes. These spots coalesce to form larger spots and leads to shredding of leaves in later stages. This results in reduction of photosynthetic area and if it occurs at initial stages results in severe crop losses. The disease is severe when ginger is cultivated in the open and could be minimised by providing partial shade. In addition to this leaf spots are also reported to be caused by several pathogen (Table 1). Leaf spots caused by all these organisms could be controlled by spraying mancozeb 0.2% (Dithane Z-78 or Dithane M-45) or Captafol. Spraying of carbendazim 0.1% (Bavistin) thiophenyl methyl 0.1% (Topsin) or a combination of carbendazim and mancozeb.

Leaf spot of turmeric

Greyish-white spots of varying size appear on the leaves with a brown margin and an indefinite halo. The adjacent lesions often coalesce causing leaf rot and the affected leaves dry up. This is caused by the fungus *Colletotrichum capsici*. The disease can be controlled by spraying the foliage with mancozeb or copper based fungicides.

Leaf blotch of turmeric

Pale to yellowish spots occur on the leaves which later turn brownish with a chlorotic halo. The adjacent lesions coalesce forming large necrotic blotches and the infected leaves dry up. This is caused by the fungus *Taphrina maculans*. Such dried leaves form the primary inoculum. The disease can be controlled by spraying copper based fungicides.

Conclusion

Major diseases of ginger and turmeric are both soil and seed borne. Disease free planting material is the single most important component in the management of rhizome rot. Production of seed material under controlled soilless conditions and free of pathogens will go a long way in reducing the crop losses. If developmental programmes are undertaken on these lines and ensure production and distribution of disease free certified planting material on location basis it would significantly reduce the crop losses and ensure profitability to farmers.

Quality planting materials – A pre-requisite for boosting spices production in North–eastern region

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Introduction

The base for successful crop production system is the use of quality planting materials. For enhancing the production, use of quality planting material is of utmost importance as it forms the base for horticulture development. All efforts put into improve the production and productivity of horticulture crops would go in vain, if the good quality planting materials are not used. Hence, there is a great need for production of sufficient quantity of quality planting materials and making it available to the beneficiaries at the right time for the success of crop production. One of the main focus areas in horticulture development has been the production of quality planting materials since 8th five year plan. Despite various interventions, the supply of quality planting materials has not improved significantly. Till today, a large number of nurseries continue to operate without any certification. Quality planting material production in vegetatively propagated crops like spices becomes prime importance in increasing area and production in NE region considering its vast potential for spice crops.

North East region has a great scope for growing various spice crops due to varied agro-climatic conditions offering a huge potentiality for boosting spice industry. The present area and production of spices crops in NE states is given in Table 1. Based on the statistics available the total spice crop productivity in Arunachal Pradesh, Meghalaya, Mizoram and Nagaland are found to be high as compared to the national average (Table 2). The same scenario is observed in productivity of spice major crops also. The productivity of ginger is 6.5 to 8.8 t/ha in these states as compared to the national average of 3.5 t/ha. In case of turmeric it ranged from 3.5 to 7.5 t/ha as against 4.5 t/ha of country's average.

Table 1. Area, production & productivity of spice crops in NER (2007-08)

State	Area (ha)	Production (t)	Productivity (t/ha)
Arunachal Pradesh	8,200	47,500	5.8
Assam	27,200	18,500	0.7
Manipur	8,700	7,700	0.9
Meghalaya	18,400	80,900	4.4
Mizoram	9,000	38,300	4.3
Nagaland	4,500	26,200	5.8
Sikkim	34,000	42,400	1.2
Tripura	4,500	9,400	2.1

Source: National Horticulture Board (2009)

Table 2. Area, production and productivity of important spices in NE states (2006-07)

(Area: '000 ha, Prod: '000 t, Yield: kg/ha)

State	Black pepper			Chilli			Ginger		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
Arunachal Pradesh				1.9	2.7	1421	5.8	42.87	7379
Assam				15.0	10.0	667			
Manipur				6.5	3.9	600	2.2	3.7	1682
Meghalaya	0.90	0.68	753	1.9	1.4	748	9.6	57.3	5969
Mizoram				1.3	0.8	615	4.5	29.6	6578
Nagaland				0.8	1.0	1250	2.6	23.1	8885
Sikkim				1.6	2.3	1438	6.5	34.7	5338
Tripura							1.4	2.8	2000

Table 2. Contd….

(Area: '000 ha, Prod: '000 t, Yield: kg/ha)

State	Large cardamom			Turmeric		
	Area	Production	Yield	Area	Production	Yield
Arunachal Pradesh				0.5	2	4000
Assam				12.0	9	750
Manipur				0.0	0.1	
Meghalaya				1.9	14.3	7526
Mizoram				1.9	2.3	1211
Nagaland	0.90	1.40	1556	0.1	0.5	5000
Sikkim	24.80	3.70	142	0.5	1.7	3400
Tripura				1.5	4.3	2867

Source: DASD, 2008

The major and potential turmeric producing state like Andra Pradesh itself shows a productivity of 6.2 t/ha. Hence, one possibility for higher productivity values is the reported values from NE states are on fresh weight basis and post harvest processing like drying is seldom practiced in these areas as the entire produce is marketed/consumed fresh. This trend is also seen in case of large cardamom productivity of Nagaland as compared to that of Sikkim, the major producer. Under this assumption (productivity on fresh weight basis), the productivity in NE states is low and needs technological interventions like introduction of high yielding varieties (Table 3) and improved technology packages for achieving higher production targets. Preference should be given for high yielding, high quality local cultivars that are suited to the existing agro climatic conditions. NE cultivars like Nadia, Thinglaidon, Gorubathan and Bhaisay in ginger, Lakadong, Mega turmeric in turmeric and Naga chillies are best suited for local promotion in addition to other new varieties.

Table 3. Improved Cultivars/Hybrids available in Major Spices

Spices	Cultivar/Hybrid
Black pepper	Panniyur-I, Panniyur-2, Panniyur-3, Panniyur-4, Panniyur-5, Panniyur-6, Panniyur- 7, Sreekara, Subhakara, Panchami, Pournami, IISR-Thevam, IISR-Girimunda, IISR-Malabar Excel, IISR-Shakthi
Ginger	Suprabha, Suruchi, Surabhi, Himagiri, IISR-Varada, IISR-Rejatha, IISR-Mahima
Turmeric	CO-1, Krishna, Sugandham, BSR-I, Suvarna, Roma, Suroma, Rajendra Sonia, Ranga, Rasmi, Mega Turmeric, RCT- I, Sudarsana, Suguna, Prabha and Pratibha, IISR-Alleppey Supreme, IISR-Kedaram
Cinnamon	Konkan Tej, YCD-1, PPI(C) -1, Sugandhini, IISR- Navashree, IISR- Nithyashree
Nutmeg	Konkan Swad, IISR-Vishwashree
Fenugreek	Co-I, Rajendra Kanti, Rmt-I, Lam Selection-I
Coriander	GC- I, Co-I, Co-2, GC-2, Rajendra Swathi, RCr-4, Sadhana, Swathi, Co-3, CS-287, Sindhu, UD-24, DH
Fennel	S-7-9, PF-35, Gujarat Fennel-1, Co-1

An attempt has been made to quantify the requirement of planting materials of elite varieties for replacing the existing area under different spices. With an assumption to replace an area of 20% of presently cultivated area with the improved spices, requirement of planting materials will be 14815 t of ginger per year for NE states (Table 4). In case of turmeric the major area is in Assam, Meghalaya and Mizoram which may require 7440 t of quality seed rhizome of improved varieties per year. As regard to other spices like black pepper, large cardamom *etc*. the existing area is very limited in majority of NE states. Hence, there is a tremendous scope for introduction of these spices and area expansion.

Table 4. Planting materials needed (annually) for introducing HYV

State	Ginger (t)	Turmeric (t)
Arunachal Pradesh	1625	250
Assam	5100	4800
Manipur	1200	160
Meghalaya	2690	760
Mizoram	1260	760
Nagaland	730	20
Sikkim	1820	230
Tripura	390	460

(replacing the local low yielding varieties @20% with HYV)

Quality of planting material

The development of spices industry greatly depends upon the use of quality planting materials in the production systems. Under National Horticulture Mission as well as under TMNE, numerous model nurseries have been established across the country for production of quality planting materials. However, there is wide scope to have more nurseries in ensuring quality and diseases-free planting materials in sufficient quantity at affordable price. Some initiatives have also been taken by DBT in setting the standards for tissue cultured plants. To achieve a high quality seed, routine testing of seed borne diseases and phytosanitary certification (based on International Standard for Phytosanitary Measures, ISPM) need to be used. One important factor in avoiding diseases in seed crop is producing in region with minimal diseases pressure. Using clean, diseases-free seed for planting stock is very crucial. Rotating crops is another important step to avoid disease pressure in the soil. Seed growers must take great care in harvesting and cleaning seed to avoid post harvest infection. Only certified material should be further propagated under hygienic conditions. A proper legislation may be brought in for production of planting material by certified agencies and regulatory movement of planting material from diseased to healthy area. Micropropagation protocols and improved vegetative propagation methods for major spice crops were standardized in black pepper, cardamom, clove, nutmeg, cinnamon, cassia and allspice for rapid clonal multiplication of spices and it may be adopted and planting materials may be supplied at reasonable rates by the government/agencies.

Various approaches are adopted in quality planting material production, such as eradication (removal of infected sources), conventional & non conventional approaches (*in vitro* elimination). Reliable diagnostic tools developed by research institutions shall be used to identify pathogen free nucleus planting material which will be used for further propagation and promotion. The nucleus material should also be checked periodically and nursery planting material ready for distribution should also be checked batch wise for eliminating any incidence.

Ginger

Selection of varieties should be done mainly keeping in view of its wider adaptability and best suited for various agro-climatic conditions of NER. While selecting varieties, preference should be given to high dry matter recovery, less fiber, high yield, oleoresin content and resistant/tolerant to major pest and diseases rather than brought in types. Ginger is propagated by portions of rhizomes (seed rhizomes) and vigorous healthy plants with profuse tillering are to be identified in the seed plots for collecting mother rhizomes. Carefully preserved seed rhizomes are cut into small pieces of 2.5-5.0 cm length weighing 20-25 g each with one or two good buds. Thus selected seed rhizomes are treated with mancozeb 0.3% (3 g in 1 litre of water) for 30 minutes and shade dried for 3-4 hours before planting.

Turmeric

Varieties having high curcumin content, oleoresin, essential oil and dry matter content, long attractive fingers, high yield, resistant to pest and diseases and having 10-12 number of leaves may be selected for raising the crop. Turmeric is mainly propagated through 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 and leaves. The pits are to be covered with wooden planks with one or two openings for aeration. Whole or split mother rhizomes are used for planting. Well developed healthy and disease-free rhizomes are to be selected. For sowing, both the mother-rhizomes and primary fingers are used. The fingers are cut into pieces having 4-5 cm long each, and the mother rhizomes are planted as such or split into two; each having at least one active growing bud. The seed is sometimes sprouted under moist straw before sowing. A rapid method of multiplication is needed especially for newly developed high yielding varieties, which are available in small quantities.

Black pepper

The important criteria for the selection of the mother plant for obtaining planting materials are: vigorous growing vine having high quality characters, dry recovery and high yield and its attributing characters like long spikes, more number of spikes/unit area, bold berries and regular bearer. Pepper is propagated vegetatively through cuttings. Select runner shoots produced at the base of mother plants and keep them coiled and raised to prevent from striking roots in the soil. Separate them from the vines in February-March. The middle one-third portion of runner shoot is preferred for planting. Very tender and too hard portions of the shoots are to be avoided.

The shoots are cut into pieces with 2-3 nodes in each. Leaves, if any, are to be clipped off leaving a small portion of the petioles on the stem. Dipping the lower cut end (up to 2 cm) of the cuttings in 1000 ppm solution of 3-indole butyric acid (IBA) for 45 seconds will increase root formation and development. The dipping period of 45 seconds should be strictly adhered to, as any deviation from this may be injurious. Treating the cuttings with Seradix B2 is equally effective. But IBA treatment is cheaper and hence is recommended for large nurseries where technical supervision is available. Farmers and small-scale nurseries can conveniently use Seradix B2.

For cultivation only varieties having proven to be highly productive and wider adaptability may be selected. Selection of mother plants may be done by following pedigree record for its characters like regularly high yielder and possess other desirable attributes such as vigorous growth, maximum number of spikes per unit area, long spikes, close setting of berries, disease tolerance *etc*. Selection of mother plants should be in the age group of 5-12 years. Mark and label the selected mother plants in October-November.

Chilli

The mother plant from which the seeds, as a planting materials are to be collected should have more number of fruits per plant, more leaf area and high TSS, Vit. C and capsaicin content. Plants are propagated by seeds, often in nursery beds, and then transplanted into fields later. Chilli pepper is ready for harvest 3-6 weeks after flowering, depending on the fruit maturity to the desired level. Green chillies are harvested earlier than orange or red chillies.

Large cardamom

The main criteria for the selection of mother plants for obtaining quality planting materials are early maturity, high dry recovery percentage, suitability for high density planting, erect and compact plant, high percentage of bold capsules, retention of color even after processing, high yielding clump, resistant to pest and diseases. Cardamom is multiplied vegetatively as well as through seeds. Being a cross pollinated crop, clones are ideal for generating true-to-type planting material from high yielding clumps. However, due to inadequate availability of clonal planting materials, farmers still prefer seedlings. *In vitro* propagation method for clonal multiplication of cardamom has been standardized.

Implementation of schemes

In its venture to boost the horticulture industry in the country, the Central Government has launched various programmes such as NHM, TMNE, where the State Governments have been assigned with programmes for area expansion, high yielding variety coverage, rejuvenation *etc*., requiring sizeable quantity of quality planting materials of the respective spices crops. In order to meet the requirement of planting materials in various spice crops, nursery centres are proposed to be established in the selected locations on the identified crops. Even though a quite good number of varieties of various spices crops have been evolved from various research centers, adequate quantity of planting materials of these varieties are not available to the State Departments even after a long period of their release for large scale multiplication and distribution to the farmers under various development programmes, for want of adequate funds.

As a result, the planting material production programmes of the State Governments are mostly limited to the available stock of materials, which may not be able to generate the desired impact in the production front. In order to improve the situation, nucleus planting material production programme with all the available released high yielding varieties are being be taken up directly by the Directorate of Arecanut and Spices Development, building up the required facilities in the research farms attached to the State Agricultural Universities, ICAR Institutes *etc.* The Directorate assesses the requirement of nucleus planting materials well in advance, for the large scale multiplication programme for various State Horticulture Mission Programmes and ensures their timely supply and monitors the overall production process as contemplated in the Mission. Wherever Certification Standards are not available, Truth Full Labeled (TFL) seeds will be produced with due care on all the quality parameters. The nucleus materials are to be produced on firm indents and distributed on realization of cost, following the norms of the SAU/ ICAR Institutes. It would be the responsibility of the producing agencies to ensure quality of the planting material produced by them.

Future strategies

To make it available, the nucleus planting materials of improved varieties of major suitable spices, the stock materials should be procured and multiplied locally for further distribution under promotional schemes. The main areas to be strengthened are,

- Promoting multiplication of high yielding/ quality local cultivars suited to the agro-climatic situation
- Establishment of mother plant gardens/ nurseries of nucleus seed materials
- Promotion of certified nurseries for seed production in large scale
- Adopting "*Seed villages*" for large scale production of ginger and turmeric seed rhizomes
- Facilities for diagnostics on diseases & certification of disease free materials
- Establishment of seed storage structure for ginger and turmeric
- Establishing linkages for distribution of materials

Possibilities of mechanization of spice processing in India

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Introduction

India produces as many as 75 different spices, out of the 109 spices listed by the ISO, in its various agro climatic regions. India accounts for about 45% (2, 50,000 t in 2002-03) of the global spice exports, though exports constitute only around 8% of the estimated annual production of spices at 3.2 million tons (2002). Over all, spices are grown in 2.9 million hectares in the country. Spice production in India, as much of the agriculture in the country, is undertaken in millions of tiny holdings and determines the livelihood of large number of the rural population.

Post-harvest processing of spice crops is not as encouraging as it should be in our country. A reliable and unified technique is required so as to reduce the qualitative and quantitative losses during the post harvest period. Prevailing methods are not promising, leading to use of less scientific practices which ultimately results in rejection from export market due to imprecise processing. Various studies indicate that major production constraints of spices have been the lack of quality consciousness, poor handling of the commodity during postharvest period and qualitative deterioration during processing of these spices.

A number of such procedures have been already developed; yet, large quantities of spices produced are spoiled every year owing to the mishandling and the unhygienic methods adopted for processing and storage. Every year a considerable part of spices is rejected from the export market because of less scientific method adopted to process them.

Hence it is essential to evaluate and to employ more scientific methods so that quantitative or qualitative loss of spices can be reduced up to the minimum level.

Spice processing

Most spice processing usually takes place in the primary growing areas where harvesting and other unit operations are performed until marketing of the final product. There are two basic operations: drying and cleaning with processing point of view apart from harvesting of the crops at proper maturity level and proper packaging of the final product to ensure retention of flavor and other aromatic properties of the spices. Further spice processing refers to the series of operations in which the flavor and aromatic substances are removed from the dried material and presented in the form demanded by the industry. These products may include essential oils, alcoholic extracts, oleoresins and blended concentrates. The major factors in the spice processing are:

(i) Correct harvesting time

Harvesting of crops at proper maturity level is very necessary to produce quality products. Growers must be educated to harvest their crops at proper maturity level so that they can get better prices for their products.

(ii) Cleaning

The very first unit operation after harvesting of the crop is proper cleaning of the harvested crop. The first stage is to remove dust and dirt using a winnowing basket. Screens and other type of machinery can be used for the purpose. After winnowing the crop needs to be washed in water, all that is needed is two or three 15 litre buckets. For larger quantities a 1 cubic metre sink/basin with a plug hole needs to be constructed. This can be made out of concrete. However, the water must be changed regularly to prevent recontamination of spices by dirty water. Only potable water should be used.

(iii) Drying

This is the most important stage of the unit operation, which decides the qualitative aspects of final product ready for packaging. Inadequately dried produce will lead to mould growth. The sale value of mould spices can be less than 50% of the normal value. In addition the growth of food poisoning bacteria on some spices is a real danger if proper washing and drying is not carried out. Drying operations can be accomplished in sun or with the help of the mechanical dryers. Drying the produce too fast or at too high temperatures will burn the produce and cause a reduction in quality through both physical and chemical changes such as the loss of flavour or colour. The market price of herbs will be affected by produce that is mouldy or lacking in colour or flavour, indeed the price can decrease by as much as 50%.

(iv) Grinding

Grinding may also add value but must be done carefully as there are difficulties. A whole, intact product can be easily assessed for quality whereas a ground product is more difficult. There is a market resistance to ground spices due to fear of adulteration or the use of low quality spices. This can only be overcome by producing a consistently high quality product and gaining the confidence of customers. For small-scale production (up to 100 kg/day) manual grinders are adequate. Small Chinese or Indian models designed for domestic spice grinding are suitable. For larger scale production a small, powered grinding mill is needed and models are available that can grind 25 kg/hour. A grinding mill needs to be placed in a separate and well ventilated room because of the dust. Great care is needed to ensure uniform sized pieces/powders after grinding and also to prevent heating of spices during grinding.

(v) Packaging

The packaging requirements depend on the type of spice, form for consumption ground or intact, and the humidity of storage. Most intact spices will store adequately in sacks/boxes if the humidity of the air is not too high. Ground spices can also be stored without special packaging if humidity is low but over long periods there is a loss of flavour and risk of contamination and spoilage.

It is therefore better to store spices in a barrier film such as polypropylene (essential in areas of high humidity) to provide an attractive package, retain spice quality and prevent contamination and losses. If polypropylene is not available, cellulose film is adequate if it is heat sealable. Polythene is a poor substitute and should only be used for short term storage as it allows the flavour/aroma of the spices to escape. The selection and packaging of the herbs and spices is time-consuming and the whole family helps with it. A white concrete building with a reed thatch roof is used to package the herbs once they have been dried.

Promising technologies in spice processing

(i) Conditioning and seasoning

Spices, herbs and vegetable seasonings are valued for their distinctive flavours, colours and aromas but they can be heavily contaminated with micro-organisms because of the environmental and processing conditions under which they are produced. The microbial load has to be reduced before they can be safely incorporated into other food products. High temperature treatment can cause significant loss of flavour and aroma from a spice because the volatile oils are lost. Steam also results in a loss of volatile flavour and aroma components and colour changes. Steam can also result in an increase in moisture levels. Traditionally, most spices and herbs are fumigated with sterilizing gases such as ethylene oxide to destroy contaminating micro-organisms but the ethylene treatment may cause cancer. So new methods like irradiation and cryogenic processing are gaining popularity for spice processing.

(ii) Heat pump drying

A heat pump drying systems can be used in order to increase the quality of products where low temperature and well-controlled drying conditions are needed. Most of the convectional dryers use hot ambient air to perform drying operation. Successful outdoor drying depends upon good weather and indeterminate weather can render a product worthless. High temperature drying can damage the nutrient content and impart an unpleasant smell to the dried product. Drying the spice at the low temperature is an important consideration as they have a relatively high commercial value.

Heat pump drying system incorporating a dehumidification cycle have been developed that both conserve energy and handle the material gently. The dryer operates using a heat pump where both sensible and latent heats are recovered from the exhaust air. The heat is then recycled back through the dryer by heating the air entering the dryer. The heat pump drying system is a combination of two sub-systems: a heat pump and a dryer. The heat pump operates according to a basic air conditioning cycle involving four main components: the evaporator, the compressor, the condenser and the expansion valve. It accelerates the drying at low temperature. The advantages of heat pump dryer are high energy efficiency, better quality essentially for heat sensitive spices materials and they operate at a wide range of operating conditions.

(iii) Cryogenic grinding

Heat evolves during conventional grinding of the spices due to breaking of bigger particle into a smaller size as well as mechanical shear, impact and friction. The generated heat generally results in some loss of flavour and quality. The loss of quality can be minimized to some extent by employing some type of cooling to compensate for the heat produced in the grinding process. The use of circulating air, cooling water, etc are made to reduce the amount of heat generation to some extent in standard grinding mills. Recently, the adaptation of cryogenic liquids, such as liquid nitrogen or liquid carbon dioxide to the grinding process has given impetus to the milling industries in order to retain the quality of the food being processed. The extremely low temperature liquid provides the refrigeration needed to compensate for any generated heat in the mill. The strength of the materials depends upon their microscopic structure. A crack in brittle material reduces its tensile strength and leads to instability. Food materials exposed to cryogenic temperatures become more brittle and crisp, and as such, grinding is rendered easier. After freezing to its brittle point, if the material is removed from the cryogenic environment, its temperature begins to rise. Therefore, it is essential that in cryogenic grinding the material be fragmented in the embrittled state as quickly as possible so that grinding is completed below its brittle point. Brittle materials can be fragmented by subjecting them to an impact force.

Grinding can be achieved by different mechanisms and sometimes with combinations of two or more mechanisms. These mechanisms may be compression, cutting, impact, shear, rubbing etc. Spice grinding is an ancient industry like cereal milling industry with the difference that in spice grinding there is an additional problem of natural volatile flavouring components and essential oils getting lost during grinding. Spices are valued for aroma and flavour they impart to various foods. The fat content of spices generally poses a problem and is an important consideration in grinding. The other considerations are particle size, product yield, product uniformity, freedom from contamination, economy and dust from operation.

Post harvest management in spices

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India, reckoned, as 'The Home of Spices' is especially renowned for the vast majority of spices like black pepper, cardamom, ginger, turmeric, chillies, fennel, mace, garlic, coriander etc. India commands a formidable position in the world spice trade with 47% share in volume and 40% in value. Indian spice exports have registered substantial growth during the last one decade. It has increased from 203398 tons valued at 241 million US $ in 1995-96 to 470520 tons valued at 1168.40 million USD in 2008-09, registering an annual average growth rate of 9.4% in value terms. During the year 2008-09 India exported 444250 tons of spices worth Rs. 5300.25 crores. Our share in international spice market is 48% in quantity and 44% in value. India exported value added products worth about Rs.163.75 crores. This includes curry powders, oils, oleoresins and mint products.

