



सत्यमेव जयते

Government of Meghalaya

MEGH-AROMA MISSION



CULTIVATION, PROCESSING & MARKET LINKAGE FACILITATION
IN ALL ELEVEN DISTRICTS OF MEGHALAYA

Launched on the 27th May, 2019

By

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CSIR-CIMAP

In Collaboration with
CSIR-Central Institute of Medicinal
and Aromatic Plants (CIMAP)
Lucknow



Prepared by
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MESSAGE

Meghalaya is a land of immense bio- and eco-diversity. This diversity provides ample opportunities for the cultivation of crops of commercial importance such as medicinal and aromatic plants. Though significant efforts have been made in other states, to promote medicinal and aromatic plants and their processing, for some reasons, Meghalaya has not been able to capture any economic space despite it having wonderful and diverse climatic conditions for cultivating such plants. There is an insatiable demand in the global market for the products of medicinal and aromatic plants and the time to make a focused investment in this regard is opportune.

I am happy to launch the Aroma Mission Document to be implemented over a period of the next five years. This Mission document will mark an important chapter in Meghalaya's developmental history. The Mission aims to encourage entrepreneurship in nursery establishment, planting and promotion fo cluster plantations to processing the green herbage so it can open up opportunities for enterprising people, especially women, in the value chain. As I see it, this Mission has the potential to transform the Jhum lands and degraded landscape and hitherto wastelands of Meghalaya into economic spaces.

Even as the document is comprehensive in its scope, I am sure that as we move forward, new opportunities will emerge in the sector and several managerial challenges will arise. The implementing agency should remain alert to capture all such opportunities with alacrity. I compliment the MBDA and the whole team of officers and staff who have worked hard to bring out this document and the support rendered by the CIMAP in creating an ecosystem for the promotion of this sector in our state. I wish the farmers-entrepreneurs a great success in realizing their dreams through this vibrant sector.



(Conrad K. Sangma)

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CHAPTER 1

1.1 General Description:

Land degradation is a common problem and it occurs widely in all agro-climatic zones in the country. As per this, the total area under degraded and wastelands in the country stands at 114.01 M ha. Improvement of degraded land is an expensive proposition. Research at Central Institute of Medicinal and Aromatic Plants (CIMAP) has shown that some specific aromatic crops can be grown in such land, due to their higher tolerance to low fertility, Sodicity, slopy area, salinity, etc. Further, they offer more remunerative returns than traditional crops. MAPs are also better suited for different problematic soils such as eroded soils, semi-arid tropical condition, saline, alkaline soils, acidic soils, heavy metal contaminated soils, shaded soils, newly reclaimed soils etc. The raw produce of aromatic plants in India finds use from fragrance and perfumery, incense, cosmetics and medicinal. Most importantly, the aromatic crops are in high demands, both nationally and internationally due to their extensive use in, cosmetics, food, flavour and pharmaceutical industries. These plants offer a ray of hope and prosperity to the growers.

Simultaneously, MAPs are considered as potential future crops for diversification. Crop diversification through MAPs should be aimed at increasing the yield and quality of the produce per unit area and time leading to maximum land use efficiency. Incorporation of MAPs on marginal and degraded lands can enhance system productivity, land utilization percentage, profits and land development. Thus, having wide scope of inclusion of medicinal and aromatic plants in the existing cropping systems on marginal and degraded lands which not only improve the economic condition of small and marginal farmers owing to higher price and/or higher volume of their main and by products but also conserve the natural resources and sustainable utilization of marginal lands. There is need to increase the area and production of MAPs through up-scaling of crops and cropping systems in the existing cropping systems and on marginal and degraded lands. The probability of success is very high because the MAPs will be incorporated with the existing systems without any extra land and on marginal and degraded lands which are otherwise under limited or no use.

The diversification through introduction/integration of MAPs in existing system of cropping will make the venture more profitable and sustainable. This will result in socio-economic upliftment of rural area, employment generation, biodiversity, conservation and quality

raw material production in different phases. As compared to the traditional crops, the cultivation of Aromatic crops has many advantages. These includes:-

- Provide better returns than traditional crops.
- Have very large domestic and export demand.
- Fetch better prices in the market.
- Could be stored for a long time and sold at times when better prices prevail in the market.
- Largely draught tolerances, not easily grazed by animals
- Have low incidence of pest attack and diseases.
- Require minimum resources, therefore the cost of cultivation is lower compared to traditional crops.
- Could be raise as intercrop and also on poor soil.

