Consultancy Project on

Exploring Potential for Medicinal Plants Cultivation in Telangana

भाकृअनुप - राष्ट्रीय कृषि अनुसंधान प्रबंध अकादमी

ICAR-National Academy of Agricultural Research Management

(ISO 9001:2008 Certified)

RAJENDRANAGAR, HYDERABAD - 500 030. TELANGANA, INDIA.

In Collaboration with

TELANGANA STATE MEDICINAL PLANTS BOARD

DEPARTMENT OF HEALTH, MEDICAL & FAMILY WELFARE, GOVERNMENT OF TELANGANA

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Date

MESSAGE

Traditional systems of medicine is growing in popularity across the globe. The medicinal plants are being used as medicine since antiquity. The plants are being used to cure various ailments by different therapiesViz. Ayurveda, Homeopathy, Unani, Naturopathy and even Allopathy also. India has been known to be rich repository of medicinal plants. The forest in India is the principal repository of large number of medicinal and aromatic plants, which are largely collected as raw materials for manufacture of drugs and cosmetic products. Telangana is also having large number of medicinal plants used by traditional healers and in AYUSH therapies. There is a high demand for the medicinal plants raw materials in AYUSH based industries. To meet this demand, medicinal plants cultivation is important. Cultivation should be encouraged in Telangana so that the natural habitats are not disturbed.

I seize this opportunity to congratulate Telangana State Medicinal Plants Board and National Academy of Agricultural Research Management (NAARM) for coming up with this project "Exploring Potential for Medicinal Plants Cultivation in Telangana". This report has detailed information on medicinal plants cultivation regarding the suitable soil types, rainfall, temperature etc. in our State.

I wish this study "Exploring Potential for Medicinal Plants Cultivation in Telangana" will encourage the farmers and stakeholders in increasing the medicinal plants cultivations in Telangana State.

(DR. C. LAXMA RREDDY)

Smt. A. Santhi Kumari, IAS,
Principal Secretary to Hon'ble Chief Minister &
Principal Secretary to Government,
Dept. of Health, Medical & Family Welfare,
Government of Telangana.

MESSAGE

It is a known fact that medicinal plants sector has been occupying a significant role in the socio-cultural, spiritual and medicinal arena of our society. The Indian System of Medicine is also gaining popularity in recent times in India and other countries too. As such, the burgeoning demand of the medicinal plants for domestic and export markets is putting heavy pressure on the existing resources, mainly the forest. Hence, the increase in the medicinal plants cultivation area would be an important strategy for meeting the growing demand of medicinal plants.

I congratulate the Telangana State Medicinal Plants Board(TSMPB) and National Academy of Agricultural Research Management (NAARM) for coming up with this project **"Exploring Potential for Medicinal Plants Cultivation in Telangana"**. This report mainly explores the potential area suitable for important medicinal plants cultivation in Telangana, which will have the twin advantage of saving the forests and financially helping the farmers who grow these plants.

I hope the findings in this study would benefit multi-stakeholders including Government to formulate effective strategies and increase the medicinal plants cultivation.

(Smt. A. Santhi Kumari, I.A.S)

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National Medicinal Plants Board

FOREWORD

Medicinal Plants form the major resource base of our indigenous health care traditions. The outreach and acceptability of AYUSH systems, both nationally as well as globally, are dependent on uninterrupted availability of quality medicinal plants based raw material. More than 90% of the species used in trade continue to be sourced from the wild of which about 2/3rd are harvested by destructive means. As such, the important species in demand need to be cultivated so that these MPs and their habitats in the forest could be protected and conserved.

National Medicinal Plants Board (NMPB), Ministry of AYUSH, Government of India is of the opinion that there is an imperative need to undertake a study that would look at expansion of various medicinal plants cultivationvis-à-vis their demand by herbal industries across the country. This project **"Exploring Potential for Medicinal Plants Cultivation in Telangana"** by Telangana State Medicinal Plants Board (TSMPB), Department of Health Medical and Family Welfare, Government of Telangana along with ICAR-National Academy of Agricultural Research Management(NAARM), Ministry of Agriculture and Farmers Welfare, Government of India, funded by NMPB, has given thedetailed information on potential areas suitable for cultivation of MedicinalPlants based on temperature, soil type, rainfall etc. This report would encourage the growers and farmers to take up cultivation of medicinal plants and thereby expansion of their cultivation throughout the State. This study would also give some insight to supply chain gap between the producers/ collectors and traders and other intermediaries.

I congratulate Telangana State Medicinal Plants Board and National Academy of Agricultural ResearchManagement (NAARM) for coming up with this study on **"Exploring Potential for Medicinal Plants Cultivation in Telangana"**. I wish that this study would help the farmers in selecting right species forcultivation and traders and stakeholders in their marketing strategies.

(Shomita Biswas)

Smt. A. Sonibala Devi,I.F.S.,
Addl. Secretary to Government ,
& E.O. Chief Executive Officer,
Telangana State Medicinal Plants Board
Dept. of Health, Medical & Family Welfare
Government of Telangana

FORWORD

The traditional system of medicine especially Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy is indeed widely accepted in India as well as in abroad too. As such, the demand of medicinal plants (MPs) as raw materials consumed in ASU&H based industries is high and the heavy dependence of these raw materials collection on forest/wild is a known fact to all of us. In Telangana, there are more than 500 (Ayurveda, Unani, Homeopathy) manufacturing units. Apart from this, the flourishing industries which are indulged in herbal products especially food items, cosmetics, flavours, fragrances, etc. have escalated the demand of MPs and causing the destruction of the forest/ wild habitats due to unsustainable, unscientific collection practices. As such, the important species in demand need to be cultivated so that these MPs and their habitats in the forest / wild could be protected and conserved.

Telangana State Medicinal Plants Board (TSMPB) along with National Academy of Agricultural Research Management (NAARM) has initiated this project **"Exploring Potential for Medicinal Plants Cultivation in Telangana"** in order to explore the potential areas suitable for cultivation of MPs so that cultivation of these MPs can be further expanded across the State and also the dependence of some of the MPs in high demand can be brought under cultivation and the pressure on forest / wild for these species can be reduced. This study has given information in detail regarding the suitable areas where the MPs which are under cultivation can further be increased across the state based on the various important parameters like soil types, rainfall, temperature, etc. this study will also give an insight to further reduce the gap of the producers/ collectors and traders even though a detailed study is required to be conducted.

I truly hope and wish that this study would help in promotion, expansion of the medicinal plant species cultivation across the state and also prove beneficial to all medicinal plant stakeholders to formulate new strategies for improving MPs cultivation.

I express my sincere gratitude to National Medicinal Plants Board(NMPB), Ministry of AYUSH, GoI for financial support and ICAR-NAARM, for their cooperation .
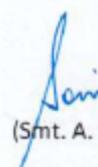
(Smt. A. Sonibala Devi, IFS)

Dr. Ch Srinivasa Rao
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Foreword

Throughout the ages, humans have relied on nature for their basic needs for the production of food-stuffs, clothing, fertilizers, flavours and fragrances, and, not the least, medicines. Many plants have formed the basis of sophisticated traditional medicine systems that have been in existence for thousands of years. The vast majority of people on this planet still rely on their traditional *materia medica* (medicinal plants and other materials) for their everyday health care needs. Over the centuries, the use of medicinal and aromatic plants has become an important part of daily life despite the progress in modern medical and pharmaceutical industry. It is also a fact that one quarter of all medical prescriptions are formulations based on substances derived from plants or plant-derived synthetic analogs. According to the WHO, 80% of the world's population—primarily those of developing countries—rely on plant-derived medicines for their healthcare. They are now being progressively cosmetics, foods and teas, as well as alternative medicines. In view of the steadily rising demands on these important natural resources, attention should be paid to the sustainable forms of production and utilization. Globally herbal market size is estimated to be approximately USD 72 Billion and further estimated to further reach to USD 7 trillion by 2050. Medicinal plants are used in various industries which are worth around USD 80 Billion. In India, approximately 15,000 medicinal plants species are available. Out of this, about 3000 plants species are reported to be used in codified Indian Systems of medicine.

In the Indian system of *Ayurveda,* the use of medicinal plants is frequently mentioned, and most of those being used from the very beginning are still used in today's traditional medicine as practiced in India. Keeping in view the growing importance of medicinal and aromatic plants in India as well as globally, the project sponsored by the Telangana State Medicinal Plants Board on '*Exploring Potential for Medicinal Plants Cultivation in Telangana*' is a timely commissioned. The identification of suitable production area for different medicinal plants would help in promoting those crops in respective districts/ region and exploring the possibilities to encourage processing and marketing facilities. This would help in increasing the farmers' income in significant proportion as well. I compliment the project team associated with this study in bringing this interesting report. I am sure this would help in great way the Telangana state to plan a roadmap for giving further fillip to production of such high value medicinal plants and the entire sector.
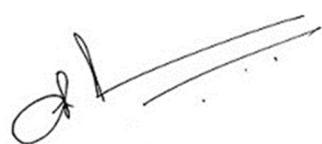
(Dr. Ch. Srinivasa Rao)

PREFACE

The ancient system of medicine in India, namely, Ayurveda, Unani, Siddha & Homoeopathy (AYUSH) is still the most prevalent system of medicine, especially in the rural areas. In the recent times, there is a renewed interest among public to go for traditional medical system, which has less or no side effects. The demand for medicinal plants has increased due to sustained demand for the medicinal products and the entry of large private companies in this sector.

United Andhra Pradesh was one of the largest producer of medicinal crops in the country. However, after bifurcation in 2014, almost the entire area under medicinal plant cultivation fell in Andhra Pradesh territory, leaving very little area under medicinal crops in Telangana. The Govt. of Telangana, through Telangana State Medicinal Plant Board (TSMPB), has been encouraging farmers to take up medicinal plant cultivation through various incentives in the form of subsidies and market facilitation activities.

For the promotion of medicinal crop cultivation, it is important to identify locations suitable for their cultivation in the state. This study has made a maiden attempt to identify the suitable location for the cultivation of some promising medicinal plants using soil and climatic variables. Geo-spatial system of analysis was employed in this study, which has helped in identifying the right areas at the micro-level in the newly formed districts of Telangana. We hope this study will be useful for formulating suitable policy options and extension strategies for expanding the area under medicinal plant cultivation in the state.

Sivaramane N & Ranjit Kumar

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1 INTRODUCTION

Traditional form of health care is still popular in several countries. In India, large proportion of the population is dependent on it. This traditional system, which includes Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy, abbreviated as AYUSH, is also known as alternative system of medicines. This system utilizes various forms of extracts extracted from different parts of medicinal plants for treatment purposes. To give due recognition to this and for optimal development and propagation of AYUSH systems of health care, the department of AYUSH under Ministry of Health & Family Welfare, Government of India was elevated to the Ministry of AYUSH in the year 2014. The National Medicinal Plants Board (NMPB) was set up in the year 2000 under this ministry and along the same lines, State Governments had also set up medicinal plants boards to meet the growing demand of medicinal plants and to conserve rare, endangered and threatened species.

