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Multilayer farming-An epitome towards boosting farmers income

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ABSTRACT

Multi-layer cropping or Multi-layer farming is an advanced way of agricultural practice of growing crop species together at different heights in layers, using the combination of vertical and horizontal dimensions as far as possible simultaneously on the same piece of land for a notable part of their life cycle. The layers can comprise of ground-level crops, climbers, trees or shrubs producing a multi-tiered ecosystem .This innovative agricultural strategy reanalyses traditional farming practices. Due to population growth and increased urbanization, the amount of cropland and cultivable land is becoming deficient day by day. This farming is an alternative practice to enhance productivity in a limited area that involves feasible technologies for multispecies cultivation as a substitute for sustainable growth for small and marginal farmers to produce higher economic returns per unit area. By layout of merging plants that complement each other in terms of growth patterns, farmers can create a mutual environment that augment the use of available resources. Resource efficiency is a principal point in multilayer farming Beyond its economic benefits, multilayer farming contributes to biodiversity preservation. Here, in this paper, a brief review of multilayer cropping, its present need, its advantages, and the practices adopted by small farmers is discussed to promote sustainable agriculture.

Keywords: Multilayer farming, resource efficiency, sustainable agriculture

1. INTRODUCTION

India is a varied land with approximately 70% of population counting on agriculture for their livelihood or steady source of income. Due to speed at which the population growth is getting worse day by day resulting in building of dams, roads, highways as well as deterioration of fertile ground as a result of soil salinity, and water logging, cultivable land is becoming increasingly scarce (Sultana et al.,2020) [1] Due to the shrinking of size of cropland 92 million farm household are under marginal farm category.

The Department of Agriculture, Co-operation, and Farmers Welfare conducts an agriculture census every five years to collect data on the structural characteristics of the agricultural sector, including the size of agricultural land holdings in the country. As per the latest information available from the Agriculture Census, 1970–71: Average land holdings were 2.28 hectares, which were reduced in 1980–81 to 1.82 hectares and 1.50 hectares in 1995–96 to 1.41 hectares in 1995–96 and to 1.08 hectares in 2015–16. The size of holdings further decreased with many sub-divisions of land holdings. More people now own smaller pieces of agricultural land. This

problem of small and fragmented holdings is more serious in densely populated states like Kerala, West Bengal, Bihar, and the eastern part of Uttar Pradesh, where the average size of land holdings is less than one hectare, and in certain parts it is less than even 0.5 hectare. This problem of small and fragmented holdings is more serious in densely populated states like Kerala, West Bengal, Bihar, and the eastern part of Uttar Pradesh, where the average size of land holdings is less than one hectare, and in certain parts it is less than even 0.5 hectare.