Among the Indian export 35000 tons of black pepper valued at 129.5 million USD, 2,09,000 tons of chilli valued 272.62 million USD, 28,000 tons cumin valued at 72.41 million USD and 13250 tons of curry powders, oils and oleoresin worth 40 miilion USD dominated the scene.

Uses

- Spices have been used for their flavor, aroma and color and as preservatives for thousands of years.
- Their use in traditional systems of medicine dates back to centuries.
- Today there is greater scientifically validated knowledge on spices phytochemistry, therapeutic effects of their bioactive principles, and mechanism of action.
- Health benefits include carminative action, hypolipidemic effect, antidiabetic property, antilithogenic property, antioxidant potential, anti-inflammatory property, antimutagenic and anticarcinogenic potential.
- Of these, the hypocholesterolemic and antioxidant properties have far-reaching nutraceutical and therapeutic value.
- Most of the medicinal properties are attributed to the secondary metabolites – the essential oils and oleoresins – present in spices, a large number of which have been identified.

Flavour compounds

The various phytochemicals present in spices include flavonoids, terpenoids, lignans, sulfides, polyphenolics, carotenoids, coumarins, saponins, plant sterols, curcumins, phthalides etc. The various flavor compounds present in spices are given below:

Spice	Important flavor compounds
Allspice	Eugenol, β-caryophyllene
Anise	(E)-anethole, methyl chavicol
Black pepper	Piperine, S-3-carene, β-caryophyllene
Cardamom	α -terpinyl acetate, 1-8-cineole, linalool
Turmeric	Turmerone, zingeberene, 1,8-cineole
Ginger	Zingeberene, gingerol, shogaol, neral, geranial
Mace	α -pinene, sabinene, myristicin, elemicin
Nutmeg	Sabinine, α-pinene, myristicin, elemicin, safrole
Cumin	Cuminaldehyde, p-l,3-mentha-dienal
Fennel	(E)-anethole, fenchone
Saffron	Safranol
Vanilla	Vanillin, p-OH-benzyl-methyl ether

Processing and value addition

Black pepper

The primary processing in black pepper involves threshing, blanching, drying (sun drying or mechanical drying), grading and packing.

Harvesting: Black pepper takes about 7-8 months after flowering to reach full maturity. In India the crop is harvested during December –January in plains and January-April in the high ranges. It is important to harvest pepper at the proper stage of maturity in order to achieve a dried product of good colour and appearance. Recent advances in product diversification have necessitated harvesting of the berries at different stages of maturity which has to be regulated depending on the various end uses (Table 1).

Table 1. Optimum maturity at harvest for different pepper products

Product	Stage maturity at harvest
Canned pepper	4-5 months
Oleoresin and essential oil	15-20 days before maturity
Dehydrated green pepper	10-15 days before maturity
Pepper powder	Fully mature with maximum starch
Black pepper	Fully mature and 1-2 berries start turning from yellow to red in each spike
White pepper	Fully ripe

Threshing: The berries are separated from the spike usually by manual trampling. This operation is crude, tedious and unhygienic. Chances of extraneous soil particles and filth contaminating the produce are also high. Mechanical threshers can improve the quality of the product, increase the efficiency of operations and save labour. Various agencies have developed threshers of varying capacity and speed.

Blanching: Dipping freshly harvested green pepper for a minute in boiling water reduces drying time and gives a shining black colour to dried pepper.

Drying: Pepper has moisture content of 60 to 70 % at harvest, which should be brought to safer levels of 8-11 per cent by adequate drying. The dry recovery varies from 29 to 40 percent depending on the variety. Sun drying is the conventional method followed. Mechanical dryers developed by various agencies such as solar and other fuel dryers are highly efficient for drying pepper. Depending on the availability of sunlight, sundrying takes about 3-4 days for drying to the desirable moisture level.

Cleaning and grading: The threshed and dried 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. On a small scale, winnowing and hand picking remove most of these impurities.

Using sieves, cleaned pepper, is sifted into different grades based on size. These standards are being implemented rigorously under the Agmark Grading Scheme for exports from India.

The major grades of black pepper are as follows:

- Malabar Garbled (MG Grades 1 and 2) Black Pepper
- Malabar Ungarbled (MUG Grades 1 and 2) Black Pepper
- Tellicherry Garbled Black Pepper Special Extra Bold (TGSEB)
- Tellicherry Garbled Extra Bold (TGEB)
- Tellicherry Garbled (TG)
- Pin heads (PH Grade special and Grade1)
- Garbled Light Pepper (GL Special, GL Grades 1 and 2)
- Ungarbled Light Pepper (UGL Special, UGL Grades 1and 2)
- Black Pepper (Non-specified)

Packing and storage: Black pepper is hygroscopic in nature and absorption of moisture from air, notably during rainy season with high humidity may result in mould and insect infestation. Before storage it is to be dried to less than 10 per cent moisture. The dried whole pepper is packed and stored in double burlap bags with polythene liners of 0.076 mm or more in thickness or in laminated poly propylene bags in order to prevent further mould development and to inhibit growth of microorganisms and insects.

Intrinsic quality: As in the case of other spices, the medicinal property and aroma quality are attributed to the volatile oils present in black pepper. The non-volatile part called oleoresin is extracted using organic solvents namely acetone, ethylenedichloride, ethyl acetate etc. Good quality oleoresin will have about 15-20% volatile oil and 35-50% piperine. In general, black pepper contains about 3-5% volatile oil, 8-16% oleoresin and 2-6% piperine. Some of the traditional varieties like Kottanadan and Kumbhakodi are rich in oleoresin and piperine. Some of the new varieties with high quality are Malabar Excel, Sreekara and Subhakara.

A variety of products have been made from pepper are classified as 1) Green pepper based products 2) Black pepper and white pepper based products 3) Pepper by- products.

Green pepper based products

The major green pepper based products are canned green pepper, green pepper in brine, bulk-packaged green pepper in brine, cured green pepper, frozen green pepper, Freeze dried green pepper, dehydrated green pepper, green pepper pickle, mixed green pepper pickle, green pepper sauce and green pepper-flavoured products.

Black pepper based products

This includes whole black pepper, sterilized black pepper, ground black pepper, cryoground black pepper powder, pepper oil and oleoresin.

White pepper based products

White pepper is the white inner corn obtained after removing the outer skin or pericarp of pepper berries. It is a product which fetches a premium price in the international market. The traditional method of preparation of white pepper is by retting. If running water is not available, the alternative is to use fermentation tanks wherein the water is changed every day for 7-10 days. Retting converts only ripe and fully mature berries to white pepper. Conversion of harvested berries to white pepper gives a recovery of 22 to 25 per cent. However getting uniform ripe red berries is a major constraint. Now many agencies including IISR Calicut have revolutionized this technique by developing cultures which can convert green pepper to white pepper.

White pepper is preferred over black pepper in light colored preparations such as sauces, cream soups etc where dark colored particles are undesirable. It imparts modified natural flavour to food stuff.

Encapsulated spices

In the production of spray dried spices, the essential oils and or oleoresins are dispersed in the edible gum solution, generally gum acacia or gelatin, spray dried and then blended with dry base such as salt or dextrose. As water evaporates from the spray dried particles, the gum forms a protective film around each particle. The protective capsule prevents the spice extractive from evaporating and from being exposed to oxygen.

Sterilized pepper

Sterilization of pepper is done to ensure high quality, contamination free, cleaned and dried pepper. Several methods are available for sterilization including hydrostatic/ pressure sterilization, ozone sterilization, irradiation, microwave heating, alcohol vapour treatment, steam treatment and fumigation. Continuous steam sterilization method involves subjecting the spice to a rapid flow of superheated steam for a predetermined period of time followed by drying, re-humidification and packaging. Microbial levels as well as enzyme activity are considerably reduced to low levels and no significant oil or flavour loss is reported. In countries where sterilization by radiation as well as chemical methods is not permitted, steam sterilization is the best.

Other products

***Pepper-flavoured products*:** Pepper mayonnaise, pepper cookies and pepper tofu are some of the products prepared from white or black pepper.

Pepper extract: It is a valuable adjunct in the flavouring of sausages, canned meat, soups, table sauces and certain beverages and liquor.

Preservative: Black pepper is a valued as an essential preservative for meats and other perishable foods. It is therefore largely used by meat packers and in canning, pickling, baking, confectionery and in the preparation of beverages.

Pepper oil: Pepper oil is used in perfumery and also for manufacturing soaps. Monoterpene hydrocarbons in oil include camphene, limonene, myrcene, α-phellandrene, β-phellandrene α and β-pinenes, sabinene, α and γ-terpinenes, terpinolene and α-thujene.

Major oxygenated monoterpenes include 1,8-cineole, cryptone and linalool. Many authors suggest (±)-linalool, (+)-α-phellandrene, (-)-limonene, myrcene, (-)-α-pinene, 3-methylbutanal and methylpropanal as the most potent odorants of black pepper . β-caryophyllene is the major sesquiterpene hydrocarbon present in pepper oil. It varies from 10-30% in many popular cultivars of black pepper. β-caryophyllene concentration in black pepper oil varies based on cultivar and altitudes. It is found in both leaf and berry oil.

Many products, in which pepper is a major ingredient, have been developed such as lemon pepper, garlic pepper, sauces and marinades that have pepper as the main component.

Spice mixtures and blends: Curry powders and spice blends for various culinary uses

Pepper flavoured products: Products such as pepper mayonnaise, pepper cookies, pepper tofu *etc.*

Pepper extracts- pepper candies, pepper perfumes *etc.*

Physical and microbial contamination

The physical quality of black pepper is largely determined by berry size, colour, light berry content, damaged berries, moisture content, microbial load, presence of foreign matter, insect infestation, *etc.*

Black pepper is exported mainly to developed countries like USA, UK, Germany, European Union, Japan and Canada. In the international market, quality specifications for trade are laid by both importing as well as the producing countries. The quality parameters assessed are extraneous matter, light berries, pin heads, bulk density, insect excreta and microbiological aspects like presence of *Salmonella*, *E. coli* and aflatoxin. American Spice Trade Association (ASTA) or European Spice Association (ESA) or International Pepper Community (IPC) or International Standards Organization (ISO) specifications are the commonly adopted standards in international trade. Among them, the cleanliness specifications for spices laid down by ASTA, which are also approved by the United States Food and Drug Administration (USFDA) are widely accepted among the consumers.

Ginger

India and China are the world's largest producers and exporters of ginger. Other important producers are Jamaica, Nigeria, Sierra Leone, Thailand and Australia. USA, United Kingdom, Germany, Japan, Saudi Arabia, Singapore, Hong Kong and Canada are the major importers of ginger.

Japan is the number one importer in the world. Japan's imports of ginger reached more than 100,000 tons valued at US$ 126 million, which accounted for 50% of the country's total spice imports in 2004. The principal supplier of quality ginger to the Japanese market is China with exports exceeding 70,000 tons valued at US$ 93 million, followed by Thailand with 26,000 tons. Among the Indian states Nagaland produces 63500 tons, Meghalaya 47100 tons, Kerala 45300 tons and Sikkim 34700 tons of fresh ginger.

Post harvest processing

Harvesting

In India normally harvesting of ginger is done from January to April, depending on the location. Fresh and dry yields of rhizomes increase steadily up to 210 days after planting. The quality of ginger is affected by the stage of the harvest.

Table 2. Stage of harvest of ginger for various end uses

End use	Stage of harvest (months after planting)
Vegetable purpose and preparation of ginger preserve, candy, soft drinks, pickles and alcoholic beverages	4 - 5
Dried ginger and preparation of ginger oil, oleoresin, dehydrated and bleached ginger	8-10
Green ginger, oleoresin and volatile oil	7
High dry ginger & starch and low crude fibre	8
Dry ginger	8 - 9
Salted ginger	4 – 5
High essential oil and High oleoresin	7-9
High crude fibre & low protein and fat	6½ - 7
Low crude fibre	7
Less fibre & mild pungency	< 7

Peeling

The skin of the ginger rhizomes constitutes a barrier to evaporation or transporation of moisture from within, hence a pre-requisite for efficient drying of ginger is peeling; hand peeling with special scraping knives is resorted to. Partial mechanical peeling of ginger has been tried with abrasive machines for 60 seconds, which is equivalent to hand-scraping with respect to loss of volatile oil, time of drying, and peeling loss of 10-20%.

Chemical treatments

Bleaching of ginger

The peeled ginger rhizomes are washed and kept steeped in plain water for 2 to 3 hours. Thereafter, they are taken out and steeped in about 1.5 to 2.0% lime (CaO) solution for about 6 hours. They are then drained and sun dried on mats, barbecues, or on a clean cement floor. This liming or bleaching of ginger not only improves its colour, but also helps to preserve it better. Care should be taken to use the best quality slaked lime in order to get better whiteness. Besides, liming is reported to retard insect infestation.

Dehydration of ginger

Unless the ginger is sliced fairly thin, its dehydration is essentially a slow process. Using a cross-flow dryer, it takes only 5-6 hours to dry sliced, scraped ginger, as compared with 16 to 18 hours for dehydration of scraped, whole ginger.

Grinding

Dry ginger is available in market in the form of stone hard branched fingers, approximately 2 cm long, and would be required to be powdered in stages. In addition, the material is fairly fibrous at the stage of harvest for making dried ginger. The choice of the type of grinding mill will be governed by these features. It is also necessary to keep in mind that at all stages of grinding and heating, aeration of the mass should be minimized to optimize the retention of volatiles, reduce oxidative changes, and maximize through put by minimal "gumming up" or "caking" at the rolls and screens.

Packaging

Hessian and straight plastic bags cannot be used for the storage of sliced ginger, as the cut surfaces are susceptible to insect attack resulting in material and quality loss. With ginger in powder form, these traditional packages are still less suitable due to rapid loss of volatiles. Fiberboard drums with or without coating or liners are in general use for powdered spices. Ginger in dried chips form are packed in multiwall Kraft bags, coated or laminated, mouth folded, and stapled as the most likely commercial package and stored up to 5 months at room temperature.

Value added products

***Products based on fresh ginger*:** Salted ginger, ginger candy, ginger paste, crystallized ginger, ginger wine, ginger in brine *etc*.

***Products based on dry ginger*:** Bleached (lime-coated) ginger, whole dried ginger, sliced and ground ginger, ginger oil, oleoresin, encapsulted flavours *etc*.

Relatively immature ginger with less fibre content is preferred for all fresh ginger based products. Pungency of fresh ginger can be reduced by repeated mild heating with water and decanting the water. Products such as candy, paste and crystallised ginger are preferred for its lemony flavour and mild pungency. Cultural practices and agro climatic locations also play an important role in the qualitative traits of ginger.

Ginger-based beverages

Among spices, ginger has the unique distinction of being used in beverages. Built around the central flavor of ginger and supported by other flavors from fruits, other spice, and herbs. There are two distinct classes of beverages, ginger beer and ginger ale. The principal difference between these two beverages lies in their higher gravity and higher extractives. Ginger beer has a complex flavor and cloudy appearance, whereas ginger ale is valued for its sparklingly clear appearance, distinct lemony-aromatic note on the basis of ginger aroma, high pungency, and high carbonation. These two classes of beverages are made in a number of variations to cater to individual marker requirements and end uses.

Turmeric

India is the major producer and exporter of turmeric at present, even though the crop is grown in several countries *viz.,* Pakistan, Malaysia, Myanmar, Vietnam, Thailand, Philippines, Japan, China, Korea, Sri Lanka, Caribbean Islands and Central America. It is estimated officially that about 80% of the world production of turmeric is from India alone.

India is the largest producer and exporter of turmeric in the world. Among the spices grown in India, turmeric ranks fifth position in area (1,61,300 ha), second in production (6,53,600 t) and third in export (both in quantity (35,556 t) and value (Rs.121.7 crores)) during 1999 – 2000 (Spices Board, 2000). In India, turmeric is produced from 230 districts in 22 states. Leading turmeric producing states are Andhra Pradesh (419000 t), Tamil Nadu (118500 t), Orissa (56800 t), Karnataka (26400 t) and West Bengal (24500 t).

Post harvest processing

In India, at various places, different methods and equipments are used for processing of turmeric, but the traditional method consists of the following steps:

Harvesting, washing, boiling/curing, drying, polishing, colouring, grinding/ powdering, packaging and marketing

The turmeric crop is ready for harvesting in about 7 to 9 months after sowing depending upon the variety. In India, sowing takes place between April to July and harvesting is done from February to April. Before harvest, the dry leaves and stem are cut close to the ground.

Washing

Rhizomes are separated after digging out from the soil and are kept soaked in water throughout the night to remove particles of soil, spray residues and non-useful particles attached with the rhizomes. This process can be achieved by soaking and spraying equipment. Spraying is done at low pressure and wide-angle jet or with high pressure jet

Boiling/ blanching/ curing

Traditionally boiling is done in metal or mud pots with (three fourth capacity) water from 1 hr to 1.5 hrs. Top of the pots are covered with a lid or dry leaves. Boiling process is continued till foams and white foams start coming out. These come out with a special quality of flavour. Rhizomes are tested by pressing with fingers depending on the quantity.

The mother rhizomes as wholes or cut longitudinally into halves and the fingers are generally cured separately, as cooking time varies with difference in thickness. Cooking helps in producing a product of fairly uniform color, due to the diffusion. Boiling considerably reduces the drying time both in the sun and the mechanical drier, while the total color and the volatile oil remained practically the same.

Drying

Sun drying in specially prepared toughened earth or cemented yards is the usual practice. Drying is slow, taking 10-15 days for completion, when properly dried, the rhizomes become hard, almost horny, brittle and of uniform yellow colour. The moisture content of the dried rhizomes is generally less than 8%. Completely dried turmeric holds 6-8 % moisture content.

Polishing

The appearance of dried rhizomes is improved by rubbing them against ground or by trampling to take out the hard layer over them and small roots are removed. By this process colour of turmeric becomes bright or shining. The product is known in the trade as 'polished turmeric'. Manual methods give low output of around 20 kg for 8 hrs for two persons.

Mechanical polishing drums have been developed for handling large quantities. Mechanical polishers with large sized drums (which may be circular, hexagonal or octagonal in shape) can handle larger batches of dried rhizomes. During polishing, scales, rootlets and some of the epidermal layer are removed as dust through the sieve mesh and the sieved dust is generally used as manure.

Colouring

Better look for exported turmeric is imparted by a dry or wet colouring process. In the dry process, turmeric powder is added to the polishing drum in the last 10 min. In the wet colouring process, turmeric powder is suspended in water and mixed inside by sprinkling inside the polishing basket. After colouring is complete, these are dried for one week.

Grinding/powdering

Traditionally dried and polished turmeric are cut into pieces and beaten in mortar and pestle. After this it is milled or ground with hand operated chakki. Hammer mill is also used for grinding. Powder should be so fine that it passes through 300-micron sieve and nothing is left over the sieve.

Packaging

Cured dried turmeric with moisture content of 15-30% is transported in gunny bags to assembling centers where it is further dried, polished and coloured, if necessary. Dried turmeric is graded according to size and stored. Fumigation and prophylactic treatments are routinely given during warehousing and before export. The colour of turmeric has been found to be stable as long as it is not exposed to sunlight.

Value added products

India is the global leader in value-added products of turmeric and exports. Value added products from turmeric include curcuminoids, dehydrated turmeric powder, oils, and oleoresin. Turmeric, like other spices is available as wholes, grinds and oleoresin. The institutional sector in West buys ground turmeric and oleoresins, while in the industrial sector, whole dry turmeric is preferred.

Ground turmeric

Dried turmeric is powdered by disc type attrition mills to obtain 60-80 mesh powder for use in various end products. The rhizomes contain 4-6 percent of volatile oil and there is a great chance of losing the oil when powdered. Since curcuminoids, the color constituents of turmeric, deteriorate on exposure to light and to a lesser extent, under heat and oxidative conditions, it is important that ground turmeric is packed in a UV protective packaging and appropriately stored.

Powdered turmeric is packed in bulk, in a variety of containers, fibre board drums, multiwalled bags and tin containers. The color of turmeric was not affected in any of the packaging or storage conditions upto six months.

Turmeric powder is a major ingredient in curry powders and pastes. In the food industry, it is mostly used to color and flavor mustard. It is also used in chicken bouillon and soups, sauces, gravies, and dry seasonings and also as a colorant in cereals.

Turmeric oil

Dried rhizomes and leaves are used industrially to extract the volatile oil. Dried rhizomes contain 5-6 % and leaves contain about 1-1.5% oil. It is generally extracted by steam distillation. Super critical extraction using liquid carbon-dioxide is a relatively new extraction technique for extracting volatile oil and oleoresin. The peculiar turmeric aroma is imparted by ar-turmerone, the major aroma principle in the oil.

Turmeric oleoresin

Turmeric oleoresin is the organic extract of turmeric and is added to food items as a spice and coloring agent. Turmeric oleoresin is essentially used in institutional cooking in meat and fish products and certain products such as mustard, pickles and relish formulas, butter and cheese. This is obtained by the solvent extraction of the ground spice with organic solvents like acetone, ethylene dichloride and ethanol for 4-5 hours. It is orange red in colour. Oleoresin yield ranges from 7.9 to 10.4 per cent. Curcumin, the principal coloring matter forms one third of a good quality oleoresin.

Curcumin

Curcumin or curcuminoids concentrate, for use as a food color, is not a regular article of commerce, because for most current uses the cheaper turmeric oleoresin has been found suitable. Curcumin is included in the list of colors with a restricted use because it has been allotted a low ADI (Acceptable Daily Intake) of 0-1.0 mg/kg body weight/day. Curcumin gives a bright yellow color even at doses of 5-200 ppm. A variety of blends are available to suit the color of the product.

Chilli and paprika

Post harvest processing

Harvesting and yield

The stage of harvest is dependent on the final use. In chilli, flowering begins 1-2 months after transplanting depending upon the variety, climate, nutritional status of soil and it takes another month for green fruits. One hundred kg of fresh ripe fruits yield 25-40 kg dry chilli depending upon the variety and thickness of inner wall. Chillies are generally harvested by hand.

Processing

Fruits are harvested at ripe stage, piled for 24 hours and then dried in the sun for about four days until they are soft and wrinkled. The fruits are then cut and sectioned and again dried in the sun for about eight days until sufficiently dried. The sun-dried product has high moisture content of 18 % and is further dried in the factories in hot air dryers to a moisture level of 8 to 12 %, which makes them suitable for storing and grinding.

With the control of airflow and humidity, the drying time varies between 2.5 to 4 hr to give a product with a moisture content of 10 to 12 per cent and a yield of 18 per cent of fresh weight. It has been found that by rapid drying the colour loss is less than by prolonged sun drying. After drying the seeds, peduncles and calyxes, the placental tissues are removed by hand or by mechanical means. The pericarp material is separated in to categories according to colour, quality, intensity and absence of blemishes for use in making a wide range of colour strengths and three qualities of paprika powder.

Curing is done by the "netsack method" based on the observation that in freshly harvested fruits stored in cotton sacks, the red pigment content increased rapidly up to the 25^{th} day to a high of 4.5 to 4.7 g/ kg and remained at that level up to 39 days and then slowly decreased. Traditionally the withered and cured fruit is further dried to a safe moisture level by spreading them in the sun for 2 to 3 weeks. The leathery skin slows the rate of loss of moisture. To cope with the increased cultivation, the withered, cured product is quickly dried to a moisture level of 8 to 10 per cent in modern dryers with hot air under $80^{0}C$ and is further ground in mills. A further development is to directly process the fresh crop after washing and to cut into slices for rapid drying at 70 to 80^{0}C, to reduce moisture from 85 to 8 per cent.

Recovery from the fruits of paprika:

68.7 %	- Skin (pericarp)
25.0 %	- Seed
6.3 %	- Pedicel
Drying percentage	-15% on an average.

Storage

After harvesting during hot weather period, the cold storage is recommended which will aid in colour retention and guard against infestation. Storage of chilli in cold store is extensively followed around Guntur (Andhra Pradesh) as the produce fetches premium price due to excellent colour retention. The use of commercial cold store for chilli storage has now become almost a general practice among farmers. The temperature in a cold store is maintained in the range of 5-8^{0}C and relative humidity is kept at 55-60%. There was a great loss of oleoresin and capsanthin when it was stored at ambient temperature for 20 days after removal from the cold store. Therefore, the chilli produce should be used immediately after removal from cold store for extraction of colour and oleoresin and other products.

