सत्यमेव जयते

DIRECTORATE OF HORTICULTURE
DEPARTMENT OF AGRICULTURE
GOVERNMENT OF MEGHALAYA

MISSION LAKADONG
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A CONVERGENT MISSION
OF THE
DIRECTORATE OF HORTICULTURE
DEPARTMENT OF AGRICULTURE
WITH
THE GOVERNOR'S SECRETARIAT
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FOREST DEPARTMENT
NORTH EASTERN HILL UNIVERSITY
&
MEGHALAYA INSTITUTE OF ENTREPRENEURSHIP

CONTENTS **Page no.**

CHAPTER ONE

BACKGROUND

Botanical description:

Turmeric is a perennial plant with oblong tubers that are deep orange inside. Leaves are about 2 feet long, tapering at each end, smooth with dull yellow flowers. It is propagated by cuttings from the root, yellowish externally, internally deep orange or reddish brown, marked with shining points, forming a lemon yellow powder. It has a peculiar fragrant odour and a bitter, slightly acrid taste, like ginger. It yields its properties to water or alcohol.

Terminally on the false stem is a 12 to 20 cm (4.7 to 7.9 in) long inflorescence stem containing many flowers. The bracts are light green and ovate to oblong with a blunt upper end with a length of 3 to 5 cm. At the top of the inflorescence, stem bracts are present on which no flowers occur; these are white to green and sometimes tinged reddish-purple and the upper ends are tapered.

Propagation:

The plant grows from finger-like rhizomes and requires a warm, humid climate but can be grown indoors in areas where the temperature drops below 18 degrees C. Propagation of turmeric is through division of growing rhizomes or by sprouting purchased or dormant rhizome sections. The plants can be harvested after 8 to 10 months of growth. The rhizomes are stored in a cool, dry location for replanting in the next spring.

Geographical distribution or Habitat

Turmeric is a perennial, herbaceous plant that attains a growth rate of 60-90 cm in height. It has a short stem and tufted leaves and is a native of the Indian and Chinese tropical lands.

Today, it is cultivated extensively in India, Sri Lanka, parts of China, Pakistan, Haiti, Jamaica, Peru, Bangladesh, El Salvador, Thailand, Taiwan and Indo-China, Cambodia, Indonesia, Lao People's Democratic Republic, Madagascar, Malaysia, the Philippines, Viet Nam and throughout the tropics, including tropical regions of Africa.

The turmeric crop occupies about 6% of the total area under spices and condiments grown in India. The crop is grown in the states of Andhra Pradesh, Maharashtra, Orissa, Tamil Nadu, Karnataka the North East, and Kerala.

India currently meets an annual production demand of about 8 lakh MT of cured turmeric. It is the largest producer of turmeric in the world and contributes to almost 80% of the total production. About 92% of the produce is consumed domestically and the remaining 8% is exported.

Medicinal Properties:

The antiseptic and anti-inflammatory properties of turmeric have been known to Indians for centuries and with the advent of modern technology, awareness of its nutraceutical value and use as a medicine to heal many health disorders like liver problems, digestive disorders, skin diseases and wound healing has been continuously increasing. It is commonly used as a preservative and food colouring, and is one of the basic ingredients in curry powder. Curcumin is the active ingredient in turmeric which has been shown to have a wide range of therapeutic effects.

USES

Turmeric is used for arthritis, heartburn (dyspepsia), joint pain, stomach pain, Crohn's disease and ulcerative colitis, , haemorrhage, diarrhoea, intestinal gas, stomach bloating, loss of appetite, jaundice, liver problems, Helicobacter pylori (H pylori) infection, stomach ulcers, irritable bowel syndrome (IBS), gallbladder disorders, high cholesterol, a skin condition called lichen planus, skin inflammation from radiation treatment and fatigue.

It is also used for headaches, bronchitis, colds, lung infections, fibromyalgia, leprosy, fever, menstrual problems, itchy skin, post surgical recovery and cancers. Other uses include depression, Alzheimer's disease, swelling in the middle layer of the eye (anterior uveitis), diabetes, water retention, worms, an autoimmune disease called systemic lupus erythematosus (SLE), tuberculosis, urinary bladder inflammation, and kidney problems.

Turmeric is also applied to the skin for pain, ringworm, sprains and swellings, bruising, leech bites, eye infections, acne, inflammatory skin conditions and skin sores, soreness inside of the mouth, infected wounds, and gum diseases.

Besides its medicinal properties turmeric also has a number of other uses:

Cosmetic Uses

- Turmeric has always been a part of an Indian woman's beauty aid.
- Turmeric works as an effective antiseptic cream and can be applied to skin prone to pimples and acne
- When mixed with sandalwood paste, turmeric can remove blemishes on the skin, left by skin disorders and ailments like chicken pox.
- Turmeric is used as an integral part of ointments and face creams

Dyeing Agent

- From time immemorial, turmeric has been used as a dyeing agent for clothes. Thanks to its fast colour properties, the use of turmeric as a vegetable dye is gaining popularity once more.
- Apart from dyeing of clothes, turmeric is widely used as a colouring agent in the pharmaceutical, food, rice milling and confectionary industries.
- The crystallised dye consists of closely related pigments, namely, curcumin, oleoresin and demethoxy curcumin and bis-methoxy curcumin. All components have similar solubility characteristics and tinctural power. Pure curcumin exhibits a reddish shade.

Food Flavouring

- Oleoresin and curcumin are extracts of turmeric and widely used as food flavouring. While oleoresin is widely used in markets all over the world, the pure extract of curcumin has only been recently discovered in the industry.
- Apart from dyeing of clothes, turmeric is widely used as a colouring agent in the pharmaceutical, food, rice milling and confectionary industries.

The most important chemical components of turmeric are a group of compounds called curcuminoids, which include curcumin (diferuloylmethane), demethoxycurcumin, and bisdemethoxycurcumin. The best-studied compound is curcumin, which constitutes 3.14% (on average) of powdered turmeric. However, there are big variations in curcumin content in the different lines of

the species Curcuma longa (1–3189 mg/100g). In addition, other important volatile oils include turmerone, atlantone, and zingiberene. Some general constituents are sugars, proteins, and resins.

Curcumin is the pigment that lends the bright stunning yellow colour to turmeric. Curcumin crystals of 95% or more purity are today preferred in the food industry because of the brilliant golden colour. It is the main biologically active phytochemical compound present in turmeric. The compound is extracted for research purposes and has proven disease preventing medicinal properties.

Nutritive Values

Indian cooking attributes a lot of nutritive value to this spice. Apart from being used as a part of daily cooking, turmeric is believed to have many curative values that work differently on the organs of the body.

Given below, is the detailed list of nutritive values that turmeric has:

Cured turmeric composition/ 100 Gram

Moisture	5.8 g /100 g
Protein	8.6 g /100 g
Fat	8.9 g /100 g
Carbohydrates	63.0 g /100 g
Fibre	6.9 g /100 g
Mineral Matter	6.8 g /100 g
Calcium	.2 g /100 g
Phosphorus	0.26 g /100 g
Iron	0.01 g /100 g
Sodium	0.5 g /100 g
Potassium	175 IU /100 g
Vit.A	0.09 mg /100g
Vit.B	0.09 mg /100g
Vit.B2	0.09 mg /100g
Vit.C	49.8 mg /100g
Niacin	4.8 mg /100g
Calorific value	390 calories per 100g
Essential Oil	Dried Rhizomes 5-6% Fresh Rhizomes 0.24%

Source: Spice Board

In addition it also contains Magnesium, Fatty Acids (> 32 milligrams of omega-3 fatty acids and 114 milligrams of omega-6 fatty acids per teaspoon) which enhance brain function, reduce inflammation, keep arteries clear and improve the body's response to insulin.

The percentage of curcumin in different varieties of turmeric is given below and listed country wise according to the ASTA method:

- Salem finger, Tamil Nadu, India: 3.5%
- Alleppey finger, Kerala, India: 5-6%
- Rajapuri finger, India: 3 - 3.5%
- Kadappa finger, Andhra Pradesh, India: 2-3%
- Burma finger, Burma: 2.5 -3%
- South Vietnam finger, Vietnam: 5 -5.5%
- North Vietnam finger, Vietnam: 2.5- 3%
- Indonesia finger, Indonesia: 4.2- 5%
- Ethiopia finger: 2.5- 3%
- Nigeria sliced finger: 2.5- 3%

(*In comparison Lakadong turmeric has a curcumin content of 6.0 to7.5% as tested by the ICAR*)

Traditionally, oleoresin is most popularly used in the food industry over ground turmeric. The oleoresin is obtained by solvent extraction of ground, dry rhizomes and is orange red in colour. It consists of an upper oily layer and a lower crystalline layer, when not homogenised.

In the recent years, crystallised curcumin of 95% purity has rapidly gained an important place as a valuable food ingredient, replacing oleoresin. The yields of oleoresin and 95% curcumin crystals are 7-14% and 2-4% in dry turmeric respectively.

Volatile Oil

This is popularly known as turmeric oil. Turmeric has three principal extracts, viz, volatile oil (which is the essential oil of turmeric), turmeric oleoresin and curcumin.

Dried rhizomes yield about 5-6% volatile oil. It is an orange yellow liquid and has a tuberous odour. Volatile oil can be obtained through a process of steam distillation of dried rhizome powder or from crushed turmeric tubers.

Oleoresin

Oleoresin is in great demand in the global food and pharmaceutical industries. This semi-viscous liquid contains both volatile aromatic principles and non-volatile acrid fractions.

This ingredient contributes to the aroma of turmeric and is devoid of starchy and fibrous materials. Oleoresin carries a dark yellow-brown pasty appearance and contains the flavour compounds and colour in the same proportion as present in turmeric.

Turmeric oleoresin can be obtained by a process of solvent extraction of ground turmeric. In India, the extraction process has been standardised by CFTRI, Mysore and follows a two-step process of solvent extraction, followed by vacuum concentration.

Optimum yields of oleoresin are achieved when the rhizomes are harvested at 29 week maturity. For best yields, the rhizomes must be harvested at 37 weeks

GLOBAL SCENARIO

Turmeric grows wild in the forests of South and Southeast Asia. It is one of the key ingredients in many Asian dishes. Indian traditional medicine, called Siddha, has recommended turmeric for medicinal uses. In recipes outside South Asia, turmeric is sometimes used as an agent to impart a golden yellow colour. It is used in canned beverages, baked products, dairy products, ice cream, yogurt, yellow cakes, orange juice, biscuits, popcorn colour, cereals, sauces, gelatines, etc. Newer uses are the incorporation of turmeric with coffee as a lifestyle drink by Starbucks (turmeric latte) which is gaining immense popularity globally. It is a significant ingredient in most commercial curry powders. Most turmeric is used in the form of rhizome powder. In some regions (especially in Maharashtra, Goa, Konkan, and Kanara), turmeric leaves are used to wrap and cook food. Turmeric leaves are mainly used in this way in areas where turmeric is grown locally, since the leaves used are freshly picked. Turmeric leaves impart a distinctive flavour.