1.2 Relevance with Meghalaya:

Meghalaya, one of the states in North East India which lies between 20°.1 N and 26.5° Latitude and 85°49 'E and 92°52 'E Longitude is bounded by Bangladesh to the west and south and Assam to the North and East. The total forest area of the state is about 15,657 sq. Km and the cultivable land is accounted as only 48% of the total geographical area of the state. According to statistical hand book of Meghalaya 2017 (Directorate of Economics and Statistics, GOM), **554579** hectares of land falls under uncultivated land excluding fallow land and 215253 hectares falls under fallow land which could be utilised for the cultivation of hardy grasses.

Meghalaya is a land of immense bio- and eco-diversity. It can boast three eco-diversity regions (temperate, sub-tropical and tropical). These conditions are suitable for cultivation of hardy crops of commercial importance such as medicinal and aromatic plants. Effort made by CSIR-CIMAP have led to the large domestication, commercial cultivation and processing of at least a dozens of medicinal and aromatic plants in the country. There is demand in the global market for the produce of these medicinal and aromatic plants which create immense opportunities for sustainable expansion in the area under cultivation. There are also several medicinal and aromatic plants which, besides being indigenous to North East can also be cultivated and domesticated in the state. Keeping in view of their ever increasing demand in trade, few selected crops can be cultivated in Meghalaya state for larger interest of the growers and entrepreneurs.

1.3. Soil and climate:

Meghalaya falls under tropical, sub tropical and temperate climate with an annual rainfall of about 2500 mm. As such the area enjoys somewhat the climatic conditions prevailing in hilly area. The physico chemical properties of the soil in Meghalaya:

SI No	Parameters	Values (in range)
1	Ph	4.5-6
2	EC (millimohs/cm)	1.41-6.54
3	Organic carbon (%)	1.44-4.09
4	Available N (Kg/ha)	280-560
5	Available P ₂ O ₅ (Kg/ha)	<10
6	Available K (Kg/ha)	118-280

1.4 Present Scenario:

At present no systematic cultivation of MAPs is being done by the farmers/growers in Meghalaya. Moreover, no other facilities exist to take up cultivation of these commercial importance crops except few farmers have started cultivation in RiBhoi District. Immediate attention is required for nursery raising of quality planting material to growers and thereafter installation of distillation unit will take place sometime later

CHAPTER 2

2.1 Scope of the Project:

Cultivation of Medicinal & Aromatic Plants is gaining momentum day by day due to ever increasing demand of plant based materials naturals in India and abroad. However, sustained supply of high quality planting materials is a common problem faced by user industries. In this endeavour efforts are being made by CSIR-CIMAP to introduced improved technologies and high yielding varieties to increase quality planting materials by the growers and entrepreneurs in the country. The Institute of Natural Resources under Meghalaya Basin Development Authorityhas planned promotion of medicinal and aromatic plants related activities in the State with the aim to introduce, develop and disseminate technologies for cultivation,promotion and processing among the growers and entrepreneurs of the state in a time boundmanner. It is emphasized to introduce only such commercially viable crops such as aromatic grasses, Geranium, Patchouli, Pyrethrum, palmarosa and other crops which are suitable to theagro-climatic conditions of the State. Indigenous aromatic plants such as Gautheria fragrantissima, Litseacubeba, Zanthoxy lumkhasianum can be explored for their aromatic oils It is emphasized to conduct trials relating to plant genotype and environment interaction, production of the plants for field trials at farmers field through CIMAP technologies with special reference to the commercially viable plant varieties in aromatic grasses, Geranium, Patchouli, Pyrethrum, palmarosa and other crops of economic value suited to the state of Meghalaya.

It is emphasized that introduction of selected MAPS crop in prevailing cropping system in the implementation area shall ensure optimum utilisation of resources effectively and augment income of the growers and entrepreneurs besides generating additional employment opportunities in the State. The MAPs on an average are likely to provide a net profit of Rupees Fifty thousand to One Lakh per hectare.

2.2 Origin of the proposal:

During detailed discussions held between officials of different bodies of MBDA, INR, BRDC and director and Scientists of CSIR-CIMAP and the Development Commissioner of Meghalaya, the importance of commercialization of Maps was strongly emphasized. Subsequent to the above discussion, it was suggested that MBDA should move forward for development and dissemination of MAPs related technologies suited for Meghalaya. Accordingly, the proposal is formulated with idea of Development Commissioner,

Meghalaya who has suggested that this initially could be taken up in the form of mission mode project for which all the eleven districts of Meghalaya could be covered with the plants well suited to the region. The minimum area to be brought under cultivation may be approximately 10-20 acres in each district through CIMAP's high yielding varieties and developed technologies. The buyback of the produce shall also be ensured with the user parties. In this endeavour, growers will be supported by providing quality planting materials and distillation facility on-site at cluster level.