Value addition and quality parameters

Quality parameters

Different aspects of quality standards vary according to uses by growers, shippers, sellers and consumers. The quality of red chilli powder and paprika products is based on visual and extractable red colour, pungency level and to a lesser degree on the nutrition value.

Colour

Colour is one of the most important attributes of red chilli and paprika. Chilli colour can be evaluated from three different perspectives: surface colour, extractable colour and carotenoid profiles. Extractable colour is measured by a spectrophotometric process, and is designated as ASTA units (American Spice Trade Association.). Generally, higher the ASTA colour value, the greater the effect on the brightness or richness of the final product. A chilli powder with 120 ASTA colour units would give a brighter red to a finished product than an equivalent amount of 80 ASTA colour.

Essentially, the paprika fruit can be portioned into pedicel, seed, placenta and pericarp, where in major portions of pigments occur in the outer pericarp tissues beneath the epidermis. Pigments constituting the color are a complex mixture of carotenoids. Red and yellow components combine to give the total color to paprika. The red color is constituted by two major pigments of capsanthin (30-60%) and capsorubin (6-18%). The accumulation and retention patterns of the red pigments and total carotenoids in the fruits are cultivar dependent. Colour, like pungency, is a priced quality characteristic of paprika which is commercially important and exported. However, the colour intensity depends on diverse factors such as varieties, stage of maturity of the fruit harvested, agro-techniques adopted, agro-climatic conditions, and post harvest operations. High colour paprika is produced in Zimbabwe, South Africa, Morocco, Spain and Hungary.

Pungency

Another important typical attribute of capsicum is pungency. Scoville heat units measure the heat of capsicum powder. One part per million concentrations of capsaicinoids is equal to 15 Scoville heat units. The nature of pungency has been established as a mixture of seven homologous branded-chain alkyl vanillylamides, named capsaicinoids. They often are called capsaicin after the most prevalent one, dihydrocapsaicin being the second. They are unique to capsicum.

Generally there is a decrease in pungency from chillies to paprika and a parallel increase in colour pigment concentration and an increase in size and fleshy nature of pericarp. The group paprika contains less than 0.1% of capsaicinoids, the best grade of Spanish paprika having 0 to 0.003% and for the pungent grade, a maximum of 0.5%. But the pungency level of chillies varies from 0.1 to 1.4%.

Dried red capsicum powder is classified into five groups based on pungency level: nonpungent or paprika (0 to 700 Scoville heat units) mildly pungent (700 to 3,000), moderately pungent (3,000 to 25,000), highly pungent (25,000 to 70,000) and very highly pungent (80,000 Scoville heat units). The last group is mainly the product from Asian countries.

Growers can, to some extent, control pungency by the amount of stress to which the plant is subjected. Pungency is increased with increased environmental stress. More specifically, any stress to the chilly plant will increase the amount of capsaicinoid level in the pods. A few hot days can increase the capsaicinoid content significantly.

Flavour and aroma

Most chillies are used for flavour. Flavour is a complex sensation determined in the mouth. Chilli connoisseurs can readily identify subtle flavours presented by each type. As in wine-tasting, one can distinguish between the subtle flavours of chillies after a few years of experience. One of the most potent volatiles known is found in chilli, the pyrazine 2-methoxy-3-isobutyl-pyrazine which gives the 'green bell pepper' smell. The three main aroma compounds in chillies are 4-methyl-1-pentyl-2-methylbutyrate, 3-methyl-1-pentyl-3-methylbutyrate, and isohexyl-isocarproate.

Value added products

Various products are being prepared from chilli/paprika, which are having high export potential.

Oleoresin

Oleoresin prepared from chillies is popular among food processors and other industries where a concentrated pungency or red colour additive is needed. When pungent chillies are used in the extracting process, the product is called 'oleoresin capsicum'. This product is used in medicinal and food industries. When non-pungent (paprika) chilli is used, the product is called 'oleoresin paprika'. Oleoresins are available in two basic forms: oil soluble or water soluble. Oleoresin is obtained from dried chilli pericarp by extraction with a volatile non-aqueous solvent (often hexane, ethylene dichloride or acetone), which is subsequently removed from the oleoresin by evaporation at moderate temperatures and under partial vaccum. Oleoresins contain the aroma and flavour of the paprika or other chilli type, in concentrated form, and are usually viscous liquids, or semisolid materials. Oleoresins are used for standardizing the pungency, colour and flavour of food products. Because of their high concentration, oleoresins cannot be incorporated into food products unless they are diluted. The dilution is usually achieved by dissolving the oleoresin in an appropriate solvent to make an essence. The paprika oleoresin is usually diluted with soybean oil. Oleoresin capsicum is made from the most pungent pod types and where colour content is not important.

The Indian oleoresin industries have been using some of the land races such as 'Byadagi kaddi', 'Byadagi dubba' and 'Warangal tomato chilli', for extraction of oleoresin. Other value added products include dehydrated chilli, canned chilli, brined/pickled chill, fermented chilli, brined/ pickled chilli.

Paprika powder

Paprika powder is obtained by grinding the dried red fruits after removing the seeds and pedicels.

Nutmeg

Harvesting and drying

Fruits

The female nutmeg tree starts fruiting from the sixth year, though the peak harvesting period is reached after 20 years. The fruits are ready for harvest in about 9 months after flowering. Fruits are harvested when they split open on ripening. The split fruits are either plucked from the tree with a hook bill or are collected soon after they drop onto the ground. Nutmeg is dried in large trays by various procedures. The unshelled nutmegs are dried in the sun until the seeds inside rattle on shaking. Normally, nutmeg dries in about a week. The seed cover is removed by breaking the hard seed coat mechanically.

Nutmeg is usually packed in double layered linen, jute, sisal or polythene bags. If other packing materials are used, care must be taken to avoid materials which might lead to 'sweating' and mould development. Packaging should be such that the maximum weight loss should not exceed 10%.

Mace

Mace is detached from the nut carefully soon after harvest, washed, flattened by hand or between boards and then sun dried until they become brittle. Hot air ovens can be used for drying and the colour retention is much better than sun dried mace. Dried mace is graded and packed. The fixed oil content of mace ranges from 20% to 35%.

Mace is dried in single layer over a wire mesh in copra drier separating the plenum and drying in the chamber. The temperature of drying is maintained around 50^0C.

As a pretreatment if mace is blanched at 75^0C in hot water for 2 minutes, the leathery texture can be maintained and the drying process will be fast. Drying in hot air drier will take about 4 hrs to complete the process. In addition, blanching provides glossiness and thus mace acquires more attractive and pleasing appearance. The moisture content, volatile oil and oleoresin in dried mace range from 4.85 - 5.05, 11.57-12.40 and 21.25-22.57 per cent respectively, whilst the lycopene is up to 149.0-182.2 mg/100g.

If drying is delayed or prolonged even by a day, chances of mould and fungal contamination are very high. Drying to optimum moisture level without losing the inherent qualities especially the colour, is a prerequisite for long storage and better price. Sun drying bleaches the colour and may contaminate mace with mould.

Nutmeg oil and mace oil

The essential oil from nutmeg is steam distilled usually from nutmeg and nutmeg oil ranges from 5% to 15% of the seed weight. The essential oil is highly sensitive to light and temperature and yields a colourless, pale yellow or pale green oil with a characteristic odour of nutmeg. The oil is soluble in alcohol and insoluble in water. The essential oil of East Indian nutmeg and West Indian nutmeg differ in their flavour and odour characteristics. The East Indian nutmeg oil is considered superior to the West Indian nutmeg oil, having a better aroma and a higher amount of phenyl propanoid ethers and terpenes. The physico-chemical properties of the two oils are reported to be different. East Indian nutmeg oil is also reported to have a higher concentration of myristicin (up to 13.5%), than West Indian nutmeg oil (less than 1%). The yield and quality of the oil depends on the geographical location, grades and the distillation process involved.

Mace oil is obtained by steam distillation of dried aril and yields 4 to 17% oil. It is a clear red or amber dark red liquid with characteristics odour and flavour. Mace oil is more expensive than nutmeg oil. Leaves also yield oil (0.34-0.65%), chemically similar to nutmeg oil, but its flavour and odour are inferior to both mace and nutmeg oil.

Nutmeg oleoresin

Nutmeg oleoresin is obtained by solvent extraction of spices. Oleoresins contain saturated volatile oil, fatty oil and other extractives soluble in the particular solvent employed. Nutmeg oleoresins, obtained by solvent extraction from the dried spice of nutmeg, are used in colouring and flavouring in the food industry. Nutmeg extracted with benzene yields 31 to 37% of oleoresins and with cold ethanol yields 18 to 26%. Higher fatty oil is obtained by hydrocarbon solvents while polar solvent like alcohol and acetone yield low fatty oils and resins. Commercial mace oleoresins are available with volatile oil content ranging from 10 to 55%. When extracted with petroleum ether, it yields 27 to 32% and contains 8.5 – 22% volatile oils, and after chilling the yield reduces to 10 – 13%.

Nutmeg butter

The fixed oil of nutmeg is known as nutmeg butter. Nutmeg butter contains 25 to 40% fixed oil, which is obtained by expressing the crushed nuts or by extracting with solvents. Fixed oil is a semi solid or reddish brown fat with both the aroma and taste of nutmeg. It is completely soluble in hot alcohol and sparingly soluble in cold alcohol. The fixed oil is freely soluble in ether or chloroform and is composed of trimyristin, unsaponifiable constituents (9.8%), and oleic acid (3.5%), resinous materials (2.3%), linolenic acid (0.6%) etc. Trimyristin is a triglyceride of myristic acid and is creamy to yellowish grey solid.

Cinnamon and cassia

Harvesting and processing

The cinnamon tree may attain a height of 10 – 15 m, but in cultivation, it is generally coppiced or cut back periodically. When the plants are 2 years old, they are coppiced during June – July to a height of about 12 cm from the ground. Coppicing can be commenced from the fourth or the fifth year of planting.

The shoots are harvested from September to November, under Kerala conditions. Coppicing is done in alternate years and shoots having 1.5 – 2.0 cm thickness and uniform brown colour are ideal for bark extraction. A 'test cut' can be made on the stem with a sharp knife to judge the suitability of the time of peeling. If the bark separates readily, coppicing can be commenced immediately. The stems are cut close to the ground when they are about 2 years old, as straight as possible, 1.00 to 1.25 m length. Such shoots are bundled after removing the leaves and terminal shoots.

Cutting is followed by scraping and peeling operations. Peeling is a specialized operation, requiring skill and experience. It is done by using a specially made knife, which has a small round end with a projection on one side to facilitate ripping of the bark. The rough outer bark is first scrapped off. Then the scrapped portion is polished with a brass or an aluminium rod to facilitate easy peeling.

A longitudinal slit is made from one end to the other. Then working the knife between the bark and the wood, the bark is ripped quickly. The shoots cut in the morning are peeled on the same day. The peels are gathered and kept overnight under shade. They are dried first in shade for a day and then in sunlight for four days. During drying, the bark contracts and assumes the shape of a quill. The smaller quills are inserted into larger ones to form compound quills.

The quills are graded from ‘00000’, being the finest quality, to ‘0’ the coarsest quality. The small pieces of the bark, left after preparing the quills are graded as ‘quillings’. The very thin inner pieces of bark are dried as ‘featherings’. From the coarser canes, the bark is scraped off, instead of peeling, and this grade is known as ‘scraped chips’. The bark is also scraped off without removing the outer bark and is known as ‘unscraped chips’. The different grades of bark are powdered to get ‘cinnamon powder’.

Cinnamon products

In addition to cinnamon bark, various other products are obtained from the tree namely, bark oil, leaf oil, bark oleoresin *etc.*

Bark oil

Bark oil is one of the expensive oils in the world market. It is extracted from the bark through steam distillation. The quills can yield high quality oil when distilled. Usually, quillings are used for quality bark oil extraction. Commercial grade bark oil is prepared from a mixture of broken pieces of quills, quillings, pieces of inner bark from twigs and twisted shoots. The oil is light yellow in color and when distilled and turns to red on storage. The bark oil is graded based on its cinnamic aldehyde content. The oil is widely used for flavouring confectionary, liquors, pharmaceuticals, soaps and dental preparations. Its major constituent is cinnamaldehyde, but other components present in minor or trace quantities impart the characteristic odour and flavour which distinguishes this oil from other oils.

Leaf oil

It is obtained by distilling the leaves through steam or water distillation. The leaves are allowed to dry for 3 – 4 days before distillation. Cinnamon leaf oil is yellow to brownish-yellow in colour and possesses a warm, spicy but rather harsh odour. The major constituent of leaf oil is eugenol (70 – 90%) while the cinnamaldehyde content is less than 5 per cent. It is used as a raw material for synthesis of vanillin. The oil is used for flavouring confectionary and sweets and in perfumery. The yield and quality of cinnamon leaf oil, like that of the bark oil, is dependent upon the geographical origin of the leaf oil material and upon the cropping and distillation practices used.

Cinnamon powder

The quills and remnants of the bark can be powdered and used as cinnamon powder. For most baked products, cinnamon is used in the powdered form. The essential oil content of the powder is less compared to the bark due to losses during the process of grinding.

Oleoresin

The oleoresin may be prepared by extracting cinnamon bark with a variety of organic solvents. It contains the steam-volatile oil, fixed oil and other extractives of the spice soluble in the particular solvent employed.

Root bark oil

Cinnamon root bark oil is a colourless to pale yellowish-brown liquid with an odour similar to the stem bark oil but it is weaker, lacking in fragrance and is camphoraceous. The major component of this oil is camphor (about 60%) which crystallizes out on standing.

Storage

Cinnamon should be stored in a cool, dry place. Excessive heat will volatilize and dissipate its aromatic essential oils, and high humidity will tend to cake it. Under good storage conditions, the qualities of aroma and flavour for which cinnamon is prized will be retained long enough to meet any normal requirements of commercial baking. Whole cinnamon does not lose its volatile oil as fast as that of the ground form. When ground cinnamon is stored in bulk in an ambient ware house, a loss of 0.1% volatile oil per month occurs. Whole quills will keep their flavour for a longer time. Oleoresin flavour is stable at high temperature.

All spice

Processing

Berry clusters are harvested, taken to drying shed and left in heaps or sacks for up to 5 days to ferment, according to local preference. Berries are then spread on outdoor drying floors, turned daily to ensure uniform drying (covered at night if it rains) for about 5 days in sunny weather, up to 10 days if cloudy but dry. At the end of this period, moisture content is 12-14% and the yield from 100 kg green berries is 55-65 kg. The dry berries are then cleaned and bagged, and kept in a clean dry store.

Correctly dried spice should have a pleasant characteristic odour and as little microbiological contamination as possible. These objectives are most easily met by artificially drying the green berries under controlled conditions, but a large proportion of berries are still sun-dried and manually prepared.

Larger forced-air dryers can also be employed for drying. Berries received can be handled under more hygienic conditions prior to drying, and data indicate that a temperature of 75^0C is the maximum that can be used for drying without loss of essential oil.

Conclusion

Post harvest management is very important to ensure the intrinsic quality traits of spices which are valued for their aroma and unique taste.

Prospects of product diversification in spices

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Spices are high value and export oriented commodities, which play an important role in agricultural economy of the country. India is the principal source for supply of spices in the global market, though there are number of other countries producing and exporting to the international market. India contributes to about 45-50 percent of the world demand with a total area of around 2.6 million hectares under spices cultivation. India produces around 4.1 million tons (Table 1) of spices annually (NHB, 2008), of this around 10 per cent of the total produce is exported to over 150 countries. The USA, Europe, Australia, Japan, the Middle East and Oceanic countries are the major importers of Indian spices. With a variety of spices in its inventory, almost one third of the world demand is being met by Indian exports.

Table 1. All India area, production and productivity of spices

Year	Area (000' ha)	Production (000't)	Productivity (t ha^{-1})
1991-92	2005	1900	0.9
1995-96	2216	2410	1.1
1999-00	2500	3023	1.2
2003-04	5155	5113	1.0
2005-06	2858	5108	1.8
2007-08	2603	4103	1.6

The North eastern region comprising of states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura has tremendous potential for production of spice crops. The region produces about 272.6 thousand tons (2007-08) of spices with a productivity of 2.38 t/ha which is higher than the national average (1.60 t/ ha). The climatic condition *i.e.* high rainfall and cool climate of the region is highly suitable for cultivation of a large number of spices *viz.*, ginger, turmeric, chillies and large cardamom. Though recently introduced, the region has a potential for commercial cultivation of black pepper, vanilla and saffron. As per basic statistics of NER 2002, among spices, maximum area is covered by chilli (29.7 thousand ha) followed by ginger (16.4 thousand ha) and turmeric (13.6 thousand ha). Ginger is the main cash crop for the tribals of Meghalaya, Mizoram and Arunachal Pradesh. Since India has been playing a major role in production and export of spices, the world still looks upon India as the source of many spices for consistent supplies.

Table 2. Area and production of spices in North eastern states (2007-08)

State	Area ('000 ha)	Production ('000 t)	Productivity (t/ha)
Arunachal Pradesh	8.2	47.5	5.79
Assam	27.2	18.5	0.68
Manipur	8.70	7.70	0.885
Meghalaya	18.4	80.9	4.4
Mizoram	9.00	38.3	4.26
Nagaland	4.50	26.2	5.82
Sikkim	34.0	41.9	1.23
Tripura	4.50	9.40	2.09
North east India	114.6	272.6	2.38
All India average	2603	4102	1.60

Though initiated in the last decade, value addition in the spice sector has achieved commendable position in areas of exports. More than one third of the total exports are in the form of value added products. More than 150 value added products are now available for export. The most important among them are spice oils and oleoresins. State of the art technologies are developed in this sector, which gives a unique position to India in the global spice extraction market. India supplies more than 70 per cent of the total world supply of spice oils and oleoresins.

Scope for product diversification

In North eastern region, a huge quantity of good quality spices *viz.,* ginger, turmeric, chillies and black pepper are produced, but most of the growers during peak season sell their produce at throwaway prices in the local market or to the commission agent. Fresh produce is sold without any value addition and thereby fetches very low price in the market. Therefore, value addition in spices need to be emphasized so that farmers/grower will be able to get more return from their produce. Value addition of spices not only fetches good profits but also makes it suited to various end products. We need to develop post harvest technologies of spices with emphasis on product development and product diversification for domestic and export purposes. Different value added products from spices *viz.,* ginger, turmeric, chillies and black pepper may be prepared which are described subsequently.

Table 3. **Promising varieties of ginger grown commercially in North eastern region**

Sl.No.	Adapted variety	Crude fibre content (%)	Dry matter content (%)	Gingerol (%)	Oil (%)	Yield (t/ha)
1	Nadia	4.56	22.25	0.64	1.45	30.00
2	Poona	6.24	19.76	0.93	1.17	25.10
3	Varada	5.93	21.38	0.96	1.75	22.00
4	Thingpui (local)	5.74	22.47	1.25	1.80	19.30

Among the spices, ginger is one commodity having excellent scope for product diversification. Many value added products from ginger like ginger beer, ginger wine, ginger candy, ginger cookies, ginger flakes, ginger in brine, salted ginger, ginger powder, ginger paste *etc*. are now available in the super markets. Success and acceptability of the end product to a great extent depend on the choice of a suitable variety.

Table 4. Promising local genotypes of ginger of North East region

Genotype	Crude fibre content (%)	Dry matter content (%)	Gingerol (%)	Oil (%)	Yield (q ha^{-1})
Manipuri No. 1	6.77	21.18	1.14	1.45	171.26
Basar	7.02	22.54	1.12	1.30	209.40
Tura Local	5.50	21.9	1.32	1.55	178.26
Thingpui	5.74	22.47	1.25	1.80	193.41
Maran	6.25	24.02	1.10	1.75	198.15
Meghalaya Local	6.02	20.12	1.71	2.10	147.65
Thinglaidum	5.86	22.38	1.23	1.45	154.25
Kachai Ginger	5.72	24.87	1.20	1.70	200.97
Nagaland Local	6.93	19.8	1.18	1.85	191.80
Nadia	4.56	22.25	0.64	1.45	300.00

Source: Sanwal et al., 2007

Value added products from ginger

Dried ginger

Ginger dried for the market contains 7 to 12 per cent moisture. Nadia, Varada and Maran *etc.* are the suitable varieties for preparation different ginger dried products. There is very good demand of whole rhizome dried products in both national and international market. North Eastern Regional Agricultural Marketing Corporation Ltd (NERAMAC), Guwahati is helping the entrepreneurs in marketing the dried products.

Fresh ginger juice

It has got very good demand in pharmaceutical and beverage industries. All the local varieties are suitable for extraction ginger juice.

Ginger paste

There is a very good demand of ginger paste in our country. Dabor India Ltd. is the major player for marketing of this produce in India. NERAMAC has established a close network with Dabor for marketing of ginger paste from the region.

Ginger oil

Oil content varies from 0.5 to 3.0 % depending upon varieties. Most of the local varieties of the region are good source of oil. Meghalaya Local is the most suitable variety for oil extraction as it contains more than 2 % oil. NERAMAC in its factory at Byrnihat is extracting oil since 2007 using the RRL, Trivandrum technology.

Ginger oleoresin

It is a blend of oil and resinoides. It is extracted from ginger powder using organic solvents like acetone, ethylene dichloride *etc*. Its content ranges from 3.5 to 9.5 %. Major pungent principle is gingerol (phenyl ketone). All the local varieties of the region are good source of oleoresin.

Ginger beer

They are made by fermenting extracts of ginger and other spices and brought into condition in bottles corked and tied to stand the pressure developed by secondary fermentation.

Fresh ginger products

Nadia, Varada, Mahima and Jamaica etc are very good varieties for preparation of different products like ginger preserve or muraba, ginger candy, soft drinks like ginger cocktail (which aids in digestion), ginger pickle, salted ginger *etc*. ICAR Research Complex for NEH Region has developed the protocols for instant ginger candy and preservation of ginger slices in acidified brine solution.

Ginger by-products: Different value added by-products like "agarbatti", manures, vermicompost and cattle & poultry feed *etc*. may be manufactured from the industry waste.

Value added products from turmeric

Turmeric powder

Megha Turmeric-1 and Lakadong are the leading varieties in the region used for preparation of turmeric powder. The powder is obtained by grinding of dried rhizome or dried turmeric slices to a fine mesh (50-60) to use in various product. The powder is packed in thick aluminum foil immediately to reduce loss of oil.

Turmeric paste

The paste is an important component in pharmaceuticals and cosmetic industries. Hindustand Lever Ltd in its factory at Dumdooma, Assam produces different products using turmeric paste.

Turmeric curcumin

It is extensively used in bakery products, meat, pharmaceutical and cosmetic industries. Megha Turmeric-1 and Lakadong are the most suitable varieties for extraction of curcumin as it contains curcumin in the range of 6.5-8 %. Other promising varieties are Prathibha, Suranjana and IISR - Kedaram *etc.*

Turmeric oil and oleoresin

The turmeric oleoresin, which is obtained by solvent extraction, is highly valued. Curcumin forms about one third of the oleoresin. Curcumin or curcuminoids concentrate for use as food colour is not a regular article of commerce, because for most current uses the cheaper turmeric oleoresin has been found suitable.

Turmeric by-products

Different value added by-products like "agarbatti", manures, vermicompost and cattle feed *etc*. may be manufactured from the industry waste.

Value added products from chillies

Chilli powder

This is one of the most popular products of chilli having export potential. Suitable varieties having higher colour values are being identified by different organization including ICAR.

Oleoresin

In food and beverage industry, chilli has acquired a great importance in the form of oleoresin, which permits better distribution of color and flavor in food as compared to chilli powder. The food industry generally prefers to use large, highly colored and less pungent chillies for the preparation of oleoresin. Chilli oleoresin, which is prepared from dried chilli powder by solvent extraction, represents the complete flavor or the true essence.

Capsanthin

There is a great damand for natural chilli fruit color, which is used in processed foods in place of synthetic colors. Basically, the coloring matter of chillies is a mixture of carotenoids, yellow and red pigments, which encompass carotenes and xanthophylls. Capsanthin and capsorubin are the red pigments and the yellow include β-carotene, cryptoxanthene and zeaxanthin. Considerable variability exists among the genotypes with respect to color values.

