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Awareness and adoption of multilayer farming: A step toward safeguarding farmers' livelihoods

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Abstract

The amount of cropland is shrinking as a result of population growth. Due to increased urbanization, cultivable land is becoming increasingly scarce. Multi-layer farming combines vertical and horizontal land with sunshine and other natural resources. Due to a large number of farmers and the limited quantity of arable land available, this farming method allows farmers to grow a variety of products, including fruits, vegetables, flowers, and medicinal plants, all at once. The concepts of this cropping system include minimizing input and production costs and building a sustainable and organic farming system to reduce the use of chemicals. A survey was undertaken to study the level of awareness and adoption of multilayer farming in the Hisar and Fatehabad districts of Haryana state. From each district, four villages, and from each village 15 farmers were selected randomly. The study revealed that the majority of the respondents (79.17%) were 'aware about multilayer farming' followed by 'horticultural and vegetable crops can be grown simultaneously in multilayer farming (77.50%)', 72.50 percent of farmers know about the plans to grow crops in multilayer farming (72.50%) followed by multilayer farming needs extra expertise (70.00%). Only 18.06 percent of farmers were found adopted multilayer farming, which is very low. It also discusses the constraints associated with the adoption of multilayer farming. This study provides a useful viewpoint from past multilayer farmers and emphasizes that multilayer farming concepts and practices require significant training for the farming community.

Keywords: multilayer farming, awareness, adoption, arable land, urbanization

Introduction

Due to increased urbanization, the building of dams, rivers, and highways, as well as the deterioration of fertile ground as a result of soil salinity, and waterlogging, cultivable land is becoming increasingly scarce (Sultana *et al.*, 2020) ^[1]. Every person is aware of the overpopulation issue, which is getting worse daily. The amount of cropland is shrinking as a result of population growth. In India, marginal, small, and semi-medium farmers make up around 62%, 19%, and 12% of all farmers, respectively. We may use any space to enhance unit production by utilizing cutting-edge technologies that combine vertical and horizontal land with sunshine and other natural resources. Numerous food shortages around the world and the potential for shortfalls in supplies continue to encourage more intensive agricultural practices, such as multi-layer cropping. Thus, multi-tier farming will be well-suitable as it effectively uses solar energy, soil moisture, nutrients from different depths, and airspace. It is a self-sustaining system. The system is made up of three primary elements: the main crop, the filler crop, and the intercrops. These three elements are located on three separate tiers within the production system (Koley *et al.*, 2019) ^[3]. Increased use of the subsurface, surface and vertical space is the goal of multi-layer farming. The tallest parts of this approach comprise foliage that is highly evaporatively demanding and exposed to bright light. The shorter, vegetated components need less shade and/or more humidity (Anonymous, 2022) ^[2]. Due to a large number of farmers and the limited quantity of arable land available, this farming method allows farmers to grow a variety of products, including fruits, vegetables, flowers, and medicinal plants, all at once. By doing this, marginal, tiny, and semi-medium farmers can make a reasonable living even with limited arable land (Singh, 2020) ^[10]. In a multi-tier system, crops ranging from tall trees to low-growing annuals that typically have diverse rooting patterns and complement one another are planted together in different canopy layers. Compared to traditional approaches, multilayer farming is more competitive. The same resources can be used by cultivators to grow three to four different crops simultaneously in a three-tiered arrangement (Saxena and Rai, 2022) ^[8]. A multi-tier cropping system is also advantageous for supplying insurance against market gluts of a single commodity, growing

crops in accordance with market demand, maintaining an ecological balance, and generating more income per unit area. It also provides regular employment, as well as food and nutritional security for the farming family. The concepts of this cropping system also include minimizing input and production costs and building a sustainable and organic farming system to reduce the use of chemicals. Many authors (Meena *et al.*, 2022; Sultana *et al.*, 2020; Mali *et al.*, 2019; Singh and Negi, 2013) [5, 11, 4, 9] claimed that multilayer farming provided a higher net return than pure crop farming. Using the resources at their disposal, the farmers can use the same land to produce a good crop and increase their earnings. Additionally, it addresses the issue of feeding a growing population with limited arable land. The farmers attempted to grow certain crops by making use of the existing vertical and horizontal space in order to increase productivity and profits. As a result, a study was conducted to determine the extent to which farmers in different sectors were aware of and using multilayer farming.