2.3 Success Story:

Cultivation and primary processing of Lemongrass and Citronella have been initiated in 2016 by a group of entrepreneurs at Byrwa, Ri Bhoi, in an area of about 10 acres and have been expanded to about 30 acres with a net production of 100-120 Kgs/ha of oil annually. Two units, one **pulley chain distillation unit** funded by the Government of Meghalaya through MBDA and the other one was funded by CSIR-CIMAP under National Aroma Mission were installed at the plantation site. 15-20 families have been benefited from the aroma initiatives. At present a cluster of farmers was registered under the name Fountain Green Reliability Group in 2018 with total members of 15 including both male and female. In April 2019, cultivation has been expanded to adjacent villages as well. Similar initiatives have also been started at Cham Cham Village in East Jaintia Hills as well as in Sohra with the area of about 1 acre and 10000 m² respectively.



Figure 1: Citronella Plantation at Byrwa Figure 2: Lemongrass Plantation at Byrwa



Figure 3: Geranium Nursery in Farmers Field at Cham Cham



Figure 4: Improved Field Distillation Unit installed at Farmers Field

CHAPTER 3

3.1 Mission Objectives:

In order to bring a decisive and transformative change in the rural economy, a mission has been conceptualized which aims to:

- Promotion of cultivation of High value crops in all districts of the State.
- Developing demonstration blocks in form of cluster of commercially importance medicinal and aromatic plants for the state at district level with the area of approximately 10-20 acres in each district initially.
- Establishing multiplication and processing facility for elite planting material of high yielding varieties of selected medicinal and aromatic plants suitable for Meghalaya.
- Establishing conservatories of genetic resources as a part of further providing planting material to the growers.
- Demonstration of processing facility (distillation unit) related technologies to development entrepreneurship.
- GLC
- Establishing laboratory units for determining chemical content or analysing quality of oil.
- To arrange buy back of produce
- To identify and domesticate the excess exploited medicinal and aromatic plant from wild source of Meghalaya

3.2 List of medicinal and aromatic plants proposed for Meghalaya:

After a series of survey conducted by Scientist from CSIR-CIMAP, Lucknow in collaboration with Institute of Natural Resources (MBDA), following crops were proposed for Meghalaya

1. Lemongrass (*Cymbopogon flexuosus*)
2. Patchouli (*Pogostemon cablin*)
3. Geranium (*Pelargonium graveolens*)
4. Vetiver (*Vetiveria zizanioides*)
5. Palmarosa (*Cymbopogon martini*)
6. Citronella (*Cymbopogon winterianus*)
7. Peppermint (*Mentha piperita*)
8. Lavendar (*Lavandula officinalis*)

CHAPTER 4

4.1 Project Area:

4.11 District wise crop, area, no. of distillation required in I phase

Sn.	District	Crops	**Area (in hectare)	*FDU requirement
1	West Jaintia Hills	Lemon Grass Citronella Palmarosa Vetiver Geranium Menthapiperata	5 hectare	1
2	East Jaintia Hills	Lemon Grass Citronella Palmarosa Pachauli Pyrethrum Lavender	5 hectare	1
3	East Khasi Hills	Lemon Grass Citronella Pachauli Lavender Vetiver Rose	5 hectare	1
4	West Khasi Hills	Lemon Grass Citronella Vetiver Palmarosa Geranium Lavender	5 hectare	1
5	South West Khasi Hills	Lemon Grass Citronella Rose Geranium Lavender Menthe piperata	5 hectare	1
6	Ri Bhoi	Lemon Grass Palmarosa Vetiver Citronella Patchauli	5 hectare	1
7	North Garo Hills	Lemon Grass Citronella	5 hectare	1

		Geranium Lavender Pyrethrum Rose		
8	East Garo Hills	Lemon grass Rose Menthe piperata Citronella Lavender Vetiver	5 hectare	1
9	South Garo Hills	Lemon grass Vetiver Citronella Patchouli Geranium	5 hectare	1
10	West Garo Hills	Lemon grass Citronella Palmarosa Geranium Pyrethrum Vetiver	5 hectare	1
11	South West Garo Hills	Lemon grass Citronella Palmarosa Patchali Geranium Rose	5 hectare	1
<p>*distillation unit may increase as per availability of area under aromatic crops cultivation **the crops and area may be verified according to local prevailing conditions</p>				

CHAPTER 5

5.1 Mission Outcomes:

- a) Bringing about 1000 hectares of additional area under captive cultivation aromatic cash crops particularly targeting rain-fed degraded land across the state.
- b) Provide technical and infrastructural support for distillation and value-addition to farmers/growers all over the state.
- c) Enabling effective buy-back mechanisms to assure remunerative prices to the farmers/growers.
- d) Value-addition to essential oils and aroma ingredients for their integration in global trade and economy.