Although typically used in its dried, powdered form, turmeric is also used fresh, like ginger. It has numerous uses in East Asian recipes, such as pickles that contain large chunks of soft turmeric, made from fresh turmeric. Turmeric is widely used as a spice in South Asian and Middle Eastern cooking. Many Persian dishes use turmeric as a starter ingredient. Various Iranian *khoresh* dishes are started using onions caramelized in oil and turmeric, followed by other ingredients. In India and Nepal, turmeric is widely grown and extensively used in many vegetable and meat dishes for its colour; it is also used for its supposed value in traditional medicine.

In South Africa, turmeric is used to give boiled white rice a golden colour. In Vietnamese cuisine, turmeric powder is used to colour and enhance the flavours of certain dishes, such as *bánh xèo, bánh khọt*, and *mi quang*. The powder is used in many other Vietnamese stir-fried and soup dishes. The staple Cambodian curry paste *kroeung*, used in many dishes including *Amok*, typically contains fresh turmeric. In Indonesia, turmeric leaves are used for Minang or Padang curry base of Sumatra, such as *rendang*, *sate padang*, and many other varieties. In Thailand, fresh turmeric rhizomes are widely used in many dishes, in particular in the southern Thai cuisine, such as the yellow curry and turmeric soup.

In medieval Europe, turmeric became known as Indian saffron because it was widely used as an alternative to the far more expensive saffron spice. *(Source – Wikipedia)*

- Global production of turmeric is estimated at around 7 to 8 lakh tonnes.
- Turmeric cultivation is confined to South East Asian countries such as India, Sri Lanka, China, Indonesia, Australia, Africa, Peru and the West Indies and needs temperatures between 20°C and 35°C, and a considerable amount of annual rainfall to thrive.
- India dominates the world turmeric market and produces nearly 80% of the total world's production.
- China is the number two exporter of Turmeric. Other turmeric exporting countries are- Vietnam and Myanmar.
- Major importers of turmeric are UAE, USA, UK, Japan and other Asian countries

Turmeric producing countries

Sl. No	Country Name
1	India
2	Bangladesh
3	Pakistan
4	Sri Lanka

5	Taiwan
6	China
7	Myanmar
8	Indonesia
9	Mozambique
10	Jamaica
11	Haiti
12	Costa Rica
13	Peru
14	Brazil
15	Malaysia
16	Vietnam
17	Thailand
18	Philippines
19	Japan
20	Korea

Source: Turmeric world

- These countries contribute to the production of around 800000 tons of turmeric annually.
- India wholly dominates the world production scenario contributing to approximately 75% of world's production, amounting to 600000 tons of turmeric annually.
- It also holds the top position in the list of world's leading exporters of turmeric.
- Asian countries usually consume a large share of their own produce and India stands at the top in this case also.

In 2006-07, turmeric exports increased from 51,500 tonnes at Rs 164.80 crores as against 46,405 tonnes valued at Rs 152 crores in 2005-06. The most sought after exports from India are dry turmeric, oleoresin and turmeric powder. In terms of volumes, turmeric oleoresin exports accounts for 200 tonnes per annum. Comparatively, turmeric powder constitutes a very small portion, Andhra Pradesh leads in the production of turmeric, meeting an average of 55- 57% of the total production.

Key export markets include:

- UAE: 17%
- USA 10%
- Bangladesh 9%
- Sri Lanka 7%
- Japan 7%
- Malaysia 6%
- UK 6%

TURMERIC IN INDIA

India is the largest producer, consumer and exporter of turmeric The important turmeric growing States in India are, Andhra Pradesh, Tamil Nadu, Orissa, Maharashtra, Assam, Kerala, Karnataka and West Bengal, in which Andhra Pradesh occupies 40 per cent of total turmeric area followed by Orissa and Tamil Nadu occupying 17 per cent and 13 per cent of total turmeric area respectively. In terms of production Andhra Pradesh accounts 60 per cent of total turmeric production in India followed by Tamil Nadu (13 per cent) and Orissa (12 per cent).

Turmeric is not just a part of the Indian kitchen. It is an integral part of our way of life. Its usage covers 4 distinct areas:

Cuisine:

- Turmeric is an integral part of almost every meal prepared across homes. It's warm mild aroma and distinctive yellow colour is essential to curry powders and used to flavour almost all Indian dishes.

Medicine:

- According to the system of traditional Indian healing, turmeric is used as an antiseptic, forming a part of many ointments and lotions for external wounds and skin infections. Turmeric is also used in the treatment of arthritis and to treat jaundice in the initial stages. The Ayurvedic and Unani forms of medicine use turmeric as a vital ingredient of their medicines to heal a variety of disorders: from blood purification to digestive ailments to liver problems.

Dyeing agent:

- Silk and woollens from India are dyed with turmeric by immersing the fabric in an acidic bath. It is also used in the food, pharma, confectionary and rice milling industries.

Cosmetics

- It is widely used as part of cosmetic preparations from the traditional kumkum to anti- acne and pimple creams. It is also used by the women of India to remove facial hair.

Traditions and Myths

- In India, the use of turmeric travels far beyond the kitchen. It is an integral part of every auspicious occasion, tradition and celebration. No festivities or special occasion is complete without the use of this wonder ingredient.
- Its classical name in Sanskrit is Haridra, symbolising its special bond with Hari or Lord Vishnu. It is believed that the clothes worn by the gods of Hindu mythology were dyed in turmeric.
- Many synonyms for turmeric exist in Sanskrit; more than 55 synonyms are indicated in Amarakosha and Nighantus. Most of the vernacular names for the spice are derived from Sanskrit or Hindustani.

Traditional uses

In Ayurvedic practices, turmeric has been used as an attempted treatment for a variety of internal disorders, such as indigestion, throat infections, common colds, or liver ailments, as well as topically to cleanse wounds or treat skin sores.

Turmeric is considered auspicious and holy in India and has been used in various Hindu ceremonies for millennia. It remains popular in India for wedding and religious ceremonies.

Indian Varieties :Approximately 30 varieties have been recognized in the type of Curcuma in which turmeric belongs. Amalapuram, Armour, Dindigam, Erode, Krishna, Kodur, Vontimitra, P317, GL Purm I and II, RH2 and RH10 are some popular Indian varieties among them.

Major varieties of Turmeric

- Alleppey Finger'(Kerala)
- 'Erode and Salem turmeric' (Tamil Nadu),
- 'Rajapore' and 'Sangli turmeric' (Maharashtra)
- 'Nizamabad Bulb' (Andhra Pradesh)

- In Tamilnadu, the important varieties cultivated are Erode local, BSR-1, PTS-10, Roma, Suguna, Sudarsana and Salem local. Among these varieties, 70-75% is occupied by the local varieties
- Allepey Finger Turmeric, Rajapuri, Madras and Erode are some of important exported varieties.

Varieties Name	State Name
Alleppey Finger	Kerala
Rajapore, Karhadi, Waigon and Sangli turmeric	Maharashtra
Nizamabad, Armoor, Vontimitta, Mydukur, Duggirala, Sugandham, Tekurpeta etc	Andhra Pradesh
Erode local, BSR-1, PTS-10, Roma, Chinnanadan, Perianadan, Suguna, Sudarsana and Salem local	Tamil Nadu
Pattant	West Bengal and Assam
Lakadong (*high curcumin content - 7.5%)*	Meghalaya

Source: http://agriexchange.apeda.gov.in, http://www.turmeric.co.in

The most popular varieties of turmeric in India are:

South Indian varieties

Kasturi

The core of this rhizome variety is pale yellow or white in colour. It has a heady fragrance after curing and is often used as a part of beauty treatments

Mundaga

These rhizomes are thick and have many fingers

Balaga

These have fewer numbers of fingers with thinner corns.

Yalachaga

These rhizomes are characteristically small, but have a large number of fingers;

Maharashtrian varieties

Lokahandi and Rajpuri

Andhra Pradesh varieties

Duggriala, Tekurpeta, Katuri, Pasupa, Amoar, Nizamabad, Chayapasupa

North Eastern Varieties

GL Puram, Dehradun local, Daghi, Lakadong

Note: Lakadong is very famous for its high curcumin content of more than 7.5%

India accounts for 60% of world exports. The main growing states in India are Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and Kerala.

Major Spice Wise Area & Production (2016)

SPICE WISE AREA & PRODUCTION

(Area in Hec, Production in Tonnes)

Spices	2011-12		2012-13(P)		2013-14 (P)		2014-15 (Est)		2015-16 (Adv.Est)	
	Area	Prodn.	Area	Prodn.	Area	Prodn.	Area	Prodn.		
Pepper	201381	43000	122500	65000	122400	37000	123900	70000	128870	48500
Cardamom(Small)	71285	15000	69870	14000	69970	16000	69970	18000	69970	22000
Cardamom(Large)	26460	3860	26060	4145	26060	4465	26387	4850	26387	5300
Chilli	793921	1448215	787530	1378400	791930	1376400	766620	1621480	769210	1628100
Ginger	125374	924417	134430	669350	138200	683160	153100	795820	153450	799860
Turmeric	251824	1398862	194330	986690	207570	1092630	178470	846250	190420	843530
Coriander	362148	428687	531070	503240	516070	496240	604090	546800	585710	557000
Cumin	843401	462645	593980	394330	690080	445030	701560	372290	701560	372290
Celery	4176	5271	4070	5510	4070	5510	4070	5510	4070	5510
Fennel	92446	144112	99610	142940	94070	135930	46760	78570	46760	78570
Fenugreek	96304	121775	93110	112870	90500	110530	124710	134100	124710	134100
Ajwan	45693	28050	39690	26620	39260	26610	24010	17180	24010	17180
Garlic	171800	898438	247430	1260210	238760	1221380	261510	1424860	261740	1431540
Tamarind	52788	182089	58300	189980	58720	191750	54120	200390	54740	202510
Clove	2100	1035	2060	1060	2060	1060	2380	1260	2310	1200
Nutmeg	18407	12138	18730	12730	18730	12730	21110	14400	21110	14400
Grand total including others	**3541804**	**6324920**	**3172468**	**5801114**	**3145610**	**5833870**	**3192640**	**6169900**	**3190070**	**6187590**
GRAND TOTAL IN MLN TONNES		**6.32**		**5.80**		**5.83**		6.17		6.19

(Est) : Estimate ; (P): Provisional

Source: State Agri/Hort. Departments/DASD Kozhikkode

Cardamom: Estimate by Spices Board

Market Segmentation of Turmeric Market:

The Turmeric market is segmented on the basis of its form and application. In terms of form, turmeric is categorized into three different forms which are dried slices, powder and liquid form. As per application, it is segmented as food and beverages, medicinal and cosmetics. Market segment of turmeric with reference to food and beverage type, is segmented as per its usage in culinary dishes, bakery products, dairy products and beverages. Further in context to health care segment, turmeric has application to combat health issues related to digestion, liver, cancer, cholesterol, osteoarthritis and many other health disorders. Another application of turmeric is in cosmetic industry where it is used as an herbal product in skin and body care products. Further the market of food type can be segmented in terms of using the turmeric for different purposes such as an ingredient, taste enhancer and colouring purpose and in terms of beverage it is used in tea, juices and canned beverage.