The area and production of medicinal and aromatic plants in India is 499 thousand hectares and 926 thousand tonnes, respectively, while that of erstwhile Andhra Pradesh (including Telangana) is just 1.88 thousand hectares and 3.5 thousand tonnes, respectively (Govt. of India, 2016). In Telangana state, over 2000 species of medicinal plants are found. The Telangana State Medicinal Plants Board (TSMPB) implements several schemes to boost the medicinal plants production in the state. The popular and commercially grown medicinal herbs in the state are Senna or Swarna Pathri, Ashwagandha, Kalmegh, Bhuamlaki/ Nelavusiri and Coleus (Singh and Vidyasagar, 2015).

The TSMPB has implemented a scheme with the help of National Medicinal Plants Board (NMPB) wherein the farmers are encouraged to take up cultivation of medicinal plants in their farm through subsidies. The Girijan Cooperative Corporation (GCC) has promoted collection of medicinal plants from the forest lands by the tribal people and helps in marketing the produces. There are two main issues confronting the medicinal plants production in Telangana state. Firstly, after the bifurcation of the state, the area under medicinal plants in Telangana state is very less. Therefore, there is a need for identifying potential area where different types of medicinal plants can be promoted. Secondly, the constraints pertaining to the medicinal plant cultivation and marketing need to be probed to formulate strategies to make medicinal plant cultivation economically viable for farmers

to venture into this enterprise or the existing farmers to expand their area. To address these issues, the study is taken up with the following specific objectives:

1.1 Objectives of the study

1) To characterize the production system of selected medicinal plants in Telangana state;
2) To identify the locations suitable for cultivation of medicinal plants based on soil, and topographic maps and to project supply of different medicinal plants; and
3) To identify the problems faced by medicinal plant cultivators and suggest suitable policy options to promote medicinal plant cultivation in Telangana.

2 DATA AND METHODOLOGY

The study area *viz.* Telangana state is a newly formed and 29th state of India, created by bifurcating Andhra Pradesh state on 02nd June 2014. The state, with Hyderabad as the capital city, is spread in an area of 1,12,077 square kilometres and has a population of 3,51,93,978 (2011 census). Recently, all the districts in the state has been reorganized from 10 to 31. These districts are further divided into 68 revenue divisions which are in turn divided into 584 mandals. The districts in the state (in alphabetical order) are:

1. Adilabad
2. Bhadradri Kothagudem
3. Hyderabad
4. Jagtial
5. Jangaon
6. Jayashankar Bhupalpally
7. Jogulamba Gadwal
8. Kamareddy
9. Karimnagar
10. Khammam
11. Komaram Bheem Asifabad
12. Mahabubabad
13. Mahbubnagar
14. Mancherial
15. Medak
16. Medchal
17. Nagarkurnool
18. Nalgonda
19. Nirmal
20. Nizamabad
21. Peddapalli
22. Rajanna Sircilla
23. Ranga Reddy
24. Sangareddy
25. Siddipet
26. Suryapet
27. Vikarabad
28. Wanaparthy
29. Warangal Rural
30. Warangal Urban
31. Yadadri Bhuvanagiri

There are 12 cities in the state, including 6 municipal corporations and 38 municipalities. Hyderabad is the only million plus city. The state agriculture is predominantly rainfed and its net cropped area is 49.61 lakh ha with cropping intensity of 127 per cent. The average farm holding is 1.128 ha. The major crops grown are paddy, cotton, maize, soybean, chilli and turmeric. The past decade has witnessed a sharp shift in the cropping pattern in favour of cotton and soybean and to paddy and Redgram to some extent while all other crops have lost area to these crops. About 80 per cent of the rainfall is received through South-West Monsoon and about 14 per cent received during North-East Monsoon.

The TSMPB provides a subsidy of 30 per cent of the cost of cultivation to certain notified medicinal plants growers in the state. Some medicinal plants have subsidy of 50% to 75% of cost as per norms laid out by NMPB. The area under various cultivated medicinal plants (excluding tree medicinal crops) covered under this scheme is about 717 acres (Annexure-1)
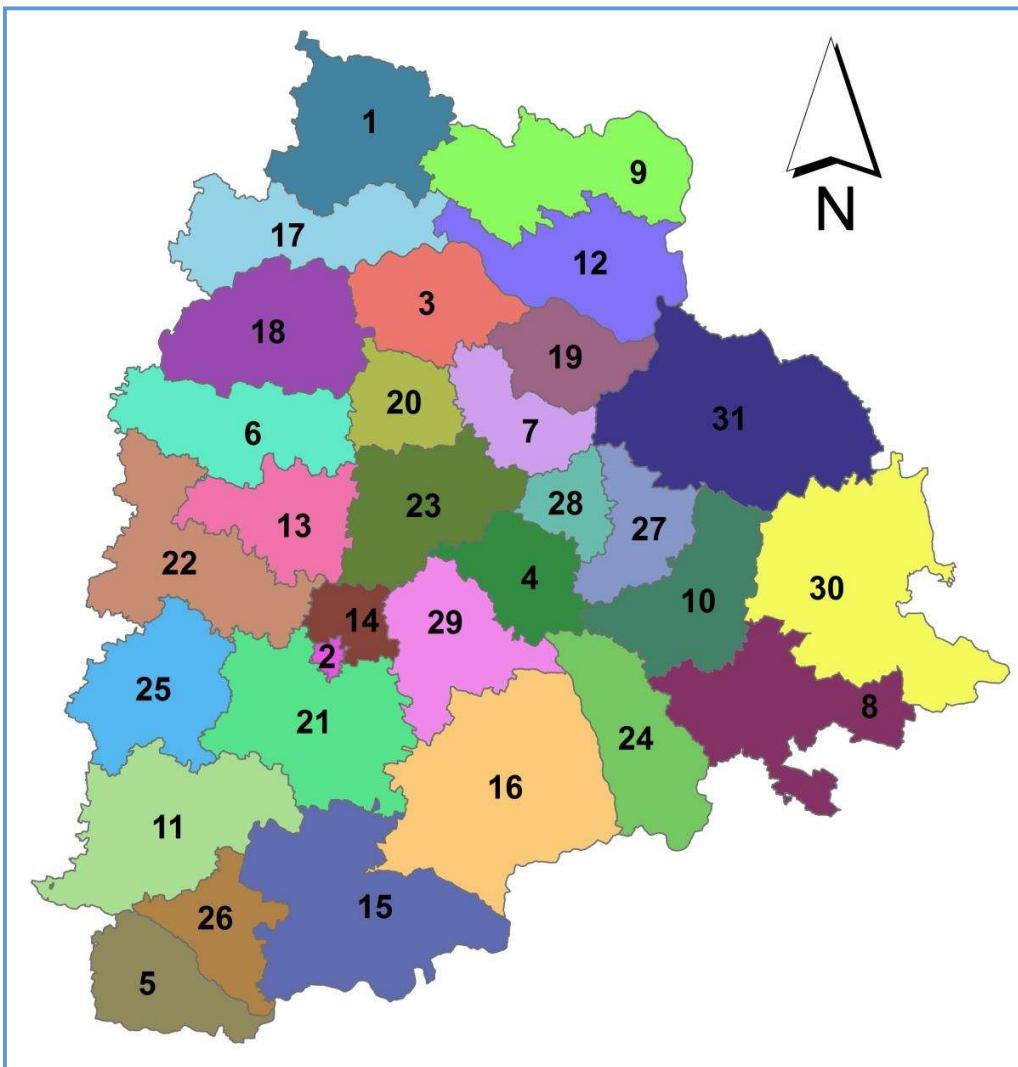
Figure 1. District Map of Telangana State

1. Adilabad
2. Hyderabad
3. Jagtial
4. Jangaon
5. Jogulamba Gadwal
6. Kamareddy
7. Karimnagar
8. Khammam
9. Kumarambheem Asifabad
10. Mahabubabad
11. Mahabubnagar
12. Mancherial
13. Medak
14. Medchal Malkajgiri
15. Nagarkurnool
16. Nalgonda
17. Nirmal
18. Nizamabad
19. Peddapalle
20. Rajanna Sircilla
21. Rangareddy
22. Sangareddy
23. Siddipet
24. Suryapet
25. Vikarabad
26. Wanaparthy
27. Warangal Rural
28. Warangal Urban
29. Yadadri Bhuvanagiri
30. Bhadradri Kothagudem
31. Jayashankar Bhupalpally

2.1 Medicinal Crops Selected

For the study, TSMPB identified eight commercially cultivated medicinal crops for which suitability maps are prepared. The crops selected are Aswagandha, Sandal Wood, Aloe vera, Red Sanders, Mucuna, Tulsi, Vacha and Guggul. The details of the crop, soil and climatic factors suitable for each of these crops are discussed in brief and given in the proceeding sections.

2.2 Data Sources & Sampling Procedure

The study used secondary data to collect information about the suitable conditions in which the crop grows well. The sources of information include crop information of National Medicinal Plants Board, brochures or leaflets published by TSMPB and other information available in authenticated domains. In addition to these, the primary data obtained by TSMPB through survey of the beneficiaries of schemes implemented by the board was also used to understand the economics of cultivation of the medicinal plants in Telangana. The study was limited to the following eight medicinal plants identified by TSMBP:

1. Aswagandha
2. Sandal Wood
3. Aloe vera
4. Red Sanders

5. Mucuna

6. Tulsi

7. Vacha

8. Guggul

2.3 Context of suitability in this study

The suitability of the location for cultivating medicinal plants is scaled as most suitable, moderately suitable and less/not suitable locations. The most suitable location has soil and climatic conditions most suitable for the cultivation of medicinal plants. On the other hand, soil and climatic condition which is detrimental to the cultivation of the selected medicinal plant is categorized as less or not suitable locations. Here cultivation of medicinal plants without external input such as irrigation and fertilizers leads no or less yield. The locations where the conditions are neither highly favourable nor unfavourable is categorized as moderately suitable.

2.4 Methodology

The methodology used in study is given as:

2.4.1 Characterization of production system of medicinal plants

The information on area, production and productivity of medicinal plants at disaggregate level collected by TSMPB are used in addition to the data collected from secondary sources. Tabular analysis has been used to achieve this objective.