CHAPTER 6

6.1 Methodology, Approach and Strategies:

To achieve the objective of the project the following approaches are planned-

- Developing cluster of priority medicinal and aromatic plants by planting high yielding varieties developed by CSIR CIMAP.
- Observation and data recording on suitability of these plants.
- Release of an information brochure on these plants in local language.
- Development of macro propagation and nursery techniques.
 1. Establishment of varieties of selected plants for further distribution to growers.
 2. Macro propagation under green house for large scale multiplication.
- Conducting training programmes on cultivation and production of MAPs and one or two awareness camps in the farmers' clusters.
- To provide motivation and skill promotional training to growers/farmers in MAPs cultivation and distillation methods for development of entrepreneurship.
- Establishing distillation and quality evaluation facility for processing of plants for demonstrations.
- Further identification of plants of regions which are overexploited in some pockets and needs cultivation to safeguard the biodiversity.
- To increase organic farming through set up of vermin-composting units for distillate waste utilization.

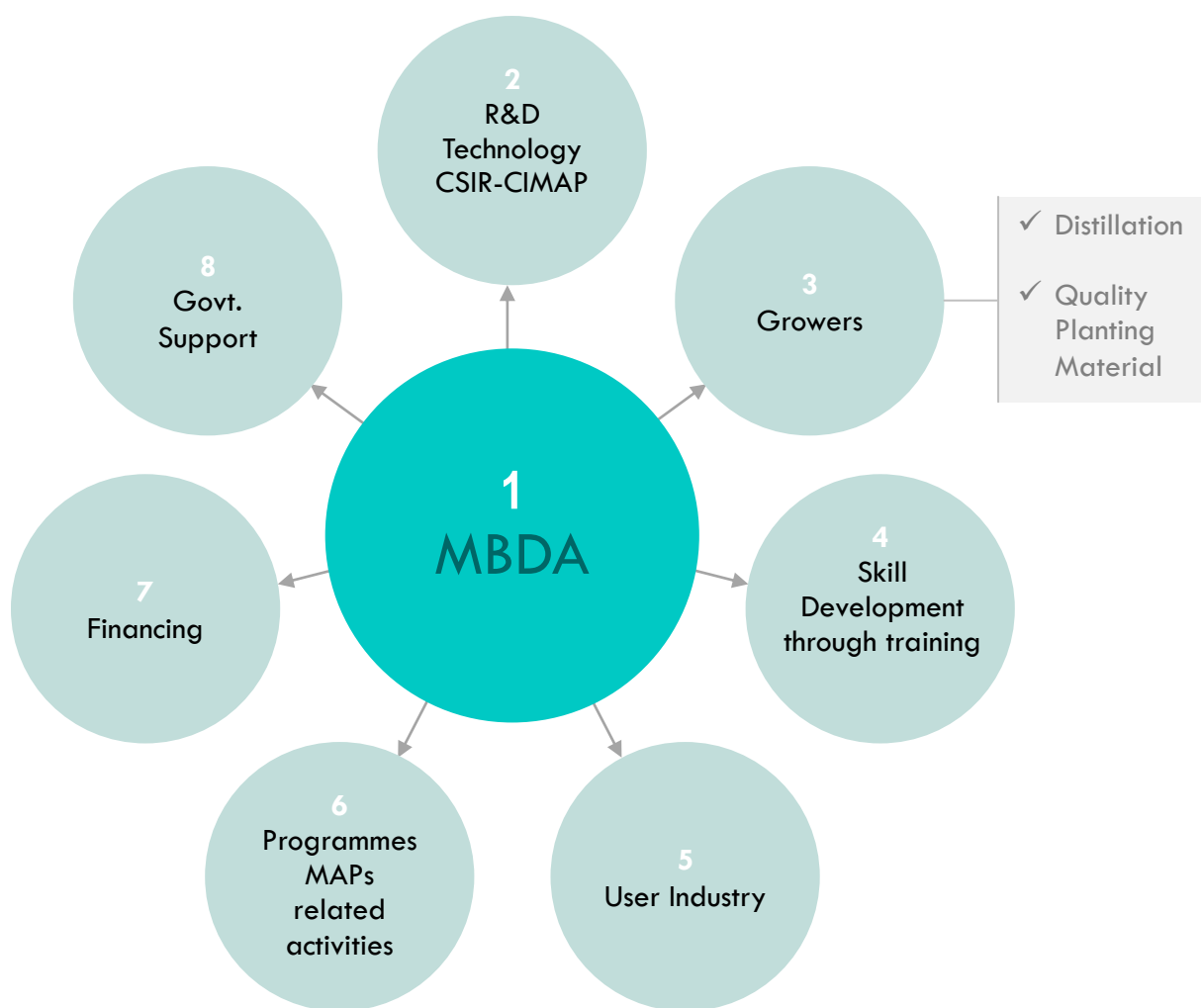


Figure 6a: Diagram showing cluster formation of MAPs in Meghalaya

1. Implementing agency
2. Access to MAPs related agro-technology
3. Production of oil and other raw material for user industry
4. Development of human resource
5. Buyers
6. Dissemination and extension
7. To facilitate growers/farmers
8. Infrastructure and staffing