Grade Specification

Though the export market is a lucrative avenue for turmeric the produce has to conform to certain standards to be acceptable. The following table elucidates the stringent trade specifications for whole and ground turmeric.

Important turmeric trade requirements

After harvesting proper care should be taken to ensure the product is in conformity with the trade requirements. The major important attributes which should be kept in mind at the time of harvesting and storing are as follows:

Grade specifications

Grade designations and definitions of quality of Turmeric Finger:

Special Characteristics						
Grade Designation	Flexibility	*pieces % by weight (max)	Foreign % by weight(max)	Chura and defective bulbs % by weight(max)	%of bulbs by weight (max)	Admixture varieties of turmeric (%)
Special	Should be hard to touch and break with metallic twang	2	1.0	0.5	2.0	-
Rajapore special	-	3	1.0	3.0	2.0	2.0
Allepey good			1.0	3.0	4.0	-

* Pieces are fingers, broken or whole, 15 mm or less in length.

Grade designation and definition of quality of Turmeric Ground:

Special Characteristics						
Grade Designation	Moisture % by weight (max)	Total ash % by weight (max)	Lead as (Pb) parts per million (max)	Starch % by weight (max)	Chromate test	Acid insoluble ash, % by weight (max)
Standard	10.0	7.0	2.5	60.0	Negative	2.5

Characteristics

In accordance with the norms of the Spice Board, the physical characteristics of turmeric are finger like in shape, and forms the secondary rhizomes of the plant Curcuma longa L.

Typical characteristics include:

- Well set, closely grained, free from bulbs (primarily rhizomes) and ill developed, porous rhizomes
- Their shape, length, colour and other characteristics are typical of the variety

As stipulated by the Spice Board, good grades of turmeric must conform to the following specifications:

- Perfectly dry
- Free from damage caused by weevils, moisture, over-boiling or fungus attack
- In a sample of good grade turmeric, only 1-2% by weight of rhizomes will be accepted under the damaged or over boiled clause.

CHAPTER TWO

MISSION LAKADONG

INTRODUCTION: TURMERIC IN MEGHALAYA

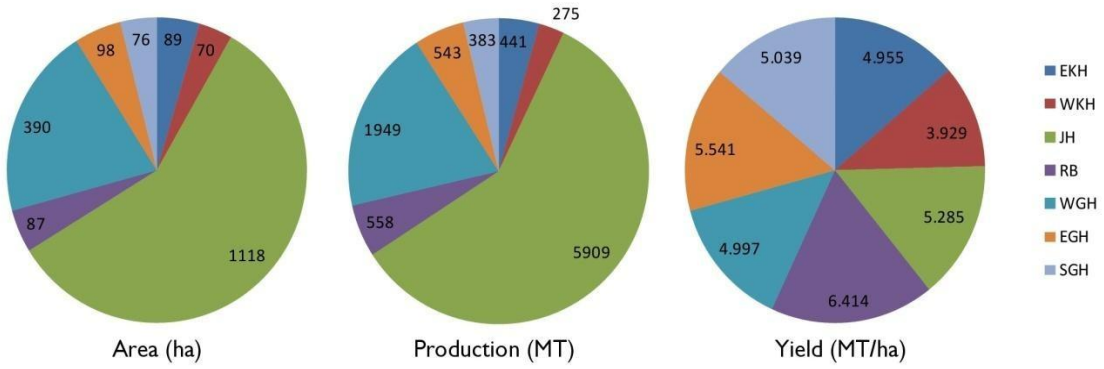
Meghalaya has natural advantages in growing a variety of spices of which the prominent ones are turmeric, ginger, chilli, black-pepper and bay-leaf. Except for bay leaf, which is a minor forest produce, the other spices are cultivated. The Lakadong turmeric is unique in the world with the potential to change the lives of countless farmers if its uniqueness is properly exploited. There is an established demand for the variety and buyers who are willing to pay a premium for its quality. However the variety and the name is being threatened by other producers from other areas who have latched onto the name to sell sub-standard or even adulterated turmeric, thereby confusing the market and lending a bad name to the variety and to the original areas from where it is produced.

Turmeric is synonymous with Jaintia Hills and the Jaintia Hills Districts of Meghalaya is home to one of the finest turmeric varieties in the world – the famous "Lakadong" variety. With a curcumin content of more than 7% (almost 2% higher than other varieties), chemical free, the turmeric from the region is much sought after for use in the cosmetic, pharmaceutical and food industry. However despite this good demand, farmers have not, till date, been able to realise the full economic potential of this crop primarily because of the preponderance of small and marginal farmers, absence of focussed research, low individual volumes exacerbated by lack of organized aggregation, weak post harvest management and market facilities, lack of universal access to information, skills and technology, unreliable price discovery, dominance of middle men, trader cartelization, weak extension, lack of assured irrigation, access to finance and most importantly, insufficient planting material in Lakadong.

The Jaintia Hills region consisting of the two districts of East and West Jaintia Hills produces at least three varieties of turmeric - Lakadong, Laskein and Ladaw, each having their separate identity. As per data available with the horticulture directorate, the cultivation of turmeric (Lakadong variety) is concentrated in the Nongbah-Shangpung belt of West Jaintia Hills district with around 1000 cultivators of the crop spread over 2577 hectares and covering villages like Shangpung, Raliang, Sahsniang, Lakadong, Nongryngkoh, Mootyrchiah, Khliehrangnah, Thadmuthlong, Pasyih, Mukhap, Mowkaiaw, Nongkynrih, Kyrwen, Mulieh, Ynniawkmai, Sahsniang, Iongkasaro, Umsalait, Mooshrot, Saphai, Iooksi, Priang, Nongryngkoh, Biar, Rtiang, Psiar, Kyndongtuber, Pammanik, Samatan, Shilliangmyntang, Thangrain, Barato, Saba, Sookhlieh, Thadbamon, Khliehsniriang, Lummuriap, Musiaw, Umsalang, Latymphu, Moobandu, Umshangiar and Umplu.

The Lakadong variety has about 7.4% curcumin content and has very good commercial value in the market. The volatile oil content in dry turmeric varies between 3.6% to 4.8%. The district is known for the production of high quality turmeric with curcumin content of > 7.5 per cent. Though, the crop is grown in an extent of 1928 hectares, Jaintia Hills accounts for 58.0 % and West Garo Hills for 20.2 % of the total area due to favourable soil and climate. Each of the other five districts has about 4.0 per cent of the area. The State produces around 16 thousand MT of turmeric, of which 72.0 percent is contributed by Khasi-Jaintia Hills and 28.0 per cent by Garo Hills. Production grew at an annual rate of 2.47 per cent and area at 3.14 per cent per annum, indicating that yield may have marginally declined.

Area, Production and Yield of Turmeric by Districts



(*Source: In conversation with people of Meghalaya IBDLP*)

One possible explanation that has been offered for the decline is that a majority of the people who have been traditionally growing the crop have shifted to the mining of coal during the coal boom that existed in the Jaintia Hills especially East Jaintia Hills due to the high margins offered by coal mining and export. However the April 2014 order of the NGT banning coal mining in the state came as a game changer as people started looking for alternative sources of income and has resulted in many of those engaged in coal mining activity switching back to turmeric farming for their livelihood. For the past one year, these coal-miners, who previously practised unscientific mining and transportation of coal, have taken to cultivation of the famed curcumin-rich Lakadong turmeric variety at their villages in East Jaintia Hills District.

The Indian Council for Agricultural Research (ICAR) has through its trails and tests proven that the curcumin content of Lakadong variety is 6.0-7.5 per cent, about 2 per cent higher than the turmeric available in the market. There is a very high demand from the pharmaceutical industry for these curcumin-rich turmeric varieties as it can be used in cosmetic, pharmaceutical and dye/food- colouring industries.

Taking advantage of the default organic nature of the crop and its high curcumin content, a number of private companies have been making inroads into the turmeric growing villages of Jaintia Hills to source turmeric, viz the Bangalore based company Sami Sabinsa Group which is keen to source high curcumin turmeric produced in Shangpung area of West Jaintia Hills for manufacture of its anti-cancer curcumin tablets. Similarly ITC Ltd is also sourcing dried turmeric slices from the area but through middle men. There is also interest among the Hyderabad based pharmaceutical companies that are keen to have a long-term procurement relationship with the farmers of the region, if necessary, even by establishing processing facilities in Laskein.

Realising the need to being the farmers to come together and for leveraging this market and negotiate better prices with buyers, the Livelihood Improvement Project for Himalayas in Meghalaya (LIPH) project implemented by the Meghalaya Rural Development Society (MRDS), facilitated the establishment of a farmers' federation called 'Laskein Federation for self-help groups' (LIFE), an apex body of 120 SHGs and 7 clusters, with the express objective of creating opportunities for the farmers to obtain a better value for their own product and to negotiate with market players like ITC for bulk supply to cater to the needs of the pharmaceutical industry. With assistance from NEHU, Department of Biotechnology, MRDS and ICAR , the federation set up an oleoresin oil extraction plant with a capacity of 300 kgs dry and 150 kgs fresh turmeric per day for value addition of turmeric so that high-quality turmeric would be available in the market. The lack of training, management capacity, ignorance of the market, certification and lack of a distinctive brand and capital has however prevented the federation from

realising its goals and today the unit is barely managing to keep itself afloat. Though the Federation is in a position to market turmeric in powder form, it has yet to commence its steam distillation unit.

Also with the objective of tapping into the widespread cultivation of the crop and its uniqueness for the benefit of the farmers, the Directorate of Horticulture did establish a Turmeric aggregation cum processing Hub in Thadlaskein. However the unit has yet to put in place an organized supply chain that would enable it to run profitably year round.

RESOURCE AVAILABILITY

Turmeric varieties like Lakadong and Megha Turmeric-1 and a number of local cultivars exist in the north eastern region. The turmeric produced in this region contains high oleoresin and curcumin content. The product is mostly marketed in the fresh form. The local demand being very limited, roughly 70-80 % of the total production is reportedly available as marketable surplus from the region. As it is abundantly available in the region, different products like turmerones (turmeric oil), oleoresin, and powder can be prepared for export, which are very common in developed countries.

The area under turmeric in the region is 2577 ha with a total production of 16324 tonnes (2015-16). In Meghalaya, Lakadong is the main variety with more than 50 per cent area under this variety.

Markets in Meghalaya

In Meghalaya the marketing of turmeric takes place primarily in unregulated markets called 'haats', or weekly bazaars. Traders come from Shillong and Assam to purchase Lakadong at wholesale prices in Jaintia Hills haats and even at the farm-gate of cultivators. Even organized trading companies such as ITC Ltd procure turmeric from the rural haats of Jaintia Hills through local middlemen. The marketing of Lakadong turmeric is thus controlled by a handful of middlemen.