2.4.2 Identification of locations suitable for cultivation of medicinal plants

Geo-Spatial analysis was carried out for the entire state for identifying the area suitable for various medicinal plants using GIS spatial data *viz.,* Telangana district map, mandal map, soil map; and non-spatial data *viz.,* monthly average temperature, rainfall, pH (potential of hydrogen) using Arc-GIS software with the help of Map Overlay analysis. Map Overlay analysis is a group of methodologies applied in optimal site selection or suitability modelling. It is a technique for applying a common scale of values to diverse and dissimilar inputs to create an integrated analysis for classifying the suitability area into different classes. There are various assumptions and limitations in this method which is very important to note while interpreting the results. One important assumption is that the suitability is analysed assuming no or less irrigation facility. The other assumptions are homogeneity in soil within the single pixel as the scale of the soil map used in the study is 1:250,000, unlimited demand for the crop and no competing crop. The limitations

of the study include use of average annual rainfall and average monthly temperature data of old districts of Telangana (Table 10 & Table 11). The methodological framework employed in this study is given below in the form of flowchart.
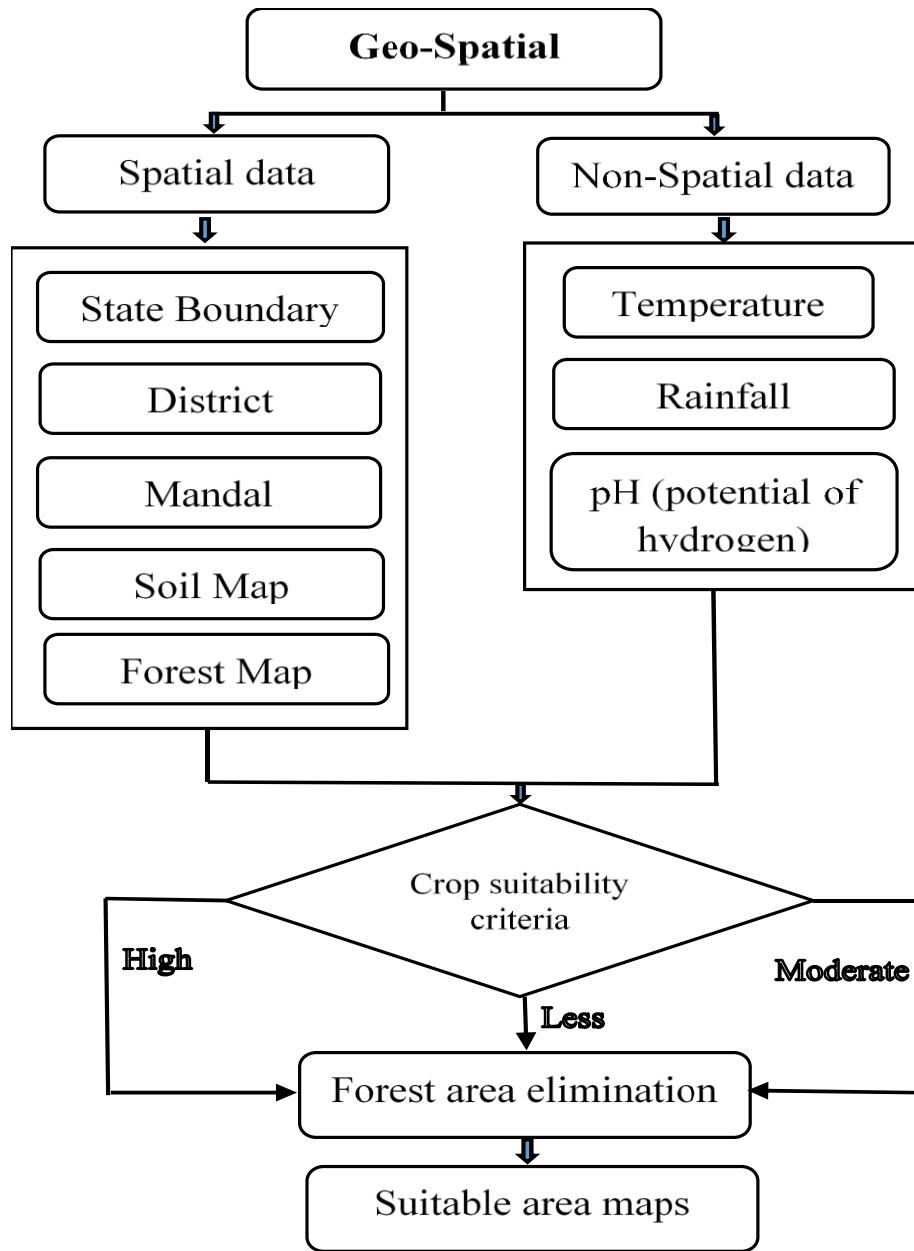
Figure 2. Flow Chart of steps used in estimating suitable locations

The units provided in the study for the estimation of land under various crops is acres, which can be converted into hectares by dividing by a factor of 2.5 or to sq. KM by dividing with 250. The types of soils found in Telangana are given below in the form of map. It shows that there are 12

types of soils in the state. The major soil types are clay and loam. The soil range from neutral pH to slightly alkaline.
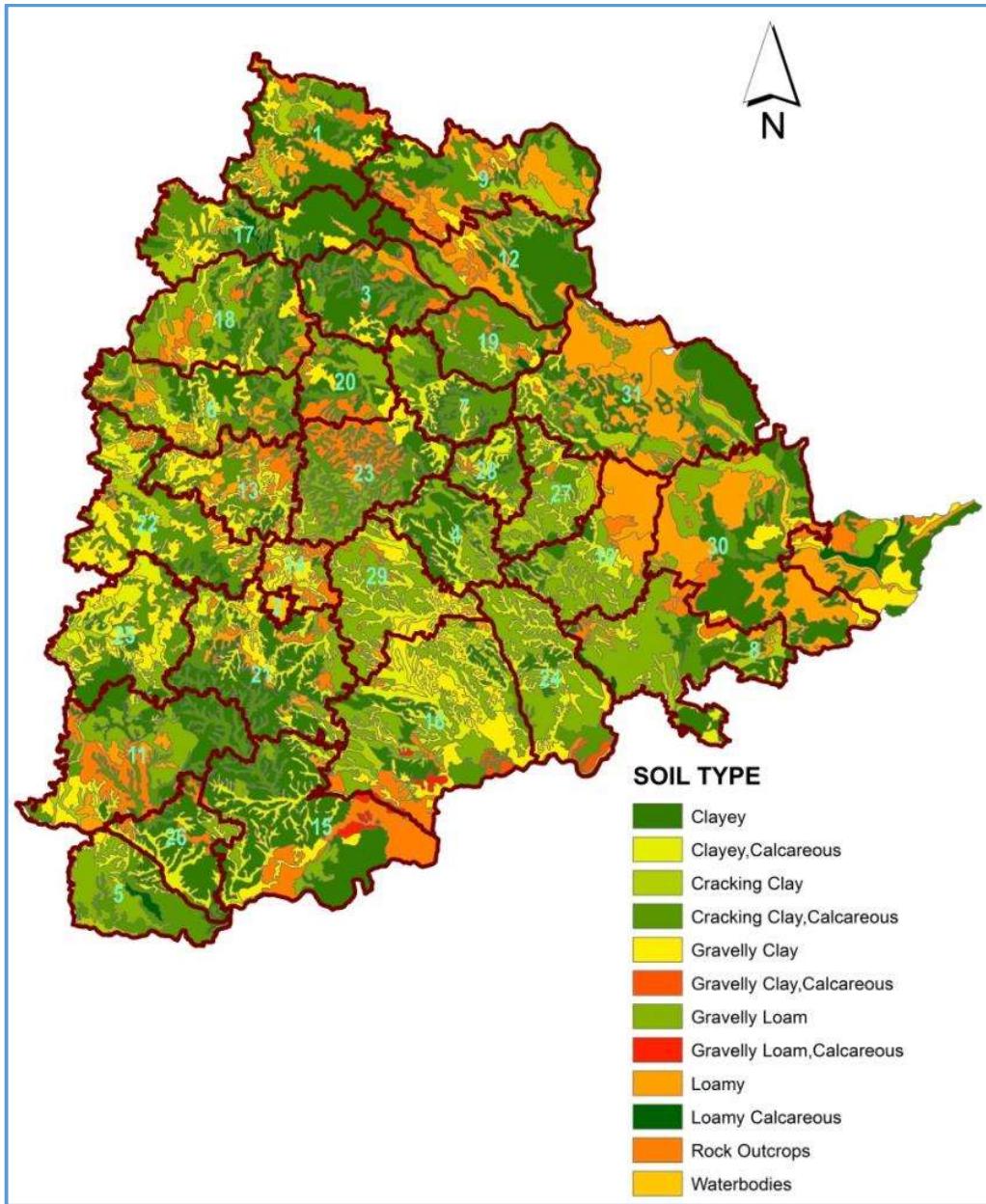
Figure 3. Soil Types in Telangana

2.4.3   Identification of problems of medicinal plant cultivators

Despite continued support by the government, the medicinal plants production in the state is not really peaking. This study tries to examine the problems faced by medicinal plant growers in Telangana State. It may be noted that very few farmers were growing selected medicinal plants

other than Ashwagandha and Mucuna. Simple percentages were used to highlight the problems faced by the growers of these medicinal plants.

3   RESULTS AND DISCUSSIONS

The results of the analysis carried out in this study are presented objective-wise along with the discussions.

3.1   Production system of selected medicinal plants in Telangana state

The production system was studied mostly from the secondary data supplemented with primary data. The area, production and productivity of medicinal crops growing in Telangana are compiled from primary data collected by TSMPB. Further, the climatic and soil requirements of each medicinal plant used in the analysis of identifying suitable area for cultivation of medicinal plants, were documented in this chapter.

3.1.1   Area under medicinal plant cultivation in Telangana State

The district wise cultivation of all medicinal plants is presented in Table 1.

Table 1. District-wise Cultivation of Medicinal Plants in Telangana

S No	Districts where medicinal crops are grown	Area (acres)
1.	Jangon	11.15
2.	Jogulamba Gadwal	223.61
3.	Komaram Bheem Asifabad	36.63
4.	Mahabub Nagar	97.01
5.	Mancheriyal	11.19
6.	Medak	83.32
7.	Nagar Kurnool	18.52
8.	Nalgonda	11.46
9.	Nirmal	101.84
10.	Ranga Reddy	106.41
11.	Sanga Reddy	22.1
12.	Suryapet	14.5
13.	Vikarabad	7.47
14.	Wanaparthy	2.76
	Telangana	747.97

It can be seen that districts namely Jogulamba Gadwal, Nirmal, Ranga Reddy and Sanga Reddy were having land of over 100 acres under cultivation of medicinal plants in the state. Further, districts like Mahabubnagar and Medak were also having area close to 100 acres.

The species wise cultivation of various medicinal plants in Telangana is presented in Table 2. It is found that Ashwagandha is the most common medicinal crop cultivated with an acreage of over 400 acres. Sandal wood and Aloe Vera are the other medicinal crop presently taken up in Telangana.