CHAPTER 7

7.1 Project Components:

A. Awareness/Capacity Building/Skill Development

Activities Proposed	Venue	Resource Agency	Deliverables
1. Awareness cum promotion	Conduct in all the 11 districts either at the Block level or cluster/village level.	Scientist from CSIR-CIMAP, Institute of Natural Resources (MBDA)	<ul style="list-style-type: none"> One-day awareness programmes at state level, block level or cluster levels will be organised for farmers and progressive growers to motivate them about the benefits of cultivation of medicinal and aromatic crops for different agro-climatic regions in the state.
2. Skill up-gradation programmes on cultivation and processing of medicinal and aromatic plants.	CIMAP, Lucknow Existing farmers field (in this case Byrwa, Ri Bhoi)	CIMAP, Nodal farmers from Ri Bhoi	<ul style="list-style-type: none"> Farmers from each district will be attending training programmes of 2-3 days duration on cultivation and processing technologies for skill up-gradation which is held at CIMAP, Lucknow. Advanced training of 1-2 weeks on the processing technologies (distillation, quality testing, fractionation, product development etc.) will be organized to develop semi-skilled to skilled manpower/entrepreneurs to take up value addition activities related to aromatic crops.
3. Advanced training on value addition of the MAP produce and quality assessment	CIMAP, Lucknow	CIMAP	<ul style="list-style-type: none"> hands on practical training on fragrance quality of aromatic oils- skill development as aroma tester would be conducted

Regular training at different locations, on farm demonstrations and identification of clusters are the integral component of the mission programme to be implemented by INR/MBDA.

B. Cultivation/primary processing/cluster formation

Activities Proposed	Approach	Nodal Agency	Deliverables
1. Selection of interested farmers/ growers willing to take up nursery raising at the initial stage	10 nodal farmers from each district is to be selected based on their willingness to express their interest or through local administrative unit/BDU/EFC as an outcome of the awareness conducted in particular district or block.	INR/MBDA	<ul style="list-style-type: none"> One or two nodal farmers can be selected for their willingness to establish a distillation unit and the same can be utilised by other farmers within the vicinity of the nodal farmers. Selection of crops providing higher benefits to the farmers and having the ability to grow well under degraded land.
2. Selection of crops	Crops will be selected based on the demand of their essential oils to provide higher economic returns to the farmers as well as their suitability to a specific agro climatic condition of the area.	CIMAP	<ul style="list-style-type: none"> 8-10 aroma clusters constituting a group of 15-20 farmers with minimum area of 12 hectares in each District will be established for bulk production of oil.
3. Promotion of cultivation and processing of aromatic crops	Initially 10000 planting materials to be planting in 0.1 hectare area which will be distributed to each nodal farmers for setting up of aroma nurseries free of cost and after a period of 6 to 8 months the plants will be multiplied 10-20 times which can be taken up for further expansion	CIMAP will provide quality planting materials of high yielding variety	<ul style="list-style-type: none"> Ensuring availability of quality planting materials to the farmers. Increasing the area under cultivation by 1000 ha across the state

Activities Proposed	Approach	Nodal	Deliverables
4. Multiplication of the planting material of the selected crops	After 8-10 months the crop from the first nurseries will be able to multiply 10-20 times which is enough to expand the plantation to about 2 hectares (approx.) in the next planting season.	CIMAP/INR	<ul style="list-style-type: none"> 1 Improved field distillation unit will be installed in each cluster
5. Selection of clusters of farmers and promotion of cultivation of these crops to newer suitable areas to enhance area under cultivation of selected crops.	farmers at their instance will initiates formation of a robust and vibrant clusters for bulk production in future	CIMAP/INR	
6. Setting up of distillation units, and catalyzing setting up of farmers cooperatives for marketing the produce	Once the area under cultivation is expanded to a minimum of 5-6 hectares, one distillation unit will be installed by the nodal institute and side by side forming a co-operative society for future remunerative marketing	CIMAP/INR	
7. Market Linkage	Buy back of the primary processed oil will be as per the policy followed by CIMAP.		

