IOSR Journal Of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 18, Issue 5 Ser. 2 (May. 2025), Pp 11-21
www.Iosrjournals.Org

Farmers' Awareness And Adoption Level In Mixed Orchard Farming In Haryana

Sube Singh, P. S. Shehrawat, Balwan Singh Mandal And Rati Mukteshwar
Assistant Director (Extension Education), COA, CCSHAU, Hisar
Professor (Agricultural Extension Education), COA, CCSHAU, Hisar
Director Extension Education, CCS Haryana Agricultural University, Hisar
Assistant Professor (Agricultural Extension Education), COA, CCSHAU, Hisar

Date of Submission: 17-05-2025 Date of Acceptance: 27-05-2025

I. Introduction

Mixed orchard farming, also known as diversified fruit farming, involves cultivating multiple fruit species on the same land. In Haryana, this practice can increase income, reduce risk, and enhance the nutritional value of produce. It leverages the diverse agro-climatic conditions of the state, including its proximity to the National Capital Region (NCR) for marketing opportunities. The benefits of Mixed Orchard Farming in Haryana are:

Increased Income: Diversifying fruit production can lead to a more stable and higher income for farmers.
Risk Reduction: By not relying on a single fruit crop, farmers can mitigate the risk of market fluctuations, disease outbreaks, or pest infestations.
Improved Nutritional Security: Mixed orchards can contribute to better nutritional diversity for local consumers.
Enhanced Marketing Opportunities: The proximity of Haryana to the NCR offers excellent market access for various fruits, including mangoes, citrus fruits (like Kinnow), and other fruits.
Potential for Export: Some fruits, like mangoes and citrus, have export potential, particularly to the Far East.

Specific Examples of Mixed Orchards in Haryana:

- **Diversification beyond traditional crops:** Farmers are encouraged to diversify beyond traditional crops like wheat and paddy, incorporating a range of fruits.
- **Utilizing water resources effectively:** The Department of Horticulture, Haryana promotes water-saving techniques like micro-irrigation in orchards, which can increase productivity and reduce water consumption.
- **Focus on high-value crops:** The Department of Horticulture, Haryana also supports the cultivation of high-value crops like kinnow, which have proven profitable and have a good internal rate of return

The Government of Haryana support Government and Initiatives as under:

- **Subsidies and financial assistance by the government:** The Department of Horticulture, Haryana provides financial assistance and subsidies to farmers for orchard establishment and cultivation, including area expansion and the use of quality planting material.
- **Training and extension services:** The department offers training programs for farmers on various aspects of orchard management, including planting, pruning, pest and disease control, and post-harvest management.
- **Promotion of Farmer Producer Organizations (FPOs):** The government encourages the formation of FPOs to enable farmers to pool resources and access better marketing channels and technology.
- **Development of nurseries:** The Department of Horticulture, Haryana is actively involved in developing high-quality nurseries to provide farmers with true-to-type and healthy planting material.
- **Price protection scheme (BBY):** The Department of Horticulture, Haryana has implemented a price protection scheme to safeguard farmers from price fluctuations and encourage diversification.

Keeping the above facts in view the study was conducted to assess the Farmers' awareness and adoption level in Mixed Orchard Farming in Haryana.

II. Research Methodology

The study was conducted in Haryana state which comprises of 22 districts and out of these Hisar district was selected during the year 2023-24. From Hisar district, Barwala block was selected and four namely; Sarsod, Jewra, Rajli and Panghal villages from Barwala block of Hisar district were selected randomly for data collection. A total of 80 farmers were selected/interviewed (20 farmers from each village) through random sampling technique. Appropriate statistical measures like mean, frequency, percentage and rank orders were applied to draw meaningful inferences.