Despite Lakadong's high value, it is still marketed as ordinary turmeric. ITC Ltd procures only Lakadong turmeric slices from Jaintia Hills and mainly processes it to extract curcumin content for pharmaceutical units. The pharmaceutical units pay as high as US$ 35 per kg for turmeric active ingredients (95 per cent curcumin content). Since ITC also buys from middlemen, farmers are not benefiting from the value addition of turmeric and the benefits of bulk procurement. The farmers simply market turmeric at Rs 40 per kg (US$ 0.9) while turmeric powder is sold at Rs 70 per kg (US$ 1.50).

The regional consumers are also unable to buy pure turmeric since there is large-scale adulteration of turmeric in the market. Lack of market information among cultivators, lack of adequate infrastructure and topographical constraints are some of the factors which limit the marketing efforts of the cultivators. Lakadong turmeric in Jaintia hills is currently sold in powdered form, catering to local markets. There are approximately 40 mills in the district, all privately owned and located in the above-mentioned villages. The average output per mill is 200 kilograms per day.

A study published in the Indian Journal of Economics on the "Development on Economics of Turmeric Marketing in Jaintia Hills District of Meghalaya'- (April 2016), examined the marketing system and the major constraints in marketing of turmeric in the Jaintia Hills district of Meghalaya across 80 farmers and 40 market intermediaries. The study revealed that a large number of the farmers were female. The marketable and marketed surplus was found to be 63.08 percent and 60.56 percent to the total production respectively. Three major marketing channels were identified; Channel-III (Producer-Commission agent – Wholesaler – cum – processor – Retailer -Consumer) was most common. The producer's share in consumer's rupee was more or less equal in all the channels with a difference of 2 to 3 percent. Channel-I was found to be more efficient than Channel-III, but the volume transacted was more in the case of Channel-Ill. Price fluctuation was the major problem faced by farmer,

whereas unavailability of proper storage facilities was the serious problem faced by market intermediaries.

Current research has conclusively proven the tremendous health benefits of turmeric and its constituent curcumin in the treatment of various diseases and ailments. One of the most exciting findings has been the role of curcumin in the treatment of cancer and this research has resulted in an increased awareness and interest from pharmaceutical entities in Lakadong given its high curcumin content. While this is a high value emerging market that promises potentially very good returns to the farmers and the state, the volumes available currently are too small to sustainably tap into this market.

Taking all these factors into account there is a very strong case for scaling up the cultivation of Lakadong turmeric through focused strategic interventions especially in the areas of quality planting material production, area expansion, farmer mobilization, organized marketing, value chain creation, branding and quality control which if properly implemented could change the landscape of the spice sector in Meghalaya and truly make Lakadong turmeric worth its weight in gold. To this end the Directorate of Horticulture, Government of Meghalaya intends to scale up Lakadong turmeric related activities in Jaintia Hills several fold and implement future interventions in a convergent mission mode, to be known as the '**LAKADONG MISSION'** with the following objectives.

Mission Objectives:

1. Enhancement of the livelihood and income opportunities of Lakadong turmeric farmers by leveraging on the uniqueness of Lakadong to tap the current and emerging opportunities in the spice sector. This will call for setting a target of 50,000 M.Ts. of Lakadong in a period of five years.

2. Building up the brand equity of Lakadong as a uniquely Meghalayan premium product, both online and offline, that is synonymous with quality and purity. This will call for investment to register the Geographical Indication for Meghalaya's Lakadong.

3. Induction of the latest technology and management practices for enhancing the availability of quality planting material. This will call for establishing Tissue culture Labs in key locations of the state and using the available resources of NEHU, Forest and Agriculture Departments.

4. Creation of an ecosystem that catalyses the emergence and growth of local private enterprises in the value chain. This will call for sustained capacity building of the potential entrepreneurs and establishing market linkages by the Meghalaya Institute of Entrepreneurship.

Mission Approach

The Mission will adopt a very focused approach of leveraging on the current brand equity of Lakadong and the increasing demand especially from the pharmaceutical industry, to ensure better returns for the farmers of the crop through streamlining and facilitating the demand supply chain. To this end the Mission will operate in a highly convergent mode as there are already a number of organizations and agencies in addition to the Directorate of Horticulture that are currently involved in the Lakadong turmeric space like the DRDA which is focused on livelihoods around Lakadong, the MeghaLAMP which is mapping the value chains, the Meghalaya Institute of Entrepreneurship (MIE) which is striving to promote entrepreneurship and enterprises through value addition. There are also a number of local private entities like Zizira, COLKS, Country Spices, Nest, Wan's, Hunbait, LIFE Cooperative Society etc which have either tied up with Lakadong farmers to buy turmeric from them or are processing Lakadong turmeric to feed their own clients. The Mission would strive to bring them all onto a convergent and enabling platform that would ensure fair

returns to farmers and stabilising the market through facilitating the growth of these local enterprises and linking them to big institutional buyers. The Mission would also strive to put in place the requisite IPRs to ensure that the brand name is not diluted by unscrupulous element that are trying to cash in on the name. This approach it is believed would usher in the much needed ecosystem that would allow farmers to take maximum advantage of their USP while stimulating the growth of enterprise and consequent employment generation in the district. The Lakadong Mission will have a specific time frame of five years from the launch year ie., by April, 2023.

Brief of Mission components

A) Capacity Building & Farmers' mobilization

Capacity development is the cornerstone of inclusive development. Mobilization, capacity building and fostering a sense of ownership amongst the farmers is critical to the success of the Mission and the most important means of empowering the people. This is particularly true of the poor and vulnerable sections that do not own land or do not have access to capital. Endowing them with human capital will empower them to gainfully participate in mission activities. For the mission to be able to achieve what it sets out to do, farmers have to be sensitized and mobilized so that they become active partners in the development process. Furthermore and with the objective of ecosystem building, this capacity development needs to be extended not only to individuals but to intuitions also which starts with the VECs and extends to various institutions in the state such that they are able to effectively implement various components of the mission and ensure that funds defrayed result in commensurate outputs and outcomes. Of equal importance is the need to build capacity in the government bureaucracy in various aspects of mission governance and to make them sensitive to the needs of the people and the market. This component of the mission will be undertaken by the Agricultural Technology Management Agency (ATMA) and the District Horticulture Office (DHO) working in tandem with the DRDA, the C&RD Department through the office of the Block Development Officer (BDO), Laskeiñ, the Basin Development Unit, the Meghalaya State Rural Livelihoods Society, Laskeiñ and the Meghalaya Institute of Entrepreneurship (MIE) through meetings, awareness programme, workshops, seminar, farmers conferences, kisan mela / exhibitions, field day, field demonstration / on farm trial, exposure visit, media and radio talks.

B) Area Expansion: -

The current area under Lakadong is around 2577 ha with a total production of 16324 tonnes (2015-16) and a productivity of 6 MT per hectare which many sources have quoted as not being enough to feed the demand. To address this issue and meet future demands the Mission aims to increase the productivity to 8 MT per hectare, production to 50,000 metric tonnes and area under the crop to 15,000 acres (6070 hectares) over the next five years through a combination of intensive area expansion, organic and scientific agronomic practices and production of quality seed material. Convergence initiatives under the Bottom 40 programme of the MNREGA, which is aimed at livelihoods promotion, will be primarily used to bolster and support initiatives under this component through the VECs.

C) Planting material propagation and multiplication: -

The basic input in any area expansion programme and development of value chains for any crop starts from the seed and turmeric is no exception. Turmeric is vegetatively propagated by means of underground rhizomes. Rhizomes, also known as "Clump," "Bulb," "Corms," "Set," and "Tuber" in scientific literature, are of two types, namely "mother rhizome" and "finger rhizome," also known as "daughter rhizome" (developed from mother rhizome). The fingers are primary, secondary, and tertiary depending on their position. Primary fingers constitute a major share in the clump, while secondary

and tertiary are less in quantity. Both mother and finger rhizomes are used in propagation. However, primary fingers are commonly used in planting owing to its availability in large quantities. In field performance, mother rhizomes have been found to perform better than finger rhizomes. Whole mother rhizomes grow rapidly and develop well and are found to be better yielders than finger rhizomes. Farming families of the Jaintia Hills have been preserving and multiplying Lakadong mother plants for many generations but of late the decline and non availability of quality mother rhizomes is a growing cause for concern. There is no Lakadong seed farm in the district and registered growers few and far between.

One of the Mission's objectives is to foster enterprises in the spices sector through value chain interventions but these interventions will not happen in the absence of sufficient quantity of produce to justify and make enterprises in the value chain economically viable. The Mission aims to improve the availability of planting material in the district by focusing on the production of quality mother rhizomes through the following initiatives:

i. Seed production in the Horticulture Turmeric Farm at Iongkyndar (Mowkaiaw)

With a total area of 9 hectares out of which only about 2 hectares is currently under utilization, the departmental farm has been struggling to meet the seed requirement of the farmers. Under the mission it is proposed to utilize and additional 7 hectares of the farm for the production of quality seed rhizomes to be distributed to new aspiring farmers and areas. As the farm is manned by trained technical personnel of the department it is anticipated that this farm will evolve to be the nucleus and a **Centre of Excellence / Hub** for the conservation and continued availability of quality *Lakadong* turmeric planting material. However certain amount of investments will have to be made by the department to realise the full potential of this asset.

ii. Community Seed Banks / Seed villages

A community seeds bank is a locally governed and managed, mostly informal institution whose core function is to multiply and maintain seeds for the use of local farmers. This concept is in harmony with *Lakadong* turmeric production and conservation, since it is a location specific crop. With this concept in mind, farmers groups, self help groups, Village Employment Council (VECs) who are interested in producing *Lakadong* turmeric rhizomes at their own land or in community land will be assisted financially and technically under this mission etc by the state department, in collaboration with the BDUs, the DRDA and the Meghalaya Institute of Entrepreneurship (MIE) which already has a project in place. The seed rhizomes so produced will be another option of seeds source for the farmers. Since the seeds are produced at the village level, farmers' accessibility to seeds is much easier, variability of seeds is minimized and adaptability of the crop may be enhanced. Community seed banks may be started in every village. Such seed banks can be linked to the Hub for technical support, technology clearing, quality control and forward linkages.

iii. Rapid Multiplication of seeds through

(a) Single Bud Rhizome pro-tray method (standardized by Tamil Nadu Agricultural University, Coimbatore)

This method can be done under 50% shade (shadenet house). Under this method a Lakadong turmeric rhizome is cut into small pieces weighing 5-7g each with a single bud. The pieces are to be treated with trichoderma /pseudomonas fluorescens to avoid infection. The single bud rhizomes are sown in protrays filled with cocopeat and covered with a polythene sheet for 7

days for faster germination. After seven days the buds will germinate and the polythene will need to be removed. Regular watering is to be done such that there should be no water stress. Sprouted rhizomes after 30-35 days) are ready for transplanting in the main field. While this method can ensure quick availability of rhizomes it requires trained manpower to manage the operations and can also be a potential enterprise opportunity for educated youths in the villages. In fact the Turmeric Farm at Iongkyndar (Mowkaiaw) could be the incubator for such enterprises as a Centre of Excellence for Lakadong.