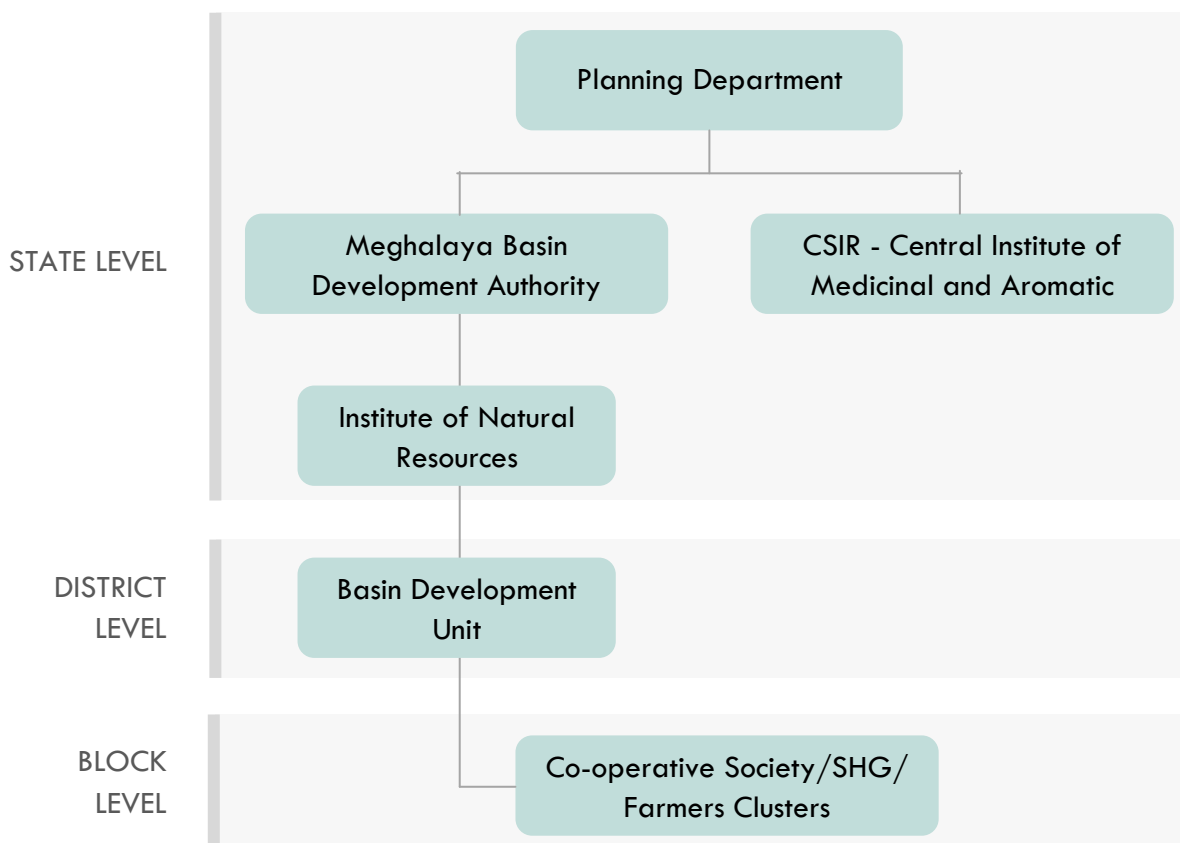
Procurement of quality seeds and planting materials of Lemongrass and Citronella at the initial stage will be made available from CSIR-CIMAP on payment basis or by procuring from local aroma nurseries present at Ri Bhoi. The seed and planting material of rest of the crop species under trial can be procured from authentic institutions or the farmers can approach the nearby nurseries from nearby state like Assam and for Lavender from Regional Research Laboratory, J&K.

CHAPTER 8

8.1 Project Implementing Agency:

Initially the Mission will be driven by the INR, MBDA in closed collaboration with CSIR-CIMAP where efforts are being made to introduce improved technologies and high yielding varieties to increase quality raw material by the growers and entrepreneurs in the country. Regular training at different locations, on-farm demonstrations and identification of clusters are the integral component of the mission programme. Training and Capacity building will be organized in collaboration with CSIR-CIMAP, Lucknow. Training and demonstration of sustainable green technologies will be taken up so as to ensure the organic production of Aromatic oils which has a higher market value. Other Agro-Technological inputs will be taken up by CSIR-CIMAP, Lucknow and INR, MBDA. Monitoring, Area expansion to other Blocks/ Districts will be taken up jointly by BDU and INR, MBDA. However as the Mission gains momentum a CIMAP like centre will be created under a Nodal Department of the state to be notified later.

Project Implementation Structure



CHAPTER 9

9.1 Mission Action Plan with Timeline:

Mission implementation will be divided in phase-wise manner for the smooth function of the project.

