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Sustainability Enhancement of Traditional Cropping Framework in Surgana Tehsil of Nashik District Through MAP-based Intercropping

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Abstract

Objectives: Traditional cropping framework in Surgana Tehsil Primary Crops Grown in Surgana Tehsil c rotations in tribals of Surgana mixed cropping framework in Surgana obstructions of Traditional cropp framework in Surgana sustainability enhancement by Integration of Heterogeneity in crops through MAPs-ba intercropping pattern

Materials and Methods: Selection of study area, visits were organized to tribal farmers and farming area field data collection was carried out during the whole cropping season.

Results: From decades ago, there has been 5-30% drop in mountain farming in hilly and tribal areas of Maharashtra. Only selected varieties of cereals, pulses, amaranths etc. are important cash crops in the hilly areas of Surgana Tehsil. In conventional cropping pattern, proso millet, finger millet, rice, pea, chick pea, pigeon pea, amaranth etc. were used by farmers of Surgana for mixed cropping system. This conventional cropping patterns are not found much profitable and unable to fulfil the demands of growing population. In such tribal and hilly areas of Surgana, turmeric, hemp, stevia, *Tinospora*, *Asparagus*, mint, long pepper, isabgol, lemon grass, ginger, *Chlorophytum* (safed musli) etc. medicinal and aromatic plants (MAPs) can play extraordinary role in improving the sustainability of the tribal farming. Nevertheless, these crops yet are not a part of the cropping pattern in Surgana. MAP based intercropping with conventional cropping will obviously enhance the yields of main crops and make extra income to the tribal families. The topography and climatic condition of Surgana is convenient for growth of these crops and incorporation of MAPs with main crops is another choice to boost the agril production in Surgana.

Conclusions: The present study concludes in the direction of development in socioeconomic circumstance of Surgana farmers through advent of MAPs as intercrops in the current cropping System. Crop Diversification in present cropping framework including MAPs may be helpful to satisfy the needs of the tribal farmer's family in addition to improve the standard of living.

Introduction

Sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [1]. This concept encompasses the economic, social, and environmental dimensions, both locally and globally, to achieve the immediate objectives

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without jeopardizing future ones. Nowadays, humanity is faced with a major challenge to achieve sustainable agriculture that provides sufficient food and ecosystem services for both present and future generations. Modern agricultural systems, which are based on high technological inputs and oriented to maximizing profits, have been criticized as often being detrimental and nonviable when considered from social and ecological perspectives [2-3].

Demand for agricultural products is expected to continue to boost and the human population is growing in both size and inflation. However, due to the widespread environmental impact of traditional agricultural intensification, there is a general consensus that a global transition to agricultural systems that ensure food security and nutrition, social and economic justice, and create and protect ecosystem functions which is foundation of agriculture. This has caused the promotion of several alternative pathways (Table1) that exploit instead of combine the ecosystem services supplied with the aid of using biodiversity (e.g. nutrient cycling, pest control or pollination) to create resilient and effective farms [4].

The agriculture sector in India has always played a crucial role in driving the wheels of socio-economic development of the country. India was primarily an agrarian economy with almost 60% of the country's population depending on agriculture for their livelihood.

Table 1. *Diverse Classes of Systems of Farming [4]*

Conventional Intensification	Led to larger fields of monoculture crops that rely on external inputs, including synthetic fertilizers and pesticides. Include traditional farming approaches.
Diversified Farming	Integrate several crops and (or) animals in the production system, Promote agrobiodiversity across scales, regenerating ecosystem services, and reducing the need for external inputs
Sustainable Intensification	Relied on sustainable practices, such as agroforestry, conservation agriculture, and biological pest control to establish low-input 'resource-conserving systems' that are based on promoting favourable ecological interactions within the agroecosystem, rather than depending on external inputs.
Ecological Intensification	Emphasizes management to enhance ecological processes that support production, including biotic pest regulation, nutrient cycling, and pollination; there is an explicit focus on conserving and using functional biodiversity.
Agro ecological Farming	Agro ecological farming is knowledge, management, and labour-intensive rather than external input-intensive, and aims to regenerate long-term agroecosystem properties by incorporating functional biodiversity, leading to sustainable, resilient systems.
Organic Farming	Holistic system for enhancing soil fertility, water storage, and the biological control of crop pests and diseases. Prohibits the use of most synthetic inputs and GMOs, while allowing organic fertilizers and pesticides.