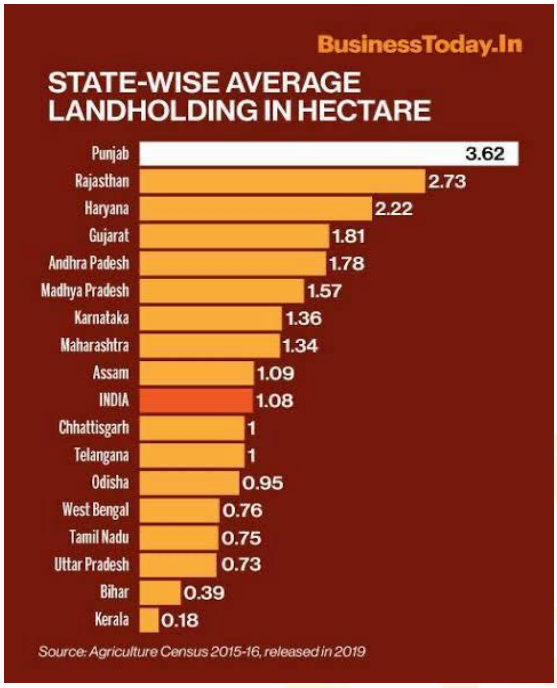

Fig. 1

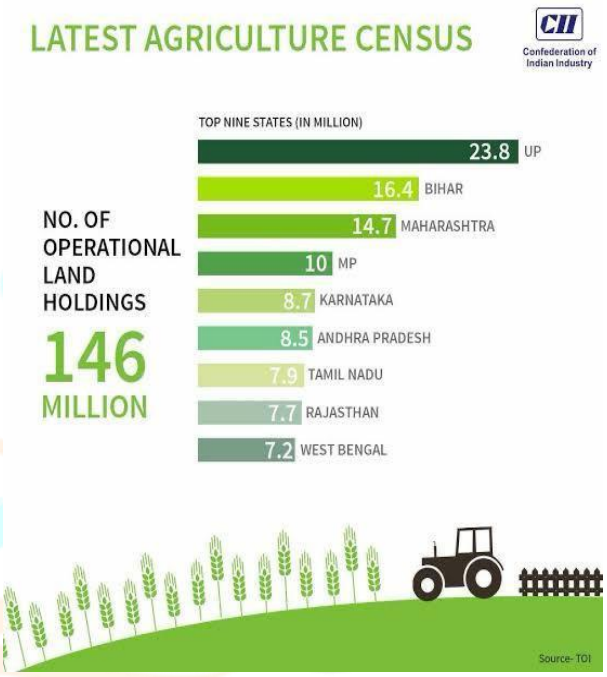

Fig. 2

2. MULTILAYER FARMING

Multi-layer cropping is a system of growing crops together at different heights simultaneously on the same piece of land. It is also referred to as multi-storied cropping or multi-tier cropping, . Multi means many, and layer means strata of different heights. This type of cropping is mainly practiced in orchards and plantations to make optimum use of solar energy even under high plant density. Indoor farming is beneficial as it protects from excessive sunlight, excessive rain, and dew drops. Multilayer farming is an advanced way of integrated farming, which allows one to grow multiple crops on the same piece of land in a specific time (Singh, 2020). It can include vegetables, flowers, fruits, medicinal plants, crops, or big trees. Plants of different heights are used , by using advanced technologies using vertical and horizontal land along with sunlight and other natural resources, we can use any area to optimize unit production. This is quite well-known and true among minor and marginal landholders. Adopting multilayer farming is more competitive than conventional systems. Cultivators can grow 3-4 separate crops under the same time and resources. (Rai, 2022). As the population is increasing there is a high demand for food to fulfill this demand. The traditional farming method is not that effective in fulfilling the challenges in Indian agriculture.

2.1 Basic principle of Multilayer farming

It is an integrated farming method of producing crops of various heights simultaneously on the same plot of land based on the principle of total utilization of water, manure, and land to obtain more productivity per unit area. It is based on time annidation i.e when two crops of widely varying duration are planted, their peak demands for light and nutrients are likely to occur at different periods, thus reducing competition. When early

maturing crop is harvested it becomes favorable for late maturing crop - Eg- Sorghum +Redgram, Groundnut + Redgram and maize + greengram. This approach allows for continuous agricultural production.

2.2 Current Challenges in Indian Agriculture

Agriculture plays an important role in the Indian economy as the livelihoods of about two-thirds of the population are directly or indirectly dependent on the agriculture sector. However, the country faces several challenges in agricultural development that have contributed to the stagnation of agricultural growth in India. Stagnation in crop productivity due to outdated farming techniques, mostly farmers' land holdings are small and fragmented with limited access to inputs and resources, deterioration of natural resources: -Land, groundwater, environment, and biodiversity, the impact of climate change, inadequate use of fertilizers and pesticides that led to lower yields, high production cost. Lack of awareness among farmers about modern technology is affecting the growth in the agricultural sector.