Table 2. Species wise Cultivation for the year 2016 - 2017

Sl.No	Name of the Crop Cultivated	Area (in Acres)	%
1.	Aswagandha	430.58	57.57
2.	Sandal Wood	141.39	18.90
3.	Aloe vera	98.31	13.14
4.	Red Sanders	24.04	3.21
5.	Mucuna	21.25	2.84
6.	Tulsi	11.69	1.56
7.	Vacha	13.05	1.74
8.	Guggul	7.66	1.02
	Total	747.97	100.00

Source: Compiled from data provided by TSMPB, Hyderabad

3.1.2   Suitable Conditions for Ashwagandha (Withania somnifera)

The other popular names of this plant are Winter Cherry, Indian Ginseng, Asgandh, Nagouri Asgandh and Punir. Its roots and orange-red fruit have been used for hundreds of years for medicinal purposes. Presently, over 200 traditional medicinal formulae are prepared in Ayurveda, Siddha and Unani systems. The roots of this crop are harvested and shade dried and sold in the market. This crop enjoys insatiable demand in the country and is

Figure 4. Ashwagandha (Withania somnifera) plant and its dried roots

one of the top ten traded herbs. It is grown in semi-tropical areas receiving 600-700 mm rainfall and requires relatively dry season during its growing period. It can tolerate temperature ranging from 10˚C to 38˚C while the ideal temperature is 20˚C to 35˚C. It grows well in sandy loam or light-red soils with good drainage with pH ranging from 7.5 to 8.0. The crop is sown during July-August and the duration of the crop is 150-170 days. Commercial varieties are available for this herb such as Arka Ashwagandha and Jawahar Ashwagandha which has high withanolide content.

Medicinal uses: It is an important constituent in a majority of medicine preparations. It is used in the preparations for its anti-inflammatory, anti-convulsive, anti-tumor, immune-suppressive and antioxidant properties besides promoting vigour and stamina.

3.1.3   Suitable Conditions for Sandal Wood (Santalum album)

Figure 5 Sandal Wood (*Santalum album*)

The common names of the tress is Chandanamu and Srigandamu. It is a woody evergreen tree popular for its aroma and used extensively in perfumes and as medicines. It is majorly grown in Karnataka and Tamil Nadu. However, it is also grown in Telangana in smaller area. It is grown in red ferrogenous loamy/ sandy soil. It requires 600 mm to 1600 mm rainfall. The economic life of the tree is 15-20 years. It yields 20-25 kgs per tree. The production is to the tune of 5 to 6 tonnes per acre.

Medicinal uses: It is used for skin diseases and in the treatment of headaches, sneezing, diabetes, etc. It is also used as refrigerant, cooling and for skin eruption.

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3.1.4 Suitable Conditions for Kalabanda (Aloe barbadensis)

This plant is also known by various names like Indian Aloe, Aloevera, Ghiguvar, Ghrit Kumar and Kunvar pathu. The leaves of the succulent plant is used for medicinal and cosmetic uses. Its demand is growing exponentially owing to increasing awareness of its uses and health consciousness. This crop is found in tropical and sub-tropical regions and more suited for cultivation in arid and semi-arid regions for it can come up well in areas with mean annual rainfall of 350-400 mm and it tolerates high pH, ranging

Figure 6. Kalabanda (Aloe *vera*)

from 7.0-8.5 as well. It can tolerate temperature ranging from 10°C to 50°C. It grows well in almost all types of soil with good drainage and climatic conditions. However, the most suitable soil type is well drained loam to coarse sandy loam soils with moderate fertility and pH up to 8.5. The crop can withstand prolonged drought conditions. Almost entire Telangana is suitable for cultivation of this crop as the average rainfall in all districts are above 800 mm and has suitable temperature and pH. This crop can be planted any time during the year. The economic life of the plant for commercial cultivation is 3 to 5 years. In the first year, it yields about 20 tonnes of leaves per acre and in the second and third year, the average yield is expected to be about 25 tonnes per acre. The is grown under contract farming in the state where buyer assures to buy the harvest from contracted area of the crop at the rate of Rs.2.50 per Kg.

Medicinal uses: It is extensively used in medicinal and toiletries preparations. It is used in the treatment of Asthma, skin disorders, diabetes, weight loss, cardiovascular diseases, arthritis and cancer.

3.1.5 Suitable Conditions for Red Sanders (Pterocarpus santalinus)

Figure 7 Red Sanders (Pterocarpus santalinus)

The common names of the plant is red sandalwood, Saunderswood, Agilankattai and Rakta Chandhanamu. It grows extensively in east of Andhra Pradesh and other states like Telangana. It has a very high export potential. It grows well in well drained red soils with gravelled loam. It requires 800 mm to 1000 mm of rainfall. The economic life of the tree crop is 15-20 years. It yields about 8 tonnes per acre.

Medicinal uses: It is used for the treatment of diabetes, stomach ulcers and other ailments. It is extensively used in Chinese medicines.

3.1.6 Suitable Conditions for Kaunch (Mucuna pruriens)

The common names of the plant are Velvet beans, Kapikachu, Gonca and Koncha. This crop is

Figure 8. Kaunch (Mucuna pruriens) and its

also raised as fodder and green manuring crop in Central and Southern India. This crop is found in tropics and sub-tropical regions. The crop grows in all types of soils, but sandy loam soil with good drainage and pH between 5.50 to 7.50 is preferred. It thrives in sub-tropical to tropical climate with a minimum temperature of 15 °C in winter and maximum of 38 °C in summer months. The crop is seen growing in varied climate such as coastal humid climate to dry arid climate. Hence, the crop is said to be highly acclimatizing and adaptive. Regions with rainfall ranging from 1200-1500 mm are highly suitable. The crop is sown during June-July in Telangana and does not thrive well in water logging conditions. The crop is harvested in about 200 days after sowing.

Medicinal uses: In Ayurveda and Unani medicine systems, seeds of Kaunch is used for treating sexual and other nerve disorder. The seeds of the plant are used as tonic, aphrodisiac and in treatment of Parkinsons' disease and for rheumatic ailments. The beans are also eaten by people and the plant is used as fodder.

3.1.7 Suitable Conditions for Tulsi (Ocimum sanctum)

Figure 9. Tulsi (Ocimum sanctum)

The common names of tulsi are Manjari, Brinda and Holy Basil. Tulsi is a sacred plant associated with Hindu religion in India. It is a tropical and sub-tropical herb flourishes well in high rainfall and high humid regions. This crop grown in rich loam to poor laterite soil having pH in the range of 6.5 to 8.0. The most preferred temperature for this crop is 14-30 °C. This crop is susceptible to water logging and found at an altitude upto 900 mean sea level (MSL). All parts of the plant are used for medicinal purposes. The leaves of the plant can be harvested multiple times starting from 90 days. There are two types of Tulsi crop- Sri Tulsi (also called Ram Tulsi, the most common type) and Krishna Tulsi (with purple leaves, which is more preferred for drugs). About 1.2 tonnes of dry leaves and 8 tonnes of wet leaves yielded per acre/annum per acre.

Medicinal uses: Tulsi is used in the treatment of eczema, psoriasis and aging effects. It is also used as an antibiotic, an immune system booster, an anti-inflammatory and a stress reducer.

3.1.8 Suitable Conditions for Vacha (Acorus calamus)

The other common names of this plant are Sadgrantha, Ugragandha, Vayambura and Bach.This crop is a popular medcinal plant used in several ayurvedic preparations. Due to rapid exploitation of this crop from wild, it is listed as endangered species. It's a hardy plant found growing from tropical to sub-tropical climates. This crop also found in temperature and semi-temperate regions. Plenty of sunshine should be available to the plant during its growth and after harvesting for drying the rhizomes. Temperature ranging from 10°C to 38°C and annual rainfall between 700-2500 mm are best suited. Cultivation should be avoided in places where there is no irrigation facility. This

species comes up well in clayey loams, sandy loams and light alluvial soils of river banks. This crop prefers water logging and is grown in telangana as rice fallow crop. The economic parts of the plant are roots and stem. This crop is sown during June-July months in Telangana. The crop comes to harvest in about 10 months. The yield is expected to be in the range of 15-20 quintals per acre.

Medicinal uses: Its rhizomes are used in epilepsy and other mental ailments, chronic diarrhoea, dysentery and abdominal tumours.

Figure 10. Vacha (Acorus calamus) and its rhizome

3.1.9 Suitable Conditions for Guggul (Commiphora mukul / G. wighti)

Figure 11 Guggul (Commiphora wighti)

The common names of this tree are Indian bdellium-tree or Mukul myrrh tree. The guggul plant is widely distributed throughout India and adjacent dry regions. The tree is a small shrub with thorny branches. The gum, called "guggul" or "gum guggulu," is tapped from the stem of the plant, and the fragrant yellow latex solidifies as it oozes out. Excessive production of the gum eventually kills the plant.

Medicinal uses: It is used as resolvent expectorant, asphrodisiac, muscle rheumatism, abdominal troubles, dyspepsia and piles. It is also used in the treatment of nervous diseases, urinary disorders and skin diseases.

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3.2 Identification of locations suitable for cultivation of medicinal plants

The location suitable for selected medicinal plant cultivation in Telangana was estimated based on soil types, rainfall, and temperature conditions. The soil type used in this study was measured on a scale of 1:250,000. For rainfall, annual average rainfall data for Telangana for different districts were used for the analysis. For temperature, the average monthly temperatures for different districts were used.