Capsaicin

The hot flavor of chilli is caused by capsaicin and allied constituents, which have good counter irritant function. It is used in pharmaceuticals and cosmetics for this property and perhaps helps in absorption and movement of bowels. Capsaicin is considered as double-edged sword providing nutritional and toxic effects. King chilli of North east India is reported to be the hottest chilli of the world with highest capsaicin content.

Value added products from black pepper

White pepper

White pepper is prepared from ripe berries or by decorticating black pepper. Approximately 25 kg white pepper is obtained from 100 kg ripe berries.

Dehydrated green pepper

Dehydrated green pepper is a premium quality pepper, processed out of farm fresh green pepper berries into dried form, by air drying, retaining its green colour and giving out the best flavour. This is par excellent in quality, flavour, colour *etc* than black pepper. This value added spice product is based on technology developed by the CFTRI India.

Green pepper in brine

Major applications of green pepper in brine are in making sauces, meat-processing industries, steak preparations and in the food service sector. The uniform tender berries that pass the quality control measures are washed and cleaned and put in to a brine solution. The cleaned berries are stored in 17% ± 2% salt solution and vinegar around 0.6% ± 2%. This is washed three times in 45 days and each time changing the brine solutions, so that they are properly matured and then packed in high density poly ethylene (HDPE) food grade cans or as required.

Green pepper paste

Like ginger and turmeric paste, green pepper paste may be a future product of spice industries.

Freeze dried green pepper

India is one of the very few countries, which produces and supply freeze dried green peppercorns, wherein even the natural form of the green peppercorns is retained. This is a specialty product, which finds a wide application in instant soups and dry-meals on account of its special characteristics and subtle flavor. It is also used in the cheese industry and for preparation of pastes.

Dehydrated salted green pepper

Dehydrated salted green pepper is a product developed by the Pepper India Corporation; it is a 100% substitute for green pepper in brine and is much more convenient as it is easier for transportation and storing as it does not involve any brine solution. It is a product, which can be used instead of pepper in brine as it contains both pepper and salt in the same proportion and at the same time maintains the natural green colour.

Canned green pepper

Green pepper after harvest is preserved in 2% brine solution and the product is heat sterilized. This product has the additional advantage over dehydrated green pepper in that it retains the natural colour, texture and flavour.

Bottled green pepper

Green pepper is preserved without spoilage in 20% brine solution containing 100 ppm SO_2 and 0.2% citric acid. Addition of citric acid prevents blackening of berries.

Cured green pepper

To overcome the disadvantages of poor texture and weak flavour of dehydrated green pepper and the high unit weight and packing cost of canned and bottled green pepper, cured green pepper has been developed. Berries are thoroughly cleaned in water, steeped in saturated brine solution for 2-3 months, drained and packed in suitable flexible polyethylene pouches.

Sterilized black pepper

Sterilized black pepper is a premium quality pepper. It is more noble and aromatic than the other species of pepper. Pepper berries are thoroughly washed in boiling water and dried under controlled conditions, till the moisture is brought down to less than 11%. Packaging is done using double-layered poly bags of 25 kg net weight.

Black pepper crushed

Special quality black pepper is crushed and sieved into various sizes varying from 10-30 mesh according to the choice of the buyers and packed in double lined polybags of 25 kg each.

Decorticated black pepper

This is a form of white pepper produced by mechanical decortications of the outer skin of black pepper. This is generally done when white pepper is in short supply. The appearance of decorticated kernel is inferior to traditionally prepared white pepper, but is satisfactory when ground. Also the milling operation requires considerable skill to avoid excessive volatile oil loss.

Pepper oil

Black pepper is crushed to coarse powder and steam distilled to obtain 2.5 to 3.5 per cent colourless to pale green essential oil which becomes viscous on ageing. It is used in perfumery and in flavouring. Oil can also be distilled from white pepper but high price of white pepper and low oil yield do not favour its commercial production.

Pepper oleoresin

Extraction of black pepper with organic solvents like acetone, ethanol or dichloro-ethane provides 10-13% oleoresin possessing the odour, flavour and pungent principles of the spice. The content of the pungent alkaloid piperine ranges from 4 to 6% in dry pepper and 35 to 50% in oleoresin. One kg of oleoresin when dispersed on an inert base can replace 15 to 20 kg of spice for flavouring purpose.

Tapping the potential of organic spices in the North Eastern region: Status and strategies

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Introduction

"It is more important to do what is strategically right than what is immediately profitable." - ***Phillip Kotler***

In the late 1960s, due to increasing population and faced with food scarcity and security, India ushered in the green revolution. In the following two decades, India witnessed a boost in agricultural productivity thanks to the developments in Indian agriculture, including its scientific and policy direction, and led by eminent researchers and agriculture scientists.

The Green revolution technologies involved high usage of synthetic agrochemicals such as fertilizers and pesticides and adoption of nutrient- responsive, high-yielding varieties of crops. These measures boosted the production output per hectare in most of the cases but it is apparent two decades later that this increase in production has slowed down and in some cases there are indications of decline in growth of productivity and production (Source- Planning Commission- 'Approach Paper to the 11th Five year Plan). Also, the excessive use of pesticides and fertilizers have resulted in far-reaching ecological and environmental damages *viz*. drastic decline in soil fertility, lowering water tables and increasing toxicity in food products. These results have made a compelling case for scientists and policy makers to restructure Indian agriculture and production of safe foods.

Increasing consciousness about conservation of environment, health hazards associated with agrochemicals and consumers' preference to safe and eco-friendly food are the major factors that lead to the growing interest in organic food production in the world. Consumers are asking for eco-friendly products across the world and India is also catching up fast in this trend. Eco-friendliness has various parameters and it has started to go beyond only soil, water, air; as it started to address the interrelation of society to its entire surroundings including ecology, man, animal, their health and how they are cared.

These attributes are enshrined as four cardinal 'Principles of Organic Agriculture' by the International Federation of Organic Agriculture Movement, Germany (IFOAM), an umbrella organization working closely with the international community including FAO, Codex Elimentarius, EU, USDA, *etc.* It states that organic agriculture is based on the following "Principles of Organic Agriculture" (www.ifoam.org):

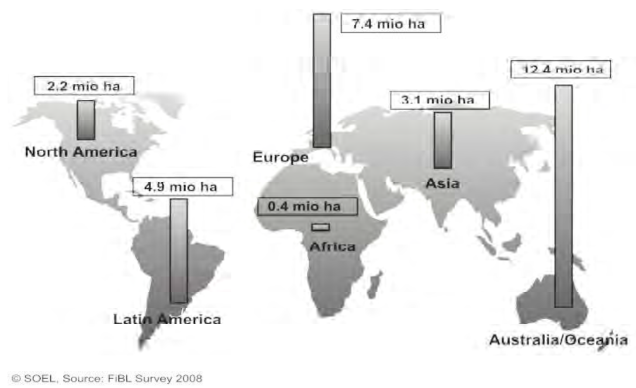
1. Principle of health
2. Principle of ecology
3. Principle of fairness
4. Principle of care

Development of organic agriculture worldwide

Recently, United Nations Food and Agricultural Organisation (FAO) in its report *Organic Agriculture and Food Security* explicitly states that organic agriculture can address local and global food security challenges. The organic sector is flourishing today more than ever.

The world community is increasingly becoming aware of the need to preserve mother nature. All over the world, synthetic/chemical products are quickly replaced by eco-friendly organic products. Organic agriculture is developing rapidly and is now practiced in more than 130 countries of the world. Its share of agricultural land and farms continues to grow in many countries. Worldwide 30.4 million hectares of land is currently under organic production. The value of world trade today is US $ 40 billion, while it was only US $ 18 billion in 2000. And the world trade of organic products is expected to reach USD 100 billion by 2012, as estimated by Organic Monitor, UK.

Worldwide 30.4 million hectares of agricultural land are managed organically

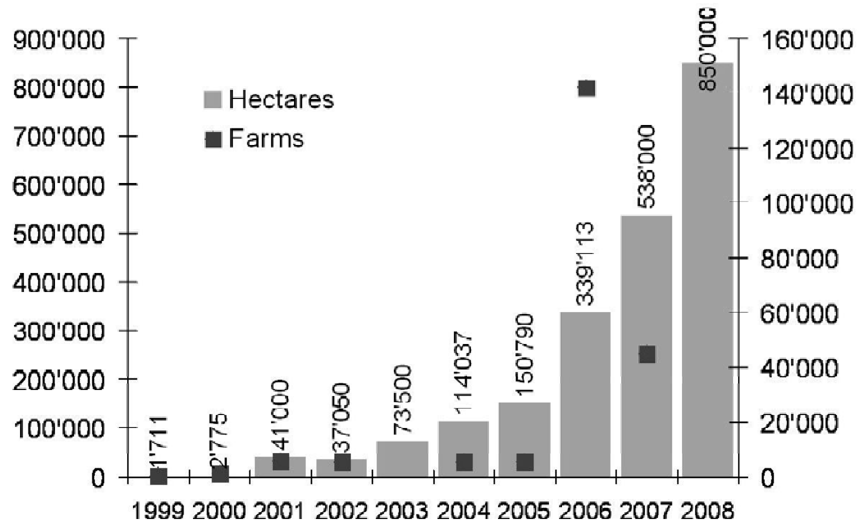


Development of organic agriculture in India

Organic farming is not new to Indian farming community. Organic farming is being successfully practiced in diverse climates by farmers and supported by entrepreneurs, policy makers and agricultural scientists.

Organic systems have been thriving in various parts of India for 20 to 25 years now, but no systemic and institutional work had happened until 2001. In 2001, the Government of India started the 'National Program on Organic Production' (NPOP). From 2005, the International Competence Centre for Organic Agriculture (ICCOA: www.iccoa.org) based in Bangalore started organizing India's biggest marketing platform, 'India Organic Trade Fairs' for organic and related eco-friendly products. By 2008, this fair has become one of the biggest events in this part of the world. Since then, India's organic sector has shown rapid progress.

In 2003 only 73,000 hectares of cultivated land was certified organic, and by 2007 it touched 5,38,000 ha. By 2008, this figure reached 8,65,000 ha and the latest data (from NCOF, Min. of Agri, Govt of India) shows that now the figure has crossed the one-million mark, *i.e.* 12,00,000 ha is organically managed in India. Even then, this constitutes only 0.8 % of the total cultivated area of 142 million hectares.



Development of the organic and in-conversion land area in India

Source: NCOF, APEDA, ICCOA. Graph: FiBL

Markets for organic products

India was exporting organic products worth 730 million Indian Rupees in 2003 and in 2007 this figure touched 3000 million Indian Rupees constituting almost 0.2 % of the organic world market. In parallel, the domestic market for organic products in India is also growing, and India's first market survey conducted by the International Competence Centre for Organic Agriculture ICCOA indicates a huge potential of over 15 billion Indian Rupees in the eight major cities alone.

Domestic markets in India (Nationwide survey)

ICCOA conducted a market study in 2006 in the top 8 metros, covering SEC A and SEC B segments of the consumers, which comprise about 5.3 % of the households. Over 3600 consumers among the target group were surveyed across four regions of the country.

The market study estimates the accessible market potential for organic foods in the top 8 metros of the country at Rs 562 crores, taking into account current purchase patterns of consumer in modern retail format. It is hypothesized that for some time to come organic foods will cater to the up market customer through these formats or dedicated organic retail stores. The overall market potential is estimated to be around Rs.1452 crores, the availability will however be a function of distribution-retail penetration and making the product available to the customer.

Strategies to tap the potential of NER for organic farming

The North East Region (NER) of India is the geographical region that spans along the Himalayan ranges with unique and distinct characteristics. This region comprises of eight states, *viz.* Assam, Sikkim, Arunachal Pradesh, Arunachal Pradesh, Nagaland, Manipur, Mizoram and Meghalaya. The total geographical area is 18,374 million ha (5.6% of the country) with 390 lakhs population. It is the 8th mega biodiversity hotspots with rich ethnicity and social set up. The region represents wide variation of climate ranging from cold to warm pre-humid and receives mean annual rainfall exceeding 2000 mm/ annum. The soils of the region are usually rich in organic matter and acidic to strongly acidic (pH 4.5 – 5.0) in reaction.

The NER is most uniquely suitable for organic farming with all its abundant natural resources and relative-freedom from chemical usage. It is estimated that about 18 mn ha of such land are available in the region. With the sizeable acreage under naturally organic / default organic cultivation in the NE region, India has tremendous potential to grow crops organically and emerge as a major supplier of organic products in the world organic market. And among the various crops, spices from the NER region are even more unique given the special micro-climates that make these spices the best in the world.

State wise area, production & productivity of spices in North East region

S. No.	State	Area ('000 ha)	Production ('000 t)	Productivity (t/ha)
1	Arunachal Pradesh	8.2	47.5	5.8
2	Assam	27.2	18.5	0.7
3	Manipur	8.7	7.7	0.9
4	Meghalaya	18.4	80.9	4.4
5	Mizoram	9.0	38.3	4.3
6	Nagaland	4.5	26.2	5.8
7	Sikkim	34.0	42.4	1.2
8	Tripura	4.5	9.4	2.1
	Total	**114.5**	**270.9**	**25.2**

Potentials of organic spices in NER

- Less use of fertilizers and pesticides in the region, which is far below the national average, makes the region very potential for organic cultivation of spices.
- Area under organic spice cultivation can be instantly recognized and the process of certification will be expedited.
- Currently a total area of 114500 ha is under spice cultivation. A major part of this area can be converted for organic farming.
- Vast traditional and indigenous knowledge systems (time tested indigenous farming systems & other indigenous practices) in agriculture and allied sectors can be exploited and utilized in NER.
- Vast resource of biomass, green manure and litter falls through forest species that can be utilized judiciously in organic farming.
- Varied agro-ecological zones (from foothill to alpine zone) offer great scope for production of different spice crops.

Important spices of North East and present price-scenario

S. No.	State	Spices	Approx. cost (Rs kg^{-1})
1	Arunachal Pradesh	Ginger Large cardamom Black pepper	18.00 65.00 65.00
2	Assam	Ginger Turmeric Black pepper	20.00 25.00 80-100
3	Manipur	Chilli Ginger Turmeric	40-90 0.00 225.00
4	Meghalaya	Ginger Turmeric Black pepper	20.00 25.00 65.00
5	Mizoram	Chilli Ginger Turmeric	40-90 20.00 25.00
6	Nagaland	Naga chilli (dry) Naga chilli (fresh) Ginger Cardamom Turmeric Black pepper	600-700 130-150 20.00 65-70 25.00 65.00
7	Sikkim	Cardamom(large) Ginger Turmeric	65-75 20.00 25.00
8	Tripura	Ginger Turmeric	20-25 25.00

Source: Directorate of Horticulture, NER states (2007-08)

Strategy for tapping the potential

Strategic planning is the managerial process of developing a viable fit between the organization's (in this case of the State or its Departments) objectives, skills, and resources and its changing market opportunities.

In the context of agriculture, the need of strategy is to analyze how the resources available for agriculture can be optimized with an objective of maximizing returns (*i.e.* gross production or net returns). Resources available in agriculture can be enlisted as:

i. Land (soil)

ii. Water (for irrigation and for livestock keeping)

iii. Labour (farmers family and external labour)

iv. Capital (especially for purchase of inputs for fertilization, pest control, *etc*)

And the returns, which should be maximized, are:

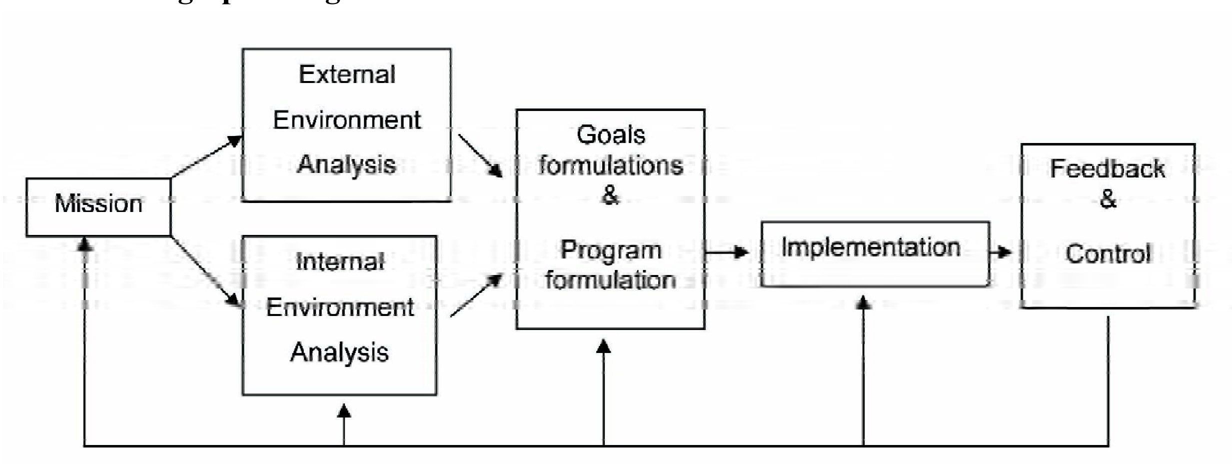
1. Production (of crop, fodder, milk *etc*)

2. Net income (factor of cost, prices, premium, logistics *etc*)

In the NER scenario, among the resources, the soil is healthy and conducive to organic cultivation; water is available as the rainfall is good and plenty at places. Here most are small and marginal farmers, therefore capital is scarce and labour is mostly from the family. For the optimum utilization of these resources, it is best to adopt a farming method that is less risk prone and more value-providing. Therefore, among the available options, organic agriculture is definitely the best option for these small and marginal farmers in NER. This is because all small and marginal farmers are struggling with the problems of ever increasing cost of cultivations due to cost of resources and the continual reduction in resource use efficiency (soil, water, labour, *etc*) due to non-strategic management of these resources.

The term strategy originally comes from the military during the early twentieth century. Today it is predominantly used by corporate, and also by the development sector as well as governments. For the corporate, the strategic planning starts with the headquarters preparing the statements of vision, mission, policy, goals, internal and external analysis, and establishing the framework for its division to prepare their plans, its implementation and control.

The strategic planning: The fundamental and classical model



Strategy and its implementation

I. Mission:

The mission is to make the NE region the biggest hub for cultivation and marketing of organic spices across the world.

II. Environment analysis

From the SWOT analysis, the external and internal environment can summarise as follows:

II a. External Environment (opportunities and threats)

There is a good potential export market for organic spices *viz.,* ginger, Naga chillies, large cardamom, black pepper and turmeric. Similarly the growing domestic market within India is also promising for these spices as well as a range of other organic products from the NER.

As productivity is linked to soil health, there is an opportunity to establish integrated input production units (e.g. vermicomposting, biocomposting, biofertilizers, biopesticides, animal feed units, *etc*) and also an integrated processing units for spices as well as other fruits and cereals*, etc* for the growing area under organic.

Among the threats, inadequate infrastructure and difficult logistics are the main ones. There are also market forces can constantly pose new challenges, e.g. organic spices form other parts, especially Kerala, Karnataka, *etc* can drive prices down. Additionally at some states in the NER, the political situation that does not support free enterprise could also be a threat.

II b. Internal environment (strengths and weakness)

The strengths of NER lies in the fact that traditionally this region is low on chemical usage, farmers have valuable traditional knowledge and agro climate suitable for high value crops (e.g. spices and MADPs). There is also tremendous potential to explore other horticultural and agronomic crops.

Lack of capacities, especially in management of crops and input use, is one of the major weaknesses of NER organics. The current focus is more on crop-mix for traditional food requirements. Lack of processing units, transportation/logistics, grading and value addition, microfinance for SHG/ farmers and support systems are some of the other weaknesses.

III. Formulation of goals and programs

The ultimate mandate of organic farming is to enhance the livelihoods of small and marginal farmers. Organic agriculture and market access are the best tools to achieve this goal. Organic agriculture can reduce cost of cultivation through sustainable practices thereby improving the net income of farmers.

In order to formulate programs towards achieving such goals, we intend to integrate the following activities/ programs in the NER:

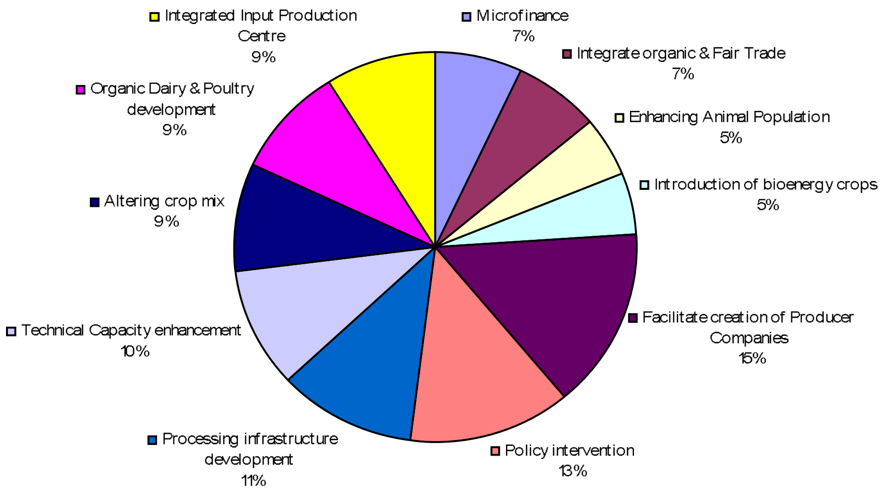
- Enhancing Capacities of farmers and group them into clusters.
- Organizing value-addition opportunities in these clusters.
- Facilitate scale economies for critical mass.
- Encourage public-private partnerships (PPP).
- Facilitate Government support and schemes across the value-chain
- Work towards safeguarding organic & ecological integrity

IV. Implementation

For the implementation of strategy it is recommended to have clear intervention areas that should be facilitated through Govt Depts, NGOs and farmer groups. Based on the environmental analysis and the SWOT analysis, eleven interventions are identified for unleashing the organic potential of NER. These interventions are presented in the form of a pie chart (given below) with certain percentage values allocated to indicate its degree of importance.

Suggested interventions as a percent of total activities for unleashing the organic potential in NER

The above-said micro interventions can be further categorized into broader components for strategic focus on a time period basis.



A. Short to medium term (immediate to 3 years time period) intervention areas

i. Capacity building

ii. Establishing cluster and producer company

iii. Establishing small units for inputs and processing

iv. Strategic partnerships between Govt programs, NGOs and the private sector

B. Long term (above 3 years) intervention areas

i. Help establish medium to large scale infrastructure facilities

ii. Policy intervention through Govt support schemes.

iii. PPP models (with producer companies scaling up operations).

V. Feedback and control

The entire strategic plan is continually given feedback from existing activities/ components, so that corrections and/or improvements can be incorporated on a periodic basis. This ensures that the plan stays on course for delivering the targeted goals efficiently and punctually.

For this monitoring role, a Cross Functional Team (CFT) comprising of members from Govt Dept, projects, its NGO partner organizations and some select consultants (expertise from organic agribusiness, including production, processing and marketing) can be recommended. This CFT can give feedback and recommendations, based on which NER organic program can control the strategy plan effectively.

Conclusion

The strategy for NE regions should be to work with organic spice farmers/groups at the micro-level in the direction of building their capacities continually. Government should bring such partners together to form projects that is recommended by the farmers and their organizations, and managed by professionals hired for their expertise in marketing, value addition and other functions. In the future, such projects will result in the formation of producer company/companies which becomes competent in taking up more and more roles and grow; and in turn make the farmers' livelihood sustainable and much improved.

The long-term strategy is to work at the macro-level in the direction of policy advocacy with the government of the state/region. This function can be taken up with close partnership with other organizations/associations working with similar mandate, e.g. developing state policy for organic agriculture, getting government subsidies and schemes for farmers, getting tax sops for exports of organic products, coordination and extension of research works in organic sector, *etc.*

Future projections for India's organic sector

The area under organic cultivation is likely to cross the two million hectare mark by 2012, according to National Centre for Organic Farming (NCOF) under the Union Ministry of Agriculture and International Competence Centre for Organic Agriculture ICCOA. This constitutes a major growth from the present 12,00,000 hectares.