Materials and Methods

The present study was conducted in the Hisar and Fatehabad districts of Haryana state. A total of 4 villages from each district were chosen using a random sampling technique *viz.*, Behbalpur, Bugana, Rajli, and Ghirai from the Barwala block of Hisar district and Bighar, Dharniya, Barseen, and Majra from the Fatehabad block of Fatehabad district. To collect the data fifteen farmers from each selected village were also selected randomly. As a result, 120 farmers were chosen as responders in the current study. The farmers' socio-personal (age, education, land holding), socio-economic (irrigation facilities available, cropping pattern, farming system, crop rotation followed), and communicational characteristics (mass media exposure, extension contact, social media for getting information), as well as their overall awareness and adoption level for use of solar energy for agricultural operation, were considered. The awareness level of farmers about multilayer

farming was measured on a 2-point continuum *viz.*, 'Aware'- '1' and 'Not aware'- '0'. Similarly, the level of adoption ('Adopted'- '1' and 'Not adopted'- '0'), and the constraints faced in the adoption of multilayer farming ('Severe'- '1' and 'Not severe'- '0') were also measured. A purposefully created interview schedule that had been pretested before being given to the sampled respondents was used to gather data from the respondents who had been selected for the sample. Appropriate statistical measures were used *i.e.*, mean, frequency, percentage, and rank order were applied to draw meaningful inferences.

Results and Discussion

Profile of selected respondents: A descriptive analysis of the sampled respondents' socio-personal, socio-economic, and communicational characteristics were conducted. The majority of respondents (60.00%) belonged to the middle age (31 to 50 years) group and had educational qualifications of matriculation (26.67%). According to the present study, about one-third (32.50%) of the respondents have land holding above 5 acres up to 10 acres and above seventy percent of the respondents (73.33%), have both sources of irrigation (canal + submersible pump/ tube well). A majority (90.00%) were doing livestock with agriculture followed by the integrated farming system (18.33%), practicing sole cropping pattern (66.33%), and having cotton-wheat cropping system (65.00%). In the case of communicational characteristics, the newspaper ranked first with a weighted mean score of 2.30 among the mass media exposure, the progressive farmers with a weighted mean score of 2.65 among the extension contact of the farmers, and the majority got information through WhatsApp (77.50%).

Farmers' awareness about solar energy for agricultural operations: Awareness is a crucial decision-making tool for making farming more profitable and sustainable. Table 1 shows the extent of awareness about multilayer farming.

Table 1: Awareness of Farmers about Multilayer Farming (n=120)

S. No.	Statements	Awareness level			
		Aware		Not Aware	
		Frequency	%	Frequency	%
1	Aware about Multilayer farming?	95	79.17	25	20.83
2	Multilayer farming beneficial for farmers	81	67.50	39	32.50
3	Multilayer farming doesn't need extra land	69	57.50	51	42.50
4	Multilayer farming gives extra returns by cultivating the same piece of land	66	55.00	54	45.00
5	Multilayer farming helps to reduce the input cost	57	47.50	63	52.50
6	Multilayer farming improves soil health conditions.	72	60.00	48	40.00
7	Multilayer farming needs extra expertise	84	70.00	36	30.00
8	Multilayer farming needs crop sequence information.	54	45.00	66	55.00
9	Multilayer farming gives employment throughout the year	63	52.50	57	47.50
10	In multilayer farming, the crop residues can be used for other crops in the same field.	72	60.00	48	40.00
11	Multilayer farming can also be done with limited resources of irrigation water	68	56.67	52	43.33
12	Multilayer farming helps farmers to use fewer amount of chemical fertilizers	66	55.00	54	45.00
13	Multilayer farming helps to reduce expenses on manpower	92	76.67	28	23.33
14	Multilayer farming increases the productivity of crops	39	32.50	81	67.50
15	Multilayer farming encourages the judicious use of farm inputs	61	50.83	59	49.17
16	Use of mobile phone applications for multilayer farming	74	61.67	46	38.33
17	Knows about the crop grown in multilayer farming	90	75.00	30	25.00
18	Knows about the plans to grow crops in multilayer farming	87	72.50	33	27.50
19	Horticultural and vegetable crops can be grown simultaneously in multilayer farming	93	77.50	27	22.50
20	Multilayer farming minimizes the risk of crop failure by climatic hazards	42	35.00	78	65.00
21	Multilayer farming system is best for a higher return	47	39.17	73	60.83
22	Multilayer farming helps in increasing the production efficiency of field	45	37.50	75	62.50