2.3 Objectives of Multilayer farming

- The most prime objective of multi-layer farming is to expand the use of space on agricultural land
- To make effective use of every piece of land, total utilization of water, and manure for production in a specific time
- To provide much more income at low-cost cultivation compared to another farming system
- To encourage sustainable agriculture
- To lessen soil erosion
- To sustain soil texture and fertility
- To cut down the effect of insects, pests, or crop-weed competition

2.4 Procedure to Execute Multilayer Farming

Selection of land: It is the foremost prerequisite for multilayer farming and the size of land depends on the number of crops intended to be planted. Geometric shapes are believed to be most favourable such as rectangles and squares.
Selection of crops: Diverse crops selected for cultivation that vary in height and time to maturity
Seed selection& Treatment: A good quality seed is selected, it should be pure, healthy, and have high-yielding potential, they are treated to disinfect and guard them against seed-borne disease or soil-borne disease
Irrigation: It is one of the most important aspects of the growth of plants. To ensure photosynthetic activity and transpiration adequate irrigation is necessary, and the ring basin method is effective in irrigation.
Manure & Fertilizers: They are added to the soil for good growth and development of crops. Different crops vary in their amount of nutrition, so the basal method is mostly preferred. Compost, FYM, and NPK are vital for crop growth.
Weeding: It is done to kill unwanted plants in the field. The efficient weeding techniques in multilayer farming are Hand weeding, hoeing, and sickling methods.
Harvesting & Post-harvesting: Gathering of beneficial parts from crops and storing them in a safe place
Marketing and Packaging: Materials obtained are packed and sold in the market for income

2.5 Planting methods in multilayer farming

Minor crops are planted in between rows or mixing of seeds in a certain proportion with major crops

Ex-Maize, mustard, garlic, onion, okra, coriander, and melons can be intercropped with sugarcane in between the rows (Based on the principle that they may have a different sowing and harvesting time) Depending on the season and region combination of intercropping varies

Components of multilayer farming

For the planting method to give more effective results following points are to be considered

The taller plants should be planted nearer to the base crop and the shorter ones gradually away from it

Base crop: It is the main component, the base crop selected should be tall growing, widely spaced to provide scope for other plants to grow, perennial nature.

Another crop: The interspace of the base crop is best suited for locally adapted crops having varying depths of the root system. This is to avoid competition among the crops for nutrients.

The crops should be of different heights to receive adequate sunlight by all the crops uniformly, it should be capable of growing under partial shade or shade by the base crop

2.6 Growth pattern of crops in multilayer farming

In this type of farming, 3-4 crops can be grown in the same field at the same time, sowing seeds appropriately is the key. The first layer is to be sown of plants that take maximum germination time than others. The second layer crop must germinate faster than the deepest crop and slower than the topmost crop, third layer crop is to be matured at ground level, it should grow and mature before other crops.

The first layer crop should be a fruit crop that grows for a long time in certain spaces in fewer numbers and matures at maximum height.