The market for organic produce from and within India is expected to grow six to seven times in the next five years. India may reach 40 billion Indian Rupees (Rs. 4000 crores) by 2012, thereby reaching about 2.5 % of the current global trade value:

- Exports from India reaches about Rs. 2500 crores.
- Domestic markets within India reach about Rs. 1500 crores.

	2003	2009	2012
Organic area	76000 hectares of cultivated area	12,00,000 hectares= 0.8 % of the agricultural land	2 million hectares =1.5 % of the agricultural land
Exports from India	73 crores Indian Rupees	350 crores Indian Rupees	2500 crores billion Indian Rupees
Share of global market		0.2 %	2.5 %
Domestic market		Rs. 100 crores	Rs.1500 crores
Total turnover with organic products (domestic & exports)		Rs. 450 crores	Rs. 4000 crores

Developmental programmes on spices for NE states - Need and focus

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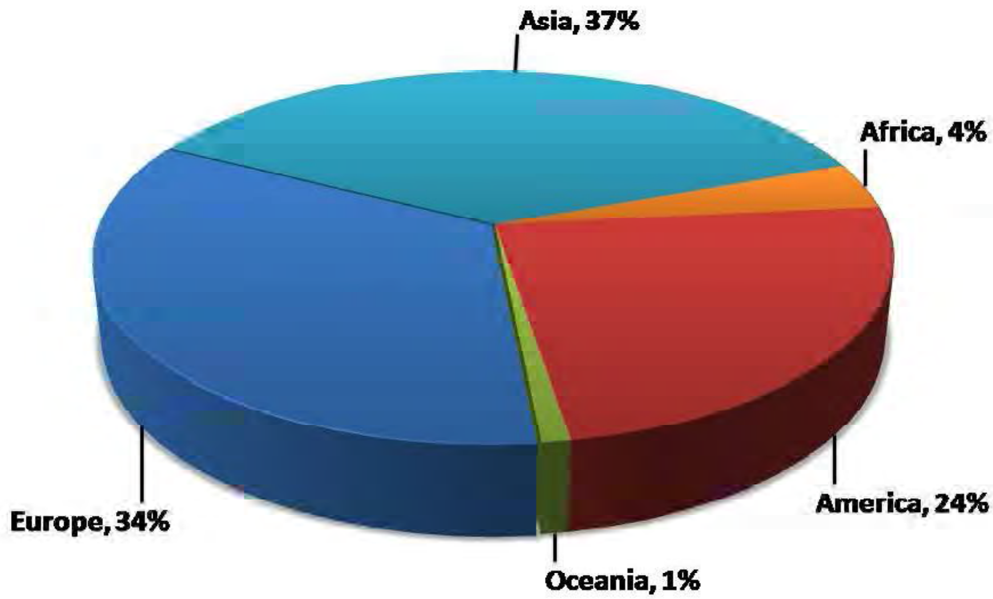
Introduction

India is known as "The Home of Spices". There is no country in the world that produces as many kinds of spices as India. The climate of the country is suitable for almost all spices. Spices constitute an important group of agricultural commodities which are virtually indispensible in the culinary art. In India, spices are important commercial crops from the point of view of both domestic consumption and export. Besides, huge quantities of spices are also being consumed within the country for flavouring foods and also use in medicine, pharmaceuticals, perfumery, cosmetics and several other industries.

Out of the 109 spices listed by the International Organization for Standardization (ISO), India produces as many as 75 spices in its various agro-climatic regions. The area and production of spices in India was 2647637 ha and 46, 63,117 t respectively in 2006-07 (Spices Board, India). The spices that India can grow in abundant quantities are black pepper, ginger, turmeric, chilli, cardamom, celery, fenugreek, fennel, coriander, cumin, dill, ajowan, cinnamon, cassia, clove, nutmeg and mace, saffron, garlic, aniseed, asafoetida, basil, bay leaf, cambodge, caraway, mint, mustard, rosemary, saffron, sage, star anise, tejpat, thyme, vanilla *etc*. The global market for spices is estimated to be around US $ 4.60 trillion. As per the trade statistics by International Trade Centre (ITC), value of global spices import has gone up from US $ 1.60 billion in 1996 to US $ 2.97 billion in 2004. During the period 200 to 2004, the value of spices import increased on an average, by 1.9% per year, whereas the volume increased by 5.9%. Except whole spices, India exports spice mix, spice oil, oleoresin, spices powder, spice blends, freeze dried green pepper, dehydrated pepper, spice in brine, spice extract and other value added products like curcumin and capsaicin to more than 120 countries in the world. But few countries dominate the importers' list for Indian spices by virtue of the quantity imported. Region-wise export data for various periods indicated that the Asian zone is fast emerging as the major destination for Indian spices with 59.79% in quantity and 42.07% in value followed by American zone and European Union countries. However, India has lost its stable market in the eastern Europe (other European countries) after the political changes there.



Market share (qty.) of major spice importing areas in the world, 2006

North eastern states of India *viz.,* Arunachal Pradesh, Assam, Manipur, Mizoram, Nagaland, Sikkim and Tripura offer immense potential for large scale cultivation spices. It is estimated that the region can create exportable surpluses at competitive prices so that the top slot occupied by the country in the international spice market would be maintained. It also gives large scale employment opportunities and wealth creation in the area. North eastern states are well suited for the cultivation organic spices particularly turmeric, ginger, chilli and cardamom *etc*. The consumption of inorganic fertilizers and pesticides in this part is negligible as compared to rest of the country.

Table 1. Area and production of major spices in North eastern states

State/Spice	2002 - 03		2006 - 07	
	Area (ha.)	Prodn (t)	Area (ha.)	Prodn (t)
Arunachal Pradesh				
Chilli	1610	2340	1900	3000
Ginger	4450	32330	5500	40000
Turmeric	510	1950	600	2300
Total	**6570**	**36620**	**8000**	**45300**
Assam				
Chilli	14890	9780	15450	9980
Ginger	17970	115230	18180	123990
Turmeric	12070	8320	11740	8540
Corriander	19900	16600	20210	18970

Garlic	6690	21970	6710	22180
Total	**71520**	**171900**	**72290**	**183660**
Manipur				
Chilli	10140	6080	8910	5340
Ginger	1270	2100	4270	7050
Turmeric	330	230	400	280
Total	**11740**	**8410**	**13580**	**12670**
Meghalaya				
Chilli	1850	1200	1870	1380
Ginger	7920	45650	9640	57280
Turmeric	1540	8680	1910	14350
Tejpat	6140	15961	6140	15961
Total	**17450**	**71491**	**19560**	**88971**
Mizoram				
Chilli	1400	1300	990	990
Ginger	5100	31140	2950	17220
Turmeric	290	2790	1740	24460
Garlic	50	80	40	50
Total	**6840**	**35310**	**5720**	**42720**
Nagaland				
Pepper	370	260	7	7
Chilli	810	7994	860	976
Ginger	1020	13450	1225	12250
Turmeric	610	3599	18	62
Garlic	130	780	112	148
Total	**2940**	**26083**	**2222**	**13443**
Sikkim				
Cardamom(Large)	26734	4650	26734	3833
Ginger	4950	23610	6680	35630
Turmeric	430	1300	580	1920
Total	**32114**	**29560**	**33994**	**41383**
Tripura				
Chilli	1590	5560	1840	2085
Ginger	1360	5450	1410	4170
Turmeric	1340	5910	1150	3380
Total	**4290**	**16920**	**4400**	**9635**
NE Total	**153464**	**396294**	**159766**	**437782**
India Total	**2536033**	**3032052**	**2647637**	**4663117**

Source: Spices Board, India

Lakadong turmeric, bird eye chilli and ginger are spices of high intrinsic value in the North east. The region has vast potential to contribute its share to the export basket of spices from India (Table 2).

Table 2. Export potential of North eastern states

Spices	End product	World market	
		Qty. (t)	Value (Rs. Crores)
Birds Eye Chilli	Capsaicin	2000	110
Chilli	Oleoresin	2500	300
Turmeric	Curcumin	300	35
Ginger	Oil	30	14
	Oleoresin	250	28
	In brine	100000	500
	Candy	18000	350

Source: Spices Board, India

Role of Spices Board of India

The Spices Board of India has been entrusted with the promotion of spice crops in the country and it has taken up number of programmes for promotion of spice crops in the North eastern states. The programmes are as given below.

Developmental programmes of Spices Board in North East region:

- Large cardamom development
- Construction of large cardamom curing houses
- Production of organic pepper
- Development of herbal spices
- Setting up of vermicompost units
- Organic cultivation of Lakadong turmeric
- Organic cultivation of ginger
- Supply of driers for drying ginger and turmeric
- Construction of ware house cum cold storages
- Training for officers and farmers in North eastern states
- Training of farmers of North eastern states
- Extension advisory services
- Recognition of large cardamom growers
- Rapid multiplication units for North eastern Region

Besides, these programmes the board has also taken up market promotion scheme for high-tech spice processing and also created equity fund to promote spice processing in the region. No doubt, the Board is providing yeomen's service for promoting spice cultivation in this part of the country. But, these efforts and the programmes will not be sufficient to take the improved spices production technology to the maximum number of growers. The need of the hour is to promote public-private partnership so that the production technology of important spices is taken to every nook and corner of North eastern region.

Role of ICAR Research Complex for NEH Region

ICAR Research Complex for NEH Region has initiated research programmes on spice crops *viz.,* turmeric, ginger, king chilli *etc*. The emphasis is being given on evolving high yielding varieties of turmeric, collection, evaluation, maintenance and molecular characterization of turmeric, ginger and king chilli, off season production technology of king chilli and value addition in ginger. At the same time training are being imparted to the farmers on improved package of practices of these crops. Front line demonstrations on turmeric and king chilli are being conducted under Technology Mission (MM I) and NAIP to popularize these crops. The institute is also giving consultancy to NGOs on organic turmeric cultivation. Information on these crops is being transferred to the stakeholders through leaflets and pamphlets *etc.*

Research need

Productivity of spice crops in North east region is very low despite their importance and economic output. Considerable variability is available. There is need to work on resistance breeding and breeding for abiotic stresses. The recent trend in global spice trade is demand for high quality varieties in tune with international demand for diversified uses (medicinal and neutraceutical). Location specific organic production package for select crops has to be developed and popularized. Promotional activities are needed for organic spice production in the region to capture the growing world organic market. Research and development programmes on value addition and proper post harvest handling of the produce need to be taken up. In order to get momentum in spices research, Assam (for ginger), Manipur (for turmeric, ginger and chilli) and Nagaland (for turmeric, ginger and King chilli) need to be included as either co-opting or voluntary centre of AICRP on Spices.

Spices development in North eastern region: SWOT analysis

Strength

1. Rich agricultural resources *viz*., land, rain, water, vegetation *etc.*
2. Abundance of literate manpower *viz*., labourer, women worker, unemployed youth etc.
3. Adequate rainfall during monsoon
4. Rich in turmeric and ginger germplasm
5. Nearly 80% of existing potential area for spice crops is yet to be exploited
6. Sufficient expertise from ICAR, Spices Board and allied departments
7. Financial support from Spices Board and other government agencies is available

Weakness

1. Poor socio-economic condition of majority of farming community
2. Lack of knowledge regarding improve package of practices
3. Poor transport facility
4. Lack of marketing and storage facility
5. Gap between demand and supply of quality planting materials
6. Slow pace in adoption of technology
7. Lack of proper extension network

8. Limited credit facilities
9. High capital investment for organic certification
10. Improper functioning of Growers' cooperatives
11. Low productivity and high production cost make spices costlier in the world market
12. Uneconomic and senile genetic stock, incidence of diseases like *Phytophthora* foot rot in pepper, viral diseases in cardamom and chilli, soft rot and bacterial wilt in ginger and turmeric.

Opportunities

1. Vast scope for area expansion under spices particularly turmeric, ginger, cardamom and King chilli
2. Scope for increasing productivity
3. Scope for area expansion under organic spices
4. Exploration of natural resources
5. Establishment of nursery, rapid multiplication units
6. Growing market for value added products
7. Development of spice processing industries
8. Scope for low cost farm mechanization applicable to hill farming

Threat

1. Land degradation due to inadequate soil and water conservation measures
2. Severe water scarcity during winter months
3. Ecological degradation due to shifting cultivation
4. Growing interest of rural youth towards off-farm jobs
5. Ever increasing market competition

Future strategies

1. Identifying sources of resistance from wild species and exploiting them to develop resistant/tolerant lines; alternatively, developing transgenics against the viruses
2. Morphological, molecular and qualitative characterization of indigenous spice germplasm of North east India
3. Complete characterization of the viruses in cardamom and development of diagnostics against them
4. Establishment of certified nursery enabled with indexing facility
5. Establishment of tissue culture laboratory for production of disease free planting materials of ginger, turmeric and cardamom *etc.*
6. Integration of effective, economical and practically feasible components to develop INM and IPM packages
7. Developing different cropping models taking spices as a component integrated with soil and water conservation measures
8. Development of location specific organic production package for different spices
9. Popularization of technology like mulching, INM, IPM, off season cultivation *etc.*
10. Research as well as training on low cost marketable technology for value added product

11. Installation of effective extension network for transfer of technology on scientific management practices, post harvest handling, processing and marketing of spice crops
12. Development of basic infrastructural facilities like transport and storage
13. Establishment of Spices Park and Quality Control Laboratory in collaboration with ICAR
14. Establishment of regulated market for spices
15. Development community based spice processing industries particularly in ginger and turmeric
16. Development of ICT Centre or Information kiosk at remote area
17. Government subsidy on planting materials and other agricultural inputs
18. Ensuring financial assistance for organic certification.
19. Strengthening Growers' cooperatives, SHGs engaged in spice cultivation
20. Formulation of bankable projects to the stakeholder for spices cultivation
21. Strategic advertising by using print, electronic and web media for marketing and export promotion of North east Spices
22. Developing multimedia module and publication in local languages on cultivation, post harvest handling and value addition of spices for effective transfer of technology
23. Coordinated planning for development of agri-export zones in Sikkim for cardamom, Meghalaya for turmeric, Manipur and Nagaland for king chilli.
24. Propagation of Public-Private-People Partnership in relation to organic spice production and spices based agro-industries
25. Strengthening of proper coordination between Indian Society for Spices, Spices Board of India and ICAR along with allied department of State Government and other organizations like DASD, APEDA, NABARD, NGOs, Other funding agencies *etc.*

North East Consortium for Development of Spices (NECDS)

For integrated research and development of spices in North eastern India, a common platform is urgently required, where action plan for need based research and developmental activities on spices will be formulated, implemented and monitored. The objective can be achieved by constituting the North east Consortium for Development of Spices (NECDS). IISR and ICAR Complex will take the responsibility of conducting research, whereas Spices Board and line departments of State Governments will implement the developmental programmes. Indian Society for Spices will act as coordinating agent between the partner organizations. Progressive spice growers, Different funding agencies (like NABARD), NGOs, other institutes (DASD, ICRI, AAU, CAU, CIH *etc*.) and spices based industries will be the member of this consortium.

Conclusion

Despite the various schemes and programmes of the government for popularization of spice crops, a lot needs to be done. The cultivation technology of different spice crops has to be taken to farmers. For this purpose, the extension machinery has to be geared up. The per hectare productivity is low and the cost of cultivation is high in India especially in North Eastern Region. The gap between the potential yield and the yield obtained by the framers needs to be bridged to make cultivation of spice crops remunerative. Awareness among the growers needs to be grown regarding commercial cultivation of spices for earning more profit Moreover, wide publicity needs to be given to the government schemes for promotion of spices through print and electronic media. Thus a concerted effort of all the agencies will help the North eastern region in finding an important place in the spice map of India.

Development and post harvest improvement schemes of Spices Board implemented during XI plan in NE region

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During XI Plan the following schemes are being implemented in NE region towards production and productivity improvement of large cardamom and post harvest improvement of spices.

1. Scheme for special purpose fund for replantation and rejuvenation of large cardamom plantations in Sikkim.
2. Scheme for export oriented production and post harvest improvement of spices implemented in NE states including Sikkim.

Programmes envisaged and activity components for achieving the objectives under the schemes and the eligibility fixed and assistance available to growers during XI Plan are detailed below.

I. Scheme for special purpose fund for replantation and rejuvenation of large cardamom plantations in Sikkim

The objective of the scheme is to improve production and productivity through replanting/rejuvenation of the old and uneconomic plantations of cardamom (large) in Sikkim and Darjeeling District of West Bengal. Production and distribution of disease free, healthy and quality planting materials are also taken up through certified nurseries opened in growers' field with the technical supervision of the officers of the Board. Beneficiaries selected under the scheme are given financial assistance as cash subsidy on successful completion of the following programmes in their plantations.

(i) Replanting

This programme is intended to encourage small and marginal growers of large cardamom to take up replantation of old, senile and uneconomic plantations in Sikkim and Darjeeling District of West Bengal using disease free and healthy planting materials. Subsidy will be provided in two annual installments.

Eligibility criteria and subsidy provided under replanting are given below:

Eligibility	% of Subsidy	Subsidy (Rs ha^{-1})		Total subsidy (Rs ha^{-1})
		1st Installment	2nd Installment	
Up to 4 ha	33%	5900.00	6600.00	12,500.00
4 to 8 ha	25%	4500.00	5000.00	9500.00

(ii) Rejuvenation

Under rejuvenation programme, poor yielding plants in the existing plantations will be identified and removed and the gaps thus formed will be filled with quality planting material. In addition to this, gap filling, scientific plant protection operations, fertilizer application, inter-cultural operations, irrigation and other good agricultural practices as per the recommended package of practices will be adopted. This programme is implemented in the States of Sikkim and Darjeeling District of West Bengal for cardamom (large) for small and marginal growers of cardamom having holdings up to 4 ha.

Subsidy provided under rejuvenation is given below:

(Eligibility up to 4 ha only)

State	% of Subsidy	Amount (Rs ha^{-1})	
Sikkim and Darjeeling	33%	5,808.00	Subsidy paid in a single installment

(iii) Planting material production

High yielding healthy and quality planting material of cardamom is mainly produced through certified nurseries opened in growers' field under the guidance and supervision of Board's technical personnel. Subsidy offered per planting material produced through certified nurseries is Rs.1.15 per sucker.

II. Scheme for export oriented production and post harvest improvement of spices implemented in NE states including Sikkim.

Chilli, ginger and turmeric are extensively cultivated in the North Eastern states. Some of the varieties in that area *viz.,* China, Nadia and Thingpur in ginger, Lakadong in turmeric and birds eye in chilli are considered rich in oil, curcumin content and capsaicin content respectively. The agro–climatic conditions prevailing in NE states are suitable for cultivation of pepper and large cardamom and these crops can be profitably grown in these regions to create exportable surplus. There is great scope in promoting production of organic spices in these states by popularizing organic farming practices among the growers so that sufficient quantity of organic spices can be made available for exports.

Hence the following programmes are being implemented:

(i) Large cardamom development (new planting)

Large cardamom cultivation is presently concentrated in Sikkim and North West Bengal. The agro-climatic conditions prevailing in other NE states are suitable for cultivation of large cardamom. The programme envisages extending large cardamom cultivation to these areas by providing financial assistance by way of subsidy. Production of disease free healthy planting material through certified nurseries is also an activity component of the programme.

Eligibility: Growers having holding upto 8 ha.

Subsidy: Rs. 17500/ ha towards 62.5% of the cost of planting material and maintenance during gestation period disbursable in two annual installments of Rs.15000/- and Rs.2500/- respectively.

(ii) Rain water harvesting devices

The Board has started implementing the programme of rain water harvesting in the state of Sikkim and Darjeeling District of West Bengal for providing irrigation to large cardamom plantations in summer months as done in the case of small cardamom plantations of South India which is proposed to be replicated in other North Eastern states also.

Eligibility: Large cardamom growers having holding upto 8 ha.

Subsidy: 33.33% of the actual cost or Rs. 8000/- whichever is less per 200 cu. Mt. capacity device (Estimated cost Rs. 24000/- ; Rs. 16000/- for excavation work and Rs. 8000/- for silpaulin sheets).

(iii) Construction of curing houses: Modified bhatti

Large cardamom growers traditionally cure their cardamom in the locally fabricated bhattis. This does not ensure proper drying and ideal colour in the cured cardamom. Board had introduced and evaluated a number of curing methods using different fuels in the state of Sikkim and has selected a modified system which gives good quality. Spices Board proposes to popularize this method in other North Eastern States also.

Eligibility: Large cardamom growers having area upto 4 ha.

Subsidy: Rs.5000/- for 200 kg capacity and Rs.9000/- for 400 kg capacity bhattis towards 33.33% and 36% of the cost whichever is less respectively.

(iv) Organic cultivation of pepper

This programme is mainly implemented in the states of Assam, Arunachal Pradesh Manipur and Meghalaya. Organic inputs required will be multiplied with the assistance of Non Governmental agencies and supplied to the growers. The required planting materials will be produced and supplied through rapid multiplication units raised by Governmental/Non-Governmental agencies under the technical guidance from Spices Board. Organic certification will be facilitated by the Board.

Eligibility: Growers having area upto 8 ha.

Subsidy: 33 % of the cost subject to a maximum of Rs.15000/- per hectare in two annual installments of Rs.13000/- and Rs.2000/-

(v) Organic cultivation of Lakadong turmeric

Lakadong turmeric is having high curcumin content (5.5%) and hence suitable for extraction of colour. This variety is highly location specific and is very much preferred by the exporters for extraction of the colour. Hence, organic production of Lakadong turmeric in Meghalaya and other North Eastern states is supported. Availability of quality planting materials is a major limiting factor in its production. This programme is implemented with the assistance of Government/Non-Governmental agencies.

Eligibility: Growers having area upto 8 ha.

Subsidy: Rs.12500/- per hectare is provided as subsidy towards 50% of the cost of planting material.

(vi) Organic cultivation of ginger

Ginger varieties like Nadia and China are having higher oil content and hence suitable for export. Organic production of these varieties in NE states is proposed to be promoted. The programme will be implemented with the assistance of Governmental/Non– Governmental agencies.

Eligibility: Growers having area upto 8 ha.

Subsidy: Rs.12500/- per hectare is provided as subsidy towards 50% of the cost of planting material.

vii) Training of officers and farmers of NE states

Board arranges training programmes for the officers of the state Agriculture/ Horticulture departments and selected growers of North Eastern states on the recent advances in spices cultivation, harvest and post harvest operations in elite plantations, research stations like IISR, ICRI, KAU, NGOs, spice processing units of South India and Quality Evaluation Laboratory of Spices Board. Training of officers will be conducted in alternate years. Entire expense for travel and stay, DA of the trainees, local transport *etc.* will be met by Spices Board.

Out of the above programmes under the scheme for export oriented production and post harvest improvement of spices, rain water harvesting and construction of modified bhatties are implemented in Sikkim also. Other programmes are only intended for states other than Sikkim.

Seed spices production for export - An insight to safe practices

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The seed spices are the important export oriented commodities and are source of foreign exchange earnings to the country. The prominent seed spices are coriander, cumin, fennel, fenugreek, ajowan, dill, celery, anise, caraway and nigella. The seed spices cultivation is gaining importance due to their profitability, short duration nature and greater potential to grow in low rainfall areas in semi-arid to arid regions. Today, India is the world's largest producer, consumer and exporter of seed spices. The usage of spices by consumers is increasing worldwide because they are completely natural, rather than artificial additives for seasoning and flavouring of foods. Thus an increasing trend in export of seed spices has been observed in the last decade particularly to Asian, Latin American and Middle eastern developing countries. The global demand estimated for seed spices world wide is 150000 tons, of which at present our country is able to supply about 82150 tons annually, which is 55 percent of the total demand.

The developed countries USA, Japan, Canada, Australia and Europe are the major market for Indian seed spices and have their own stringent food laws and regulations. The spices produced for export purpose should conform to both intrinsic and extrinsic quality measures. The extrinsic qualities mainly are seed size, shape, luster, and cleanliness from dead insects, animal excreta, hair and other foreign materials. The intrinsic qualities are high essential oil content, free from pesticide residue, low aflatoxin level and microbial load. India is exporting a good amount of seed spices and there is scope of increasing export to two times if quality aspect is considered at paramount as per international standards and requirements of the importing countries. The emergence of stringent quality parameters by the importing countries in post WTO trading has necessitated to export safe food.