23	Multilayer farming helps in providing a shady canopy	43	35.83	77	64.17
24	Multilayer farming keeps ecological balance in the environment	61	50.83	59	49.17
25	Multilayer farming prevents water evaporation from the soil	39	32.50	81	67.50
26	Multilayer farming provides microclimatic conditions that advantage crops underneath	41	34.17	79	65.83
27	In multilayer farming, 4-5 crops simultaneously can be taken on the same piece of land	49	40.83	71	59.17
28	Multilayer farming increases return per unit of land	60	50.00	60	50.00
29	Multilayer farming is more beneficial to small and marginal farmers	62	51.67	58	48.33
30	Cost of multilayer farming is 4 times lower but returns 8 times higher	58	48.33	62	51.67

The majority (79.17%) of the respondents were aware about multilayer farming and 77.50 percent were aware that in multilayer farming, horticultural and vegetable crops can be grown simultaneously. About 76.67 percent of the sampled respondents were aware about multilayer farming helps to reduce expenses on manpower, 75.00 percent of them knows about the crop grown in multilayer farming, 72.50 percent knows about the plans to grow crops in multilayer farming, and 70.00 percent were aware about multilayer farming needs extra expertise to be practiced in the field. Therefore, they are more conscious of multilayer farming and are as a result taking part in field activities. Of the respondents, 67.50 percent were aware about multilayer farming, and that it is beneficial for farmers, 61.67 percent of them knows about the use of mobile phone applications for multilayer farming, and only 60.00 percent knows that multilayer farming, in which crop residues can be used for other crops in the same field.

However, only 57.50 percent were aware about multilayer farming doesn't need extra land, 56.67 percent were aware about multilayer farming can also be done with limited resources of irrigation water, 55.00 percent were aware about multilayer farming helps the farmers to use fewer amounts of chemical fertilizers. Whereas only 52.50 percent of the sampled respondents were aware about multilayer farming gives employment throughout the year, 51.67 percent knows that multilayer farming is more beneficial to small and marginal farmers, and only 50.83 percent knows it encourages judicious use of farm inputs. On the other hand, only 39.71 percent of the respondents were aware about the multilayer farming system is best for higher returns and the rest were not aware about it. Only 37.50 percent were aware about multilayer farming helps in increasing the production efficiency of fields and 62.50 percent were really not aware of it. About 64.17 percent were not aware and only 35.83 percent were aware about multilayer farming helps in providing shady canopy. Similarly, 34.17 percent were aware and 65.83 were not aware about multilayer farming provides microclimatic conditions that advantage crop underneath, and only 32.50 percent of the sampled respondents were aware about multilayer farming increases the productivity of crops as well as prevent water evaporation from the soil.

As depicted in Table 1, the awareness level is found to be better in the case of solar energy for agricultural operations at various levels, viz., about multilayer farming (79.17%), in multilayer farming, horticultural and vegetable crops can be grown simultaneously (77.50%), helps to reduce expenses on manpower (76.67%), about the crop grown in multilayer

farming (75.00%), about the plans to grow crops in multilayer farming (72.50%). The overall awareness level is found to be relatively lower in the case of awareness about increases in the productivity of crops as well as preventing water evaporation from the soil (32.50%), provides microclimatic conditions that advantage crop underneath (34.17%), helps in providing shady canopy (35.83%), helps in increasing the production efficiency of fields (37.50%), best for higher returns (39.71%).

Farmers' adoption level about multilayer farming: Since adoption is a sign that a technology is practical and widely used, adoption is the primary goal of technology development. The level of adoption of the sampled farmers was measured with the help of an interview schedule. The extent of the adoption of multilayer farming is presented in Table 2.

Only 26.67 percent of the sampled respondents had adopted different types of crops, vegetables, and fruit trees beneficial for multilayer farming and the rest of the respondents (73.33%) have not adopted them. Followed by, only 25.00 percent of respondents had adopted a sowing bed in the North-South direction to help the plants to get adequate sunlight and 75.00 percent have not adopted the sowing bed. Whereas the majority 76.67 percent of the sampled respondents have not adopted multilayer farming as effective in the adoption of crop rotation, only 23.33 percent had adopted it in their fields. About 77.50 percent of farmers have not adopted multilayer farming used as a hedge at farm boundaries. Thus, only 22.50 percent had adopted it as a hedge in their respective fields. Only 21.67 percent of them adopted multilayer farming to increase the moisture-holding capacity of the soil, then about 78.33 percent have not adopted it for that purpose. Only 20.83 percent had adopted multilayer farming for a balanced diet produced and 79.17 percent have not adopted it.