III. Results And Discussion

The results so obtained were interpreted in the following heads and subheads as under:

Table 1.1 Socio-Economic Profile of respondents **(n=80)**

Sr. No.	Variable	Category	Frequency	Percentage
1.	Age	Young (20-35 years)	25	31.25
		Middle (36-50 years)	46	57.50
		Old (above 50 years)	09	11.25
2.	Education	Primary	05	06.25
		Middle	07	08.75
		Matriculation	31	38.75
		Higher secondary	21	26.25
		Graduate	10	12.50
		Postgraduate	06	07.50
3.	Caste	General Caste	50	62.50
		Other backward class (OBC)	22	27.50
		Scheduled Caste (SC)	08	10.00
4.	Landholding	Marginal farmers (< 2.5acres)	21	26.25
		Small farmers (>2.5 – 5 acres)	32	40.00
		Medium farmers (>5 - 10 acres)	23	28.75
		Big farmers (>10 acres)	04	05.00
5.	Irrigation sources*	Water Tank	03	03.75
		Tube well /submersible pump	46	57.50
		Canal	64	80.00
		Both (Tube well and Canal)	44	55.00
6.	Farming system*	Livestock	65	81.25
		Poultry	02	02.50
		Fishery	01	01.25
		Beekeeping	02	02.50
		Organic farming	09	11.25
		Mushroom cultivation	01	01.25
		Floriculture	00	00.00
		Poly house vegetable production	05	06.25
7.	Crop rotation*	Rice-Wheat	43	53.75
		Cotton-wheat	64	80.00
		Pearl Millet/Guar/Green Gram- Mustard	46	57.50

**** Multiple responses***

Age: The data presented in table 1 indicates that more than half (57.55%) of respondents belong to middle age group followed by young age group (31.25%) and old age group (11.25%) i.e., above 50 years of age.

Education: As for as education level of respondents is concerned, the data presented in table 1 predict that 38.75 per cent of respondents were educated up to matric while 26.25 per cent respondents were having educational qualifications upto higher secondary followed by 12.50 per cent of respondent farmers were having educational qualification of graduation level and 07.50 percent were having post graduate educational qualifications. Only 08.75 per cent of respondents having middle class education and remaining 6.25 per cent of them were having education upto primary school (5^{th} class).

Caste: The data pertaining to caste distribution of respondent presented in table 1 indicates that about one-third (62.50%) of respondents belongs to general caste followed by other backward class (27.50%) and scheduled caste (10.00%).

Land holding: The data about land holding of the respondents presented in table 1 predict that 40.00 per cent of respondents belong to small farmer category (>2.5-5.0 acres) followed by 28.75 per cent of farmers having medium farmer category (>5.0-10.0 cares) and just more than one-fourth (26.25%) of farmers having marginal land holding category (<2.5 acres). Only 05.00 per cent of respondents were large farmers having land holding (> 10.00 acres).

Irrigation Sources: The data presented in table 1 also indicates that a majority (80.00%) of the respondents having canal as a source of irrigation, whereas 57.50 per cent farmers had tube well as source of irrigation and just more than half (55.00%) of respondents had both the sources of irrigation i.e., canal and tube well.

Farming System: The data in table 1.1 reveals that a majority (81.25%) of respondents were doing livestock practices in their farming system followed by organic farming (11.25%), poly house vegetable production (6.25%). A very few percentages of respondents (2.50%) had farming systems of poultry followed by fishery, beekeeping and mushroom cultivation to the extent of 1.25 per cent, respectively, farming system at their fields.

Crop Rotation: The data presented in table 1 also indicates that majority (80.00%) farmers have adopted cotton-wheat crop rotation followed by pearl millet/guar/green gram-mustard (57.50%) and rice-wheat crop rotations to the extent of 53.75 per cent.

Table 2: Possession of Farm Machinery **(n=80)**

Sr. No.	Name of Farm Machinery	Frequency	Percentage
1.	Tractor	58	72.50
2.	Harrow	54	67.50
3.	Rotavator	46	57.50
4.	MB Plough	16	20.00
5.	Seed-cum-fertilizer drill	39	48.75
6.	Laser land leveler	03	03.75
7.	Straw reaper	18	22.50
8.	Multi crop thresher	34	42.50

It is apparent from table 2 that 72.50 per cent of respondents possessed tractor at their farm among other farm machineries and 67.50 per cent of respondents had harrow followed by rotavator (57.50%), seed-cum-fertilizer drill (48.75%), multi crop thresher (42.50%), straw reaper (22.50%), MB plough (20.00%) and a very less number of respondents (03.75%) were having Laser Land Leveler at their farm.

