

## Multilayer farming: A way towards farmer prosperity

### Multilayer farming; a way towards farmer prosperity: Systematic Review

#### Abstract

Multilayer farming is an innovative agricultural strategy that redefines traditional farming practices by harnessing vertical space to cultivate multiple layers of crops within a single agricultural system. This approach is designed to overcome challenges associated with land scarcity and inefficient land use. The concept involves arranging different crops in layers, utilizing the vertical dimension to its fullest extent. The layers can include ground-level crops, vines climbing on trellises, and even trees or shrubs, creating a multi-tiered ecosystem. This arrangement optimizes sunlight exposure, nutrient distribution, and water usage, resulting in enhanced productivity. One of the key advantages of multilayer farming is its potential to significantly increase overall yield per unit of land. By strategically combining plants that complement each other in terms of growth patterns, resource requirements, and ecological interactions, farmers can create a symbiotic environment that maximizes the use of available resources. Resource efficiency is a focal point in multilayer farming. The intercropping of different plant species helps in nutrient cycling, reducing the need for external inputs. Furthermore, the diverse plant composition can deter pests and diseases, reducing the reliance on chemical interventions. The vertical stacking of crops also allows for efficient water usage through integrated irrigation systems. Beyond its practical benefits, multilayer farming contributes to biodiversity preservation. The coexistence of various plant species fosters a more resilient and ecologically diverse agricultural landscape. This can have positive effects on soil health, pollination, and overall ecosystem stability.

**Keywords:** Multilayer farming, vertical space, biodiversity preservation, sustainable approach

#### INTRODUCTION

Human want is indefinite that never satisfy. For that reasons they burned anything for their need. We can see it from our periphery that industrialization is occur more and more day by day. Understanding that human population is increasing rapidly from past few decade and urbanization is possible way to give stay for that population but not in cost of agriculture land. According to the most recent United Nations figures, India has overtaken China to become the country with the largest population in the world, with 142.86 billion people. China is currently the second most populated country in the world with 142.57 billion people (Anon, 2023). A

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recent UNFPA research states that 25% of Indians are between the ages of 0 and 14 years; 18% are between the ages of 10 and 19 years; 26% are between the ages of 10 and 24 years; 68% are between the ages of 15 and 64; and 7% are above 65 years. Experts say that whereas the population of Uttar Pradesh and Bihar is young, that of Kerala and Punjab is ageing. According to a number of studies conducted by various organisations, India's population is predicted to grow for about three decades before peaking at 165 crore. ~~Anon (2023)~~. (Anonymus, 2023).

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## INTERCROPPING

Intercropping is a method of increasing agricultural productivity by planting two or more crops simultaneously on a specific plot of land in a specific row pattern for utilizing efficient sunlight, nutrient, land, water and space in economic way. Small farmers who depend on rain for higher production are more likely to use it. This procedure has a specific row pattern, such as 1:1 or 1:2, which having the base crop and second one is intercrop. These crop having different nutrient needs are blend with each other. It guarantees the best possible use of the nutrients given. (Rare of information, and previous studies and references need to be conducted)

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## MULTILAYER FARMING

Farmers often try new ideas in their fields based on deep knowledge of their local environment and develop many ecologically and environmentally sound local technologies/ farming practices by innovations and adaptations. One of these practices is known as Multilayer Farming. It is based on space and time annidiation. In tropical regions, where there is more rainfall, higher temperatures, and a longer growing season, planting two or more crops on the same plot of land is increasingly usual. This approach allows for continuous agricultural production. A method of producing crops of various heights simultaneously on the same plot of land is called multilayer farming. It's also known as multi-tiered or multi-storied cropping. (Rare of information, and previous studies and references need to be conducted)

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The main goal of this kind of cropping is to maximise solar energy even at high plant densities. Using the resources at their disposal, this technique will assist farmers in getting more revenue and a decent output from the same area of land. It also addresses the issue of feeding the expanding population in light of the scarcity of arable land. Making better use of

the vertical space is the primary goal of this kind of farming. The tallest elements in this system have foliage that requires a lot of light and evaporation, while the shorter elements have foliage that needs shade and a high humidity level. Other goals of multilayer farming include increasing output while conserving water, harvesting crops regularly throughout the year, and making the best use of the land area per unit. (Rare of information, and previous studies and references need to be conducted)