3.2.1 Suitability of cultivation of Ashwagandha

The area highly suitable, moderately suitable and less or not suitable area for the cultivation of Ashwagandha is presented in the Figure 12. The district-wise classification of area based on suitability is presented in the Table 3. It shows that the districts Nalgonda, Nizamabad, Khammam and Suryapet have more area under highly suitable range. A majority of the area under Telangana fall under the moderately suitable category for this crop.
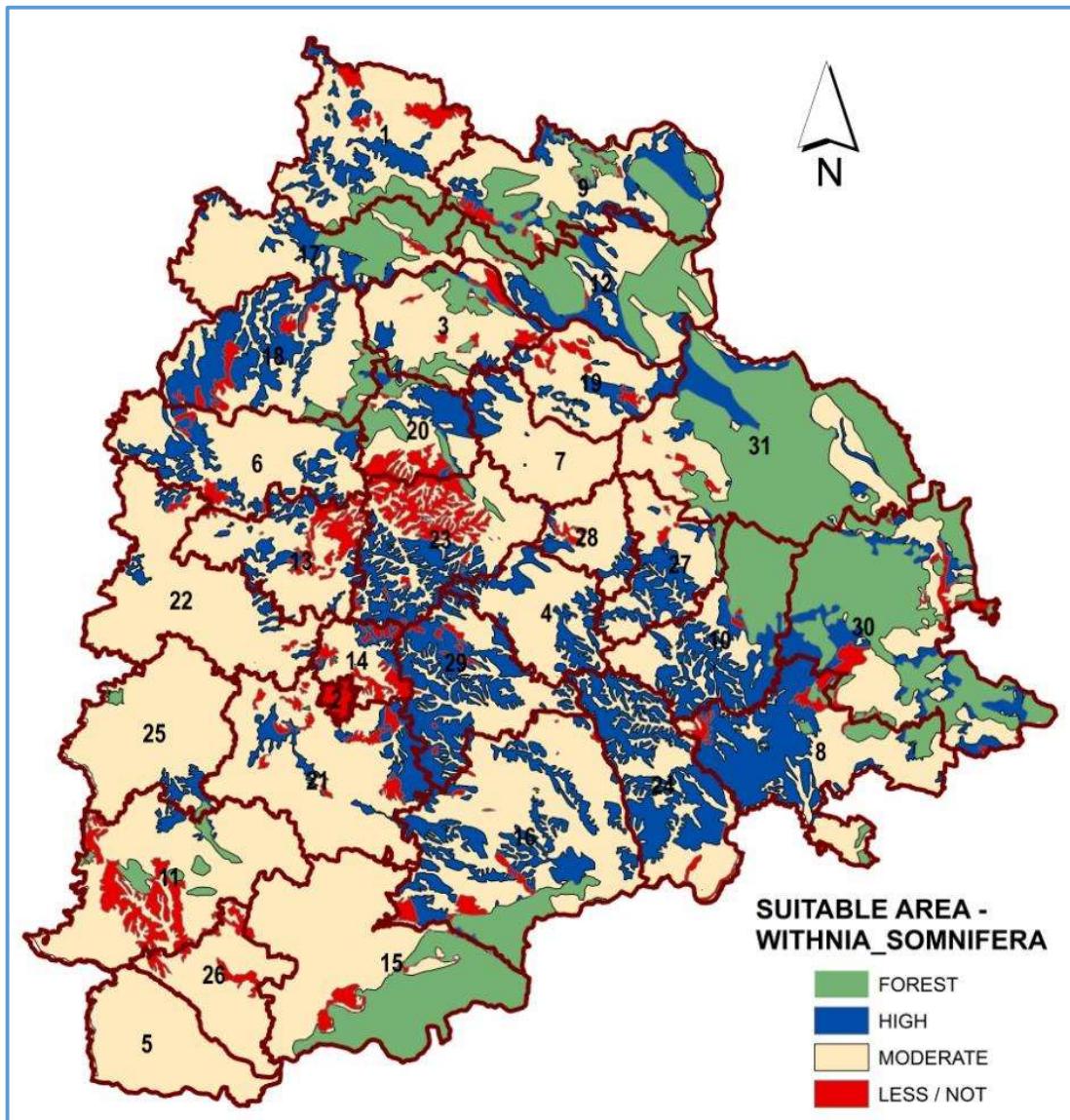
Figure 12. Map depicting suitable area for Ashwagandha Cultivation in Telangana

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Table 3. Area Identified for Cultivation of Ashwagandha in Telangana

DISTRICTS	Most suitable Area (Acres)	Moderately suitable Area (Acres)	Less or not suitable Area (Acres)	Total cultivable area (Acres)
Adilabad	177,045	651,365	65,870	894,278
Bhadradri Kothagudem	276,520	421,575	81,178	779,273
Jagtial	65,843	465,635	53,310	584,785
Jangaon	158,200	411,415	-	569,618
Jayashankar Bhupalpally	162,280	459,660	18,290	640,230
Jogulamba Gadwal	-	629,763	-	629,763
Kamareddy	206,355	649,785	37,953	894,093
Karimnagar	72,255	458,758	-	531,013
Khammam	475,180	474,453	49,058	998,690
Kumarambheem Asifabad	201,875	449,660	35,525	687,060
Mahabubabad	295,640	294,248	6,960	596,848
Mahabubnagar	25,845	962,020	184,510	1,172,378
Mancherial	194,558	359,963	5,540	560,058
Medak	109,323	485,723	97,840	692,888
Medchal Malkajgiri	41,858	154,795	73,238	269,890
Nagarkurnool	570	961,975	51,618	1,014,163
Nalgonda	436,953	1,120,448	60,673	1,618,075
Nirmal	123,923	530,253	8,168	662,343
Nizamabad	377,940	513,388	63,115	954,443
Peddapalle	105,835	400,445	44,533	550,813
Rajanna Sircilla	113,740	194,838	72,988	381,563
Rangareddy	176,663	991,900	80,018	1,248,580
Sangareddy	58,660	1,021,013	13,993	1,093,665
Siddipet	239,815	462,603	193,578	895,995
Suryapet	434,950	431,413	21,553	887,915
Vikarabad	41,523	822,710	348	864,580
Wanaparthy	-	487,618	54,998	542,615
Warangal Rural	157,883	344,800	9,395	512,078
Warangal Urban	49,745	258,480	15,388	323,613
Yadadri Bhuvanagiri	415,380	369,403	29,945	814,728
Telangana State	5,196,348	16,240,093	1,429,578	22,866,018

3.2.2 Suitability of cultivation of Sandal Wood and Red Sanders

Sandal wood and Red Sanders are endemic to certain selected pockets where the soil and climatic conditions are suitable for their cultivation. Upon discussion with experts in the field of medicinal plant cultivation, the following districts are found to be more suitable for its cultivation.

> Jayashankar Bhupalpally,
> Kamareddy,
> Kumarambheem Asifabad,
> Mahabubabad
> Bhadradri Kothagudem,
> Mancherial
> Nagarkurnool and
> Nirmal

3.2.3 Suitability of cultivation of Kalabanda

The suitability of different locations for the cultivation of Kalabanda (Aloe Vera) is presented in the Figure 13 and the district-wise area under different classification according to suitability is presented in the Table 4. The table revealed that districts namely Khammam, Sangareddy, Bhadradri Kothagudem and Medak have more relative advantage to cultivate these crops. While a vast majority of the land in Telangana is moderately suitable for the cultivation. Some of these moderately suitable lands can be treated as highly suitable area if there is availability of copious irrigation.
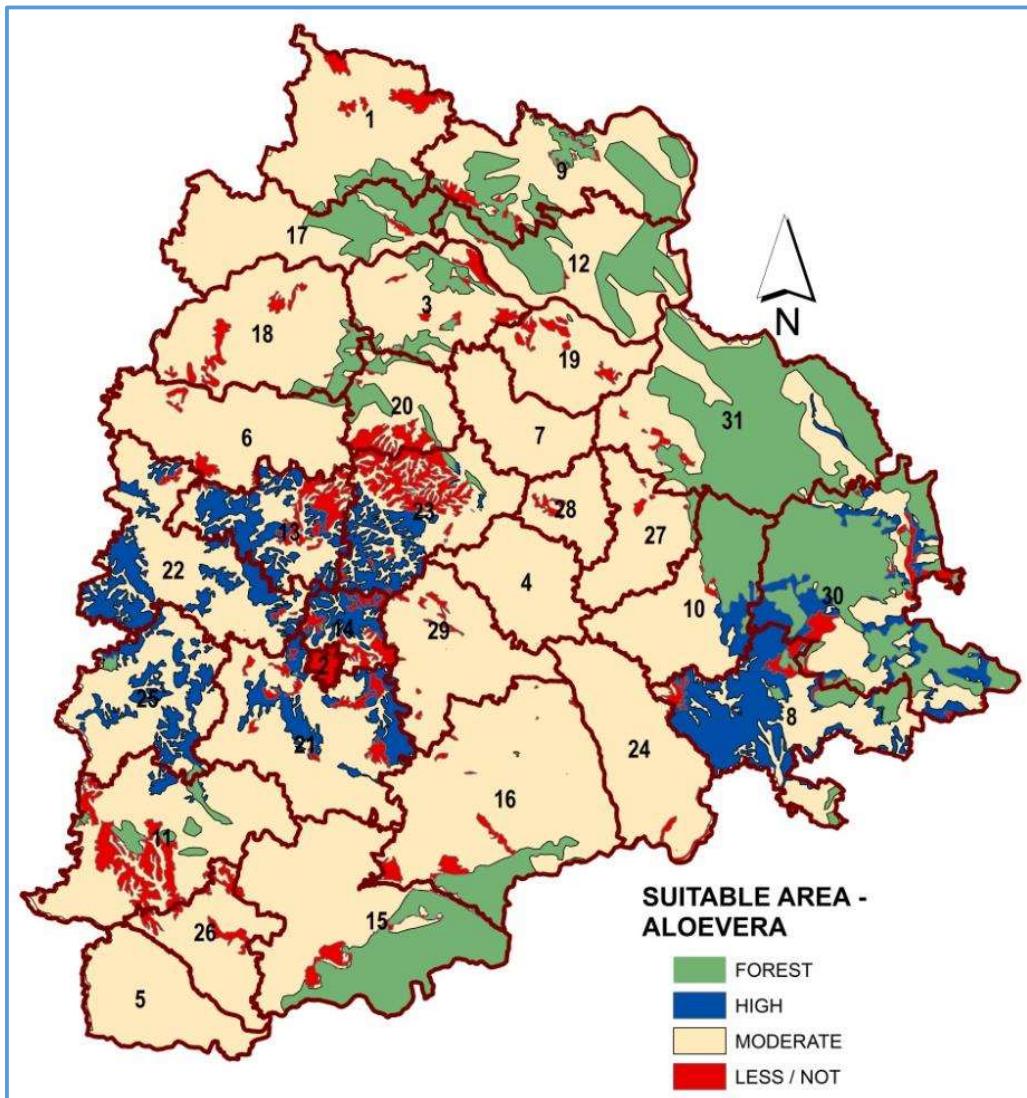
**Figure 13. Map depicting suitable area for Kalabanda Cultivation in Telangana**

Table 4. Area Identified for Cultivation of Aloe Vera (Kalabanda) in Telangana

Districts	Most suitable Area (Acres)	Moderately suitable Area (Acres)	Less or not suitable Area (Acres)	Total cultivable area (Acres)
Adilabad	-	828,408	65,870	894,278
Bhadradri Kothagudem	299,195	398,900	81,178	779,273
Jagtial	-	531,475	53,310	584,785
Jangaon	3	569,615	-	569,618
Jayashankar Bhupalpally	10,705	611,235	18,290	640,230
Jogulamba Gadwal	-	629,763	-	629,763
Kamareddy	795	855,343	37,953	894,093
Karimnagar	-	531,013	-	531,013
Khammam	510,810	438,820	49,058	998,690
Kumarambheem Asifabad	-	651,535	35,525	687,060
Mahabubabad	69,690	520,198	6,960	596,848
Mahabubnagar	25,845	962,020	184,510	1,172,378
Mancherial	-	554,518	5,540	560,058
Medak	255,898	339,150	97,840	692,888
Medchal Malkajgiri	111,175	85,478	73,238	269,890
Nagarkurnool	-	962,545	51,618	1,014,163
Nalgonda	1,113	1,556,288	60,673	1,618,075
Nirmal	-	654,175	8,168	662,343
Nizamabad	-	891,328	63,115	954,443
Peddapalle	-	506,280	44,533	550,813
Rajanna Sircilla	430	308,145	72,988	381,563
Rangareddy	244,365	924,198	80,018	1,248,580
Sangareddy	332,285	747,385	13,993	1,093,665
Siddipet	202,653	499,765	193,578	895,995
Suryapet	503	865,860	21,553	887,915
Vikarabad	235,678	628,553	348	864,580
Wanaparthy	-	487,618	54,998	542,615
Warangal Rural	-	502,683	9,395	512,078
Warangal Urban	-	308,225	15,388	323,613
Yadadri Bhuvanagiri	6,583	778,200	29,945	814,728
Telangana	2,307,725	19,128,713	1,429,578	22,866,018

