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# Resilience of Climate Change through Medicinal and Aromatic Plants

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**Abstract:** From time immemorial Medicinal and Aromatic plants (MAPs) being used by our common people for therapeutic purpose, as minor vegetables and for worshipping. These plants are more or less contributing to our society by healing our day to day health problems. But due to overexploitation, these MAPs are almost in its extinct phase and have to be brought under conservation. These MAPs are also getting importance because of their hardy nature and strength to survive in worst climatic situation. The climate trends and variability are generally characterized by increasing surface temperature and unpredictable rainfall. Indigenous people traditionally follow the weather and climatic patterns for their agricultural, forestry and other livelihood activities. However, these climatic patterns have become less reliable and more unpredictable because of amplified, climatic ambiguity. It has been projected that by the end of this century, global temperatures are likely to increase by 1.8 to 4.0 ° C, leading to more frequent hot extremes, floods, droughts, cyclones and recession of glaciers. These changes put more threats on livelihood security of farmers, thereby, requiring increased adaptation of crops to withstand the changing climate. Hence, development of suitable crop cultivars to bear the impact of climate change has become essential. MAPs basket is having a large number of species, with different climatic requirements. Since we cannot change our cropping system but we can introduce these medicinal and aromatic plants to the existing cropping patterns to manage the adversity of climate change.

**KEYWORDS:** Medicinal and aromatic plants, cropping patterns, climate ambiguity, livelihood security

### I. INTRODUCTION

Climate change is an unprecedented threat to the food security of millions of people by bringing change in agriculture and affecting the rural life, food security and livelihood of the indigenous as well as urban people. According to IPCC 2007, climate change is the change in state of the climate that can be identified and persists for an extended period, typically decades or longer. Climate change and agriculture are interrelated and it may have significant effects on crop production and food availability. The arable lands, pastures and forests that occupy 60% of the Earth's surface are gradually being exposed to threats from increased climatic variability and, in the longer run, to climate change. The UN Intergovernmental Panel on Climate Change (UNIPCC) reported that an overall increase of 2°C temperature and 7% rainfall would lead to an almost 8% loss in farm level net revenue. Studies say that we may lose 4-5 million tonnes of wheat (*Triticum aestivum*) with every rise of 1 °C temperature [1]. In India, about 10-40% loss in crop production with increase in temperature by 2080-2100. [2-5]. As India falls in low latitude region so there will be an increase of 1-2°C temperature that will have negative impact on yields of major cereals. On the other hand, places which falls in mid to high latitude region, the moderate 1-3°C temperature increase along with associated CO<sub>2</sub> increase and rainfall will be beneficial to crop yields. [6]. A World Bank report on climate change impact based studies in India has focused on drought-prone regions of Andhra Pradesh, Maharashtra, and flood-prone districts in Orissa on the edge of climate tolerance limits. Sugarcane farmers of Maharashtra may see yields go down by as much as 30%. Orissa will face a similar fate with reduced rice production in the flood-prone coastal regions dropping by 12 %.

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## II. WHAT IS CLIMATE RESILIENCE?

In ecology, resilience is the capacity of an ecosystem to respond to a perturbation or disturbance by resisting damage and recovering quickly. Resilience refers to our ability to absorb disturbances while retaining a high quality of life. A resilient community has a secure future despite the effects of climate change. It represents an effort to incorporate in our work the new challenges posed by climate change and its impacts on poor people's lives. It is based on the identification of the major risks and challenges local communities face, and/or are likely to face in the near future, and on the design and implementation of site-specific adaptation strategies aimed at reducing vulnerabilities and increasing the resilience of the smallholder production systems.

## III. HOW MEDICINAL AND AROMATIC PLANTS ARE USEFUL?

Medicinal and aromatic plants (MAP) are found in vast number all over the world. Now a day's people rely mostly upon the organic herbal drugs and medicines. Due to the climate change, many of the wild MAPs have already been extinct and some are under threat of extinction. The extinction of the species has mainly occurred due to the wild collection of species from the forest for trade, since these MAPs are more now having more market, demand and can fetch good price over traditional crops. Due to the availability of numerous MAP species, they might be included easily for cultivation under the different cropping systems as well as sole crop.