(b) Tissue Culture

The limiting factor for wider area expansion of *Lakadong* turmeric is the imbalance between availability of quality seed material and the number of new farmers wanting to grow it. To meet this challenging issue, rapid mass multiplication techniques like Tissue Culture would need to be explored as the way forward for producing sufficient seed material of turmeric. The Mission will mobilize and bring in the expertise and resources of the Directorate of Horticulture, Department of Forest and North Eastern Hill University for this component as there are competent professionals and resources within these institutions to carry out the work. A separate project proposal on tissue culture propagation of Lakadong has been prepared by the NEHU which is being dovetailed into the Mission. The NEHU, through this Mission, will be mandated to standardize the protocols and pass them on to the Forest and Horticulture department TC Labs for production and supply of the requisite number of Lakadong planting material through the Mission period. A brief of the proposed intervention is placed in Annexure – III.

D) Post harvest management and processing:-

Lakadong may have the highest curcumin content but the quality of the final product whether it be slices, powder or fingers is dependant to a very large extent on the post harvest treatment and processing of the turmeric. There are reportedly around 40 mills with an average output of 200 kgs per day per mill located in the turmeric areas. In the private sector, the LIFE Spices Processing Cooperative Society Ltd is the most well equipped with an oleoresin and powdering plant in Laskein block but has not been able to achieve full production due to lack of training, marketing outreach and skilled manpower. The Directorate of Horticulture has also established a turmeric processing plant in Thadlaskein Horti Hub which is supposed to cater to the processing needs of the district. The quality of the final product of these establishments is dependent on the turmeric that is being sourced from the farmers and how it has been treated post harvest.

The traditional method of curing turmeric involved the slicing of the rhizomes and then sun drying which takes anything from 15 days to a month depending on the thickness of the slices. This method results in poor curcumin content of the dried slices due to the effect of sunlight and increased chances of microbial and fungal growth especially in humid conditions. The standard recommended method is to boil the rhizomes for around 45 minutes and then either dry them whole or slice and dry them. This is a better method as the drying times are reduced and microbial growth arrested but is more time consuming and requires a source of fuel for boiling which farmers are reluctant to invest in. The CFTRI, Mysore and the Tamil Nadu Agriculture University (TNAU) have both developed new, improved and more efficient value addition technologies for turmeric processing which are reported to bring down the cost of fuel and time taken to cure the rhizomes while resulting in a better product.

The Meghalaya Institute of Entrepreneurship (MIE) had submitted a project proposal to the NEC titled "Area expansion and value chain development of Lakadong turmeric" for Rs. 1.50 crores which has been approved for 2018-19. Though the project has a small component of area expansion for seed purposes, its main focus is support for small scale turmeric processing enterprises, packaging, branding and trade promotion. The project would extend support to around 4 (four) eligible and well functioning processing units in terms of equipment like turmeric steamers / boiler, polisher, packaging equipment and facilitating access to certification and quality testing facilities in order to boost up their production and quality. However the enterprises incubated through this project will have to make their own investments in working capital, human resources and raw material either from their own resources or through bank linkages which will ensure stakeholder participation, continuity and sustainability of the enterprise. Assets created through this project will be operated and maintained by the respective enterprises. It is proposed that the MIE project may be dovetailed as an accompanying support to the Mission and as a convergence initiative for the overall benefit of the farmers and entrepreneurs. It will also be necessary to induct Solar Dehydrators of reasonable capacities as a part of the Mission, to enable the SHGs to use them periodically, during the harvest season. Solar dehydrators have the capacity to shorten the cycle of drying and with better hygiene for which support is coming from the Governor's Secretariat, which has evinced keen interest for taking Lakadong on to greater heights.

E) Ecosystem Building & Enterprise Promotion:-

(i) Promotion of producers 'groups and FIGs

Mobilizing and bringing Lakadong farmers together into clusters and groups for the purpose of aggregation and volume so that their bargaining power is enhanced. Farmers need to be sensitized and taught the power of collective action. Individual turmeric farmers are mostly small and marginal with low individual volume production. As their production per farm is small they are forced to sell their produce either at the farm gate or in the local markets at prices determined by the trader. They have limited access to technical, market information and financial resources, which could enable them to negotiate better prices with buyers. As a group however the dynamics change in favour of the farmers and thus the need of the hour is for farmers to organise themselves together by establishing commodity groups, farmers' interest groups, self help groups, farmers' federation and producer groups to realize greater economies of scale, help in improving their purchasing and selling power, sustainability and building social cohesion. Groups may also serve as a forum for solving production and market issues, training and information sharing and self help approaches. This activity can be part of the mobilization component to be carried out by the office of the BDO and working through the VECs.

(ii) Promotion of agripreneurs / agribusinesses:-

Motivating, mobilizing and training agribusiness entrepreneurs to take up higher end functions of the Lakadong value chain like establishment of aggregation centres, organised processing and trading of this valuable spice and creating ethically and socially responsible businesses that can sustain them and their families while giving the farmer his / her fair share is critical to take the Mission forward and ensure good returns. Learning from past experiences, the identification and creation of collection and aggregation centres in the private sector which are linked to buying / auction houses while addressing the issues of local middle men and how to bring them into the system to that their livelihood options are not affected will be one of the focus areas of this component.

(iii) Supply Chain:-

Structuring of a post harvest logistics and supply chain and putting in place processes for movement of both information and funds in such a manner that all actors in the value chain benefit will be another crucial link in the value chain. The Department of Agriculture has launched the 1917iTEAMS which is structured for precisely this kind of intervention and the Mission should make full use of it.

(iv) Networking:-

Establishing relationships with the pharmaceutical, cosmetics and spice industry to explore the possibility of direct off take of turmeric from the farm gate / aggregation centres and even establishment of small scale manufacturing in the state is the other essential ingredient that will ensure the success of this Mission.

F) Marketing:-

The turmeric market is segmented on the basis of its form and application. In terms of form, turmeric is categorized into four different forms which are fresh, dried, powder and liquid form. As per application, it is further segmented as food and beverages, medicinal and cosmetics. With regards to food and beverage type, it is segmented as per its usage in culinary dishes, bakery products, dairy products and beverages. This market can be further segmented in terms of the usage of turmeric for different purposes such as an ingredient, taste enhancer and colouring purpose and in terms of beverage it is used in tea, juices and canned beverages. In the context of the health care segment, turmeric has applications in combating health issues related to digestion, liver, cancer, cholesterol, osteoarthritis and many other health disorders. In the cosmetic industry it is used as an herbal product in skin and body care products.

An analysis of the market segmentation shows that higher values are being realised in the food and medicinal use segment due to increasing food consumption level among consumers while in the medicinal usage segment the demand is driven by the presence and percentage of curcumin and its application in ayurveda and its significant role in the modern conventional development of medicine. In this respect Lakadong has the advantage of a higher content of curcumin which is a major attraction for pharma companies.

A small example of the emerging demand from the food industry is that of turmeric Latte which is experiencing a wide following and has attained a cult status in markets abroad. From Sydney to San Francisco, cafes and restaurants are adding turmeric latte to their menus and the rising popularity of the same is reflected in the gradual loss of sales of different coffee lattes. The Guardian analyzing the market demand has given Turmeric Latte a title – '2016's drink of choice'. Google, too in its report of November 2015 to January 2016 has mentioned turmeric latte as a rising star as the search for turmeric saw a steep ascent of fifty six percent.

(i) Regional Segmentation of Turmeric Market:

Regionally the turmeric market can be categorized into seven different regions which include North America, Latin America, Eastern Europe, Western Europe, and Asia-Pacific region, Japan, Middle East and Africa. The Asia-Pacific region is one of the largest turmeric producers in world with a majority of the production coming from India and China. On the other side American and European regions are the two major importers of turmeric.

(ii) Key Market Players in the Turmeric Market:

Key market players in turmeric market are mainly from Asia-Pacific region and some of the global players in this industry are Taj Agro Products, Nani Agro Foods, Earth Expo Company, Curcuminea, Sino-Nature, Shah Ratanshi Khimji and Co., Everest Spices, MDH Spices, Natural-Spices and ITC Spices.

As can be seen turmeric has a huge market across the world, more so the Lakadong variety. A majority of Meghalaya's turmeric goes outside the state through traders and middle men either in the form of slices or powder. Farmers sell raw turmeric at Rs. 30/- to Rs. 35/- per kg while the dried slices fetch around Rs. 150/- to Rs. 160/- per kg as per current market rates. Processors then turn it into powder and sell it at around Rs. 160/- to Rs. 170/- per kg. The conversion ratio of rhizome to slices is 6:1 while the ratio of slice to powder hovers around 1:0.8. A quick scan of the futures markets shows turmeric trading at around Rs. 6900/- per quintal while spot markets indicate a price of Rs. 8500/- per quintal for fingers. Online retailers are also selling Lakadong at around Rs. 1280/- per kg.

As can be seen from the above numbers there is a big margin between what the farmers get and what trading houses and marketers get even after taking into consideration logistics and marketing costs. Local traders either buy turmeric from local haats or directly from the farms. There are also many instances of informal contract buying in the Jaintia Hills. As it stands now the market is unorganised with many small and medium players in the market backed by major corporate houses like ITC and Tata.

(iii) Branding & packaging support:-

For Lakadong to take its rightful place as the golden spice of Meghalaya, a Lakadong Turmeric Brand needs to be created, both online and offline, that is synonymous with quality and purity as today the market is flooded with sub standard turmeric especially in the powder form. The MIE project has a very strong in built component of marketing, branding, packaging, advertising and trade promotion which will come in as accompanying support to the Mission.

(iv) Geographical Indication:-

In view of the emerging demand from the markets and their willingness to pay a premium for authentic, certified quality products, it has become an imperative that the GI of Lakadong be registered in order to leverage on the USP of Lakadong and its curcumin content for the benefit of the farmers by creating a brand and a premium market for it. Besides ensuring the protection of the IPR of the producing communities, GI registration is a marketing tool aimed at benefiting the producers of Lakadong by taking advantage of its unique characteristics imparted to it due to its specific geographical location, soil and climatic conditions to realise better prices.

It is anticipated that registration of the GI of Lakadong will lead to better market reach and niche placement as well as positive brand recall. However the benefits of GI registration will not actually be felt nor realised if the communities producing are not able to make use of the GI. In this regard it is important that the farming community is made aware of their rights under the GI Act and the benefits and advantages of GI through a series of sustained awareness campaigns, FGDs and trainings. The project of the MIE proposes to work together with cooperatives / societies / SHGs / FIGs / individual farmers etc to so that they are able to take on the responsibilities of authorized users. It is also important that the registered proprietor be a lawful entity that represents the best

interest of the producing communities and there is none more suitable than the Directorate of Horticulture, Govt. of Meghalaya.