Table 3: Extension Contact of the respondents **(n=80)**

Sr. No.	Extension Contact	Frequency of Contact					Cumulative Score	Weighted Mean Score	Rank
		Weekly (4)	Fort nightly (3)	Monthly (2)	Whenever needed (1)	None (0)			
1.	Progressive farmer	25	23	13	17	02	212	2.65	**I**
2.	Private agencies (input dealers/ sales rep. etc.)	24	24	11	16	02	206	2.47	**II**
3.	ADOs/HDOs	14	22	12	23	09	169	2.11	**III**
4.	SDAO/SMS/ DHO	04	09	23	30	14	119	1.49	**IV**
5.	Scientists (KVK/Univ.)	04	09	23	26	18	115	1.44	**V**

The data in table 3 revealed that among the extension contact of the farmers, the most popular were the progressive farmers with weighted mean score of 2.65 followed by private agencies (input dealers/sales representative etc.) with weighted mean score of 2.47. The extension contacts with ADOs/HDOs; SDAO/SMS and DHOs and Scientists of KVK/University with weighted mean scores of 2.11, 1.49 & 1.44 which ranked third, fourth and fifth, respectively.

Table 4: Mass Media Exposure of the respondents **(n=80)**

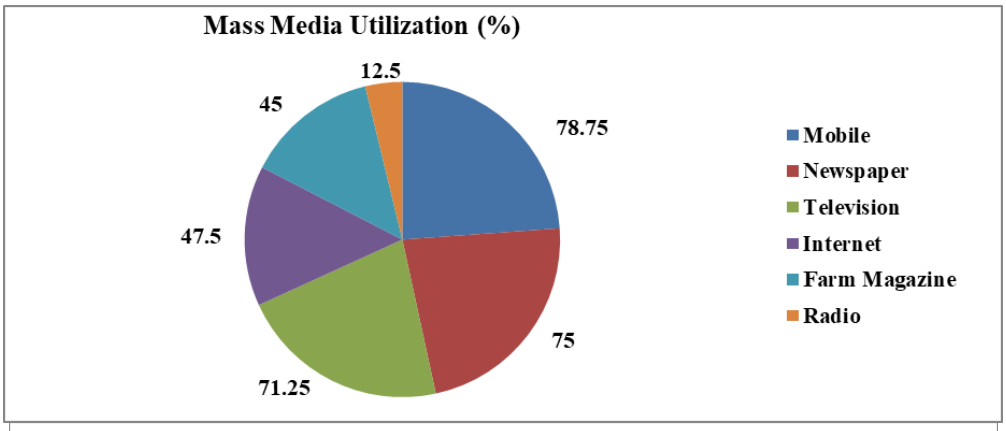
Sr. No.	Means of Mass Media	Used		Rank order
		Frequency	Percentage	
1.	Mobile	63	78.75	**I**
2.	Newspaper	60	75.00	**II**
3.	Television	57	71.25	**III**