### Growth pattern of crops

- Various crops (4-5) grow at various rates and have varying heights when they are planted in layers.
- The initial crop develops and grows within the soil. Deep-rooted crops should germinate with the longest germination time.
- The next crop should emerge from the soil at the middle surface, germinating faster than the crop with deep roots and slower than the crop at the top.
- The following crop should reach maturity at ground level and grow and mature at the fastest rate possible, freeing up space for subsequent harvests.
- The last crop should reach its maximum height of maturity. It's a fruit that grows slowly. These should be cultivated in specific areas and in smaller quantities. (Previous studies and references are required)

### Basic principles of multilayer farming

The foundation of multilayer farming is high-density planting and optimal and effective use of manure, water, soil, labour, and vertical space. In order to reduce the amount of chemicals used, this farming system also strives to minimise production costs and input usage, promote organic and sustainable agricultural practices, and guarantee food and nutrition security for every home. Overwatering a plant can be detrimental. Thus, it is important to water properly to maintain the moisture. (Rare of information, and previous studies and references need to be conducted)

### Objective of multilayer farming

1. One of the major objective is to maximize the use agricultural land, water, manures and fertilizers

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2. To promote sustainable agriculture
3. To increase the production of different crops in a specific time
4. To generate good income from one piece of land
5. To minimize crop-weed competition
6. To observe allelopathy phenomenon for further research purpose
7. To minimize soil erosion
8. To maintain soil texture and fertility

(Previous studies and references are required)

### Management practices

- It is necessary to provide appropriate staking for crops that climb. Regular harvesting of the leafy crops growing on the surface is recommended.
- Insect traps must to be accommodated within the building.
- This kind of cropping isn't allowed in public areas. Thus, we ought to erect a bamboo and wild grass shade structure.
- It is possible to train several crops to create adequate room beneath the building.
- It is best to eliminate weak seedlings and build a trellis specifically for climbers.
- Overwatering a crop can be detrimental. Thus, it is important to water properly to maintain the moisture. (Rare of information, and previous studies and references need to be conducted)

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### Steps to perform multilayer farming

- Selection of crops: Various crops are selected for cultivation. Crops need to vary in height and time to maturity.
- Selection and setup of the field: It is believed that geometric shapes, such as squares and rectangles, make good terrain for multi-tier farming.
- The ideal seed is one that is pure, healthy, energetic, and has a high potential yield.
- To guard against diseases spread by seeds or soil, seeds are disinfected.
- Enough irrigation is necessary to ensure transpiration and photosynthetic activity. In irrigation, the ring basin method is effective.

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- Weeding: Hand weeding, hoeing, and sickling are efficient weeding techniques in multi-layer farming.
- Manures and fertilisers are added to the soil to help crops grow and develop in the right ways. Compost, NPK, and FYM are vital for crop growth.
- Procedures both before and after harvest: Marketing and packaging: The materials are packaged and sold on the market for a profit. (Previous studies and references are required)

### Nature of crops in multi-layer cropping

- It is recommended that crops grown in subsurface or underground soil have thick roots and a preference for shade.
- Leafy crops are ideal for planting on the soil's surface. These leafy crops are harvested directly by pulling them up.
- For the climbing plants to grow and develop properly, they need to be staked. Since these climbing plants may scale roof structures, they need to be properly trained and regulated.
- Pruning the straight-growing plants can help them take up less space, and harvesting them should come after everyone else has finished.

(Rare of information, and previous studies and references need to be conducted)

### Advantages

- Multilayer farming generates employment and provides income round the year.
- Multilayer farming decreases the investment cost by 4 times and relegates the need for very expensive Polyhouse. Bamboo and green grass, two common native resources, can be used to provide shade.
- Even at the peak of summer, the crops are able to receive the proper quantity of sunshine thanks to the multilayer farming construction.
- It also aids in the preservation of soil moisture.
- It increases the nutrient use efficiency.
- The absence of climate change impacts is one of the main advantages of this kind of farming method.

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- Multilayer farming system helps to minimize the weed germination, which helps to enhance the production and productivity.
- It helps in the better use of available cultivated land for production as the farmers can produce large number of agricultural commodities from small area.

(Rare of information, and previous studies and references need to be conducted)

### Disadvantages

- Adverse competitive effect or by allelopathy.
- Labour intensive.
- Difficulty in mechanization.

(Rare of information, and previous studies and references need to be conducted)

### Effect of multilayer farming on resource conservation

Jakhar *et al.* (2012) noted that papaya + ragi : pigeonpea (6 : 2) + gliricidia system recorded significantly lower water runoff, in addition to that papaya + ginger : pigeonpea (8 : 2) + gliricidia system found significantly lower soil erosion.