This component of the project is proposed to be taken forward through a structured approach of engagement with the turmeric producing, processing and packaging community of Jaintia Hills followed by the process of registration of the GI either through the MIE or by empanelled agencies of the Registrar of GI. It is anticipated that the process may take more than a year to complete all the formalities required for the registration of the GI. The NGOs empanelled with the IBDLP will also be tasked with the formation of groups / societies etc and bringing them together into authorized user groups for better aggregation and quality control.

CHAPTER - III

Implementation process and mechanism

The Mission is proposed to be implemented by a State Mission Management Unit (SMMU) under the chairmanship of the Agriculture Production Commissioner and comprising of representatives from the Directorate of Horticulture, the Governor's Secretariat, the DRDA, West Jaintia Hills, the Forest Department, North Eastern Hill University (NEHU) and the Meghalaya Institute of Entrepreneurship (MIE).

Accompanying support for GI, some part of area expansion for seed purpose, post harvest support to small scale turmeric processing enterprises, Training cum Exposure, Packaging, Branding, advertising, marketing / trade promotion will come from the MIE under its NEC project titled "Area expansion and value chain development of Lakadong turmeric" and and dehydrators / slicers from the Governor's Secretariat. Wages for area expansion and seed material will be mobilized under the Bottom 40 programme of the MNREGA while the rest of the Mission's investments will come in from the Directorate of Horticulture.

While the pre production, area expansion, production technology and mobilization of farmers would be handled by the Directorate of Horticulture in coordination with the Block Office through the DRDA, the tissue culture propagation of rhizomes will be handled jointly by the Forest Department, NEHU and the Directorate. The post harvest interventions and marketing will be handled by the BDU / DRDA with support from the MIE.

Sources of funds and management: Funds are sought to be sourced in three ways: (1) Partial funding support from the Department of Agriculture, insofar as it relates to the establishment of the Tissue Culture Labs in the Lakadong production areas as well as within the Horticulture Hubs. (2) Funding support from the NEC relating to the activities that have been projected by the Project document already sanctioned by the NEC. This fund will be channelled through the MIE (3) Partial funding support from the Governor's Secretariat, to meet the costs relating to the Dehydrators, Turmeric slicers, etc. Additional funds that may be required will be evaluated through the Departmental budget by the Agriculture Production Commissioner as and when the need arises.

CHAPTER – IV

Monitoring and evaluation

The Mission will put in place an M&E system that would detail the monitoring procedures at various levels as well as guidelines for submission of various reports. Roles and responsibilities of various technical as well as project implementing staff with respect to MIS and monitoring & evaluation will be defined. Specific requirement with respect to training needs will be clearly indicated along with identified source for training arrangements. Key performance indicators for various activities under the Mission will be specified in order to ensure success of the Mission. The key highlights of the M&E function are as follows.

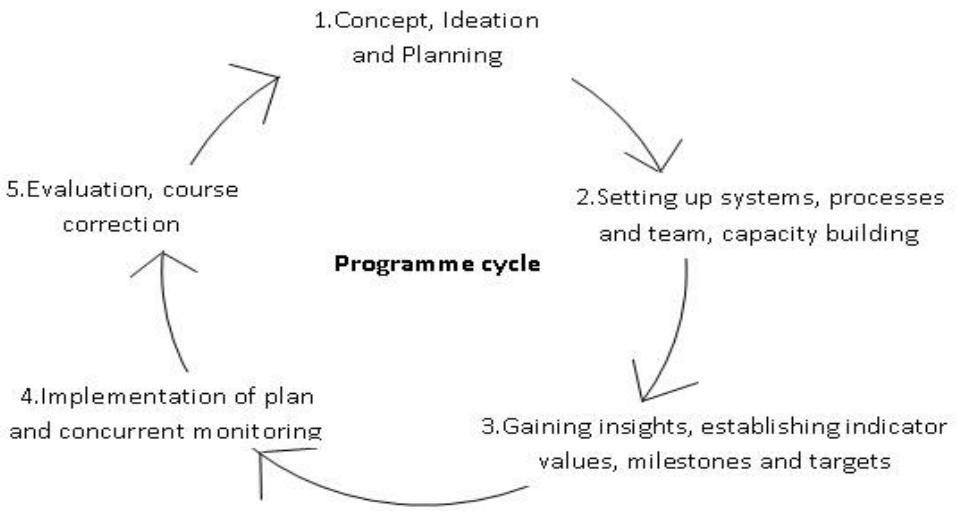
The goal of M&E is to outline a strategy for the Mission which will help monitor the progress of the implementation and aid in informed decision making.

This section also aims to lay the foundation of setting up Monitoring and Evaluation systems to help achieve the programmatic goals.

This section aims to provide a structure of the activities to be undertaken under Monitoring and Evaluation, how progress will be monitored, periodic evaluations be undertaken by the M&E team, and how the team will interpret and add value all the information for effective decision making by the Mission Administration.

The proposed Strategy for Monitoring and Evaluation is based on three fundamental stages in a Programme /Project Life Cycle – Planning, Implementation, Evaluation. These stages have been explained as under.

Figure: Programme / Project Life Cycle stages



Planning

The Planning stage would comprise concept planning, ideation, systems setup namely MIS and monitoring, processes and timelines for monitoring, setting up the team, appointment of professionals and their capacity building, gaining insights through research and studies, establishing indicator values, fixing milestones and targets for achievement. The proposed activities and their status is explained in the following sections.

1) Concept, Ideation and Planning

This would be the start off stage in the entire process of Monitoring and Evaluation and would involve concept development through prima-facie knowledge and reports available, planning activities, setting

timelines against these activities, etc. Preparation of this Strategy paper is part of this stage.

Setting up systems, processes, M&E team and their capacity building

Based on the Strategy document and activities conceptualised and planned, the following activities will be undertaken.

1) Setting up the M&E team

A dedicated core team would be set up at the Mission HQ to monitor and report the progress of the project. This would include notification of personnel, their capacity building, establishing flow of information and value-add expected from each team member. This team may be supported by other team members based in districts for collection of information and its digitisation.

In addition to this core unit at Mission HQ, based in Shillong, staff in districts will also be nominated. A plan for capacity development of team members would also be formulated and operationalised.

The two primary functions of the team have been proposed as separate sub-units. Though majority of the tasks for these sub-units will be specific to their functions, they will not be limited to these specified tasks.

The **Monitoring** sub-unit would undertake tasks which would entail regular tracking of physical and financial progress of the programme, primarily through MIS.

The **Evaluation** sub-unit would be undertaking tracking progress of the Mission at regular time intervals and also as per the compliances of funding agencies. Their tasks would comprise surveys, impact studies, case studies / success stories, etc.

The team may undertake FGDs (Focused Group Discussions), case studies, qualitative and in-depth studies involving limited sample size (less than 30), in consultation with the reporting authority. In case of concurrent monitoring also, external agencies may be contracted to collect and synthesise data under the supervision of the M&E team. This will allow the team to focus on higher value add like analysis and interpretation for better decision making.

It is proposed that data collection and entry in computers be made mandatory under the supervision of the M&E team. However use of tablet computers or mobile phones for field data collection could eliminate the need to data entry, as data will be entered directly into tablets/phones rather than using a paper questionnaire and uploaded directly into a survey database.

2) Establishing reporting formats, requirements and calendar

This will be undertaken for the Mission and other projects under its ambit. Under this, outlines may be defined for undertaking Annual Outcome Studies, Thematic Outcome studies, KAP studies, Qualitative and case studies.

The reporting requirements for M&E will be established and the other outlines will be defined.

3) Designing MIS

This stage would include designing the MIS structure, indicators and flow along with defining the information requirement from institutions/stakeholders. It is suggested that trained personnel of DRDA may be engaged to design the MIS structure.

Gaining insights, Establishing indicator values, milestones and targets

1) Baseline Study

The Baseline Study would be undertaken before commencement of any project. Based on the values of indicators generated in the Baseline Study, mid-term and end-term assessments would indicate progress of the project.

2) Setting Milestones, timelines, targets

Based on the Baseline study and reporting requirements established, milestones, timelines and targets will be fixed annually. Along with, the periodicity of measurement would also be established.

Implementation of Plan and Concurrent Monitoring

In this stage, plans will be implemented, concurrent and regular monitoring mechanisms will be established. The M&E team, with assistance from district teams will periodically collect information and undertake its digitisation to monitor progress of programme and projects.

1) Launch of MIS

Concurrent monitoring will be undertaken with the help of quantitative information derived from MIS. It may be designed, developed, operationalised and maintained as a web enabled system which will provide continuous progress of the programme and projects on various indicators including project administration indicators like staff recruitment, sanction and release of financial tranches, receipt and expenditure, etc.

2) Output and outcome monitoring

This will ensure that the targets and milestones set are achieved in the stipulated timeline. This would be a regular exercise and agencies of the department may be utilised for undertaking these studies.

Annual outcome surveys

These will be undertaken to measure the outcomes of outputs that have been delivered in the last year or so. This would include indicators that will measure progress towards goals and objectives.

Thematic outcome surveys

These more focused surveys will be undertaken to provide information on the outcomes of specific interventions - particularly those which only affect a specific group of participants (like Lakadong farmers).

Progress monitoring

This will be undertaken on a regular basis to ascertain achievement of physical targets for project activities and outputs as set out in Annual Work Plans and Budgets and provide course corrections. This activity will be undertaken by the SMMU and will be based on reports generated and MIS.

3) Process monitoring

This will ensure that the process planned to achieve the targets and milestones are being followed and will also help in course correction.

KAP studies

KAP (Knowledge, Attitude and Practice) studies are widely-used for assessing uptake and acceptability of newly introduced technologies or income-generating activities (IGA). It comprises three components as explained below

1. Knowledge: does the trainee KNOW what to do (i.e. has she/he remembered the key points of the training?)
2. Attitude: based on her/his knowledge of the technical approach for the IGA, and knowledge of her/his own circumstances, does the trainee think the IGA is suitable for her/him (and if not, why not)?
3. Practice: She / he actually going to implement the new technology or IGA?

Case studies and success stories

These would be collected during the course of the project and would provide insights into the successes and aspirations of the target respondents, which will help in better design and delivery systems. These would be undertaken along with studies like Rapid Assessment, Baseline, Annual Outcome and Thematic Outcome. The M&E team can also, during their field visit, collect case studies and success stories.

Evaluation and Course Correction

In this stage, a periodic evaluation (half yearly and annual) would be undertaken and corrective measures suggested. All these would be compiled and prepared by the M&E team.

1) Evaluation

Based on reports from various studies, monitoring mechanisms and MIS, half yearly and annual progress reports will be compiled and submitted for review. Any issues of concern/red flags and suggestions for course correction will be included in these reports.

2) Planning for following year

At the end of the year, a planning exercise for M&E activities in the following year would also be undertaken and proposed.