Due to the impact of climate change, there is a need in acclimatizing those crops [7], which can bear the variability's of climate change and can reduce its impact on agriculture. MAPs are

- Largely tolerant to drought and floods
- Have low incidence of pest attack
- Have lower cost of cultivation as compared to the traditional crops, since most of them are not high input responsive
- Could be raised as inter-crop, mixed crop, companion crop thus can add to diversification and also overcome economic loss caused due to adverse climatic conditions
- Can provide better returns at a time as compared to traditional crops in marginal and sub-marginal lands.

## IV. CLIMATE RESILIENCE WITH MEDICINAL AND AROMATIC PLANTS

Even though agriculture is the major, emitter of green house gases (GHGs) but also offers tremendous potential to mitigate the impacts of climate change. The major sources of direct agricultural GHGs emissions are [8]:

- Soil emission(Nitrous oxide produced naturally in soils through the microbial processes of nitrification and den-nitrification but large increase in use of Nitrogenous fertilizer has increased emission)
- Enteric fermentation (Microbes in animal digestive system ferment feed and produces methane (CH<sub>4</sub>))
- Manure management(anaerobic decomposition of organic manure leads to CH<sub>4</sub> emissions)
- CO<sub>2</sub> from fossil fuel consumption
- Rice cultivation

The medicinal and aromatic plants are beneficial over other traditional crops since they can fetch better returns over other crops and have high export demand. Due to their hardy nature they can withstand adverse environment, vagaries of the climate like drought, flood, high temperature, uneven rainfall distribution etc. These plants can fit in any cropping pattern and can help in reducing the incidence of monophagous pest and diseases.

Agriculture accounts for 25% of global GHGs but can abate 18% of total emissions [9]. The possible actions to entrap the atmospheric carbon in soil are like using cover crops, farming with perennials; reduce tillage, minimizing the use of chemical fertilizers. Total wasteland as a percentage of geographical area is 20.16. In those lands, many MAPs can be grown. In sodic soils aromatic crops like Palmarosa (*Cymbopogon martini*), lemon grass (*Cymbopogon*

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*flexuosus*) and vetiver (*Vetiveria zizanioides*) among aromatic grasses and German chamomile (*Matricaria chamomilla*) is a promising crops. [10].

The sodicity is a major problem affecting about 1.5 billion hectares, in which approximately 340 M ha (23%) are saline and another 560 M ha (37%) are sodic affecting the irrigated land in the world. This is mainly due to cumulative affects over decades adding water with some of dissolved salts to the soils of arid and semi arid region Data presented in Table 1 showed that some medicinal and aromatic could be successfully grown on sodic soils and give more economic returns than the traditional agricultural crops [11]

**Table 1: Estimated cost and benefits from medicinal and aromatic plants in sodic soils [11]**

Crop	Yield (grain oil <sup>1</sup> yield)	Cost of cultivation (Rs)	Gross returns (Rs ha <sup>-1</sup> )	Net returns (Rs ha <sup>-1</sup> )
<b>Agricultural crops</b>				
Paddy	3.0a (3.5)b	7000	20,000	13,000
Wheat	2.2a(2.8)b	8000	16000	8000
<b>Medicinal and aromatic plants</b>				
Palmarosa	150c	15,000	50,500	34,500
Vetiver	30c	30,000	75,000	45,000
Isabgol	1.0a(4.0)b	10,000	60,000	50,000

a, grain yield (t ha<sup>-1</sup>); b, straw yield (t ha<sup>-1</sup>); c, oil yield (litre ha<sup>-1</sup>)

The dry land regions of our country accounts for 68.4% and on those regions traditional crops are not economical. [12]. So plants like Ashwagandha (*Withania somnifera*), Kalmegh (*Andrographis paniculata*), Senna (*Cassia angustifolia*), Makoi (*Solanum nigrum*), Tulsi (*Ocimum sanctum*), Sarpagandha (*Rauvolfia serpentina*), Guduchi (*Tinospora cordifolia*), Gudmar (*Gymnema sylvestre*), Shatavari (*Asparagus racemosus*), Langali (*Gloriosa superba*) are suitable to cultivate under dry land conditions. [12] Medicinal plants including Noni (*Morinda Citrifolia*), Naupaka (*Scaevola spp*), Kukui (*Aleurites populnea*) are very tough and well adapted to storms and damage much like climate change. They grow relatively fast, have high reproduction rates and typically resilient to salt water and wind. [13] About 10.3% of total net sown area is waterlogged in India. Either these lands are lying vacant or the productivity is very low. Apart from the productivity constraints, it is known that rice soils are one of the potential sources of methane (CH<sub>4</sub>) emissions. Hence, there is a need to identify some crops as well as cropping systems that can insure high economic returns and sustain the soil productivity. Certain MAPs i.e., Bacha (*Acorus calamus*), Brahmi (*Bacopa monnieri*), Nagar motha (*Cyprus scariuosus*) and vetiver (*Vetiver zizanioides*) grow under water logged conditions and thus may be a better alternative to traditional rice based cropping system. [14]