~~Jakhar *et al.* (2012)~~ They also reported that papaya + ginger + gliricidia multilayer system resulted better infiltration rate as compared to other system.

Sultana *et al.* (2020) revealed that multilayer farming model of bitter melon + elephant foot yam resulted in higher land equivalent ratio of system.

According to Tejaswini *et al.* (2022), growing of elephant foot yam as sole recorded significantly higher light interception throughout its life cycle which was remain at par with elephant foot yam + cluster bean + palak.

(Rare of information, and previous studies and references need to be conducted)

### Effect of multilayer farming on yield

Singh *et al.* (2013) revealed that elephant foot yam equivalent yield found higher in elephant foot yam + ridge gourd multilayer farming.

Swain (2014) concluded that mango + guava + turmeric multilayer farming recorded higher mango equivalent yield.

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Meena *et al.* (2017) observed that coriander equivalent yield were found significantly the highest with ber + fenugreek + okra multilayer farming.

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#### Effect of multilayer farming on weed

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Sankaranarayanan *et al.* (2012) investigated that, Cotton + coriander + v. cowpea + cluster bean multilayer farming found significantly lower weed dry weight at 15, 30, 60 and 90 DAS and significantly higher weed smothering efficiency reported by Sankaranarayanan *et al.* (2012).

Sankaranarayanan *et al.* (2012) They also revealed that, cotton + cluster bean + v. cowpea + dolichos system was recorded significantly lowest dry weight of weed as well as higher weed smothering efficiency.

According to Tejaswini *et al.* (2022), lower dry weight of weed and higher weed smothering efficiency (WSE) recorded significantly with the elephant foot yam + sweet corn + cowpea multilayer system.

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#### Effect of multilayer farming on soil health

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Benerjee and dhara (2011) reported that *A. auriculiformis* + sweet orange + groundnut gave significantly higher OC(%), available N,  $P_2O_5$  and  $K_2O$ .

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Kumar *et al.* (2011) found that Aonla + turmeric gave significantly higher OC(%), available N, and  $P_2O_5$ . However, there is no any significant effect on  $K_2O$ .

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OC, available  $P_2O_5$  and CEC were significantly higher with adopting papaya + ginger: pigeon pea (8:2) + gliricidia, papaya + ragi : pigeon pea (6:2) + gliricidia and papaya + ginger + gliricidia respectively. Besides that lower nutrient loss was observed with papaya + ginger + gliricidia during the investigation of Jakhar *et al.* (2012).

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Sharma *et al.* (2013) observed that mango + cowpea + toria gave significantly higher OC, nitrogen, phosphorus and potash.

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Mango + guava + cowpea multilayer farming system gave significantly higher available N and  $K_2O$  while available  $P_2O_5$  was found significantly higher with mango + guava + ginger multilayer farming. (Swain, 2014).

Eucalyptus + Spider lily multilayer farming system gave significantly higher OC, available N,  $P_2O_5$  and  $K_2O$  (Panchal *et al.*, 2017).

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### Economics as influenced by multilayer farming

Aonla + mothbean-cumin multilayer farming system gave significantly higher net returns as compared to other multilayer farming (Awasthi, 2008).

Jakhare *et al.* (2012) found that papaya + ginger: pigeon pea (8:2) + gliricidia system resulted in maximum net return, while in case of B:Cratio sole pigeon pea recorded maximum.

Sankaranarayanan *et al.* (2012) noted that cotton + radish + cluster bean + beet root system gave maximum net return and per day profitability. While multilayer system of cotton + radish + beetroot + coriander gave maximum B:Cratio.

Mango + guava + turmeric multilayer farming resulted in maximum gross as well as net return. Besides that maximum benefit-cost ratio found with mango + guava + cowpea (Swain, 2014).

Chandrashekhar *et al.* (2018), Chandrashekhar and Bhattacharjee (2018) concluded from their investigation that multilayer farming system like arecanut + banana + turmeric gave maximum net return, while in the case of B : C ration arecanut + turmeric found maximum.

Gross return, net return and B : C ratio were found maximum while adopting ber + fenugreek + okra multilayer farming reported by Meena *et al.* (2017).

Patel *et al.* (2018) found that bottle gourd var. Local + teak gave maximum net return and B : C ratio as compared to other system in experimentation.

Sultana *et al.* (2020) reported that bitter melon + elephant foot yam system gave maximum net income and benefit-cost ratio as compared to other system in experimentation.

Wajih *et al.* (2020) revealed that bottle gourd + cabbage system gave maximum net return in addition to that B : C ratio was found maximum with elephant ear + IVY gourd.