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Indian Agriculture production in most part of the country is close related to the optimum use of available natural and human resources of the country. Therefore, riding on the back of agro climatic condition and rich natural resource base, India today has become the world's largest producer of numerous commodities. The country is a leading producer of coconuts, mangoes, milk, bananas, dairy products, ginger, turmeric, cashew nut, pulses and black pepper. It is also the second largest producer of rice, wheat, sugar, cotton, fruit and vegetables [5].

About Surgana Tehsil of Nashik District

Surgana Tehsil is a sub district administrative division in Nashik District, Maharashtra India. Surgana tehsil is one of the tehsil of Nashik district Maharashtra having 846.50 km^2 area. In Surgana tehsil there are 190 villages and 1 town. Total population of Surgana tehsil is 175,816 as per Census 2011 Data. Sex ratio in Surgana tehsil is 1001 per 1000 male. Literacy rate in Surgana tehsil is 68.15%. In Nashik district, the highest proportion of Scheduled Tribe population is recorded in Surgana tehsil (96.51%) and percentage of scheduled tribe population to total population 98.15%. Running north-south in the western part of the District, the Sahyadri Hills cover the entire tehsil of Surgana. This region has an altitude varying between 900 to 1,200 metres. The central parts of these hills are more elevated than the northern and southern portions. The hills are densely covered under forests and these are mainly reserved forests. Surgana has an average rainfall of 2000 mm. while the average rainfall in the rest of the District is only 635 mm [6].

Workers profile of Surgana Tehsil

Surgana has 97,557 population engaged in either main or marginal works out of them 49,756 males and 47,801 female population are working population. Full time workers in Surgana tehsil are 81,950 and 15,607 are marginal (part time) workers [6]. The capacity of land-based activities in hilly regions of Surgana has attained its threshold limit. Farmers in the hilly areas struggle due to low manufacturing capacity and resource utilisation because of small growing season, farm fragmentation, water stress, low soil quality, remoteness, low yield, post-harvest control, unavailability of market and capitalism. All those innate and tribal fiscal pressure have caused less-utilization of favourable resources in the hilly area. Tribal people within the hilly area have restricted lifestyle choices because of current conventional cropping framework. So, there is demanding call for sustainability enhancement of traditional cropping framework in hilly and tribal regions of Surgana to make it extra effective.

Traditional Cropping Framework in Surgana Tehsil

Traditional cropping framework, means the agriculture land use pattern (percentage of area under various crops at a point of time in a unit area) used on a farm and its interaction with farm assets, other farm enterprises and available technology. In the traditional cropping framework, once in a while numerous crops are grown together, or they are grown separately at short durations in the same field (Table 2). In the hilly region of Surgana, diverse agro-climatic zones are present, i.e. (i) planes, (ii) lower altitude and (iii) medium altitude.

Crops growing seasons followed in the agro-climate zones of Surgana include: (a) Kharif (rainy season; mid-June to October), (b) Rabbi (winter season; November to February). Summer can be divided into two: (i) Spring season (March–April): space near houses are used for growing mainly vegetables. (ii) Hot summer season (May–June): regular practice of burning of fields before rainy season. Reasons for field burning have been named as to control weeds, pests and diseases, and to facilitate seedbed preparation for the following crop [7-8].

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Table 2. *Types of cropping framework in Surgana Tehsil*

Mono cropping	Growing of single crop on a piece of land year after year.
Multiple cropping	Two or more crops grown in the same field within given year with a definite row arrangement.
Inter cropping	Growing two or more crops simultaneously on the same piece of land with a definite row pattern.
Sequence cropping	Growing two or more crops in sequence on the same piece of land in single farming year.

Primary Crops Grown in Surgana Tehsil

Grains/millets: Rice, *Nagali* (finger millet), *Varai* (proso millet), *Rajgira* (amaranth), *bajri* (pearl millet) and maize (corn).

Pulses and beans: Black gram, mung bean, *Chavli* (cowpea), *urad* (black gram), *mung* (green gram), *arhar/tur* (pigeon pea) and *masoor* (lentil).

Oilseeds: Sunflower, ground nut, soya bean, Karhale/ Khursani (Niger seed).

Vegetables: Cucumber, cabbage, spinach, brinjal, bitter guard, cauliflower, chilli, tomato.