In addition to the above the following evaluation studies will also be undertaken.

· **Mid-term Assessment Study** – this would be undertaken mid way through the project to ascertain the progress achieved and any mid-course corrections which need to be introduced. It would include indicators to measure progress towards goals and objectives.

· **End-Term Assessment Study** – this will be undertaken at the end of the project period (around the time of project completion) and will assess the achievement of the project during the tenure.

Social Cost Benefit Analysis:

The social cost benefit analysis of the various mission components will be worked out to understand the income gains to farmers, employment gains and other gains to the society. Various measures of project performance will be employed to study the direct and indirect benefits of the Mission. The impact of the Mission on the State Domestic Product (SDP) will be studied based on the data generated from MIS and monitoring reports.

Social Audit and Direct Benefit Transfer (DBT)

The Mission will be making substantial investments in area expansion, infrastructure like tissue culture labs and growth houses and in processing machinery and equipment. Funds under the Mission will be transferred to the beneficiaries / partners by Direct Benefit Transfer (DBT) to ensure transparency and speedy implementation in the field and the DBT will be linked with the Social Audit which will be deployed to monitor the progress of the Mission in the field. Social audit is a process in which the details of the resources, both physical and financial, used by the public agencies for the development initiatives are shared with the people, often through a public platform. It allows people to enforce transparency and accountability, thereby providing the ultimate users an opportunity to scrutinize the development initiatives. It is proposed under the Mission to create a social audit team involving beneficiaries of the programme, civil society members, media personnel and reputed persons in the society to ensure transparency and accountability of the programme.

CHAPTER – V

FINANCIALS OF THE MISSION

The Mission has set a target of **50,000 tonnes** of turmeric production from **15,000 acres (6070 hectares**) over the next 5 years with a total outlay of Rs. **75.58** crores out of which Rs. **63.15** crores will come in as convergence for area expansion from MNREGA, Rs. **8.10** crores for seed multiplication from DOH, Rs. **2.88** crores for GI, PHM, Marketing etc from the Governor's Secretariat and the MIE and Rs. **69.75** lakhs for capacity building from ATMA. A total of Rs. **71.25** crores will be the investment from both the MNREGA and Mission for area expansion. Accompanying support from the MIE will touch a total of Rs. **1.50** crores. Administrative support for the Mission has been kept at 1% of outlay amounting to Rs**. 74.83 lakhs**. A total of Rs. **8.85** crores is therefore being sought from the Government of Meghalaya as support funds for the Mission over a period of 5 years.

CORE MISSION INTERVENTIONS	ANNEXURE -I - OVERVIEW OF MISSION INTERVENTIONS & ACCOMPANYING MEASURES OVER 5 YEARS									
	Iongkyndar Farm	Farmers' Field		Farmers' Field			TC LABORATORIES			
	HUB	Area expansion		Seed Village / Community seed bank		On farm rapid multiplication	NEHU	Forest Deptt	Horticulture	GRAND TOTAL
	MISSION	MNREGA	MNREGA	MISSION	MISSION	MISSION	MISSION	MISSION	MISSION	
MNREGA convergence Component		Wages	Inputs							
Mission Component	Establishment costs (2 years)			Land Devp	Inputs	Pro tray propagation	Y1 to Y3	Y4 & Y5	Y4 & Y5	
Quantities (No/Ha)	9 Ha	15000 acre	15000 acre	200 acre	200 acre	100 nos	1 no	1 no	1 no	
Mission Unit cost in lakhs	10000000			18100	24000	298700	6463200	8141375	8141375	
MNREGA Unit cost in lakhs		18100	24000							
Mission total cost	20000000			3620000	4800000	29870000	6463200	8141375	8141375	**81035950**
MNREGA total cost		271500000	360000000							**631500000**
Total Project Outlay (Lakhs)	**20000000**	**271500000**	**360000000**	**3620000**	**4800000**	**29870000**	**6463200**	**8141375**	**8141375**	**712535950**
MISSION ACCOMPANYING MEASURES									MISSION OUTLAY	
1	Dehydrators (Governor's Secretariat)								13828500	
2	GI Registration (NEC)								800000	
3	Area Expansion for seed (NEC)								1600000	
4	Processing support to SSI (NEC)								2000000	
5	Exposure & Training (NEC)								2750232	
6	Marketing, Branding & Packaging (NEC)								7849768	
7	Awarenes, capacity building & mobilization (ATMA)								6975000	
									35803500	**35803500**
9	Mission Administrative expenses @ 1%									**7483395**
	GRAND TOTAL									**755822845**

ANNEXURE -II

INSTITUTION WISE MISSION OUTLAY FOR 5 YEARS – 2018 – 2023

COMMUNITY & RURAL DEVELOPMENT DEPARTMENT										
COST COMPONENT					MNREGA					
Sl No	ITEM	Unit cost	Area (Acres)	AMT	Y1	Y2	Y3	Y4	Y5	TOTAL
1	Area expansion									
a	Wages @ 100 MD/Acre	18100.00	15000	271500000	181000000	22625000	22625000	22625000	22625000	**271500000**
b	Seed Rhizome @ 40/- kg for 600 kgs/acre	24000.00	15000	360000000	240000000	30000000	30000000	30000000	30000000	360000000
			Sub Total		**421000000**	**52625000**	**52625000**	**52625000**	**52625000**	**631500000**
									GT	**6315,00,000.00**
	% contribution to the Mission = 84.39%									

(Rupees sixty three crores fifteen lakhs) only

DIRECTORATE OF HORTICULTURE										
	ITEM	**Unit cost**	**Area (acres) / No**	**AMT**	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**	**TOTAL**
1	Lakadong Hub	10000000.00	9	20000000	10000000	10000000				**20000000**
2	Seed Village / community seed bank									
a	Wages @ 100 MD/ acre	18100.00	200	724000	724000	724000	724000	724000	724000	**3620000**
b	Rhizome @ 40/- kg for 600 kgs/acre	24000.00	200	960000	960000	960000	960000	960000	960000	**4800000**
3	Rapid rhizome multiplication in shade houses	298700.00	100	29870000	2987000	6720750	6720750	6720750	6720750	**29870000**
4	NEHU TC Lab	6463200.00	1	6463200	3146400	1658400	1658400			**6463200**
5	TC Lab (Forest Deptt)	8141375.00	1	8141375				6047215	2094160	**8141375**
	TC Lab (Horticulture)	8141375.00	1	8141375				6047215	2094160	**8141375**
					17817400	**20063150**	**10063150**	**20499180**	**12593070**	**81035950**
								Administrative charges @ 1%		**7483394.5**
									GT	**885,19,345**
	% contribution to the Mission = 10.83%									

(Rupee Eight crores eighty five lakhs nineteen thousand three hundred and forty five) only

INSTITUTIONAL ACCOMPANYING SUPPORT TO THE MISSION FOR 5 YEARS – 2018-2023

	GOVERNOR'S SECRETARIAT									
	ITEM	**Unit cost**	**Area / Qty**	**AMT**	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**	**TOTAL**
1	**Accompanying Support**									
a	Dehydrators 250 kg	460950.00	30	13828500	2765700	2765700	2765700	2765700	2765700	**13828500**
									GT	**138,28,500.00**
	% contribution to the Mission = 1.85 %									

(Rupees one crore thirty eight lakhs twenty eight thousand five hundred) only

	ATMA									
	ITEM	**Unit cost**	**Area / Qty**	**AMT**	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**	**TOTAL**
1	**Accompanying Support**									
a	Capacity building & mobilization for 15,000 farmers in batches of 30 through ATMA	13950.00	500 batches	6975000	1395000	1395000	1395000	1395000	1395000	**6975000**
									GT	**69,75,000.00**
	% Contribution to the Mission = 0.93 %									

(Rupees sixty nine lakhs seventy five thousand) only

MIE							
	ITEM	**Unit cost**	**Area / Qty**	**AMT**	**Y1**	**Y2**	**TOTAL**
	Accompanying Support						
1	Geographical Indication Registration	800000.00		800000.00	200000	600000.00	**800000**
2	Seed production (5 Hectares)	320000.00	5	1600000.00	1600000.00		**1600000.00**
3	PHM support to SSI	500000.00	4	2000000.00	2000000.00		**2000000.00**
4	Exposure and Training (batches)	687558.00	4	2750232.00	2750232.00		**2750232.00**
5	Marketing, branding & packaging	7849768.00	LS	7849768.00	3924884	3924884	**7849768.00**
6							
					10475116.00	**4524884.00**	**15000000**
						GT	**150,00,000.00**
	% Contribution to the Mission = 2.00 %						

(Rupees one crore fifty lakhs) only

ANNEXURE – III

Micropropagation of Lakadong turmeric

Authored by Biotechnology Department, NEHU

Plant tissue culture is an enabling technology from which many novel tools have been developed to assist plant breeding and crop improvement. These tools (micropropagation, anther culture, in vitro selection, embryo rescue, somaclonal variation, etc.) can be used to increase the speed or efficiency of the breeding process, improve the accessibility of existing germplasm and to create new variation for crop improvement. C. longa is highly in demand for therapeutical and pharmaceutical purposes. With a higher curcumin content, turmeric fetches better price in both the national and international market. In order to meet the increasing demand augmentation of its production is urgent need of the hour. However, genetic improvement of C. longa is often limited due to germplasm selection or mutation breeding of vegetative crops due to the lack of seed set. There is an urgent need to address these issues to improve production, quality and exportation of turmeric from these hills by introducing high quality turmeric into cultivation, and thereafter making it an important player in the economic market

Rationale of the study

Tissue culture is an aseptic laboratory procedure that requires unique facilities and special skills. The technique of tissue culture is the culture and maintenance of plant cells, organs or tissues in sterile nutritionally and environmentally supportive condition outside living system. In 1938 Schwann and Schleiden put forward the theory of „totipotency" which states that cells are autonomic and in principle are capable of regenerating into a complete plant. This theory was the foundation of plant cell organ and tissue culture.

Micropropagation has become an important part of scientific breeding for many plants (Boxus. and Dwart,1980).The advantages of micro-propagation as a propagation system have been reviewed so many times and can be summarized as i. Mass propagation of scientific clones ii. Production of pathogens free plants iii. Clonal propagation of parental stock for hybrid seed production. iv. Year round nursery production v. Germplasm preservation.

Mass Propagation of Specific Clones:

The objective of mass propagation is to reproduce (either sexually or asexually) copies of an original parent. The controlled aspects of micropropagation permit the rapid propagation of individuals from a single plant. Multiplication rates can be very high, since plant in culture can theoretically be multiplied at an exponencial rate by consecutive subcuturing (e.g one month apart).

Mass micropropagation is partially useful for the following:-

i. Plants whose natural rate of increase is relatively slow e.g herbaceous perennial host plant.
ii. New cultivars require getting to market in as short a time as possible.
iii. Cultivars whose high value makes micropropagation a viable alternative to conventional methods.
iv. Conservation of endangered species, etc.