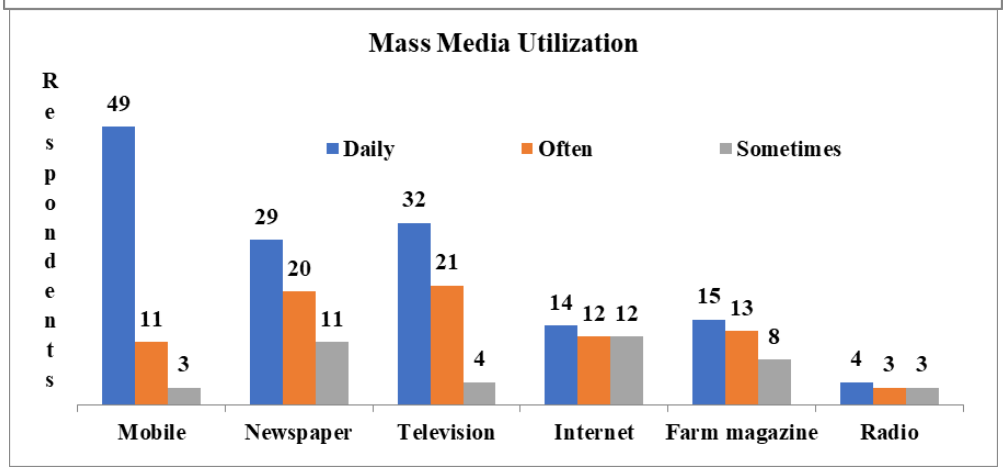
4.	Internet	38	47.50	**IV**
5.	Farm Magazine	36	45.00	**V**
6.	Radio	10	12.50	**VI**

The data in table 4 revealed that in case of mass media exposure it can be imagine that a more than third-fourth (78.78%) of the respondent assessed to mobile phone which ranked first and newspaper as a source of mass media (75.00%) which ranked second followed by Television (71.25%) which ranked third. The respondents were using Internet (47.50%), farm magazine (45.00%) as mass media and only 12.50 per cent of respondents were availing radio as mass media which ranked fourth, fifth and sixth, respectively as depicted an table 5.

Table 5: Extent of utilization of Mass Media by the farmers (n=80)

Sr. No.	Source of Mass Media	Extent of utilization			Cumulative Score	Weighted Mean Score	Rank
		Daily (3)	Often (2)	Sometimes (1)			
1	Mobile	49	11	3	172	2.15	**I**
2	Newspaper	29	20	11	138	1.73	**III**
3	Television	32	21	4	142	1.78	**II**
4	Internet	14	12	12	79	0.99	**IV**
5	Farm magazine	15	13	8	78	0.98	**V**
6	Radio	4	3	3	21	0.26	**VI**





The data presented in table 5 also reveal the extent of mass media utilization. Thus, mobile ranked first with weighted mean score of 2.15 followed by reading newspaper (WMS=1.78) ranked second, viewing television (WMS=1.73), internet (WMS=0.99) reading farm magazine (WMS=0.98), and radio (WMS=0.26) which ranked third, fourth, fifth and sixth, respectively.

Table 6: Awareness level of farmers about mix orchard farming in Haryana (n=80)

Sr. No.	Statements	Degree of Awareness			
		Aware	%age	Not Aware	%age
Cultivation Practices:					