Phase 1: Awareness/Training/Capacity Building/Farmers and Crop selection			
Sn.	Activities	Timeline	Output
1	<ul style="list-style-type: none"> Awareness cum promotion 	1 st year	<ul style="list-style-type: none"> 11 district levels and 32 block levels awareness programme to be conducted across the state
2	<ul style="list-style-type: none"> Training cum demonstration on MAPs Technology for cultivation, production and processing Skill development On farm training on MAPs technologies Development of demonstration blocks Entrepreneurship training and value addition of Aromatic products 	1 st to 4 th year	<ul style="list-style-type: none"> 1000 farmers will be trained across the 11 district of Meghalaya 11 demonstration blocks will be formed one in each district
3	Farmers and crop selection	1 st year	<ul style="list-style-type: none"> 110 nodal farmers 10 in from each district will be selected Different Crops will be selected at different agro climatic zone across the state.
Phase 2: Cultivation/Processing			
3	<ul style="list-style-type: none"> Nurseries Establishment 	1 st to 2 nd Year	<ul style="list-style-type: none"> 110 nurseries in all the 11 district of different crops will be established at nodal farmers field based on the agro climatic condition and suitability of crops 1 distillation unit will be installed in each district for
4	<ul style="list-style-type: none"> Multiplication and cultivation 		
5	<ul style="list-style-type: none"> Installation of 		

	Distillation unit on site		primary processing of aroma oil.
6	<ul style="list-style-type: none"> Primary Processing of Oil 		
Phase3: Area expansion and Cluster formation			
7	<ul style="list-style-type: none"> Area expansion around the cultivation site. 	2 nd to 4 th Year	<ul style="list-style-type: none"> The area under cultivation will be expanded around the demonstration site using the planting material from the nursery. After the area under cultivation is expanded to more areas, cluster formation will take place side by side in order to achieve bulk quantity of oil 90-100 hectare of land will be brought under aroma cultivation in each district with the goal of achieving 1000 hectare across the state 8-10 aroma clusters of different crops will be formed in each District and minimum of 3 distillations Unit will be installed in each district amounting to 80-90 clusters and 25-30 Units across the state respectively.
8	<ul style="list-style-type: none"> Cluster formation among farmers or between adjacent villages 		
Phase4: Marketing of final produce			
9	Linkage with buyers	1 st to 2 nd year	<ul style="list-style-type: none"> Farmers industry meet to build up linkage for marketing of oil
	Storage facility		
	Quality analysis of produce, i.e essential oil		
10	Documentation and publication of brochure		<ul style="list-style-type: none"> Final report will be generated

CHAPTER 10

10.1 Package of Practices of Lemongrass and Citronella

1. Lemongrass

Common Name	:	Lemongrass
Hindi Name	:	Nibughass
Botanical Name	:	<i>Cytopagon flexuosus</i> , <i>Cymbopogon pendulus</i> and <i>Cymbopogon khasianus</i>
Improved varieties	:	Krishna, Chirharit, Kaveri, CIM-Swarna, CIM-Shikhar
Main chemical constituents	:	Citral is the main constituent of lemongrass oil.
Plant description	:	It is a perennial aromatic grass, oil is extracted from the leaves, if harvesting is delayed then flowers appears in plant. There is no oil in the flowers; however some of new varieties do not flower.
Climate	:	Warm and humid climate is best for cultivation of lemongrass, the north Indians subtropical conditions are best for cultivation of lemongrass.
Soil	:	Well drained fertile soil with pH range 7.0-8.5. It can be cultivate in rainfed condition also. It is also used for soil conversation purpose.
Propagation	:	It is recommended to grow it by slips obtained by splitting the well-developed clumps. In irrigated conditions 37,000-40,000 slips/ha are required with the spacing of 60×45 cm and non-irrigated condition 70,000-75,000 slips/ha required with spacing of 45×30 cm.
Planting and preparation of field	:	Planting is done in the last week of June-July depending upon the onset of rains. It may be also planted in Feb-March, under irrigate condition spacing line to line 60 cm and plant to plant 45 cm. Before transplanting 2-3 ploughing necessary, in non-fertile soils plant spacing is reduced as compared to irrigated condition.

- Manure and fertilizers : NPK @ 150:60:40 is required per ha per year. Entire amount of P & K is applied at the time of last ploughing in 1st year and in subsequent year after the summer harvesting. N is applied in splits thrice per harvest; under non-irrigated condition quantity of fertilizer will be reduced.
- Irrigation : Generally, less irrigation required in lemongrass. However, 2-3 time irrigation is sufficient during the months of December to March. After every harvesting, irrigation is required.
- Harvesting : Harvesting is done by cutting the grass with the help of sharp implement closer to the ground.
- Yield : In cv.Krishna, on the basis of 5 year, in irrigated conditions, 200-250 kg oil per kg/ha and under non irrigated conditions on the basis of two harvesting, 100-120 kg/ha/year.
- Crop economics : On the basis of 5 years.