The physical, biological and chemical hazards in seed spices can be minimized by proper pre- and post harvest management practices. The management of physical deterioration is rather easy as the simple post harvest handling operations are involved, whereas the management of bio-deterioration due to microbes and store grain pests is more complex. The management strategy for bio-deterioration of seed spices has not received attention in the past and the related information is not available sufficiently so far to maintain the stringent quality standard of produce meant for export purpose exclusively. Therefore, many cases of denial of entry on such non-tariff grounds have been reported by Spices Board, the ultimate agency responsible for promotion, support and verification of quality for export of spices from India.

Factors affecting seed spices export quality:

In order to maintain the quality of seed spices, certain pre- and post-harvest factors identified are enumerated and are detailed here.

1. Pre-harvest factors affecting post harvest storage and quality
2. Post harvest handling and processing factors

3. Storage conditions

4. Bio-deterioration during storage and transport

   4a) Microbial deterioration

   4b) Storage pests deterioration

1. Pre-harvest factors

The seed spices quality relates specifically to size, appearance, colour, flavour and aroma characteristics. Moisture, volatile oil, oleoresin content and major chemical constituents present in seed spices determine the intrinsic quality. These qualities are greatly influenced by the variety, agro-climatic conditions existing in the area of production, time of sowing, nutrients and irrigations, control of insect-pests and diseases, time/stage of harvest and method of harvesting. These pre-harvest factors contribute significantly towards storage life and quality of seed spices. The pre-harvest factors are largely responsible for pesticide and heavy metals residue in the seed and hence assume importance for growing of seed spices crops under the organic production system involving bio-control measures for control of various diseases and insect-pests at field level. The another important point is to decide the appropriate stage of harvest, so that maximum recovery of essential oil and desired quality could be ascertained. The stage of harvesting is one of the most important factors which determine the quality of produce and varies with seed spices crops.

Two most important quality components largely based on pre-harvest factors are:

- Detection of pesticide residue in seed spices
- Detection of heavy metals in seed spices

The demand for safe food globally has necessitated strict quality control of food products, even though the supply of absolutely safe food is practically impossible. Pesticide residues (organo chloride, organo phosphorus and pyrethroid), aflatoxin, heavy metals (arsenic, chromium, cadmium, lead, zinc and copper) and solvent residues are the micro contaminants of concern to the spice industry. But with crop management practices and post harvest processing seed spices can be kept to an absolute minimum.

2. Post harvest handling and processing factors

The post harvest handling activities start after the harvesting of crop, first with drying of freshly harvested crop, threshing, seed drying, cleaning, grading, packing and transportation of whole seed to market, processing plant or storage place. The quality of seed also depends upon the practices adopted in processing, packaging, storing and transportation of value added processed items. Injudicious harvest and inappropriate post harvest operations are the potential threat to quality deterioration.

Processing of seed spices consist of drying and cleaning. Sun drying is done on clean cemented yards or other suitable clean surfaces. The material is occasionally turned over to ensure uniform drying. The material is heaped and covered during night time to ensure protection from rain. There is obviously a high risk of contamination by dust and dirt occurring if the raw materials are laid out in the sun. Solar and powered dryers protect against contamination and are thus strongly recommended. It should be noted that fan driven dryers may suck in fine dust particles in dusty areas. In very dusty areas, powered dryers may need a muslin filter over the air inlet. During the early stages of drying, conditions in the dryer (high humidity and moderate temperature) are ideal for the growth of micro-organisms. The quicker the drying time the better the final microbial quality of the product. Drying rates may be increased in two ways: by increasing the air flow and by increasing the air temperature. However temperatures should not be too high as they cause damage to the product. This is particularly true of spices as there is the risk of losing delicate flavours or colours. No colouring material should be used to improve the appearance of the product as chemicals and artificial colours are highly objected to by the importing countries.

The moisture content at the time of harvesting for seed spices crops is never more than 18%, therefore freshly harvesting crop is kept in the field for 2-3 days to bring moisture level to at least 15 %. Thereafter the harvested crop is threshed and now the shadow drying for 8-10 days is recommended for bringing the seed moisture level to around 11-12%.

Much of the contamination in spices is due to microbial infection occurring mostly during the process of sun drying or through soil or air. In order to avoid dependence on weather and to reduce the microbial contaminations, mechanical drying may be used. The spices coming directly from farm contain many types of impurities. The types, shapes, varieties, characteristics of all these impurities are of varied nature and cannot be separated by one process or by one machine. The calibration of such machines can be done with context to seed spices crops for overcoming such impurities through mechanisation. Such apparatus/equipments which could prove useful are solar driers, spiral separator, magnet drum/pulley, magnet seed separator, electronic colour sorters, gravity separator/destoner and mechanical graders. The spices need protection against light, moisture and oxygen for maintenance of seed quality by minimizing the microbial level and retention of spices peculiar flavour for longer time. Separation is based on difference in physical properties between desirable seed and undesirable material. Dried seeds are cleaned to get rid of extraneous matter.

3. Storage conditions and packing

There is a general trend of selling seed spices crops by the growers in the same cropping season, owing to shortage of adequate and appropriate storage conditions. However excess stocks available at traders' level may require long term storage before marketing. The whole dried seeds are usually packed into sacks and stored in a cooled dried room at 25-28^{o}C room temperature, the critical moisture level and relative humidity more than 12% and 70%, respectively.

After drying, the material should be packed quickly into clean heavy-gauge plastic sacks to avoid any moisture pick-up. Workers should not directly handle the food, but use scoops or clean gloves. Sacks should be labelled and dated. Dried products must also be stored under proper conditions, off the floor on wooden pallets and away from walls so that the store-room may be kept clean. The store should be regularly inspected and cleaned and stock should be used in rotation. The type of packaging needed for herbs and spices depends on the product, the intended market and the types of climate that the food will be exposed to. During storage it is necessary to take care of temperature and relative humidity. The studies are required to be conducted for ascertaining the suitable packaging media for storing the seeds of seed spices with better quality for longer period and suitable temperature ranges and RH levels for safe storage.

4. Bio-deterioration during storage and transport

Among the various causes, microbial spoilage and damage due to store grain pests are largely responsible for seed spices deterioration, which includes fungi, bacteria, yeast, moulds and store grain pests during storage and transport. These days bio-deterioration is the biggest problem before the seed spices exporters, because of failure to meet out the stringent quality standards. Consequently the consignments are rejected.

a) Bio-deterioration due to storage fungi

After harvesting, microflora usually takes entry during handling and processing and later become active during storage. Storage fungi are able to freq without free water at RH ranging from 70-90% (Neergaard, 1986). Storage fungi mainly are the species of *Aspergillus*, *Penicillium*, *Fusarium*, mucor and rhizopus. The storage fungi deteriorate the quality by bringing out biochemical changes and thereby leading to loss in constituents and weight in seed. Besides, there is development of mycotoxins in the seeds, which makes the spices unfit for consumption and export.

The seed spices crops *viz*. coriander, cumin, fennel, fenugreek, ajowan are good bases for mycotoxin development. Moreover Indian climate is conducive for fungal growth, proliferation and elaboration of mycotoxins development. The Spices Board has reported incidence of *Aspergillus flavus, Aspergillus parasiticus,* *Aspergillus ochraceus, Penicillium citrinum, and Fusarium moniliforma* in most of the samples, responsible for producing toxic compounds (aflatoxin) under favourable condition of temperature and humidity. The injurious mycotoxins reported with infection of above fungi are aflatoxins (B1, B2, G1 and G2), ochratoxin, citrinin and zearalenove. Besides aflatoxin, cyclopiazonic acid and sterigmatocystin are also the toxic products of strain *Aspergillus flavus*. Natural contamination of aflatoxins B1 and G1 has been reported to 11-48 µg/kg in seed spices (Singh *et al* 1991).

b) Bio-deterioration due to storage pests

Insects and mites are known to cause bio-deterioration of seed spices grain through physical damage and nutrient losses caused by their activity. Nearly, 17-25% losses are reported in seed spices. Heavy infection causes severe losses/complete loss *i.e.* by converting seed into powder form. They also bring about mould colonization. Such infestations occurs at different temperatures below 17^0C, there is no insect infestation but mite infestations can occur between 3-30^0C and above 12% moisture content. Increase in broken spices accounts for considerable reduction in storage life, sometimes to the magnitude of one tenth with the growth moulds.

Seeds are invariably attacked by various types of insect-pests during storage. In most of the cases insect infestation comes from field and the other source is the store house. The insect infestation generally remains undetected until adults are seen. This occurs when there are internal feeders. By the time these adults are detected much of the seeds are already damaged. Most of seed spices belong to the family *Apiaceae* and the storage pests damaging in store are common for fennel, coriander, cumin, ajowan, anise, caraway, celery and are described here.

- Drug store beetle (*Stegobium paniceum* Linn.)
- Cigarette beetle syn. Tobacco Beetle (*Lasioderma serricornae* Fabricius)
- Rust red flour beetle (*Tribolium castaneum* Herbst, *Tribolium confusum* Duval)
- Fig moth syn. Almond moth (*Cadra cautella* syn. *Ephestia cautella* Walk.)
- Rice moth (*Corcyra cephalonica* Staint.)
- Seed spices midge (*Systole albipennis* Walker, *Systole coriandari* Nikol.)

Good production practices

1. Recommended seed spices agronomic practices should be followed. A due care on selection of suitable variety and seed from reliable sources preferably possessing resistance/tolerance to diseases.
2. The approach of integrated pest management (IPM) and integrated disease management (IDM) should be followed.
3. Integrated nutrient management and integrated weed management strategies be followed.
4. The irrigation scheduling is necessary to be followed as it has relation with occurrence of few diseases such as cumin blight, wilts in coriander, cumin, powdery mildew in all seed spices crops.
5. Pesticides which are banned should not be used in seed spices. In case the crop is affected by diseases or infested by pests fungicides or insecticides should be applied under the supervision of experts and at the dosage and schedule recommended.
6. In order to reduce presence of heavy metals, it is necessary to use safe water for irrigation purpose. The sewerage waste and water should be totally avoided for application in farm soils.

Good processing, storage and hygiene practices:

1. There is obviously a high risk of contamination by dust and dirt occurring if the raw materials are laid out in the sun. Solar and powered dryers protect against contamination and are thus strongly recommended.

It should be noted that fan driven dryers may suck in fine dust particles in dusty areas. In very dusty areas, powered dryers may need a muslin filter over the air inlet.

2. During the early stages of drying, conditions in the dryer (high humidity and moderate temperature) are ideal for the growth of micro-organisms. The quicker the drying time the better the final microbial quality of the product. Drying rates may be increased in two ways: by increasing the air flow and by increasing the air temperature.

3. The moisture content at the time of harvesting for seed spices crops is never more than 18%, therefore freshly harvesting crop is kept in the field for 2-3 days to bring moisture level to at least 15 %. Thereafter the harvested crop is threshed and now the shadow drying for 8-10 days is recommended for bringing the seed moisture level to around 11-12%.

4. The types, shapes, varieties, characteristics of all these impurities are of varied nature and cannot be separated by one process or by one machine. The calibration of such machines can be done with context to seed spices crops for overcoming such impurities through mechanisation. Such apparatus/equipments which could prove useful are solar driers, spiral separator, magnet drum/pulley, magnet seed separator, electronic colour sorters, gravity separator/destoner and mechanical graders.

5. During storage it is necessary to take care of temperature and relative humidity. The studies are required to be conducted for ascertaining the suitable packaging media for storing the seeds of seed spices with better quality for longer period and suitable temperature ranges and RH levels for safe storage. To ascertain critical seed moisture level, packaging material and storage conditions *viz*. storage temperature, relative humidity for retaining the quality for a longer period.

6. Use of environmentally safe bio-control means (using botanicals) as effective alternative to chemical control measures to storage pests and myco-toxicants over period and quality.

7. Development of effective biologically safe strategies for better storage at farmer level and trader level with export fitness of seed spices.

Present practice of using fumigants and insecticides which have high residual effect are:

a) Alluminium phosphide, calcium phosphide:-

@ 3 tablets (3 gm each) per metric tons of grain

@ 21 tablets (3 gm each) per 28 cubic tons for closed space

b) Ethylene dibromide

@ 3 ml per quintal

@ 8 ml per cubic meter space in closed space

c) EDCT mixture @ 160-300 ml per cubic meter space

d) Melathion 50% EC @ 0.06 ml per kg seed

e) Deltamethrin 2.8% EC @ 0.04 ml/kg seed

f) Alfa cypermethrin (Altima 5% WP)

g) Lambda cyhalothrin (Karate)

Pre and post harvest problems identified in seed spices crops:

1. Pesticide and heavy metals residue in seed spices

2. Non availability of seed spices varieties resistant to biotic and abiotic stresses and with high essential oil content.

3. Aroma-profile of essential oil of seed spices and correlation with resistance/susceptivity to various diseases.
4. Lack of organic production technology of seed spices.
5. Information on stage of harvest for realizing maximum seed and essential oil yield is lacking
6. There is lack of information on the physical properties of seed spices and varieties in support of post harvest mechanical handling operations
7. Sufficient information on critical seed moisture level, packaging material, packaging method and storage conditions for retaining the quality for a longer period is not available.
8. Bio-safety measures not available for control of storage fungi causing mycotoxins.
9. Lack of bio-control measures for storage grain pests of seed spices

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ABSTRACTS

Poster Presentations

Genetic Diversity in Spices and Suitability to NE States

P-01

Studies on identification of promising cardamom genotypes for hill zone of Karnataka

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Cardamom (*Elettaria cardamom* Maton) is one of the important spice crop in India, belongs to family Zingiberaceae. Although suitable varieties of cardamom have been identified and released through intensive evaluation and screening techniques, most of them are susceptible to pests and diseases due to change in climate and rainfall pattern. Keeping this in view a study was under taken to identify the most suitable and high yielding genotype for the hill zones. Twelve elite cardamom genotypes from different research centers were evaluated in randomized block design with three replications during 2004-2007 for yield and yield attributing traits. Observations were recorded on various quantitative traits and analyzed statistically. The results indicated significant difference between genotypes for all the traits under study. Based on mean values of the genotypes tested over the years, MHC-10 recorded significantly higher mean dry capsule yield of 274.80 kg/ha followed by CL-692 (265.90 kg/ha) and S-1 (243.04 kg/ha) than the standard check M-2 (208.07 kg/ha). The mean data on yield attributing characters revealed that MHC-10 recorded maximum for most of the traits like panicle length (52.80 cm), number of capsules per panicle (51.40), number of bearing suckers/plant (18.40) and number of panicles/plant (42.01) when compared to other genotypes and the plant height of 302 cm was observed in S-1. The evaluation study indicated that genotype MHC-10 is most suitable and promising with respect to yield and yield attributing traits.

P-02

Collection and conservation of large cardamom germplasm

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Large cardamom (*Amomum subulatum* Roxb.) is the main cash crop of Sikkim having an area of 30,039 hectares with an annual production of 4,972 metric tons in India. NE India has largest concentration of Zingiberaceous flora especially in number and genera. Many of them have their origin in this region including *A. subulatum.* Consequent to establishment of Indian Cardamom Research Institute, Regional station at Gangtok, efforts have been focused on conducting explorations and collection of genetic resources in large cardamom growing tracts of Sikkim, Darjeeling Districts of West Bengal, Elam District of Nepal and border areas of Bhutan. A total of 212 accessions have been collected and conserved in two established conservatories at Pangthang Research farm in East Sikkim (2160 msl) and Kabi in North Sikkim (1630 msl). The accessions were collected based on specific characters and with passport descriptors. Large cardamom descriptor has

been prepared for documentation. Seeds of fifty nine accessions have been deposited in National Gene Bank, Pusa, New Delhi and registered with IC Numbers and the process is continued. During the year 2007, surveys were carried out in large cardamom growing areas of Dentam, Buriakhop, Temi (South Sikkim) Sentam village, Singhik (North Sikkim), Kasyong, Nokdara Pedong and Gitbeong of Kalimpong (West Bengal). Five germplasm accessions were collected and added to conservatory. The germplasm belonged to cultivars of Sawney, Varlangey, Ramsey and Golsey. Passport data of the germplasm was recorded for the productive tillers per clump, spikes per clump, capsule per spike and seeds per capsule. Distinct variability was observed in the collected accessions.

P-03

Field evaluation of tissue culture plants and open pollinated seedlings of large cardamom selections in Sikkim and Darjeeling

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Lack of high yielding selections, variation in seedling progenies and transmission of viral diseases through sucker propagation together contribute to the decline in the productivity of the large cardamom (*Amomum subulatum* Roxb.). To increase the productivity of this crop, planting material raised through tissue culture (TC) techniques from six selections having higher productivity were field evaluated. The tissue culture plants of all the six cultivars performed better. Clone, SBLC 47A (Varlangey) and SBLC 5 (Sawney) were found superior as compared to other selections. These clones showed maximum yield in high and medium altitude. The capsule characters like size, weight and number of seeds were found to be better in SBLC 47A (Varlangey). From the study it was observed that TC plants performed better as compared to conventionally propagated seedlings. TC plants had vigorous growth during initials years, precocity in bearing and higher productivity.

P-04

Development and characterization of genomic microsatellite markers from turmeric

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A small insert genomic DNA library enriched for the microsatellite repeat $(AG)_n$ in turmeric (*Curcuma longa* L.) was constructed using the selective hybridization approach. Genomic DNA was digested with *Rsa* I restriction enzyme and ligated into super SNX linkers. Linker-ligated DNA was denatured and hybridized to biotinylated microsatellite oligonucleotide- $(AG)_{12}$, which were then captured on streptavidin coated magnetic beads. Hybridized DNA fragments were eluted from the beads, cloned into pTZ57/RT and transformed into Top10 *E. coli* cells and recombinant clones identified by colony PCR using vector specific primers. Plasmid

DNA was isolated from clones harboring an insert of 250-800 bp. Out of the 104 clones sequenced from the enriched library, 62 were found to harbor unique microsatellite repeats. A set of 30 primer pairs flanking the SSR sequences were designed and custom synthesised. The PCR conditions were optimized for each primer pair and the amplified products were size fractionated in 8.0% denaturing PAGE. Out of the 30 primers validated and characterized in a panel of 20 turmeric cultivars, 10 primers generated monomorphic patterns and five primers showed no amplification, multiple bands or stutters. Fifteen SSR loci were found to generate reliable polymorphisms with clearly distinguishable/ interpretable banding patterns. The number of alleles per microsatellite loci varied from two to seven. On an average, 4.1 alleles per primer pair were observed. These polymorphic SSR's generated in the study would serve as a useful resource/ molecular tool for the effective characterization, conservation and management of turmeric germplasm.

P-05

Genetic variability in ginger of North eastern states

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Nineteen genotypes of ginger were evaluated to study the growth behaviour, yield and quality aspects of different genotypes and to estimate the GCV and PCV, heritability and genetic advance of different traits. All the 17 characters under study varied significantly among the genotypes. Plant height, number of nodes on rhizomes, primary and secondary fingers, rhizome yield/clump, yield/ha, oil, oleoresin content and fibre content of rhizomes showed high values of GCV and PCV. High heritability coupled with high GA was recorded for plant height, leaf area, weight of secondary finger, yield/clump, oil and oleoresin content indicating that such characters are controlled by additive action of polygene. It is concluded that great variability exists with regard to many desirable characters among the genotypes particularly for crop selection and crop improvement *viz.,* number of primary and secondary fingers, weight of fingers, rhizome yield/clump, oil and oleoresin content in rhizome. Based on the yield and quality attributes the selected genotypes of various North Eastern states are categorized as (i) Genotypes suitable for rhizome yield : TRG-1, MNG, NDG, TRG-2, MZG-6, MZG-1, MZG-2, ARG-2 and MZG-5, (ii) Genotypes suitable for oil extraction : NGG-4, NGG-3, NGG-5 and MNG, (iii) Genotypes suitable for oleoresin extraction : NGG-4, NGG-3, TRG-1 and NGG-2 and (iv) Genotypes suitable for fresh consumption (low fibre) : TRG-2, MZG-4, ARG-2, ARG-1.

P-06

Evaluation of ginger germplasm of Meghalaya

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Ginger is commercially cultivated in almost all the states of North – East India and is one of the main cash crops of the region. Meghalaya and Mizoram are the leading ginger producing states of the region. Forty eight genotypes of ginger were collected from different parts of Meghalaya and were cultivated in the Horticultural

Farm of ICAR (RC) NEH, Umiam. These genotypes were evaluated for their morphological characters. Plant height ranged from 50.8 cm (MLG – 16) to 91.00 cm (MLG – 1). Stem diameter was found to be maximum (12.00 mm) in MLG – 19, whereas it was lowest (6.20 mm) in MLG – 34. The internodal distance varied from 3.20 cm (MLG – 39) to 5.90 cm (MLG – 28). MLG – 26 recorded the maximum number (10.4) of tillers, while MLG – 18 recorded the lowest (3.60). Number of leaves was highest (21.60) in MLG – 35, and lowest (11.20) in MLG – 16. Leaf length ranged from 20.50 cm (MLG – 34) to 28.20 cm (MLG – 53), whereas leaf diameter was highest (3.00 cm) for the genotypes MLG – 3, MLG - 32 , MLG – 53 and was lowest (2.30 cm) for MLG – 7, MLG – 11, MLG – 12, and MLG – 16.

P-07

Evaluation of chilli genotypes for quality attributes

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Sixty three different lines/genotypes of chilli were evaluated for yield and quality analysis. Among all the genotypes, RCC-04-12-1 recorded the highest yield (339 q/ha), followed by RCC-04-24 (280 q/ha). Ascorbic acid content ranged from 30.80 – 174.22 mg/100 g fruit weight with the line RCC-04-05 recording the maximum value. The local genotypes King chilli and Bird eye chilli also recorded higher amount of ascorbic acid (139.62 and 112.32 mg/100 g respectively). Most of the genotypes recorded good amount of color value ranging from 28.86 to 135.75 ASTA units. The highest color value of 135.75 ASTA units was recorded for the genotype RCC – 04 – 7.

P-08

Evaluation of Naga King chilli genotypes under hill zones of Nagaland

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Naga King chilli (*Capsicum chinense* Jacq) also called Bhut jolokia, or U-morok is the world's hottest chilli and it is popularly grown in Nagaland. Unaware of the availability of different genotypes within the vicinity by the farmers of Nagaland, an experiment involving three genotypes categorized by fruit color *viz.*, Green Red (GR), White Red (WR), Brown (BR) in randomized block design with three replications was carried out during 2007-2008 at Bio-Control Laboratory Experiment Station, Medziphema, Nagaland.

The maximum height of the plant (76.28 cm), number of primary branches (4.6), number of secondary branches (16), number of fruits/plant (118.4), fruit length (7.03 cm), fruit yield/plant (762 g), yield/plot (9.8

kg) fresh yield (245 q/ha), dry fruit yield/plant (99.06 g) and dry chilli yield (31.84 q/ha) were recorded by the genotype White Red (WR) followed by Brown (BR), while the maximum fruit weight (8.3 g) was observed in genotype Green Red (GR) followed by Brown (7.92 g). These observations lend support that Naga King chilli genotype White Red (WR) out yielded all the others in terms of size, fresh as well as dry chilli yield. It can be recommended to grow as superior genotype as it produced the maximum fresh chillies and dry chillies per hectare.

P-09

Naga King chilli - a rediscovered potential spice of Nagaland

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Very recently only Naga King chilli [Naga *Jolokia or bhoot jolokia* in Assamese vernacular; (*Capsicum chinense* Jacq.)] was rediscovered by the world scientific community due to its tremendous record making hotness. For the first time, its hotness was analysed in Defence Research Laboratory, Tezpur, Assam, India in the year 2000. Later on a good amount of controversies regarding the hotness of this particular chilly were observed. In the year 2005, Dr. P. W. Boseland and his co workers from New Maxico State University determined the hotness of these chillies to be 1,001,304 Scovile Heat Unit (SHU) and the investigators determined the hotness of samples of Naga King chillies carefully with the aid of well calibrated High Performance Liquid Chromatograpy (HPLC). After this confirmation the million scoville Naga King chilli was certified by Guinness World Records as the hottest chilli of the earth in September, 2006.

Chilli (*Capsicum* spp.) belongs to the family Solanaceae (Nightshade family) and is believed to be evolved from an unknown ancestral form in Peru Bolivia region of the New World. There were also controversies regarding the species status of Naga King chillies and in the year 2007, Boseland and Baral, with the aid of morphological and molecular marker studies, confirmed that the Naga King chillies belong to *Capsicum chinense* group.