More than 80 percent of the sampled respondents have not adopted multilayer farming, that is only 19.17 percent had adopted some of the crops that acted as a trap crop in multilayer farming and also for effective utilization of leaching materials. Whereas only 18.33 percent of them had adopted multilayer farming to improve the quality of vegetables produce and for additional income generation system, and based on the height and growth duration of crop, therefore it is clear that the majority (81.67%) have not adopted in the fields.

Table 2: Adoption level of farmers about multilayer farming (n=120)

S. No.	Statements	Adoption level			
		Adopted		Not adopted	
		Frequency	%	Frequency	%
1.	Different types of crops, vegetables, and fruit trees beneficial for multilayer farming	32	26.67	88	73.33
2.	Multilayer farming is effective in the adoption of crop rotation	28	23.33	92	76.67
3.	In the adoption of future cropping patterns, multilayer farming is beneficial	26	21.67	94	78.33
4.	Adopted plan of irrigation schedule in multilayer farming	20	16.67	100	83.33
5.	Multilayer farming improves the quality of vegetable produce	22	18.33	98	81.67
6.	Multilayer farming restricted the lodging of crops	16	13.33	104	86.67
7.	Multilayer farming benefitted to reduce the soil degradation/ erosion	14	11.67	106	88.33
8.	Multilayer farming helps to increase the organic matter in the soil	12	10.00	108	90.00
9.	Multilayer farming helps in the timely management of inputs	15	12.50	105	87.50
10.	Multilayer farming helps in the adoption of crops suited to soil type.	20	16.67	100	83.33
11.	Multilayer farming helps to use inputs on a sustainable basis	12	10.00	108	90.00
12.	Multilayer farming increases the moisture-holding capacity of soil	26	21.67	94	78.33
13.	Some of the crops acted as a trap crop in multilayer farming	23	19.17	97	80.83
14.	Multilayer farming benefitted in the additional income generation system	22	18.33	98	81.67
15.	Multilayer farming ensures food and nutritional security for livelihood	21	17.50	99	82.50
16.	Multilayer farming is based on the height and growth duration of crop	22	18.33	98	81.67
17.	Adopted sowing of crops in strategic manner for weeding practices adequately	19	15.83	101	84.17
18.	Multilayer farming is adopted for the effective utilization of leaching materials	23	19.17	97	80.83
19.	Balanced diet produced in multilayer farming	25	20.83	95	79.17
20.	Multilayer farming is used as a hedge at farm boundary	27	22.50	93	77.50
21.	Sowing bed in a North-South direction helps the plants to get adequate sunlight	30	25.00	90	75.00
Mean adoption score = 3.79					
Overall adoption level = 18.06%					

However, multilayer farming ensures food and nutritional security of livelihood, only 17.50 percent of the respondents had adopted it. Furthermore, multilayer farming helps in the adoption of crops suited to soil type, and the adopted plan of an irrigation schedule, only 16.67 percent of them had adopted and 83.33 percent have not adopted it. Only 15.83 percent of respondents had adopted the sowing of crops in a strategic manner for weeding practices adequately. Similarly, only 13.33, 12.50, and 11.67 percent, adopted multilayer farming for restricting the lodging of crops, timely management of inputs, and reducing soil degradation/ erosion. It is noted that about 90.00 percent of the sampled respondents have not adopted multilayer farming helps to use inputs on a sustainable basis and only 10.00 percent had adopted it. The overall adoption level of farmers found as 18.06 percent, with a mean adoption score of 3.79.

As depicted in Table 2, the adoption level is found to be relatively lower in almost all cases i.e., the level of adoption of multilayer farming was only to the extent of 26.67, 25.00, 23.33, 22.50, 21.67, 20.83, 19.17, 18.33, 17.50, 16.67, 13.33, 12.50 and 10.00 percent, respectively at farmers' fields. As for as, the non-adopted category of respondents about multilayer farming in the sequence as stated above i.e., 73.33, 75.00, 76.67, 77.50, 80.83, 81.67, 82.50, 83.33, 84.17, 86.67, 87.50, 88.33, and 90.00 percent, respectively the respondents not adopted any multilayer farming practices at their fields.