The major problems will be in near future due to changing climate would be the heavy infestation of pest and diseases. The cropping systems have to be modified based on the prevailing climate, available land and water resources. Most of the MAPs are perennial in nature which is major reason why the farmers neglecting the adoption of MAPs in commercial sector. However, perennial crops require less synthetic fertilizers compared to the traditional crops. These crops provide multiple advantages from a climate perspective, including eliminating or significantly reducing the need for tillage; deeper root systems that both protect and build soil; better drought tolerance; and lower fertilizer and pesticide requirements. Markets already exist for perennial crops such as grasses and alfalfa for animal fodder and much of the focus for sustainable bioenergy and biofuel feed stocks is on perennial crops. However, there are currently fewer options for perennial substitutes for many of our food crops, especially grains and oilseeds. [9]

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## V. ADAPTIVE TECHNOLOGIES FOR FARMERS

Following technologies have been generated for adoption by the farmers in the Himalayan cold ecosystem [15, 16]

1. **Adoption of suitable agro-forestry system:** Farmers from several villages of Sikkim and from Ilam district of Eastern Nepal have adapted a farm-based agro-forestry system to cope with the climate change. Replacing the large cardamom with *Swertia chirayita*, *Thysanolaena agrostis* and other multipurpose fodder species and medicinal plants under the *Alnus nepalensis* trees has provided additional income apart from bringing resilience to ecosystem.
2. **Plantation in wastelands:** Reclamation of 21 wastelands by introducing irrigation facilities, soil and moisture conservation measures, medicinal plants as cash crops and market linkages for their sale have benefitted landless and marginal farmers
3. **Common property resources management:** Training in sustainable use and regeneration of common property resources through 21 women's Common Property Resource Management Groups helped 120 communities in establishing fodder farms, woodlots and medicinal plants nurseries, while other 140 pastoralists were trained in improved grazing management and its sustainability
4. **Reduced exploitation of wild areas and species:** Education of 2,256 pastoralists on conservation and management of common property resources along with the establishment of seven community woodlots, 21 plantations covering 3 hectares of wastelands, fodder farms, nurseries and kitchen gardens for medicinal plants. These measures have helped further reduce pressure on wild resources
5. **Livelihood sustainability through medicinal and aromatic plant (MAP) cultivation:** To reduce the wild-take and improving the income from MAP for the better lifestyle (smokeless cook-stoves, solar lanterns, and children's education) of farmers, 746 women have found a route to economic empowerment for the first time through MAP cultivation in kitchen gardens.
6. **Improved Law enforcement regarding wild MAP trade:** In 2007, Indian Government's National Medicinal Plants Board prioritised medicinal species for conservation and cultivation. Due to this, the regulations protecting wild plant products are more rigorously enforced than ten years ago.
7. **Greening of wastelands:** To reduce desertification in Himalayan region, wastelands have been greened with native tree, fodder and medicinal plant species. Not only have 1,931 landless and marginal farmers achieved land access this way, but multiple beneficial ecological impacts – on soil, vegetation and microclimate –have also resulted.

## VI. CONCLUSION

Climate change is one of the greatest environmental, social and economic threats to the livelihood of people in developing countries. The impacts of climate change have been witness in the agriculture systems. In different latitudes, the impact on agricultural productivity will differ. It is a challenging goal to try and to relate the effects of CO<sub>2</sub> concentration to active constituents of the plant for future mitigation processes under changing climate with increased temperature and CO<sub>2</sub> enriched environment. To improve ecosystem services, adaptation to climate change impacts, the resilience and capacity of the local communities, it is important to put in place appropriate mitigation and adaptation strategies. Therefore, it is a peak time to take some possible action towards the climate change. We cannot stop the natural disasters leading to climate change but can put forward our hands to reduce its consequences on agriculture in its allied activities. One major step taken up is the climate resilient agriculture with the inclusion of medicinal and aromatic plants under different cropping system as well as sole crop in the dry land areas, degraded lands, sodic soils, water scarce areas, waste lands etc. that can reduce the risk of complete crop damage due to climatic trends and ambiguities.

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