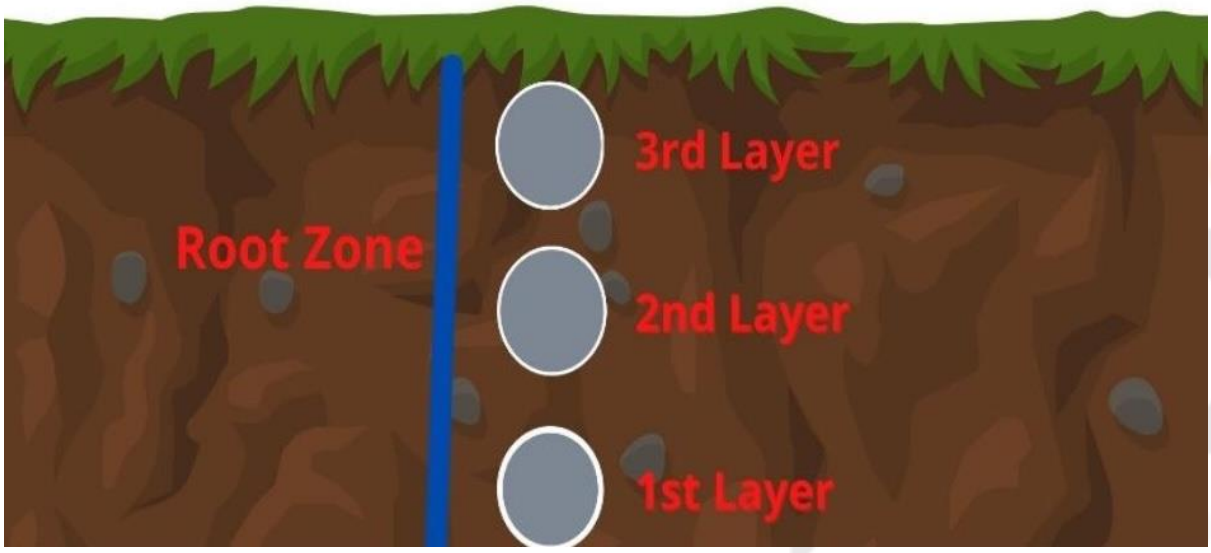

Fig. 3 Growth pattern of crops

2.7 Effect of Multilayer models

It was observed and noted that certain combination of crops had an impact on resource conservation, yield, weed smothering efficiency, soil health, net returns. The multilayer models are as below **:**

1. Papaya + Ragi: Pigeon pea+ Glircidia recorded lower water run off (Jakhar et al) 2. Bitter gourd +Elephant foot yam resulted in higher land equivalent ratio (Sultan et al) 3. 3. 3.Mango+ Guava+

Turmeric recorded Higher mango equivalent yield (Singh et al)
4.Ber+ Fenugreek +Okra -Coriander yield was high (Meena et al)

5. Cotton +Coriander +Cow pea+ Dolichos, Higher weed smothering efficiency was reported (Sankaranarayanb et al)
6. Elephant foot Yam +Sweet corn +Cowpea , Soil health-Available P2 O5,organic carbon and CEC is higher
7. Papaya +Ginger: Pigeon pea(8:2), Gliricidia, Papaya+ Ragi: Pigeon pea (6:2)- Nutrient loss also was lower (Jakhar et al)

High returns/Economics influenced by multilayer farming model

Papaya+ Ginger: Pigeon pea (8:2) +Glircidia gave maximum net returns (Jakhar et al)

Cotton +Raddish +Clusterbean +Beet root gave maximum returns +Per day profitability

Mango +Guava + Turmeric multilayer farming gave maximum gross as well as net returns

3. BENEFITS

1.**Increased Productivity**: Understanding the dynamics of multilayer farming can lead to improved agricultural productivity by utilizing vertical space efficiently, thus increasing the yield per unit area.
2. **Crop Diversity**: This model allows for cultivation of different crops on various layers, contributing to enhanced crop diversity, which is crucial for food security, nutrition, and resilience against pests and diseases.
3. **Year-round Yields**: Multilayer farming can potentially provide year-round yields, reducing seasonal fluctuations and ensuring a consistent supply of agricultural products.
4. **Resource Efficiency**: Researching this model can promote efficient use of resources like water, fertilizers, and energy, aligning with sustainable agricultural practices.
5. **Income generation**: Implementing multilayer farming can potentially improve farmers' incomes by optimizing land use and diversifying revenue streams.

6. **Climate Resilience**: By maximizing land use and diversifying crops, multilayer farming can make farming systems more resilient to the impacts of climate change.
7. **Rural Employment**: Successful adoption of this model can generate additional employment opportunities, contributing to rural livelihoods.
8. **Reduced Environmental Impact**: Properly managed multilayer farming can lead to reduced use of land and water resources compared to traditional farming methods, thus helping in conservation efforts.
9. **Technology Integration**: Studying this model encourages the integration of modern technologies like hydroponics, vertical farming, and precision agriculture, leading to innovation and advancements in the agricultural sector.

4. CONCLUSION

Multilayer farming epitomizes a sustainable approach to agriculture. It addresses the challenges posed by marginal and small farmers in terms of limited land resources and deprived of resources like irrigation. It is an innovation to evaluate the agricultural practices and opens a new door for farmer to earn whole round the year and low risk to loss of failure of crop. Good amount of returns can be earned through this system, where production can be increased by at least 2 to 3 times than traditional agriculture practices. Small farmers must be the focus of study due to uncertain climate change and uncertain agriculture. There is a need to create awareness about the usefulness of multilayer cropping over solo cropping. This can be done by involving active

participation by both public and private institutions including farmers' organizations at local, regional, and global levels.

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