3.2.4 Suitability of cultivation of Kaunch

Kaunch or Mucuna is an important medicinal crop, which is having high demand in Telangana. The suitable area for this crop is shown in the Figure 14. The area under high, moderate and less or not suitable category in each district is given in the Table 5. The results revealed that Adilabad, Bhadradri Kothagudem, Kamareddy, Khammam, Mahabubabad, Medak, Nizamabad, Sangareddy and Siddipet are highly suitable locations for the cultivation of this crop.
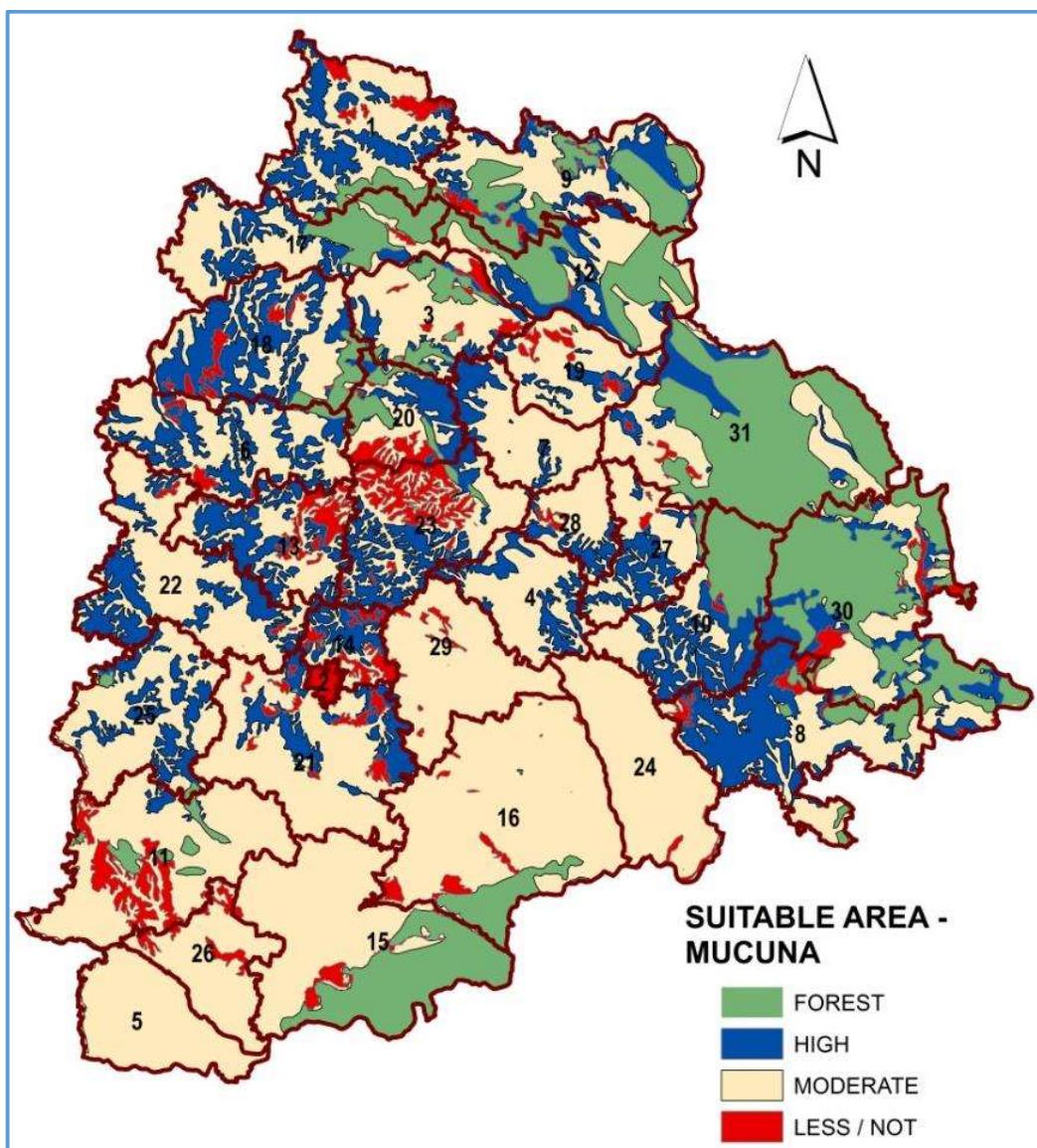
Figure 14. Map depicting suitable area for Mucuna Cultivation in Telangana

Table 5. Area Identified for Cultivation of Mucuna pruriens (Kaunch) in Telangana

Districts	Most suitable Area (Acres)	Moderately suitable Area (Acres)	Less or not suitable Area (Acres)	Total cultivable area (Acres)
Adilabad	316,080	512,328	65,870	894,278
Bhadradri Kothagudem	301,913	396,183	81,178	779,273
Jagtial	86,745	444,733	53,310	584,785
Jangaon	158,660	410,955	-	569,618
Jayashankar Bhupalpally	180,313	441,628	18,290	640,230
Jogulamba Gadwal	-	629,763	-	629,763
Kamareddy	311,265	544,875	37,953	894,093
Karimnagar	117,935	413,078	-	531,013
Khammam	491,888	457,745	49,058	998,690
Kumarambheem Asifabad	248,440	403,098	35,525	687,060
Mahabubabad	305,900	283,988	6,960	596,848
Mahabubnagar	25,845	962,020	184,510	1,172,378
Mancherial	201,555	352,963	5,540	560,058
Medak	256,268	338,778	97,840	692,888
Medchal Malkajgiri	111,175	85,478	73,238	269,890
Nagarkurnool	-	962,545	51,618	1,014,163
Nalgonda	1,113	1,556,288	60,673	1,618,075
Nirmal	182,463	471,715	8,168	662,343
Nizamabad	452,160	439,165	63,115	954,443
Peddapalle	104,275	402,005	44,533	550,813
Rajanna Sircilla	145,095	163,483	72,988	381,563
Rangareddy	244,365	924,198	80,018	1,248,580
Sangareddy	332,295	747,375	13,993	1,093,665
Siddipet	282,620	419,800	193,578	895,995
Suryapet	188	866,175	21,553	887,915
Vikarabad	235,678	628,553	348	864,580
Wanaparthy	-	487,618	54,998	542,615
Warangal Rural	163,215	339,468	9,395	512,078
Warangal Urban	80,455	227,770	15,388	323,613
Yadadri Bhuvanagiri	6,808	777,975	29,945	814,728
Telangana State	5,344,705	16,091,735	1,429,578	22,866,018

3.2.5 Suitability of cultivation of Tulsi

The areas suitable of Tulsi cultivation is shown in the Figure 15. It is found that a vast area of Telangana is moderately suitable for Tulsi cultivation. Similarly, the area highly suitable, moderate and less or not suitable area is given in the Table 6. It shows that districts Bhadradri Kothagudem, Khammam and Nizamabad are highly suitable for the cultivation of Tulsi. Further, it should be noted that the area under moderately suitable may also be suitable if it overcomes the limitation in terms of additional irrigation, changing sowing season to adjust for temperature and rainfall, etc.
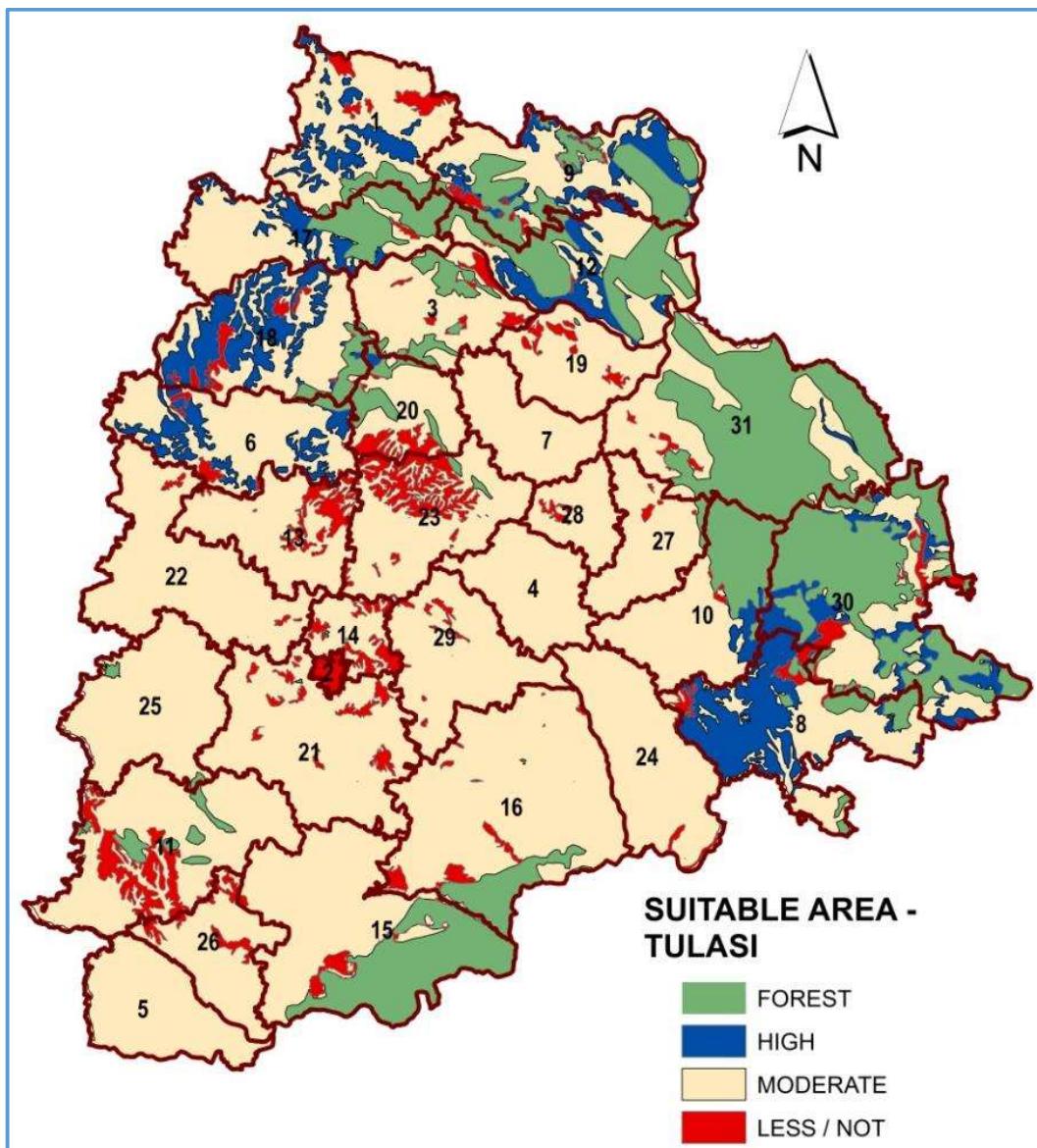
Figure 15. Map depicting suitable area for Tulsi Cultivation in Telangana