Availability of Plant Germplasm for Use in Crop Improvement:

Broad-based plant germplasm resources (PGR) are imperative for sound and successful crop improvement programs. Rich and diverse source also fuel many facets of plant research. For highly

successful research and breeding activities, the genetic diversity of experimental materials needs to be sustained to minimize the vulnerability inherent in the growing of uniform and closely related cultivars over wide areas.(Stalker, and Murphy,1992). A complete array of germplasm in a crop consist of

i. Wild relatives, weed, races and landrace in the areas of diversity
ii. Un-improved or purified cultivars used earlier in the major production areas or still used in minor areas.
iii. Improved germplasm in commercial production and genetic testers from breeding programmes and genetic studies

Crop germplasm can be made available to the users (Agronomist, breeders, entomologist, genetics, plant pathologist, plant physiologist, crop ecologist soil scientist, production specialist, and growers) on a continuing basis of the interrelated facet of field conservation, multiplication, characterization, documentation and distribution and ultimately released into the market

Hypothesis:

Cellular totipotency is the inherent potentiality of a plant cell to give rise to a whole plant, a capacity that is retained even after a cell has undergone final differentiation in the plant body. Plant, organ and tissue culture relies on the fact that many plant cells have the ability to regenerate into a whole plant. Therefore, tissue culture takes advantage of this phenomenon by offering an excellent opportunity of regenerating an entire plant from a single or few non-zygotic cell which is the basis of mass clonal propagation and is used widely in the plant sciences, forestry, and in horticulture.

Key Questions

1. Is plant tissue culture technique amenable for the mass propagation of Curcuma longa?
2. If yes, what are the biological and environmental factors/conditions for carrying out in vitro propagation of economically important cultivars of C. Longa?
3. Are the in vitro regenerants of C. Longa stay 'true-to-type' and therefore genetic fidelity intact even after several generations of mass clonal propagation?

The Expected Outcome of Proposed Study

Plant tissue culture methods have a wide scope for the creation, conservation, and utilization of genetic variability for the improvement of field, fruit, vegetable, and forest crops and medicinal/aromatic plants. Micropropagation technology, particularly for vegetatively propagated plant species, ensures true-to-type, rapid, and mass multiplication of plants for quick bulking up of new varieties and rejuvenation of old varieties. Cellular techniques, such as anther/microspore culture, somaclonal variation, embryo culture, prototoplast culture, and somatic hybridization, are being exploited to generate useful genetic variability for incremental improvement of field crops. Using anther culture/pollen culture, several cultivars are either under tests or have already been released in rice, wheat, barley, maize, rapeseed, and mustard in several countries. Therefore there is a need to employ this approach and technology in *Curcuma longa*.

Scope of the Application indicating anticipated project and processes

Plant micropropagation presently appears to have good prospects for successful commercial implementation. In recent years it has found wide practical application in agriculture, especially for rapid clonal propagation (micropropagation or in vitro propagation) of many economically important plant species. Tissue culture techniques can be widely employed in plant breeding and crop improvement of Curcuma longa, as a means to create commercial cultivars of high yield, with high tolerance to biotic and abiotic factors, elimination of plant pathogens, etc, thereby increasing the local production and harvest index of this commercially important plant.

Overall Objectives:

The main objective of the study will be:

1. Biodiversity assessment and characterization of the different cultivars of *Curcuma longa* of economic importance
2. Development of a protocol for in vitro propagation of *Curcuma longa* of economic importance.
3. Large scale multiplication and analysis of genetic fidelity in regenerants

Time schedule of activities giving milestones

Activity proposed	Timeline
Project initiation, procurement of instruments and hiring of staff	0-6 Months
Survey and collection of germplasm	0-12 Months
Characterization of the different cultivars of *Curcuma longa* of economic importance using morphological and molecular approaches	0-24 Months
Standardization of conventional and *in vitro* methods for multiplication of selected plants	13-18 Months
Mass multiplication of the selected species; Hardening and establishment of *in vitro* raised plantlets	19-24 Months
Genetic fidelity assessment of the *in vitro* raised plantlets Mass multiplication of the selected cultivars of *Curcuma*	24 – 30 Months
Mass multiplication of the selected cultivars of *Curcuma;* Project report compilation	30 – 36 months
Mass multiplication of the selected cultivars of *Curcuma;* (Y4 & Y5)	36 -60 months

BUDGET PARTICULARS FOR TC LAB (NEHU)

A. **Non-Recurring**

Sl. No.	Equipment Name	Justification	Unit cost
1	Walk – in Plant Growth Chamber	Maintenance of plant , organ and tissue culture	INR 10.9 Lakhs
2	Minor equipments (magnetic stirrer, weighing balance, vortex machine, hotplate, etc)	For carrying out the experimental work	INR 1.5 Lakhs
		Total amount (INR)	**INR 12.4 Lakhs**

B. Recurring

a) **Human resource Details**

Sl. No.	Year	Resource	Fellowship/month	amount/ year
1	First	JRF / project fellow (4 nos)	INR 60,000 (INR 15,000 each)	7,20,000
		Lab/field assistant (2 nos)	INR 16,000 (INR 8,000 each)	1,92,000
2	Second	JRF / project fellow (4 nos)	INR 60,000 (INR 15,000 each)	7,20,000
		Lab/field assistant (2 nos)	INR 16,000 (INR 8,000 each)	1,92,000
3	Third	JRF / project fellow (4 nos)	INR 60,000 (INR 15,000 each)	7,20,000
		Lab/field assistant (2 nos)	INR 16,000 (INR 8,000 each)	1,92,000
			Total Amount (INR)	**27,36,000**

b) Consumables

Sl. No.	Year	Justification	Amount
1	First	Funds will be used for purchase of chemicals, fine chemicals, reagents, solvents, etc.	3,50,000
2	Second	Funds will be used for purchase of chemicals, fine chemicals, reagents, solvents, etc.	3,50,000
3	Third	Funds will be used for purchase of chemicals, fine chemicals, reagents, solvents, etc.	3,50,000
			10,50,000

c) Contingency

Sl. No.	Year	Justification	Amount
1	First	Day to day laboratory expenses like stationeries, printing, etc.	1,00,000
2	Second	Day to day laboratory expenses like stationeries, printing, etc	1,00,000
3	Third	Day to day laboratory expenses like stationeries, printing, etc.	1,00,000
Total Amount (INR)			**3,00,000**

d) Travel

Sl. No.	Year	Justification	Amount
1	First	Field trip, sample collection, lab visits, seminars, conferences, etc.	20,000
2	Second	Field trip, sample collection, lab visits, seminars, conferences, etc.	20,000
3	Third	Field trip, sample collection, lab visits, seminars, conferences, etc.	20,000
Total Amount (INR)			**60,000**

e) Overhead

*Overhead charges will be 20% of the total budget sanctioned. As per the requisite norm of the host institute, NEHU, Shillong.

Total Budget Details

Item	1st Year	2nd Year	3rd Year	Total Amount INR
Non Recurring				
Equipments, etc.	12,40,000	-	-	12,40,000
Recurring				
Human Resources	9,12,000	9,12,000	9,12,000	27,36,000
Consumables	3,50,000	3,50,000	3,50,000	10,50,000
Contingency	1,00,000	1,00,000	1,00,000	3,00,000
Travel	20,000	20,000	20,000	60,000
Total INR	**26,22,000**	**13,82,000**	**13,82,000**	**53,86,000**
Overhead (20%)	5,24,400	2,76,400	2,76,400	10,77,200
Total INR	**31,46,400**	**16,58,400**	**16,58,400**	**64,63,200**

BUDGET PARTICULARS FOR TC MASS PROPAGATION OF LAKADONG TURMERIC

(FOREST DEPTT & HORTICULTURE)

A. Non-Recurring

Sl. No.	**Equipment Name**	**Justification**	**Unit cost**
1	Walk – in Plant Growth Chamber	Maintenance of plant , organ and tissue culture	21,18,000.00
2	Mist-Chamber 120 (sq meter)	Hardening of In Vitro raised Plants after transferring from growth chamber	11,90,400.00
3	Shade net House (1008 sq meter)	Hardening of In Vitro raised Plants after transferring from mist-chamber	4,94,655.00
4	Minor equipments (magnetic stirrer, weighing balance, vortex machine, hotplate, etc)	For carrying out the experimental and Mass Propagation work	1,50,000.00
Total amount (INR)			39,53,055.00

B. Recurring

a) Human resource Details

Sl. No.	**Year**	**Resource**	**Fellowship/month**	**Amount/ year**
1	4th year	JRF / project fellow (4 nos)	Rs. 60,000 (@ 15,000 each)	7,20,000
		Lab/field assistant (2 nos)	Rs. 16,000 (@ 8,000 each)	1,92,000
		Unskilled Workers (4 nos) @ 5670/-	Rs. 22,680 (@5,670 each)	2,72,160
			Sub Total 4th Year	**11,84,160**
	5th year	JRF / project fellow (4 nos)	Rs. 60,000 (@ 15,000 each)	7,20,000
		Lab/field assistant (2 nos)	16,000 (@ 8,000 each)	1,92,000
		Unskilled Workers (4 nos) @ 5670/-	Rs. 22,680 (@ 5,670 each)	2,72,160
			Sub Total 5th Year	11,84,160
Total amount (INR)				**23,68,320.00**

b) Consumables

Sl. No.	Year	Justification	Amount
1	4th year	Funds will be used for purchase of chemicals, glasswares, fine chemicals, reagents, solvents, etc.	4,50,000.00
1	5th year	Funds will be used for purchase of chemicals, glasswares, fine chemicals, reagents, solvents, etc.	4,50,000.00
Total amount (INR)			**9,00,000.00**

c) Contingency

Sl. No.	Year	Justification	Amount
1	4th year	Day to day laboratory expenses like maintenances of equipments, stationeries, printing, etc.	1,00,000.00
1	5th year	Day to day laboratory expenses like maintenances of equipments, stationeries, printing, etc.	1,00,000.00
Total amount (INR)			**2,00,000.00**

d. Electricity Bills

Sl. No.	Year	Justification	Amount
1	4th year	Electricity Bills is for the walk in growth chamber, Equipments, etc. (@) Rs. 30,000.00/month	3,60,000.00
2	5th year	Electricity Bills is for the walk in growth chamber, Equipments, etc. (@) Rs. 30,000.00/month	3,60,000.00
Total amount (INR)			**7,20,000.00**

Total Budget Details

Item	4th year	5th year	Total Amount INR
Non Recurring			
walk in growth chamber, Equipments, mist chamber and shade net house	39,53,055.00		39,53,055.00
Recurring			
Human Resources	11,84,160	11,84,160	23,68,320.00
Consumables	4,50,000.00	4,50,000.00	9,00,000.00
Contingency	1,00,000.00	1,00,000.00	2,00,000.00
Electricity Bills	3,60,000.00	3,60,000.00	7,20,000.00
Total amount (INR)	6047215	2094160	
Grand Total INR			**81,41,375.00**