### Conclusion

Multilayer farming represents a holistic and sustainable approach to agriculture, addressing the challenges posed by limited land resources. Multilayer farming with location specific cultivation of fruit crop, field crop, legume crop and vegetable crop increasing system productivity, proper utilization of available resources and gave maximum return.

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## REFERENCES

**Comment [MZ36]:** Arrange the references in alphabetical order

- Chandrashekhar,G.andBhattacharjee,H.(2018).Economics of different horticultural crops under Arecanut based-multistoreyed cropping system in West Bengal condition.*InternationalJournalofCurrentMicrobiologyand Applied Sciences*. 7(4): 2756-2761.
- Jakhar,P.;Barman,D.;Godwa,H.C.andMadhu,M.(2012).Multitier cropping system for profitable resource conservation and sustainable management of sloping lands of eastern India.*IndianJournalofAgriculturalResearch*.46(4): 309-316.
- Meena, R. S.; Malhotra, S. K. and Vashishtha, B. B. (2017). Fruit based seed spices diversified cropping models.*Development Quality and ExportofSeed and Spices*. pp. 181-189.
- Sankaranarayanan,K.;Nalayini,P.andPraharaJ,C.S.(2012).Multi-tier cropping system to enhance resource utilization, profitability and sustainability of Bt cotton (*Gossypiumhirsutum*) production system. *IndianJournalofAgriculturalScience*.82(12): 1044-1055.
- Sankaranarayananb,K.;Nalayini,P.andRajendran,K.(2012).Multitier cropping systems and its weed control methods for higher resource utilization, profitability and sustainability in Bt cotton.*Proceedingon“GlobalCottonProductionTechnologiesvis-a-vis Climatechange*. 68-74.
- Shehrawat,P.S.;Aditya,S.S.andArulmanikandan,B.(2023).Awareness and adoption of multilayer farming: A step toward safeguarding farmers' livelihoods.*ThePharmaInnovationJournal*.12(4): 1110-1114.
- Singh,N.(2020).Multitier cropping system for sustainable management of land. *Justagriculture*.1(4):12-13.
- Singh, R. P.; Bhushan S.; Kumar, S. and Shanker, R. (2013). Yield assessment of elephant foot yam grown under multilayer vegetable cropping system. *The Bioscan*. 8(4): 1237-1239.
- Srivastava,A.P.;Rao,D.R.;Basade,Y.;SinghA.K.;Sikarwar,M.andAshar,N.(2013).Multi-layer cropping: Ideal approach for better yield and increasing farm income.NationalAgriculturalInnovationProjectIndianCouncilofAgricultural

Research Krishi Anusandhan Bhavan-II New Delhi, pp. 31-33.

Sultana, S.; Roy, R.; Das, B.; Mondal, A. and Rahman, F.H. (2020). Vegetable Based Multitier Cropping System: A Model for Higher Income for the Farmers in Old Alluvial Soils of West Bengal. *Advances in Research*. **21**(6):30-34.

Swain, S.C. (2014). Performance and profitability study of different mango-based intercropping systems in Eastern Ghat high land zone of Odisha. *Journal of Crop and Weed*. **10**(2):170-178.

Anonymus (2023). The Economic Times News. India overtakes China to become world's most populous nation with 1.428 billion people: UN. Available at <https://economictimes.indiatimes.com/news/india/india-population-to-surpass-china-mid-year-un-estimates/articleshow/99605379.cms> accessed on 15<sup>th</sup> May, 2023.

Tejaswini<sup>a</sup>, T.; Jyothi, K.U.; Reddy, R.V.S.K.; Sasikala, K.; Kumari, K.U. and Sujatha, R. V. (2022). Effect of multi-tier cropping systems on light interception in elephant foot yam with respect to yield. *The Pharma Innovation Journal*. **11**(4):1524-1527.

Tejaswini<sup>b</sup>, T.; Jyothi, K. U.; Reddy, R.V.S.K.; Sasikala, K.; Kumari, K.U. and Sujatha, R. V. (2022). Studies on multi-tier cropping systems in elephant foot yam on weed parameters. *The Pharma Innovation Journal*. **11**(4):1300-1303.

Wajih, S.; Singh B.K.; Singh A.K. and Srivastava A. (2022) - <https://leisaindia.org/vegetable-based-farming-system-enhancing-gains-through-appropriate-crop-combinations/>

Anonymus (2023). Worldometre population of India data. Available at <https://www.worldometers.info/world-population/india-population/> accessed on 18<sup>th</sup> May, 2023.