Table 6. Area Identified for Cultivation of Ocimum sanctum (Tulsi) in Telangana

DISTRICTS	Most suitable Area (Acres)	Moderately suitable Area (Acres)	Less or not suitable Area (Acres)	Total cultivable area (Acres)
Adilabad	177,045	651,365	65,870	894,278
Bhadradri Kothagudem	273,803	424,293	81,178	779,273
Jagtial	318	531,160	53,310	584,785
Jangaon	-	569,618	-	569,618
Jayashankar Bhupalpally	10,985	610,953	18,290	640,230
Jogulamba Gadwal	-	629,763	-	629,763
Kamareddy	205,513	650,628	37,953	894,093
Karimnagar	-	531,013	-	531,013
Khammam	474,273	475,358	49,058	998,690
Kumarambheem Asifabad	201,875	449,660	35,525	687,060
Mahabubabad	61,765	528,123	6,960	596,848
Mahabubnagar	-	987,868	184,510	1,172,378
Mancherial	193,098	361,420	5,540	560,058
Medak	355	594,690	97,840	692,888
Medchal Malkajgiri	-	196,653	73,238	269,890
Nagarkurnool	-	962,545	51,618	1,014,163
Nalgonda	-	1,557,400	60,673	1,618,075
Nirmal	123,250	530,925	8,168	662,343
Nizamabad	377,868	513,460	63,115	954,443
Peddapalle	365	505,915	44,533	550,813
Rajanna Sircilla	7,475	301,100	72,988	381,563
Rangareddy	-	1,168,563	80,018	1,248,580
Sangareddy	10	1,079,663	13,993	1,093,665
Siddipet	-	702,418	193,578	895,995
Suryapet	503	865,860	21,553	887,915
Vikarabad	-	864,230	348	864,580
Wanaparthy	-	487,618	54,998	542,615
Warangal Rural	-	502,683	9,395	512,078
Warangal Urban	-	308,225	15,388	323,613
Yadadri Bhuvanagiri	-	784,783	29,945	814,728
Telangana State	2,108,498	19,327,943	1,429,578	22,866,018

3.2.6   Suitability of cultivation of Makandi

The locations suitable for cultivation of Makandi / Coleus is given in the Figure 16. Further, the district-wise high, moderate and less or not suitable area for this crop is given in Table 7. It showed that districts namely Adilabad, Bhadradri Kothagudem, Kamareddy, Khammam, Kumarambheem Asifabad, Nirmal, and Nizamabad have more area under highly suitable category for the cultivation of medicinal plants.
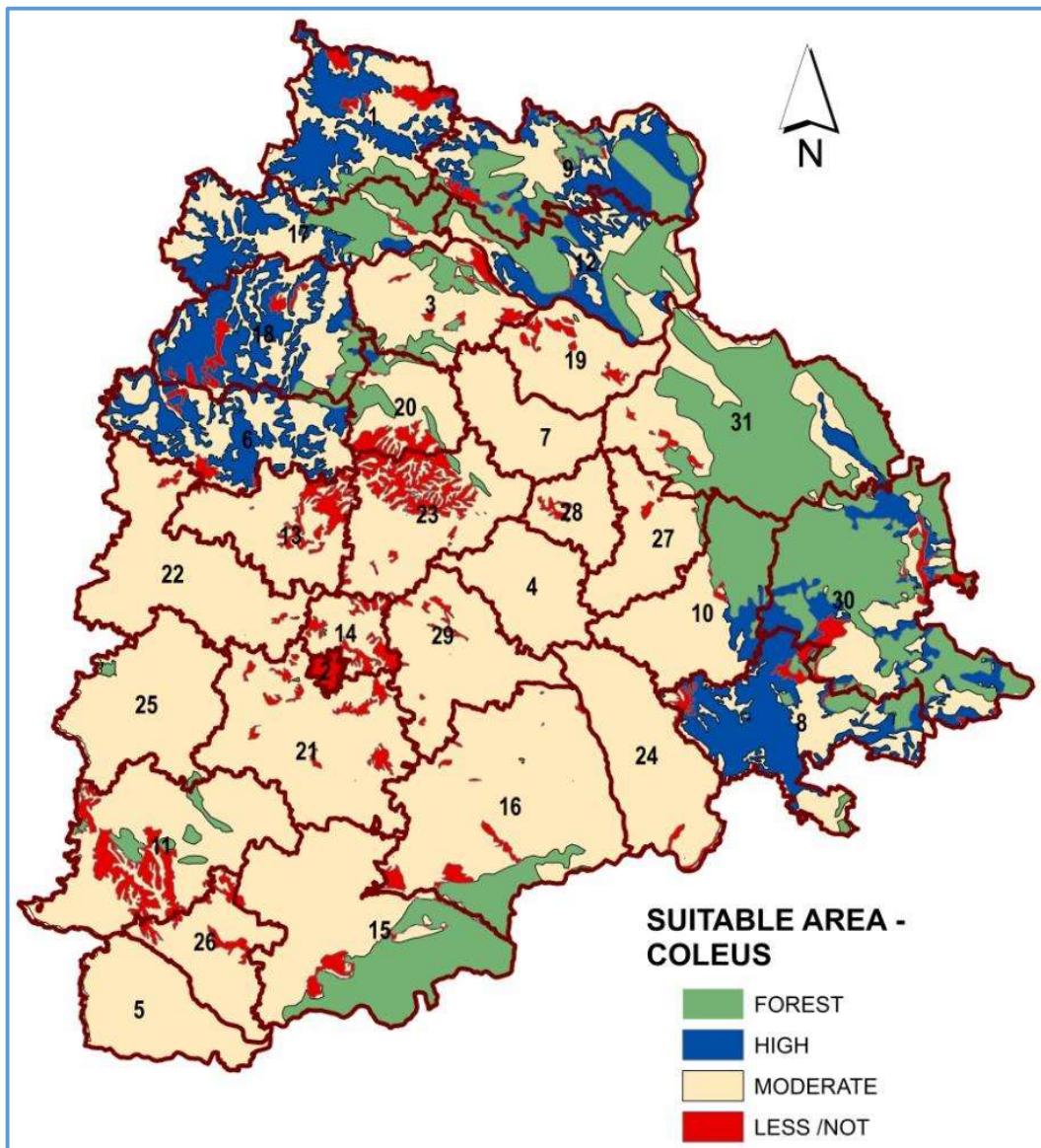

Figure 16. Map depicting suitable area for Coleus Cultivation in Telangana

Table 7. Area Identified for Cultivation of Coleus *forskolhii* (Makandi) in Telangana

DISTRICTS	Most suitable Area (acres)	Moderately suitable Area (acres)	Less or not suitable Area (acres)	Total cultivable area (acres)
Adilabad	413,300	415,108	65,870	894,278
Bhadradri Kothagudem	350,313	347,783	81,178	779,273
Jagtial	835	530,643	53,310	584,785
Jangaon	-	569,618	-	569,618
Jayashankar Bhupalpally	46,483	575,458	18,290	640,230
Jogulamba Gadwal	-	629,763	-	629,763
Kamareddy	381,818	474,323	37,953	894,093
Karimnagar	-	531,013	-	531,013
Khammam	582,085	367,545	49,058	998,690
Kumarambheem Asifabad	336,153	315,385	35,525	687,060
Mahabubabad	69,845	520,043	6,960	596,848
Mahabubnagar	-	987,868	184,510	1,172,378
Mancherial	248,468	306,050	5,540	560,058
Medak	370	594,675	97,840	692,888
Medchal Malkajgiri	-	196,653	73,238	269,890
Nagarkurnool	-	962,545	51,618	1,014,163
Nalgonda	-	1,557,400	60,673	1,618,075
Nirmal	275,083	379,093	8,168	662,343
Nizamabad	486,778	404,550	63,115	954,443
Peddapalle	655	505,625	44,533	550,813
Rajanna Sircilla	7,475	301,100	72,988	381,563
Rangareddy	-	1,168,563	80,018	1,248,580
Sangareddy	10	1,079,663	13,993	1,093,665
Siddipet	-	702,418	193,578	895,995
Suryapet	148	866,213	21,553	887,915
Vikarabad	-	864,230	348	864,580
Wanaparthy	-	487,618	54,998	542,615
Warangal Rural	-	502,683	9,395	512,078
Warangal Urban	-	308,225	15,388	323,613
Yadadri Bhuvanagiri	-	784,783	29,945	814,728
Telangana State	3,199,813	18,236,628	1,429,578	22,866,018

3.2.7 Suitability of cultivation of Vacha

Vacha, which is one of the most used herb in traditional medicines, is another highly traded medicinal crop. The query based on the soil, climate and other characteristics revealed that a vast majority of Telangana lands are either moderately suitable or less or not suitable (Figure 17). However, with the extension of irrigation or grown as fallow crop in rice fields, the moderate lands can be treated as high suitable area. The district-wise suitable area for the cultivation of this crop is given in the Table 8. It can be inferred from the table that except a few cultivated areas, all other areas (depicted in pink colour in the figure) are moderately suitable for the cultivation of this crop.
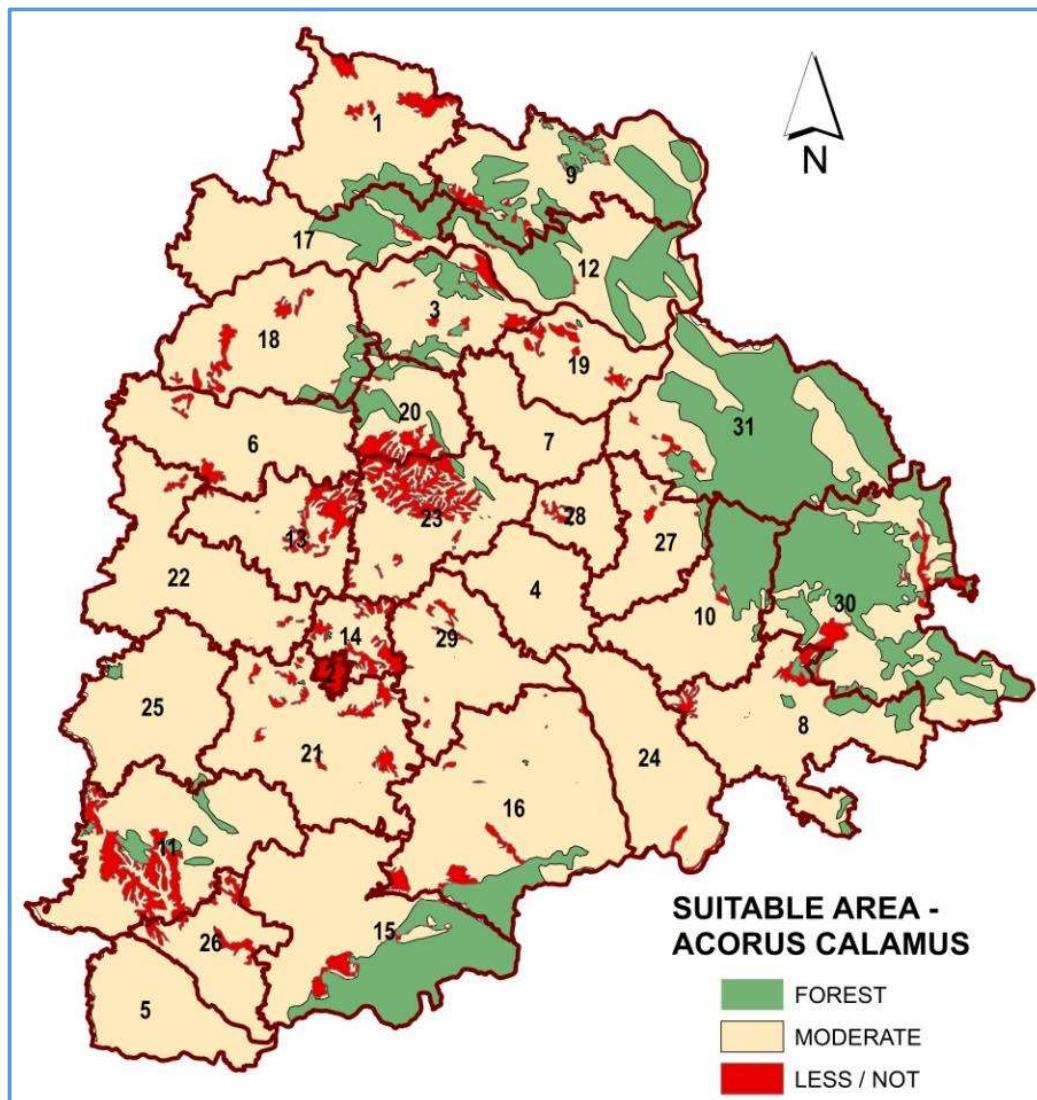