Therefore, the present study revealed overall adoption of multilayer farming is at a low level (18.06%). Anseera and Alex's (2019) study found that fewer (69.14%) people are adopting crop intensification, which includes multi-tier farming. According to the study by Phadtare *et al.*, (2022) [6], the majority of farmers stated to the researchers felt multi-layer farming was advantageous to them, however only 57 percent of people have reported engaging in multi-layer

farming. In many ways, these findings are comparable to those of the current study.

Farmers' constraints faced in the adoption of multilayer farming: There are various problems/constraints faced by the farmers in the adoption of multilayer farming and measured with the sampled respondents using the developed interview schedule. Table 3 shows the extent of constraints faced in the adoption of multilayer farming.

The majority 95.00 percent of the respondents felt the problem of intercultural practices in multilayer farming, and 93.33 percent felt it is labor intensive. About 92.50 percent of sampled respondents felt that there is not a proper spread of solar light for all components of crop grown, 91.67 percent felt it increases the workload on farmers, and 90.00 percent of them felt there is an adverse competitive effect or allelopathy in the adoption of multilayer farming. Whereas 89.17 percent felt problems of weeding in multilayer farming, 88.33 percent felt pests can shift from one crop to another crop easily, and 86.67 percent of them felt survival of insect-pest is easy in multilayer farming. However, 85.83 percent of the sampled respondents faced the non-availability of suitable machinery for multilayer farming, 85.00 percent of them faced problems due to a lack of technically skilled farmers for multilayer farming, 81.67 percent felt sometime one activity may hinder the other activity, and 80.00 percent felt they need trained labor to maintain the adopted multilayer farming. And, the constraints like problems in the use of harvesting implements in multilayer farming, controlling and monitoring of different operations are more difficult and lack of training organized by the different institutions were felt to the extent of 79.17, 78.33, and 76.67 percent, respectively, as mentioned by the respondents.

Table 3: Constraints faced by farmers in the adoption of multilayer farming (n=120)

S. No.	Constraints	Severe (1)	%	Not Severe (0)	%
1	Problem of intercultural practices in multilayer farming	114	95.00	6	5.00
2	It is labor intensive	112	93.33	8	6.67
3	Not proper spread of solar light for all components of crop grown	111	92.50	9	7.50
4	It increases the workload on farmers	110	91.67	10	8.33
5	Problem of application of insecticides and pesticides in multilayer farming system	108	90.00	12	10.00
6	Adverse competitive effect or allelopathy	108	90.00	12	10.00
7	Problems of weeding in multilayer farming	107	89.17	13	10.83
8	Pest can shift from one crop to another crop easily	106	88.33	14	11.67
9	Survival of insect-pests easy	104	86.67	16	13.33
10	Non-availability of suitable machinery for multilayer farming	103	85.83	17	14.17
11	Lack of technical skilled farmers for multilayer farming	102	85.00	18	15.00
12	Sometime one activity may hinder the other activity	98	81.67	22	18.33
13	Need trained labor	96	80.00	24	20.00
14	Problem in use of harvesting implements in multilayer farming	95	79.17	25	20.83
15	Controlling and monitoring of different operations is more difficult	94	78.33	26	21.67
16	Lack of training organized by different institutions	92	76.67	28	23.33

Conclusion

In today's agricultural environment, when land utilization for farming is deteriorating more quickly, multilayer farming is a very successful strategy. Compared to existing techniques, multilayer farming seems to be more efficient. The present study has revealed an overall gap of about 18 percent between farmers' awareness and adoption level of multilayer farming which needs to be bridged. The awareness of the farmers varied across multilayer farming adoption. Awareness level was favourable with more than 70 percent level of awareness about multilayer farming, horticultural and vegetable crops can be grown simultaneously, helps to reduce expenses on manpower, about the crop grown in multilayer farming, about the plans to grow crops in multilayer farming. However, more effort is needed to increase the adoption level of farmers about the use of solar energy in agricultural operations, which is very low. The farming community needs to undergo extensive training in the principles and implementation of multilayer farming, given the correlation between awareness of this technique and adoption. The proper presentation and diffusion of technology, together with a shift in the mentality of rural youth and farmers, significantly boosts local economies and advances in agriculture. It is now necessary to spread these technologies so that they will be more widely adopted and have a greater positive impact on production and economic growth.

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