Interestingly this particular type of chilli with its unique hotness and aroma is native to the North eastern part of India, more particularly to Nagaland. In Nagaland the crop is cultivated by traditional ways since time immemorial and a good amount of genetic variability in terms of local land races are found in the state. On the other hand, very little research towards scientific cultivation of this potential crop was accomplished and till now no scientific package of practices is available for the crop. In the present investigation local genetic worth, traditional cultivation and processing practices and traditional uses aspects were focused by the method of extensive field visits and systematic interviews of local farmers of traditional growing areas of Nagaland. At the same time, a few elite genotypes were selected from their place of cultivation and these were grown under experimental field conditions for further study of economically important characteristics of these land races. It could be safely stated that there is tremendous scope to utilise these genetic variabilities in plant breeding experiments for further development of elite genotypes in this crop. On the other hand scientific documentation of different available land races of Naga King chilli will be useful in establishing its nativeness in the state.

P-10

Variability studies in fenugreek

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Fenugreek (*Trigonella foenum-graecum* L.) is a major seed spice crop grown in the India for domestic and export purposes. The present study was carried out in a set of seventeen varieties of fenugreek during 2006-07 and 2007-08 at the experimental fields at National Research Centre on Seed Spices, Ajmer (26° 27' 0" N, 74° 38' -1" E and 700 msl). This experiment was laid in randomized block design with three replications. Among the characters studied, days to 50 % flowering (98.3), plant height (95.7), number of primary branches (84.6), pod width (74.0) and yield per plant (90.3) had high heritability and genetic advance suggesting that improvement for these characters could be brought about by directional selection. Pod length, pod width and pods per plant exhibited high heritability with low genetic advance but these characters must be taken up in advance generation.

P-11

Genetic diversity analysis in fenugreek varieties

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Fenugreek (*Trigonella foenum-graccum* L.) is a major seed spice crop grown in the India for domestic and export purposes. It belongs to family Fabaceae. It is a diploid species with chromosome number of 2n =16. The present study was carried out during 2006-07 and 2007-08 at National Research Centre on Seed Spices, Ajmer (26° 27' 0" N, 74° 38' -1" E and 700 msl). Seventeen varieties of fenugreek developed by different centers were experimented in randomized block design with three replications and studied for their genetic divergence following D^2 analysis. The study indicated that the genotypes were grouped into two clusters and there was lack of parallelism between genetic and geographic diversity. Intra cluster distance was highest in cluster I followed by cluster II. Tocher method of hierarchical cluster analysis was applied to group the varieties. The maximum inter-cluster distance between cluster I and Hisar Survarna was 4.15 and 14.42, respectively. The varieties falling in cluster I were Hisar Suvarna (Haryana), Rajendra Kranti (Patna), Lam Selection-1 (Guntur), Hisar Sonali (Haryana), CO 2 (Tamilnadu), RMt-303 (Jobner), RMt-1 (Jobner), Rmt-143 (Jobner), GM-2 (Gujrat), Hisar Mukta (Haryana), Hisar Madhavi (Haryana), NRCSS AM-2 (Ajmer), Azad Methi-1 (Kanpur), NRCSS-AM-1 (Ajmer) and RMt-305 (Jobner). The variety falling in cluster II was Pant Ragini (Pantnagar). Among the 10 characters studied for genetic divergence, seed yield per plant contributed the maximum accounting for 32.35% of total divergence, followed by plant height (18.38%). The study between genotypes of diverse clusters may be undertaken in breeding programmes for improving yield and quality traits.

P-12

Suitability and adaptability of fenugreek genotypes under Malwa Plateau of Madhya Pradesh

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An experiment was conducted in the *Rabi* season of 2005-06 and 2006-2007 at horticulture farm of K N K College of Horticulture, Mandsaur (M.P) to assess the performance of different fenugreek (*Trigonella foenum-graecum* L.) genotypes collected from different places. Morphological, yield and quality parameters were studied. Plant height, pod length, number of branches, number of pods per plant, number of seeds per pod, yield and protein content were measured and analyzed in different genotypes on the basis of pooled data of two years. Maximum yield performance was in variety Rmt-1 followed by Rmt-303 (14.51 and 13.36 q ha^{-1} respectively). Local genotypes (collected from Jobner AICRP) showed highest quality attributes. The significant variations observed in growth, yield and quality of different genotypes will be helpful in developing elite fenugreek varieties.

P-13

GIS study on Garcinia diversity in the North East Himalayan and Western Ghats regions of India

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Garcinia belongs to the family Clusiaceae. About 200 species of Garcinia occur in Asia and Africa. Out of the 35 species found in India, 17 are endemic out of which seven are available in Western Ghats. *G. indica, G. cambogia (Syn G. gummi-gutta), G. cowa and G. xanthochymus (Syn G. tinctoria)* are the important species in Western Ghats while *G. cowa (Syn G. kydia), G. lancifolia, G. pedunculata* and *G. xanthochymus* are the important species of North East Himalayan foot hills. As the crop is available in the two different eco-systems, it is possible to have a great degree of diversity in their morphological, biochemical and genetic properties. The Indian Institute of Spices Research, Calicut has a considerable collection of *G. indica, G. combogia* and *G. xanthochymus* collected from the Western Ghats. Plotting the collection sites using GIS software (Bioclim model of DIVA GIS), a suitability study was done. It showed that though the NE states are in a different ecological set up, the western parts of Meghalaya, North East districts of Assam like Jorhat, Dibrugarh, Lakhimpur have almost similar type of rainfall pattern, temperature and altitude as that of the Garcinia collection sites of the Western Ghats. With a GIS prediction a survey was done in July 2009. Excellent results were found in the Western part of Meghalaya *viz.,* Pynursla and Dawki regions. Two variants of *G. cowa* and two variants of *G. xanthochymus* which differ in fruit shape were collected. The collection

extended to Jorhat District of North Assam, where four varients of *G. cowa (*Kuji thekara), two varieties of *G. xanthochymus* and *G. lancifolia, G. pedunculata* were found. The presence of Hydroxycitric Acid (HCA), an anti obesity compound, in the fruit rind and leaves of *Garcinia* has added to the importance of the crop. A preliminary study in HCA of the collected species were done. Results showed that *G. xanthochymus* of both the ecosystems have very less percentage of HCA, while *G. cowa* from Meghalaya has 10.9 and 8.3% of HCA. Assam's *G.cowa* (Kuji thekara) has 4.3% and that of Western Ghats has 3.6% HCA.

P-14

Identification of five chemotypes in *Cinnamomum verum* based on bark oil constituents

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Cinnamon (*Cinnamomum verum)* is one of the earliest known spices. The essential oils from leaves and bark are used in perfumery, flavouring and pharmaceutical industries. Existence of several chemotypes is a special feature of *Cinnmomum* species. Keeping this in view, two hundred and fifteen *Cinnamomum verum* accessions from IISR germplasm collection were evaluated for bark oil and oleoresin contents and one hundred and sixty seven accessions for bark oil constituents. Bark oil and oleoresin contents in these accessions ranged from 0.33% to 3.34% and from 3.30% to 19.42% respectively. Accession numbers IC-370219 and IC-370310 recorded > 3% oil yield with 55.17% and 48.14% cinnamaldehyde. Thirteen accessions yielded 2.0-2.5% oil. Twenty five accessions recorded > 15% oleoresin content. Five accessions (IC-370025, IC-370095, IC-370169, IC-370310 and IC-370329) were identified with moderately high oil (>2.3%) and oleoresin (>10%) contents. The present study could identify five chemotypes of *Cinnamomum verum,* based on the bark oil constituents.

Majority of the accessions belonged to the first chemotype, namely cinnamaldehyde-type, of which, thirty two accessions contained above 50% cinnamaldehyde in bark oil. Only one accession (IC-370250) represented the second chemotype, the bark oil of which was dominated by benzyl benzoate (48%). The bark oils of IC-3700225 and IC-3700226, in which, cinnamaldehyde (26% and 36%) and cinnamyl acetate (27% and 30%) were the chief components, were identified as the third chemotype. The bark oils of IC-370209 and IC-370218, in which cinnamaldehyde (24% and 27%), caryophyllene (18% and 13%) and benzyl benzoate (28% and 20%) dominated, formed the fourth chemotype and the fifth chemotype with cinnamaldehyde (30%), eugenol (22%) and benzyl benzoate (19%) as the chief constituents included IC-370025. Out of the five identified chemotypes, third, fourth and fifth chemotypes are reported for the first time.

P-15

A SCAR marker based method for sex determination in dioecious betel vine

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Piper betle L. (family: Piperaceae), commonly known as betel, is widely used as a masticatory. It is accredited with a number of medicinal properties. Betel is strictly dioecious in nature and sex differentiation is possible only after attaining reproductive maturity based on their spike morphology. Sex determination is important for breeding programmes and since many of the economic traits are gender associated. The aim of this study was to optimise a specific and easy molecular marker based technique for sex identification in betel vine. Sex associated RAPD markers were identified by comparing the profiles of sex bulked DNA from nineteen betel accessions composed of nine males and ten females. Out of the 82 different primers screened, the primer OPB-20 produced a presumably female specific band (OPB-20_{488}) both in the bulk DNA as well as in the individual samples. The putative female specific band was excised from the gel, cloned, and sequenced. A SCAR primer, 'Pibet-20' (Pibet-20 F-5'GGACCCTTACCTATACTAAATGATGA3' and Pibet-20 R-5'GGACCCTTACATTCAAACCC3') was designed manually containing the RAPD primer sequences at the 5' end followed by the initial sequences of the OPB-20_{488} RAPD marker. The utility of the SCAR marker was further validated in 26 betel accessions comprising nine males and 17 females. The above method may be used for detection of sex in betel vine.

P-16

Lesser known indigenous spices diversity of Nagaland

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Spices are natural flavours obtained from plant sources specifically for enhancing the taste and odour of food-stuffs and many have medicinal value. Diffusing fragrance and flavour of plants have been utilized world over for spices, culinary purposes and medicines. The demand for plant base therapy has increased immensely due to growing recognition that they are natural products, non-narcotic and with no side effects. The Naga people are dependent on a variety of natural resources for their various needs including traditional medicine and culinary practices. In the present study, efforts have been made and a total of 40 lesser known indigenous spices used traditionally by the Nagas in various culinary purposes are listed.

P-17

NRCSS Ani-1 – A high yielding variety Anise for semi-arid region

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Anise (*Pimpinella anisum*), belonging to family Apiaceae is an annual seed spice. It is one of the under-exploited seed spices crops grown mostly for the seeds. Anise is used for flavouring food, confectionery, bakery products, chewing gums and beverages. The essential oil extracted from anise seeds has industrial importance and is used for flavouring soaps, mouthwashes and toothpastes. In addition to above uses it possesses medicinal properties and is extensively used as an ingredient in cough syrups, lozenges, gripe water and as a carminative. The anise has been considered as a future seed spices of India and commercial cultivation at large scale has been recently taken up by farmers. NRCSS Ani-1 is the first variety of anise in India, has been developed at NRCSS and identified for release very recently under AICRP on Spices. It is a high yielding variety, bears attractive seeds with a high volatile oil content of 3.2 %. This variety is suitable for cultivation in semi-arid region under irrigated conditions. It gives an average yield of 733 kg/ha with potential yield of 1150 kg/ha under semi-arid conditions. The variety has been developed through single plant selection from an Exotic line. The leaves are dark green in color. The lower leaves are broadly triangular, incised serrate and the upper ones are trifid. It takes 103 days to reach 50% flowering and 162 days to maturity. The selection AAni-01-2 renamed as NRCSS Ani-1 have shown 23.4 % higher yield than check. Due presence of pleasant fragrance and high essential oil, this variety is suitable for export purpose. Introduction of this new variety with potential nutraceutical value is a best alternative crop to extend the diversity of farming system in the semi-arid agro-ecosystem.

Production Technologies and Crop Management

P-18

Crop diversification in black pepper garden through intercropping of tuber and fodder crops

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An Experiment was conducted at Ambalavayal (Kerala) during 2007-08 and 2008-09 with an objective to augment the income from black pepper plantation by intercropping tubers and fodder crops. Tuber crops such as tapioca, amorphophallus, coleus, ginger, turmeric, and fodder crops like hybrid napier grass, guinea grass and Congo signal grass were selected and treatments were laid out in RBD with three replications. The results indicated that higher black pepper yield was obtained from intercropping situation compared to sole black pepper. Among tuber crops maximum black pepper equivalent yield (PEY) (5131 kg/ha) was recorded by amorphophallus followed by ginger (3137 kg/ha). In the case of fodder crops, maximum PEY was recorded by hybrid napier grass Co 3 (2633 kg/ha) followed by guinea grass (2347 kg/ha). Maximum net return of Rs. 82,700 per ha was obtained from black pepper + amorphophallus followed by black pepper + ginger (Rs 68,097). In case of fodder, hybrid napier grass recorded maximum net returns (Rs 52,150) followed by guinea grass with black pepper. Benefit: cost ratio was higher for hybrid napier grass (4.5), ginger (3.3) and amorphophallus (3.1) intercropped with black pepper.

P-19

Impact of irrigation on cardamom production

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An experiment was conducted in cardamom (*Elettaria cardamomum* Maton) with four irrigation treatments *viz.,* control-mulching with local materials (protective irrigation), drip irrigation- 8 litres per day, sprinkler irrigation once in 12 days and sprinkler irrigation once in 15 days in summer during 2001 to 2004 with five replications by planting (IISR-Kodagu Suvasini) suckers. Irrigation treatments were imposed during 2003 and 2004 cropping season. Results revealed that drip irrigation with 8 litres plant^{-1} daily, recorded better growth parameters followed by sprinkler irrigation once in 12 days. Soil moisture content recorded significant variation between treatments. In spite of early initiation of panicle and poor setting at early stage, drip irrigation with 8 litres plant^{-1} daily from January 15th onwards recorded significantly higher yield (575.58 kg ha^{-1}) followed by sprinkler irrigation once in 12 days (396.2 kg ha^{-1}) than sprinkler irrigation once in 15 days (378.72 kg ha^{-1}). The control recorded lowest yield (224.03 kg ha^{-1}). In general, the study revealed that irrigating cardamom during summer with drip (8 litres plant^{-1}) daily or sprinkler irrigation once in 12 days leads to higher yield.

P-20

Production trend of turmeric in Nagaland

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India contributes 23-30 per cent value in international trade of spices. Turmeric is one of the principal spices crop grown in Nagaland in 163 thousand hectare with a production of 552.3 thousand tons. An attempt has been made to estimate the effect of cropped area, rainfall and year on the production trend of turmeric in Nagaland. To evaluate the impact of cropped area, rainfall and year, a regression equation for turmeric crop has been fitted by method of least square and to examine the significance of the estimated regression equation, analysis of variance has been carried out.

P-21

Impact of cropped area and rainfall on production of ginger and turmeric in Nagaland

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Ginger is one of the principal spice crops of India as well as the world. In the North eastern region, area of ginger has increased from 9.7 thousand hectare to 33.24 thousand hectare during the period of 1992-93 to 2006-07. Turmeric is another important crop with 163 thousand hectare of area with production of 552.3 thousand tons and productivity of 3.4 tons per hectare having 14.7 per cent of the total share among the spices crops during the year 2006-07.

In this paper an attempt has been made to estimate the effects of cropped area and rainfall on the production of ginger and turmeric crops in Nagaland. To evaluate the impact of cropped area and rainfall on both crops, regression equations for each crop have been fitted by method of least squares and to examine the significance of the estimated regression equations, analysis of variance has been carried out.

P-22

Soil conservation measures in degraded watersheds for production of turmeric in Kandhamal District of Orissa

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Kandhamal District is a hilly area prone to soil loss. So creation of temporary structures across drainage line in degraded watersheds is essential to prevent soil erosion and increase the yield of tribal crops like turmeric. So a trial was conducted during 2003-04, in farmer's field of Sudreju village of Kandhamal District under National Agricultural Technology Project (NATP, RRPS-7). The objectives were to reduce peak flow, to check soil erosion, to increase soil and water conservation and to improve ground water recharge. The treatments included T_1-Vegetative measures of vetiver (line to line spacing 30 cm and plant to plant spacing 15 cm in staggered fashion.), T_2- Loose rock structure (less than 30 cm height), T_3-Brushwood structure (with local wood pegs) and T4- Loose rock (boulder) structure. Results revealed that maximum amount of soil was deposited in loose boulder structures T4 (0.67m^3 and 0.965 t/structure) in middle reach followed by loose boulder structures T_2 (0.49 m^3 & 0.711 t/structure) in upper reach of the watershed. The vetiver at upper reach did not sustain, so the effect of vetiver could not be assessed. Crop yield data also indicated the superiority of loose boulder structure over others. So loose boulder structures may be recommended across drainage line in middle reaches and upper reaches to prevent soil erosion and to get more yields.

P-23

Growth and yield of ginger as influenced by various sources of organic manures

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The investigation on effect of various organic manures on growth, yield and quality of ginger (*Zingiber officinale* Rosc.) cv. Nagaland Local was carried out to determine the efficacy of organic manures. The experiment was carried out in RBD with three replications on terrace conditions. Rhizome bits (28-30 g) were planted on 15th May in 2 x 2 m plot size keeping a spacing of 30 x 20 cm. The treatment comprised of FYM (10, 15, 20, 25 and 30 t/ha) and pig manure (10, 15, 20, 25 and 30 t/ha) and control. The physical parameters of the plant were found to be significantly improved with the application of higher doses of FYM (20-25 t/ha). Similarly the yield and volatile oil content were also observed to be highest with the application of FYM at 20 and 25 t/ha respectively. Application of FYM at 25 and t/ha also caused the highest dry ginger recovery percentage. Pig manure @ 15 t/ha was found to be the second best source of manuring with regard to yield and quality of ginger under Nagaland conditions.

P-24

Effect of different sources of nutrients on growth, yield and quality of King chilli

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The King chilli or Naga chilli is a native of the North eastern region of India. It has a long standing association with the ethno – agricultural activities of people of the region. It has gained popularity as the ‘hottest chilli in the world’. It is used in medicine, pickles, sauce *etc*. Due to its extraordinary pungency level, it is especially suitable for preparation of oleoresin as well as extraction of capsaicin. An experiment was conducted to compare the effect of different locally available organic sources of nutrients with inorganic fertilizers on the growth, yield and quality parameters of King chilli. The different manures used were FYM (25 t/ha), pig manure (25 t/ha), ash (10 t/ha) and inorganic fertilizers (N: P: K 100: 60: 60 kg/ha). The highest yield per plant (1.80 kg) was recorded in chillies grown with FYM. The average fruit weight was also found to be maximum (11.83 g) in the same treatment. Chillies grown with pig manure recorded the highest amount (161.57 mg/100g) of ascorbic acid and β carotene (30.66 mg/100 g). It was also found that the fruits took 45 – 60 days to mature to red stage.

P-25

The effect of date of sowing on growth, yield and quality of fennel

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Fennel (*Foeniculum vulgare* Mill.) is one of the important cash crops of family Apiaceae. It is cultivated in India in about 41.02 thousand hectares with a production of 61.49 thousand tons and productivity of 1499 kg/ha. India exported around 5250 tons of fennel worth Rs. 2850 lakhs in 2007-2008. The experiment was conducted with three dates of sowing (15^{th} September, 30^{th} September and 15^{th} October) to identify the date of sowing for better yield and quality. The results indicated that sowing on 15^{th} September recorded maximum time for days to 50% flowering (99.93 days), number of umbels per plant (3.48), number of umbellets per umbel (39.59), number of seeds per umbel (931.36), umbel dry weight (8.68 g), 1000 seed weight (8.70 g), yield per plant (57.57 g), maximum seed yield (18.67 q/ha), straw yield (29.78 q/ha) and harvest index (38.88%). The maximum chlorophyll content (1.78 mg/g), carotenoids content of leaves (0.89 mg/g) and essential oil content of seed (1.35 ml) were also registered at this date of sowing. Therefore, among the different dates of sowing, 15^{th} September was found to be significantly superior to rest.

P-26

Effect of rhizobacteria on growth and seed yield of fenugreek

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Fenugreek *(Trigonella foenum-graecum L.)* is a seed spice mainly used as a principal odour constituent in curry powder. Being a leguminous crop, it utilizes atmospheric nitrogen through symbiotic association. The productivity of a crop is controlled by many factors of which the mineral nutrition by and large is the most important factor. To maintain soil fertility and to supply plant nutrients in balanced proportion for optimum growth and yield, an integrated approach is essential. Keeping this in view, a field experiment was conducted to evaluate the beneficial effect of two different strains of Rhizobacteria (FK 14 and FL 18) alone as well as their combinations by seed treatment and soil application along with *Trichoderma* (MTCC 5179) in fenugreek cv. Hisar Sonali at Vegetable Research Farm of CCS Haryana Agricultural University, Hisar during rabi season of 2007-08 and 2008-09. The application of different strains of Rhizobacteria and their method of application affected different growth and yield parameters significantly except seeds per pod. Maximum pods per plant (117.1) were recorded with application of Rhizobacteria FL-18 (seed treatment + soil application). The maximum seed yield (1827 kg ha^{-1}) was recorded with the application of Rhizobacteria FL-18 (seed treatment + soil application) followed by Rhizobacteria FL-14 + FL-18 (seed treatment + soil application) yielding 1824 kg ha-1 and *Trichoderma* MTCC 5179 yielding 1640 kg ha^{-1}.

P-27

Integrated nitrogen management in coriander

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A field experiment was conducted to study the effect of inorganic fertilizer, farm yard manure, poultry manure, vermicompost and neem cake on growth, yield and quality of coriander (*Coriandrum sativum* L.) during rabi season of 2008-09. The experiment consisted of 14 INM modules involving 50 and 75% recommended dose of N applied through farm yard manure, poultry manure, vermicompost and neem cake along with 50 and 25%, application of inorganic fertilizer and 100% recommended dose of N through inorganic fertilizer (60 kg N ha^{-1}), farm yard manure, poultry manure, vermicompost and neem cake at different combinations and an absolute control. The design was randomized block with three replications. The coriander variety RCr-435 was sown on November 15th, 2008 using seed rate of 12 kg ha^{-1} in rows 30 cm apart. The results revealed that application of 75% recommended dose of N through vermicompost + 25% inorganic fertilizer N recorded significantly higher dry matter production at 45, 90 DAS and at harvest, plant height, number of branches per plant, umbels per plant, umbellets per umbel, seeds per umbellet, test weight, seed and stover yield, total uptake of NPK, protein content in seed, organic carbon content and build up of available NPK status of surface soil after harvest of crop which remained statistically at par with 75% N through farm yard manure + 25 % N through inorganic fertilizer, 75% N through poultry manure + 25% N through inorganic fertilizer as well as 100% N through inorganic fertilizer alone and proved superior to rest of the treatments.

P-28

INM protocol for improved production of onion

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Conventional cultivation of onion (*Allium cepa* L) utilizes inorganic fertilizers on site specific basis, which has often not touched the desired yield expectancy due to non-redressal of fertility constraints in soil. This warrants the use of comprehensive soil management policy. In this context, an experiment involving three levels of NPK (100%, 75% and 50% RDF as 100 N – 60 P – 60 K kg/ha), four sources of manure (FYM 15 t/ha, poultry manure 5 t/ha, pig manure 10 t/ha and vermicompost 3 t/ha computed on N-equivalent basis to supply 100 kg/ha) and three sources of biofertilizers (*Azotobacter, Azospirillium*, and PSB, the phosphate

solubilizing bacteria alone and in combination with 50% and 75% RDF) with a total of 16 treatments, was carried out during 2007-09 using onion (var Agrifound Dark Red as test crop) on acidic *Rhodustalf* soil type. A significantly higher bulb yield (3.86 t/ha) was recorded with 100% NPK over control (2.74 t/ha), but lower to 100% manure (2.92 t/ha). However, combined application of inorganic NPK + manures on an average registered a much high bulb yield (4.91 t/ha). The bulb yield was much lower with combined application of inorganic fertilizers at 50% RDF plus biofertilizers (2.86 t/ha) or inorganic fertilizers at 75% RDF plus biofertilizers (3.01 t/ ha). The highest bulb yield of 5.12 t/ha was observed with inorganic fertilizers at 50% RDF plus vermicompost (3 t/ha). This combination (inorganic fertilizers at 50% RDF 50 N – 30 P – 30 K kg/ ha plus vermicompost 3 t/ha) maintained significantly higher fertility level (215.8 N, 14.3 P, 232.6 K, and 6.32 Zn mg/kg) than either inorganic fertilizers 100% RDF (204.2 N, 10.1P, 192.1 K and 4.12 Zn mg/kg) or inorganic fertilizers at 75% RDF plus biofertilizers (194.3 N, 9.1 P, 188.1 K and 3.68 mg/kg). The net nutrient balance (kg/ha) was on the positive side (nutrient loading within rhizosphere) with 50% inorganic fertilizers + vermicompost (40 N, 8P and 60 K kg/ha) over either control or 100% inorganic fertilizers (10 N, 2 P and 20 K kg/ha) or (-52N, -15P and -70 kg/ha). INM based treatment replacing 50% inorganic fertilizers with vermicompost proved to be more remunerative than exclusive use of either 100% inorganic fertilizers or 100% manurial treatment.