In the hilly regions of Surgana the following crop rotation and mixed cropping patterns are practiced.

Crop Rotations in Tribals of Surgana

The tribal ways of crop rotations of Surgana are as follows

Proso millet–rice–wheat

Proso millet–rice

Maize–rice–wheat

Lentil–rice–wheat

Finger millet/proso millet–rice–wheat

Chilli–tomato

Black gram–finger millet–proso millet

Soya bean–green gram/black gram

Mixed Cropping Frame work in Surgana

The tribal cropping framework associates sowing of different regional well adopted crop seeds in a single field during the kharif or monsoon season, which facilitates the farmers to invest diverse foods, preserving agri-biodiversity, improving soil fertility (by the use of legumes), prevention of pests. It is anticipated that mixed crop systems helps to boost production per acre. Dominant mixed cropping Patterns in Surgana are as follows:

Rice + Finger millet + barnyard millet

Rice + soybean + black gram

Barnyard millet + finger millet + Soya bean + pigeon pea

Bajri (pearl millet) + maize (corn)

Pea + masoor (lentil) + chick pea

Obstructions of Traditional Cropping Framework in Surgana

Traditional farming practices are based on the indigenous knowledge and experience developed over the centuries and have remained popular even now. Routine conventional cropping framework consist of agroforestry, intercropping, crop rotation, cover cropping, traditional organic composting, integrated crop-animal farming, shifting cultivation, and slash-and-burn farming. Although there are many profits associated with these systems, such as enhanced soil fertility, carbon sequestration, resource utilization, biodiversity maintenance, sustainability, and environment protection, there are also certain negative implications associated with some practices such as slash-and-burn activities in shifting agriculture. Traditional cropping is getting global attention for being a source of sustainable food production in times of environmental degradation and need for safe food production [9].

The following are some limitations in traditional cropping framework in Surgana Tehsil:

Definite proportion or pattern is absent in crop cultivation.

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Use of traditional cropping only to meet the domestic needs of the farmer's family.

The poor yield of crops is due to competition for resources.

Farmers invest practically nothing on inputs, such as seed, fertilizers, irrigation facilities, pest control.

Small and fragmented land holdings of farmers in the Surgana Tehsil.

The soil becomes infertile with sowing of many types of crops collectively in a single field.

Yield of cash crops is poor because of low population frequency.

Ultimately, traditional cropping framework in Surgana was not helpful to the farmer in terms of income, ecology and biodiversity.

Heterogeneity of crops is the only solution to environmental and socio-economic pressure. This can be achieved through integration of extra cash crops as intercrops like medicinal and aromatic plants (MAPs) in the traditional cropping framework, which accomplish the fundamental needs of the farmer's family, and supports to achieve extra profit and improves their lifestyle.

Sustainability Enhancement by Integration of Heterogeneity in Crops through MAPs-based Intercropping Pattern

The sustainability goals for Rice-based systems in the Surgana region were chosen as "To increase the productivity of rain-fed cropping systems per unit (1) land and (2) water, (3) increase the profitability of production, and (4) maintain or enhance soil fertility" [10]. Many reports have been published earlier for MAP-based intercropping pattern with main crops for sustainability enhancement in tribal and hilly regions. Within Surgana tehsil, Rice (*Oryza sativa)* is the main staple food. Rice-based systems dominate the zone delineated by the 1500 - 2000 mm rainfall. Typical rain-fed rice-based rotations include food (*Cicer arietinum*, *Lens culinaris* (*Kulid*), mung bean, black gram [10-12].

Fields are commonly left uncultivated over summer; as insufficient moisture prohibits the reliable production of rain-fed summer crops. Long fallows (winter plus summer) have been largely replaced by MAP based intercropping to enhance production through intensified land use [10]. Traditional nitrogen-fixing legumes have been used to improve soil fertility and staple crop performance for a long time, and a rich diversity of local species have been employed such as mung bean (*Vigna radiata*), cowpea (*Vigna unguiculata*), black gram (*Vigna mungo*), and groundnut (*Arachis hypogaea*) [13]. The Figure 1 contains list of some medicinal and aromatic plants which are recommended for integration of heterogeneity in main crops through MAPs-based intercropping pattern for enhancement of sustainability in hilly and tribal regions of Surgana tehsil.