2. Javagrass (Citronella)

- Common Name : Javagrass, Java citronella, Citronella
- Botanical Name : *Cymbopogon winterianus*
- Improved varieties : CIM-Jeeva, Bio-13, Manjusa, Mandakini, Jalpallavi
- Uses : The oil is used in cosmetic, soaps, perfumery and mosquito repellents.
- Main chemical constituents : Citronellal, Citrinellol, Geranial.
- Plant introduction : This is multicut perennial grass having light green long leaves. It requires good well drained soil for cultivation.
- Climate : Tropical and subtropical climate are most suitable for citronella crop.
- Soil : Fertile soil having pH range of 5 to 7.0 with proper drainage system is best for cultivation.
- Propagation : Slips having 1/2 inches roots and 6 inches of stem part.
- Planting and preparation of field : Planting is done in the month of Feb/March under irrigated condition while July-August for rained fed condition with the

- spacing. Of 50×40 or 60×30 cm line to line and plant to plant.
- Manure and fertilizers : 20-25 tonnes well decomposed FYM (Farm Yard Manure) or 10-15 ton vermin compost properly mix in the field during preparation. NPK @ 150:60:60 kg/ha/year will be applied. Nitrogen is applies in 4 regular intervals entire amount of phosphorous and potash mix during last ploughing.
- Irrigation : First irrigation applied immediately after transplanting and subsequent is applied as and when required. The crop requires less water in rainy season as compared to summer season.
- Harvesting : First irrigation applied immediately after transplanting and subsequent 2nd /3rd year after 3 months interval. Harvesting is done above 6-8” above the ground level.
- Crop economics : Expenditure (on 5 years basis)
Oil yield, 200-250 kg/ha year, Expenditure Rs. 40-45,000 ha/year.

ANNEXURE 1

Cluster wise action plan of MAPs cultivation, processing and marketing (minimum 10 Acres/cluster)

1 st phase	2 nd phase	3 rd phase	4 th phase
Cultivation	Processing	Cluster formation + expansion in area	Market of final produce
Tasks	Tasks	Tasks	Tasks
<ol style="list-style-type: none"> 1. Selection of sites/ farmers beneficiaries 2. Organizing of awareness programme for each cluster 3. Procurement of high yielding quality planting materials from authentic source for quality produce 4. Multiplication of planting materials for distribution among farmers following Nursery techniques <p>Resource requirements</p> <ol style="list-style-type: none"> i. Agricultural practices ii. Manpower iii. Planting material iv)transportation 	<ul style="list-style-type: none"> • Creation of facility for distillation on site <p style="text-align: center;">↓</p> <p>Resource requirement</p> <ol style="list-style-type: none"> i) a distillation unit on site (5 quintal unit suitable for hilly region) ii) water supply iii)Fuel iv) waste management of same crops 	<ul style="list-style-type: none"> • Village as a unit for bulk produce • A group of 10-15 farmers beneficiaries ranging from marginal small to big holding farmers may be selected • Area we may consider for the willingness of farmers from 500² to acreage 	<ul style="list-style-type: none"> • Linkage with buyers • Storage facility • GLC for quality analysis of produces ie essential oils • Farmers industry meet to build up the linkage for marketing of oils

Illustration profile for cluster making

ANNEXURE 2

Data to be recorded as follows, since crop is of multi-cut in nature and perennial

Treatment	Yield of herbage (in quintal)	Oil yield (in kg)
Crop in winter		
Crop in summer		
How many plants/ha		
Time of harvesting		
Row to row distance		

ANNEXURE 3

Expected estimated yield/ha as per plains agro-climatic conditions

Name of crop	Herb yield/ha (in quintal)	Oil yield (approx) average sale price per kg (in kg)	Net profit (approx.)per/ha/year in rupees	Current market rate in Rs./kg
Citronella (bio-13)	300-320 qts	220-250 kg/ha/year	1,20,000-1,60,000	1000/kg
Lemongrass (Krishi)	200-300qts	200-250 kg/ha/year	1,20,000	800/kg
Palmarosa (Prel)	400 qts/ha	125-150 kg/ha	1,20,000	1500/kg
Patchouli	210 qts	60.7 kg/ha	1,00,000	4000-4500/kg
Geranium	297 qts/ha	25-30 kg/ha	1,20,000	8000/kg
Rose (noorjahan)	40 qts/ha		3,00,000	500000/kg
Pyrethrum	7-8 qts/ha	Dry flower yield		
Menthapiperata		160 Kg/ha		

Note: Yield and quality varies from season to season, location to location and environmental condition may play an important role.

ANNEXURE 4

Per charge economics of Lemongrass and Citronella

Crop	Average Herbage Yield/ha/harvest	No. of harvest per year	Average Oil yield/ha/yr in Kg	Market Price of oil per kg	Net profit (approx)/ha/yr in Rs
Lemongrass	40 quintals	3	84	1000	50,400
Citronella	40 quintals	4	96	900	51,840