P-29

Response of sole versus enriched organic manures on yield and quality of onion

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Escalating cost of inorganic fertilizers coupled with depleting soil organic carbon and inconsistency in response to fertilization has attracted worldwide investigation on different INM based modules to raise vegetable onion (*Allium cepa* L.) productivity. Keeping this in view, studies were carried out at the Experimental Farm of Department of Horticulture to evaluate different organic manure based treatments *viz.,* T_1 (control – untreated), T_2 (FYM, farmyard manure at 30 t ha^{-1}), T_3 (pigmanure at 20 t ha^{-1}), T_4 (vermicompost at 5 t ha^{-1}), T_5 (*Azotobacter* at 10 g 10 kg^{-1} bulbet), T_6 (FYM + *Azotobacter*), T_7 (pigmanure + *Azotobacter*), and T_8 (vermicompost + *Azotobacter*) computed on N-equivalent basis using onion (variety Agrifound Dark Red) as test crop on *Kandic Rhodustalf* soil type. Various growth parameters, yield and yield attributes, and quality parameters were recorded.

Replicated pooled data analysis showed significantly ($p < 0.05$) higher plant height with treatment T_2 (30.3 – 45.2 cm) compared to other treatments either with (26.3 – 41.8 cm) or without bioinoculant (25.0 – 41.7 cm) at 15 days interval upto 75 days after planting. The other growth supporting parameters *viz.,* number of leaves plant^{-1} and neck thickness further supported the best response with treatment T_2. Individual bulb weight and bulb yield were significantly ($P < 0.05$) higher with treatment T_2 (40.0 g bulb^{-1} and 140 tonnes ha^{-1}) compared to rest of the treatments (24.5 – 34.9 g bulb^{-1} and 85.7-122.1 t ha^{-1}) and control T_1 (19.9 g bulb^{-1} and 69.8 t ha^{-1}) suggesting abundance of microbial population in well decomposed FYM which enhanced the availability of nutrients like N (119.1 in control to 168.4 mg kg^{-1} with T_2), P (5.1 in control to 9.3 mg kg^{-1} with T_2), Mn (9.2 in control to 14.8 mg kg^{-1} with T_2), Cu (0.54 in control to 0.67 mg kg^{-1} with T_2), and Zn (0.82 in control to 1.23 mg kg^{-1} with T_2). The total soluble solids with treatment T_2 (14.3%) were higher by 2.1% over control (12.2%) compared to other bulky manures (11.6 – 13.4%) or manures plus bioinoculants (12.3 – 13.1%). The study, hence, envisaged the dual role of FYM as nutrient source and amendment both for improving productivity of onion under rainfed conditions.

P-30

Effect of nitrogen levels and bulblets size on yield and nutrient uptake of onion

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A field experiment was conducted to study the effect of different levels of nitrogen and size of bulblets on growth, yield, quality and nutrient uptake by onion and soil fertility status after harvest during 2008 in kharif season. Different doses of nitrogen and size of bulblets significantly affected the plant height, number of leaves, neck thickness and yield. The highest bulb diameter (5.85 cm) and yield (297.77 q/ha) were recorded with the application of 120 kg N plus maximum bulblet size (1.5-2.0 cm diameter). Minimum bolting (6.20%) was observed with control (lowest size bulblet + no nitrogen). By application of nitrogen even in small doses and/or increase in size of the bulblet significantly affected the bolting. However, doubling was not affected either by levels of nitrogen and/or size of bulblets. Total soluble solids was significantly affected by nitrogen levels and/or size of bulblets and it was maximum (12.60^{o} Brix) with highest dose of N and biggest size bulblets. The highest N, P and K uptake was also recorded with the application of 120 kg N/ha combined with largest bulb size. Moreover, the available N, P and K contents in the soil increased with application of fertilizer N compared with control. Most of the treatment combinations had a favorable impact on enhancing the economic returns of onion. Though the treatment combination with highest dose of nitrogen (120 kg/ha) and bigger size of planting material (1.5-2.0 cm) had the maximum cost of production (Rs. 48,520/ha), maximum gross and net returns were received from the treatment due to increase in bulb yield with cost benefit ratio of 1: 6.13.

P-31

Management of anthracnose disease in black pepper

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Anthracnose (Pollu) disease caused by *Colletotrichum gleosporoides* is a serious emerging disease of black pepper in the states of Kerala, Tamil Nadu and Karnataka. The economic loss due to this disease ranges from 2 to 10 %. At Mudigere, 24.5 % leaf damage and 9.9 % spike damage (shedding) were recorded. The crop loss due to this disease at the time of spiking may extend up to 93%. The experiment was under taken during 2003-2007 to find out suitable fungicides for the management of this disease. There were totally five treatments, out of which, three sprays of 1 % Bordeaux mixture @ 5 litres per vine during the last week of May, July and August was found to be the most effective in reducing the disease with mean PDI of 2.27. This was followed by two sprays of 0.1 % Propiconazole @ 5 litres per vine during the last week of May and August with 2.45 PDI. The other treatments *viz.,* two sprays of 1% Bordeaux mixture and two sprays of 0.2 % Mancozeb during May and August was found to be on par with check.

P-32

Evaluation of fish oil rosin soap and neem oil against black pepper mussel scale

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An experiment was conducted during 2006-07 and 2007-08 with an objective of evaluating the efficacy of botanicals against pepper mussel scale (*Lepidosaphes piperis* Gr. (Diaspididae: Homoptera). To test the bio-efficacy of organic products, the experiment was laid out in Randomised Complete Block Design with five treatments *viz.* neem oil (0.5%), econeem plus (0.5%) and fish oil rosin soap (0.3%) along with standard check monocrotophos and control with four replications. Four applications of organic products were done at 15 days interval and monocrotophos was applied twice at 21 days interval. The observations on seasonal incidence was recorded at fortnightly intervals by direct counting of pest population under binocular microscope both on leaves and twigs and population was correlated with weather factors. The observations on number of mussel scale were recorded both on leaves and twigs and the data were pooled and analyzed statistically.

The observations on seasonal incidence of scale ranged from 0.45 to 14.33 on leaves 17.94 to 49.13 on twigs with a maximum population from February to May with two peaks. The minimum population was recorded from June to September. The population fluctuation of mussel scale exhibited positive correlation with maximum temperature (r = 0.7957) and sunshine hours (r = 0.6819) and negative correlation with rainfall (r = -0.293), minimum temperature (r = -0.5384) and maximum relative humidity (r = -0.3016).

All the treatments were effective in reducing mussel scales population when compared to untreated control. Among the treatments fish oil (2.81 and 8.19 on leaf and twig) and neem oil (3.01 and 9.04 on leaf and twig) were found effective and superior when compared to econeem plus (7.65 and 26.67 on leaf and twig) and these were on par with chemical check monocrotophos (3.95 and 12.03 on leaf and twig). The results indicated that, application of fish oil or neem oil effectively reduces mussel scale population and enhances the conservation of natural enemy populations and can avoid residue problem in the produce.

P-33

Effect of neem cake on productivity and disease incidence in small cardamom

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Cardamom (*Elettaria cardamomum* L. Maton.), the queen of spice is a native to the Western Ghats of India and one of the most valuable spice crops. The cardamom growing soils are susceptible to leaching of applied nutrients due to heavy rainfall, possess high P fixation, low nutrient and water holding capacity. Use of neem cake helps in controlling pest as it has pesticide property apart from being a source of nutrients. Field experiments were conducted for four years (2002-2007) to assess the effects of neem cake on cardamom growth, disease and pest incidence. The experiments were laid out in randomized block design with four replications. The treatments comprised of neem cake at the rate of 0.5 and 1.0 kg per clump applied either in May or September in split doses. All plots were provided with manures and fertilizers as per the recommendations. The variety choosen for the study was M_2 planted during July 2002 with a spacing of 1.8 x 1.8 m. In each treatment, fertilizers were applied in two split doses *i.e.* first application in the last week of May and second application in the last week of September. The harvest of the capsule was done phase wise staring from August to November in each year. Results from the pooled data of four years revealed that application of recommended package of FYM and fertilizers with neem cake @ 1 kg per clump applied once during May recorded significantly highest yield (216.23 kg/ha). However, neem cake application increased the incidence of shoot borer and capsule borer to significant levels. But shoot fly incidence was reduced significantly in the young suckers. Neem cake application also reduced the incidence of clump rot and leaf blotch. Hence, application of neem cake @ 1 kg per clump in the month of May can have a positive influence in controlling clump rot and leaf blotch in cardamom.

P-34

Effect of nutrients and biocontrol agents on rhizome rot of turmeric

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Turmeric (*Curcuma longa* Linn.) is an herbaceous perennial native to the Indo Malayan region. India is the largest producer and exporter of turmeric contributing 82 percent of production and 45 percent of export.

Turmeric is subjected to a number of fungal and bacterial diseases leading to severe crop loss. Rhizome rot of turmeric is one of the most important diseases of turmeric. It was first reported from Sri Lanka in 1934. In India, the disease is an epidemic in Andhra Pradesh, Tamil Nadu, Kerala and Assam. Losses to the tune of 50% and above have been reported in some parts of Telengana. Hence, an experiment was conducted for five years at UBKV farm with seven different treatments including different bio control agents and nutrients in different combinations with an objective to minimize the disease severity. It was found that seed treatment as well as soil application of *Trichoderma viride* and *Pseudomonas fluorescens* @ 12.5 kg ha^{-1} and 25.0 kg ha^{-1} as basal and top dressing respectively with application of recommended NPK and FYM produced the lowest disease incidence and highest yield.

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Eco-friendly management of shoot borer and rhizome fly of ginger in Nagaland

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Ginger shoot borer *(Conogethes punctiferalis* Guenée*)* is one of the major insect pests contributing to loss in production in North East hilly region. A field experiment was conducted during 2005-2006 to formulate eco-friendly management techniques of ginger shoot borer and rhizome fly. The experiment was laid out in Randomized Block Design (RBD) replicated thrice comprising of seven treatments. The data pertaining to shoot borer infestation was recorded at fortnightly interval right from 105 days after sowing (DAS) to 210 DAS. The pest population showed increasing trend at 105 DAS (11.23%), 210 DAS (15.80%), 135 DAS (17.49%) and at 150 DAS (19.75%). The highest per cent infestation was observed during 2nd fortnight of September at 180 DAS (22.16%). The results indicated that the application of quinalphos @ 0.05% + ozoneem @ 0.15% sprayed 6 times proved to be superior treatment (3.5% infestation) as compared to alternate spraying of quinalphos @ 0.05% and pestoneem @ 0.02% (7.10% infestation). The level of infestation of rhizome fly after harvesting was highest in control (12.28%) and the lowest infestation was found in quinalphos + ozoneem (1.07%), which was followed by treatment with cypermethrin 10 EC @ 0.01% and alternate spray with quinalphos @ 0.05% and pestoneem @ 0.02%.

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Influence of dates of planting and cultivars on the infestation of shoot borer on ginger

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An experiment was conducted during March 2007-February 2008 to find out the influence of planting time and cultivars on the infestation of shoot borer [*Conogethes punctiferalis* Guenee] on ginger. Five cultivars *viz*., Nagaland local (small size), Nadia, Thinpui, Nagaland local (big size) and Thinglaidum were used for the experiment and three dates of planting starting from 31st March at 15 days interval were maintained (31st March, 15th April and 30th April). In all the tested cultivars, the lowest (0.22-5.22 dead hearts/15 plants) shoot infestation was recorded on Nagaland local (small size) throughout the experimental period. The degree of infestation was highest (0.89-7.89 dead hearts/15 plants) in cultivar Thinglaidum followed by Nagaland local (big size), Thinpui, Nadia and Nagaland local (small size). The 15th April planting recorded the maximum infestation throughout the observation period. Initially minimum infestation was recorded on 31st March planting *viz*., 90, 105 and 135 days after planting, but at the later stage, minimum infestation was recorded on 30th April planting at 150 and 165 days after planting. From the present findings, it may be concluded that Nagaland local (small size) is a tolerant cultivar and 31st March planting is probably the effective planting time.

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Sources of *Colletotrichum* blight tolerance in large cardamom germplasm

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Large cardamom (*Amomum subulatum* Roxb.) belonging to the family Zingiberaceae is the principal cash crop of Sikkim and Darjeeling District of West Bengal. Blight caused by *Colletotrichum gloeosporioides* (Penz.) Sacc. and its perfect state *Glomerella cingulata* (Stoneman) Spauld & Schrenk. has resulted in severe crop loss due to its devastating nature. A study on the tolerance to blight was done using core large cardamom germplasm which consisted of seventy-two accessions representing elite collections. Plants were evaluated for symptoms from natural field infections during 2007 and 2008 by counting the number of healthy and diseased tillers on the basis of lesions on the pseudostem and leaves. Disease severity was calculated and accessions were grouped into five phenotypic groups *viz.,* tolerant, moderately tolerant, moderately susceptible, susceptible and highly susceptible. Six accessions *viz.,* Sikkim Cardamom Collection (SCC) 5, 7, 8, 11, 87 & 179 were found to be tolerant or moderately tolerant and showed least disease severity during both the years. Accessions with consistent low blight severity ratings are promising for developing into tolerant selections after further evaluation.

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Cercospora leaf spot of chilli and its management

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In the present experiment, maximum leaf spot of chilli (*Cercospora capsici*) was recorded in August with temperature and relative humidity ranging from 27-30º C and 74-92% respectively at Medziphema, Nagaland. All the fungicides tested were found significantly effective with increased yield over control. Bavistin @ 0.1% was found to be the most effective in controlling cercospora leaf spot of chilli, followed by Indofil M-45 and Fytolan. Chilli cultivars *viz.,* Krishna, Gagan and Jyothi were found moderately resistant to *Cercospora capsici*.

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Integrated management of cumin blight

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Blight caused by *Alternaria burnsii* is one of the major production constraints of cumin (*Cuminum cyminum* L.) under Gujarat conditions. In severe cases total failure of the crop is a common experience. Gujarat farmers are recommended to spray mancozeb (0.25%) from the age of one month to crop maturity. To reduce/replace mancozeb sprays, a field experiment was conducted with integration of *Trichoderma harzianum*, *T. viride* and garlic extract (5.0%) during 2007-08 and 2008-09 seasons. Minimum disease intensity (27.31%) was observed in four sprays of mancozeb (0.25%) followed by (30.65%) two sprays of mancozeb (0.25%) and two sprays of garlic extract (5.0%) as compared to 49.61 percent in control. They were statistically at par. Grain yield also followed the same trend. Highest grain yield (1157 kg ha^{-1}) was observed in sole mancozeb treatment followed by 957 kg ha^{-1} in mancozeb + garlic extract as against 385 kg ha^{-1} in control. It is recommended to apply mancozeb (0.2%) spray in the first phase and garlic extract (5%) spray at 10 days interval in the later phase of the crop to reduce fungicidal load on seeds and in environment.

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Grade specification for large cardamom

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Large cardamom (*Amomum subulatom* Roxb.) is grown in cold humid evergreen forest of the Eastern Himalayas in India, Nepal and Bhutan. Capsules are used as spice. In domestic markets, only two grades *viz.,* Chota dana (small capsule) and Bada dana (bold capsule) are available, without any specification. Bureau of Indian Standards (BIS) has standardized quality specifications for large cardamom. However, the size specification and bulk density for different grades has not been standardized. Some traders export large cardamom to the international market (Pakistan, Bangladesh, UAE, *etc*) in different grades prepared by trial and error methods. Sixty eight samples (1.0 kg each) were collected from different planters in Sikkim and Darjeeling District of West Bengal during 2007-08 and maximum width of 100 capsules selected at random from each sample were measured using vernier calipers. Based on the percent distribution of capsules width, four sieves of mesh (circular) sizes *viz.,* 1.2, 1.3, 1.4 & 1.5 cm corresponding to frequency distribution of capsules were made. In order to test the performance of sieves towards grading the capsules, 200 kg of dried capsules were taken up for the study. Percentage of capsule retained on respective sieves as well as bulk density was determined. The graded samples were compared with the grades traded / exported by the traders in Gangtok (Sikkim) and Siliguri (West Bengal) and it was found that these sieved samples correspond to the samples graded arbitrarily by the traders / exporters. A Scientific basis for these grades is provided by this study.

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Optimization of protocols for preparation of instant ginger candy using response surface methodology

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Fresh ginger (*Gingiber officinale*) suffers from weight loss, shrinkage, sprouting and rotting during storage within 3-4 weeks. Therefore, a huge quantity of these fresh materials is spoiled during storage. This spoilage may be overcome by processing this fresh produce to some value added products *viz.,* candy, paste, powder, oleoresin *etc*. An attempt was made to optimize the protocols for production of instant ginger candy. The experimental parameters considered were slice thickness (5.0-25.0 mm) and blanching duration (10-30 minutes) followed by dipping in 40°B and 75°B sugar solutions containing 2.0 % citric acid for 1 and 2 hours at 95 ºC, respectively and thereafter the slices were dried at 60 °C for 1 hour. Response surface methodology (RSM) design was considered for this experiment and final products were evaluated for its textural properties, TSS, acidity, TSS: acid, taste score and overall acceptability. The optimum product qualities in terms of hardness (2.08 kg), TSS (73.4%), acidity (1.31%), TSS: acid (56.3), taste score (7.98) and overall acceptability (8.07) were obtained at slice thickness of 10.9 mm and blanching time of 24.9 min.

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Temporal variation in curcumin content of turmeric

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The active compound of turmeric is curcumin. On farm operations focusing on harvesting and processing play an important role in ensuring quality of produce. An experiment was conducted during 2008-09 with twelve different varieties of turmeric to study the changes taking place in curcumin content at different stages of crop growth. Harvesting of rhizomes was done at monthly interval from five months after planting till harvesting and curcumin content was analyzed accordingly in rhizomes. At five months after planting, the curcumin content was maximum irrespective of varieties and thereafter it decreased. Lakadong (9.4%) and Megha Turmeric-1 (8.5%) had the highest curcumin content at harvest.

Marketing of Spices

P-43

Production and marketing of ginger in Dimapur district

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The present study was undertaken in Dimapur District of Nagaland to examine the production of ginger and to assess the producer share in consumer's price. Maximum producer's share was received, when sale of ginger was done through retailers directly. Producer's share was significantly reduced when the produce was sold through channels, involving more numbers of middlemen. High marketing cost was associated with poor market infrastructure in terms of storage, transport, grading, processing facilities *etc*. Price spread was found significant, indicating the potential to enhance the income of ginger growers. Majority of farmers reported about lack of market information in time and infrastructural facilities as major constraints for promoting ginger production in the study area.

P-44

Impact of spices cultivation training on village extension officers

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The present study was conducted to know the impact of training on knowledge gain about spices cultivation amongst the village extension officers. The study revealed that before participation in the training programme, majority of the village extension officers (46.67 per cent) belonged to medium level of knowledge about spices cultivation followed by low level (36.67 per cent), no knowledge (13.33 per cent) and high knowledge (3.33 per cent). The study further revealed that the highest mean knowledge gain was achieved in both high and low knowledge level categories (31.82 per cent).

P-45

Entrepreneurship development and constraints of ginger production in Nagaland

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Ginger is one of the most promising spices crop grown in Nagaland. A record production of ginger was obtained in 2006-2007 at 13818 MT in the state from an area of 1130 ha. The productivity of ginger in the state is 12228 kg/ha which is almost four times higher than the national average (3391 kg/ha). A research investigation was carried out in Dimapur District of Nagaland to study the constraints of ginger production and scope of entrepreneurship development among the ginger cultivators. The study was based on household survey of 85 sample respondents. Major findings revealed that majority of the ginger cultivators had medium level of risk orientation, medium level of knowledge about improved package of practices, high level of self-confidence and economic motivation, medium level of farm decision making ability and low level of scientific orientation. The variables namely - age, level of education, farm decision-making ability, annual income, self-confidence, economic motivation and risk orientation were found important in influencing the entrepreneurship characteristics of the respondents. Important constraints of ginger production included, small land holding, shifting cultivation, non availability of quality planting materials in time and lack of assured market for the produce.

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Herbal spices in Indian perspective- An overview

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Herbal spices have great demand in both domestic and international market. The country as a whole and the North Eastern states in particular has ideal climatic conditions. Herbal spices need to be produced organically and North Eastern states have natural organic production. Some of the important herbal spices are basil (*Ocimum basilcum*), bay leaf (*Laurus nobilis*), marjoram (*Origanum marjorana*), oregano (*Origanum vulgare*), rosemary (*Rosemarinus officinalis*), sage (*Salvia officinalis*), sweet flag (*Acorus calamus*), and thyme (*Thymus vulgaris*). Basil oil has good demand in USA, Germany, France, U.K, Netherlands and Spain. India produces only15 t of basil oil. Bay leaf is a prospective herbal spice in Assam and other NE states and needs concerted efforts for its total development. World market has a high demand of marjoram oil. Hence, organized cultivation of this herbal spice needs immediate attention. Oregano oil is exported from India in small quantity which is with high prospect. Rosemary is an important herbal spice which has a high demand in international market. Sage, sweet flag and thyme have good prospects and emphasis should be given for organic cultivation of these crops in the NE states. Above all the growers are to be trained in cultivation of herbal spices and marketing has to be assured so that the grower becomes confident of getting assured return from these crops.

HOT ENCOUNTER – "THE NAGA KING CHILLI"

It is real hot, widespread, untamed to fight every taste bud and although given a false identity by neighboring states, facts remain and it is still known and recorded as "Naga". The Naga King chilli grew up with the warriors of a North eastern place called Nagaland, which hosts this very chilli. There are many folklores attached to this chilli and songs and odes written by our forefathers in its honour. There are also interesting stories of it being a fierce partner of a true Naga soldier – wild, untamed, spreading over the entire region and finally landing up in Bangladesh, the erstwhile Chittagong hills of East Pakistan along with our Naga freedom fighters during the warfare, who left enough of this Naga King chilli there. In due course of time, it became an orphan and has been shamelessly adopted by foster parents, yet the name "Naga" still remains strong – be it in Assam or Bangladesh or Dorest England, no matter how hard one tries to twist the story and camouflage the name.

The farmers in Nagaland continue to grow the Naga King chilli as its favourite crop and is silently gearing up to hit the big market. Very soon the official name will be declared as Naga King chilli in document and paper by the state agencies and is also ready to brand it locally and give justice to its identity and originality.

AN ODE TO NAGA KING CHILLI

Still and sound in my blood,
Hot and piercing deep inside me,
Calling my name wherever you go
Places and countries call you a "Naga."
You make me feel good and proud,
Whenever I think of you.

Oh my Naga King chilli!
Red, green, brown and black,
You still resemble me,
Although left an orphan, high and dry
In lands unknown,
Still called by the name I gave you
To your land, you belong forever
Never to be forgotten
By the one who gave you birth.

When I see you,
I recollect our warrior days together,
Places we visited to fight our enemies,
Where you stood hot and fierce,
Running wild in my Naga blood,
To fight back and slay 'em all.

I rejoice for you Oh Naga King chilli,
You will always be mine today and forever,
As a true Naga King chilli,
Remain true to your roots,
As you continue to spread far and wide
You will remain my very own Naga King chilli!

Abeaü Mero
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