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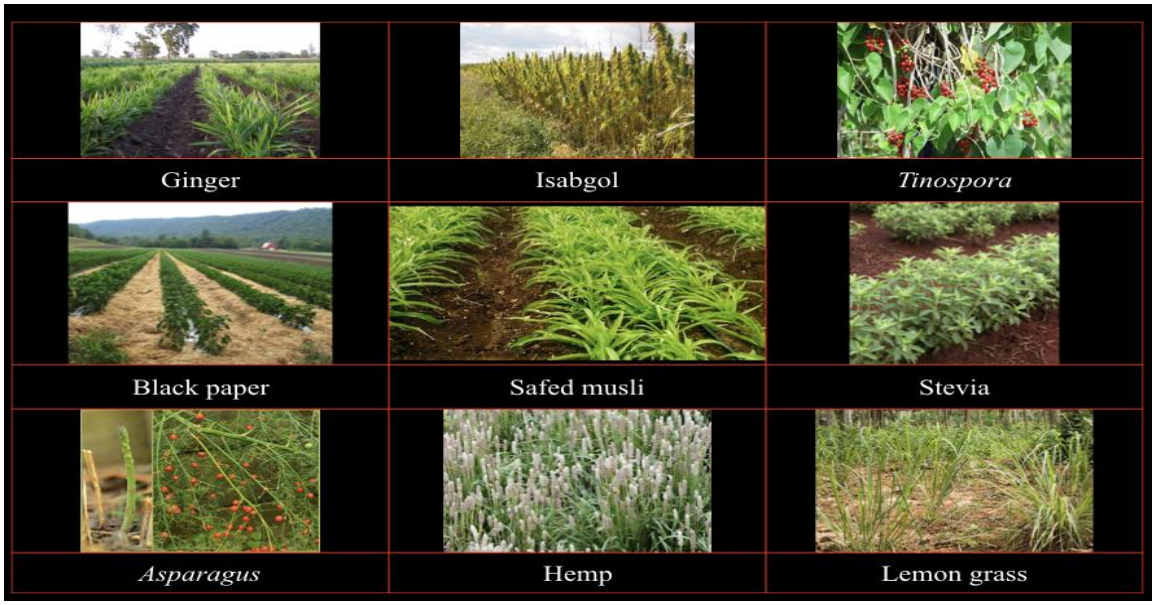

Figure 1. *Choices for MAPs-based Intercropping Pattern*

Medicinal and aromatic plants grown intercropping with short duration vegetables is essential to fulfil the requirement of vegetables. Intercropping of medicinal and aromatic plants with different horticultural plants has a great role reducing the post-harvest yield losses, production quality maintenance and increase its shelf life in storage. The aromatic nature and essential oil of MAPs enables to protect soil borne nematodes; they also protect nematode diseases by suppressing in its rhizosphere. Intercropping with the main crops greatly enhance the growth, biomass yield, oil content, composition and quality oil in MAPs. MAPs are also significantly increases soil organic nitrogen, soil water content, decreased pH and available nitrogen content. Intercropping of MAPs with other crops produce favourable environment resulting in the improvement in resource use efficiency in terms of productivity and net return per unit area [14].

Conclusion

MAPs are of prime monetary importance due to the non-stop and increasing call for products by national and international markets. Intercropping of MAPs with distinctive main crops has an excellent function in decreasing the post-harvest yield loss, quality and boosting storage shelf life. The critical oil content, oil production and content of MAPs is likewise affected by interspecific plant competition in intercropping framework.

The inclusion of MAPs allows to halt the damage with insect. MAPs produces volatile oils which can intrude with the main crop, competition, dispersal and pollination, ensuing in reduced pest abundance. MAPs intercropping with main crops enables to broaden the field. Thus, the insect repellent quality of a few MAPs it has a notable aspect for crops like tomato, cabbage, potato, onion and other horticulture plants. Intercropping with MAPs can boost soil fertility, soil organic nitrogen, soil capillarity and acidic pH. Sustainability Enhancement by Integration of Heterogeneity in Crops through MAPs bring about the increase in efficiency of resource in terms of abundance and net yield per unit area.

The current investigation designed against enhancement of social and fiscal status of farmers in Surgana by sustainable integration of heterogeneity in crops through MAPs based intercropping pattern. This results in improving the farmer's socio-economic standard of living and meets the needs and food security of growing population in Surgana.

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Conflicts of interest

The author has no conflicts of interest to declare.

Availability of data and material

Data are available on request to the author.

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