Figure 17. Map depicting suitable area for Vacha Cultivation in Telangana

Table 8. Area Identified for Cultivation of Acorus *calamus* (Vacha) in Telangana

Districts	Moderately suitable Area (acres)	Less or not suitable Area (acres)	Total cultivable area (acres)
Adilabad	828,408	65,870	894,278
Bhadradri Kothagudem	698,095	81,178	779,273
Jagtial	531,475	53,310	584,785
Jangaon	569,618	-	569,618
Jayashankar Bhupalpally	621,940	18,290	640,230
Jogulamba Gadwal	629,763	-	629,763
Kamareddy	856,140	37,953	894,093
Karimnagar	531,013	-	531,013
Khammam	949,630	49,058	998,690
Kumarambheem Asifabad	651,535	35,525	687,060
Mahabubabad	589,888	6,960	596,848
Mahabubnagar	987,868	184,510	1,172,378
Mancherial	554,518	5,540	560,058
Medak	595,048	97,840	692,888
Medchal Malkajgiri	196,653	73,238	269,890
Nagarkurnool	962,545	51,618	1,014,163
Nalgonda	1,557,400	60,673	1,618,075
Nirmal	654,175	8,168	662,343
Nizamabad	891,328	63,115	954,443
Peddapalle	506,280	44,533	550,813
Rajanna Sircilla	308,575	72,988	381,563
Rangareddy	1,168,563	80,018	1,248,580
Sangareddy	1,079,673	13,993	1,093,665
Siddipet	702,418	193,578	895,995
Suryapet	866,363	21,553	887,915
Vikarabad	864,230	348	864,580
Wanaparthy	487,618	54,998	542,615
Warangal Rural	502,683	9,395	512,078
Warangal Urban	308,225	15,388	323,613
Yadadri Bhuvanagiri	784,783	29,945	814,728
Telangana State	21,436,440	1,429,578	22,866,018

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3.3 Problems faced by medicinal plant cultivators

The problems faced by medicinal plant growers in Telangana was collected through primary survey. Since a majority of the farmers surveyed were first time growers of medicinal plants, they revealed that they have no problem so far. In total, 18 farmers were surveyed for their opinion about problems faced by them. The problems highlighted by the farmers area are presented below:

3.3.1.1 No Market or no information about the market

The farmer has no idea about the market for these medicinal crop except few individuals who risked to take the commodity to sell at Neemuch market in Madhya Pradesh State. Presently, the produce is being bought by agents at a low price than the prevailing market prices. About 60 per cent of the farmers expressed this problem.

3.3.1.2 Transportation problem

About one-third of the farmers revealed that transportation is one of the major problems faced by them. The farmers revealed that if they have to explore markets to fetch remunerative price for their produce, they have to take their produce to far away markets. In this respect, they expressed that the transportation cost is very high and hiring vehicles during peak seasons is very difficult.

3.3.1.3 Non-availability of labour

This is a common problem in the study area for all crops grown there. Labour wages are steep and the supply of labour is almost nil at lower wages.

3.3.1.4 Erratic monsoon

Receipt of showers during harvest season greatly damage the quantity and quality of medicinal plants. The quality (size) of the output is poor if rainfall is less and hence it fetches low price in the market as compared to the irrigated crop.

3.3.1.5 Non-availability of bank loan

Farmers opined that commercial banks are not extending crop loan for the cultivation of medicinal crops. The non-availability of bank loan for the cultivation of medicinal crop was perceived by the farmers as another impeding factor.

4 RECOMMENDATIONS

The selected crops may be promoted in areas which are identified as highly suitable On the basis of agro-climatic conditions and suitable environment needed for different medicinal plants, the following recommendations emerged from the study.

1. The selected crops enjoy high demand, there is enough scope for expanding the area under these crops in lines of high suitable area shown in this project.

2. They may be promoted in areas where commercial crops are not prevalent and contract buying exists especially for crops such as Aloe vera, Tulsi and Coleus

3. Crops such as Aswagandha, Sandal Wood and Red Sanders enjoy huge demand and these crops can be promoted even without contract farming as these products can be easily sold in big markets where price is relatively stable.

4. The commercial crops viz., vegetables, maize and cotton are more profitable (having higher net returns per Ha) than the medicinal crops. Hence, medicinal crops cultivation will be limited in the areas where these commercial crops are grown.

5. Unsure about market and demand for medicinal plants were expressed as some of the major issues by a majority of farmers. The farmers have expressed that they prefer contract farming or at least market tie-up to commit more land under medicinal crops. Hence, efforts in the form of facilitating contract farming or arranging transportation to pool the harvest and send to major markets like Neemuch, Chennai or Bengaluru will help them in the initial phase of establishment and instil confidence among medicinal plant growers.

6. Standards and grades may be developed for medicinal plants and arrange for buy-back from the growers at prevailing market price.

7. Further, studies on market intelligence aspects including prices in various markets, prices of competing crops, demand from processors, competition with produce collected from forest and whether to market immediately or to hold or store will help the farmers in effective decision marking like which crops to sow, when to harvest, where to sell, etc.

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6 ANNEXURES

**Table 9. Normal district-wise monthly maximum temperature (deg. C) at Telangana**

Districts (old)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
Adilabad	28.5	33.7	34.7	38.0	42.1	35.9	34.5	31.5	33.7	35.0	32.9	32.1	34.4
Hyderabad	29.3	32.5	34.5	36.3	39.9	34.3	34.6	32.6	33.0	33.4	31.7	31.9	33.7
Karimnagar	29.2	33.4	35.0	37.5	42.6	35.8	35.1	32.8	33.6	35.3	33.1	32.1	34.6
Khammam	28.5	30.2	32.5	34.6	37.3	36.7	34.3	31.8	33.3	32.6	31.3	31.4	32.9
Mahbubnagar	32.1	35.1	36.9	38.0	41.4	35.1	35.5	32.8	32.8	34.6	33.9	33.8	35.2
Medak	26.0	33.0	34.5	36.3	40.0	33.4	34.5	31.6	32.3	35.4	33.2	33.5	33.6
Nalgonda	30.2	33.1	35.9	38.1	42.1	35.3	37.0	34.5	33.6	34.4	32.6	32.4	34.9
Nizamabad	30.5	35.2	36.3	38.4	43.0	36.0	34.9	31.1	33.6	36.6	34.6	33.5	35.3
Rangareddy	28.7	31.8	30.5	38.2	39.4	34.5	31.2	30.0	30.9	30.7	28.8	27.9	31.9
Warangal	30.5	34.0	35.5	37.5	42.6	36.4	36.9	34.5	34.4	30.7	28.8	27.9	34.1
Telangana	29.4	33.2	34.6	37.3	41.0	35.3	34.9	32.3	33.1	33.9	32.1	31.7	34.1

Table 10. Normal district-wise monthly minimum temperature (deg. C) at Telangana

Districts (old)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
Adilabad	12.5	14.2	19.7	23.0	27.0	25.4	25.1	23.9	22.8	20.3	15.5	13.9	20.3
Hyderabad	15.7	17.9	21.9	23.9	27.9	24.3	24.6	23.5	23.0	21.8	20.1	18.3	21.9
Karimnagar	14.6	17.0	21.9	24.3	28.2	26.5	26.0	24.9	24.3	22.6	19.6	18.2	22.3
Khammam	23.8	25.5	27.5	30.2	32.4	31.8	29.7	29.0	28.9	27.8	25.8	24.3	28.1
Mahbubnagar	16.8	18.3	22.3	23.9	27.2	24.9	25.0	23.7	23.4	22.1	21.1	18.9	22.3
Medak	13.8	16.0	20.4	20.3	25.0	24.5	24.1	23.2	22.9	20.3	18.0	16.5	20.4
Nalgonda	15.7	17.7	22.1	24.1	28.1	25.5	26.8	25.2	24.5	23.0	20.8	19.3	22.7
Nizamabad	15.4	18.2	22.1	24.3	28.3	25.8	25.5	24.3	24.0	22.1	19.6	18.3	22.3
Rangareddy	22.2	25.1	28.4	31.5	33.0	29.3	27.0	26.2	26.6	25.7	23.2	21.6	26.7
Warangal	15.5	19.2	22.0	23.8	26.7	24.3	25.6	24.3	24.2	25.7	23.2	21.8	23.0
Telangana	16.6	18.9	22.8	24.9	28.4	26.2	25.9	24.8	24.5	23.1	20.7	19.1	23.0

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Table 11. Normal district-wise monthly Rainfall (mm) and soil pH at Telangana

Districts (old)	Rainfall (mm)	pH
Adilabad	1121	7.9
Nizamabad	1092	7.7
Karimnagar	981	7.2
Medak	923	7.3
Hyderabad	852	7.8
Mahbubnagar	732	7.7
Nalgonda	761	7.6
Warangal	988	7.6
Rangareddy	843	7.9
Khammam	1096	7.5