1.	Mixed orchard farming involves cultivating multiple types of fruit trees in the same orchard.	65	81.25	15	18.75
2.	Mixing different fruit trees in an orchard can help improve soil fertility.	63	78.75	17	21.25
3.	Diversity in a mixed orchard can improve the resilience of the orchard to climate change.	64	80.00	16	20.00
4.	Interplanting compatible fruit trees can enhance the growth and yield of each other.	62	77.50	18	22.50
5.	Crop rotation is an important practice in mixed orchard farming.	65	81.25	15	18.75
6.	Proper irrigation management is crucial for the success of mixed orchard farming.	64	80.00	16	20.00
7.	Proper spacing between trees is important in mixed orchard farming.	62	77.50	18	22.50
8.	Mixed orchard farming requires regular pruning to maintain tree health and productivity.	64	80.00	16	20.00
9.	Careful selection of fruit tree varieties is required to ensure compatibility and complementary growth habits.	62	77.50	18	22.50
10.	Companion planting can be beneficial in mixed orchards.	61	76.25	19	23.75
	Pest and Disease Management:				
1.	Mixed orchards can provide better pest and disease management compared to monoculture orchards.	58	72.50	22	27.50
2.	Integrated pest management is often more feasible in mixed orchards compared to monoculture orchards.	56	70.00	24	30.00
3.	Mixed orchard farming requires regular monitoring and management of pests and diseases.	56	70.00	24	30.00
4.	Mixed orchards can promote natural pest control by attracting beneficial insects.	52	65.00	28	35.00
5.	Mixed orchards require less chemical inputs compared to monoculture orchards.	54	67.50	26	32.50
	Productivity and Harvest:				
1.	Mixed orchards can provide a variety of fruits for both personal consumption and sale.	56	70.00	24	30.00
2.	Mixed orchards can provide a continuous harvest over a longer period compared to monoculture orchards.	58	72.50	22	27.50
3.	Mixed orchards can increase farm income by diversifying product offerings.	57	71.30	23	28.70
4.	Mixed orchards can provide opportunities for value addition through processing of different fruits.	56	70.00	24	30.00
5.	Mixed orchard farming can help reduce the risk of crop failure compared to monoculture orchards.	54	67.50	26	32.50
6.	Mixed orchards can provide a more stable income compared to monoculture orchards.	52	65.00	28	35.00
7.	Mixed orchards can help reduce the risk of market fluctuations affecting a single crop.	54	67.50	26	32.50
	Environmental Benefits:				
1.	Mixed orchard farming can promote biodiversity by providing habitats for various species.	55	68.75	25	31.25
2.	Mixed orchards can help reduce soil erosion.	52	65.00	28	35.00
3.	Agro forestry practices can be integrated into mixed orchard farming systems.	52	65.00	28	35.00
4.	Mixed orchard farming can help reduce greenhouse gas emissions through carbon sequestration.	50	62.50	30	37.50
5.	Mixed orchards can improve water use efficiency compared to monoculture orchards.	58	72.50	22	27.50
6.	Mixed orchards can provide a habitat for pollinators, benefiting both the orchard and surrounding ecosystem.	52	65.00	28	35.00
7.	Mixed orchards can help reduce the use of synthetic fertilizers.	48	60.00	42	52.50
8.	Mixed orchards can provide a more resilient farming system in the face of changing climatic conditions.	52	65.00	28	35.00
9.	Mixed orchard farming can help in the conservation of indigenous fruit tree species.	50	62.50	30	37.50
10.	Mixed orchard farming can contribute to food security and nutrition.	54	67.50	26	32.50
	Knowledge and Management:				
1.	Mixed orchard farming requires different management practices compared to monoculture orchards.	56	70.00	24	30.00
2.	Proper planning is essential for successful mixed orchard farming.	58	72.50	22	27.50
3.	Mixed orchard farming requires knowledge of different fruit tree species and their requirements.	56	70.00	24	30.00
4.	Practicing mixed orchard farming need to have a good understanding of market demand for various fruits.	52	65.00	28	35.00
5.	Practicing mixed orchard farming need to have knowledge of fruit tree pruning techniques.	56	70.00	24	30.00

6.	Practicing mixed orchard farming should be aware of the nutritional requirements of different fruit trees.	58	72.50	22	27.50
7.	Practicing mixed orchard farming should be aware of the water requirements of different fruit trees.	56	70.00	24	30.00
8.	Mixed orchard farming requires a good understanding of the nutritional needs of different fruit trees at various growth stages.	52	65.00	28	35.00
9.	Mixed orchard farming can help reduce the reliance on external inputs such as pesticides and fertilizers.	54	67.50	26	32.50
Mean Awareness level of respondents		**56.10**	**70.12**	**23.90**	**29.88**

It is evident from the data presented in the table 6 the awareness level of farmers regarding mixed orchard farming is notably high, with an overall awareness of 70.12%. This indicates that the majority of farmers surveyed are knowledgeable about various aspects of mixed orchard farming.

Farmers exhibit strong awareness regarding the fundamental practices of mixed orchard farming. The statements related to cultivation practices received high awareness scores, ranging from 61 to 65 farmers being aware. Specifically, statements such as "Mixed orchard farming involves cultivating multiple types of fruit trees in the same orchard" and "Crop rotation is important practice in mixed orchard farming" had the highest awareness levels (65 farmers each). This suggests that the basic principles of mixed orchard farming are well understood among the farmers. The slightly lower awareness regarding "Companion planting can be beneficial in mixed orchards" (61 farmers) indicates a need for further education on this specific practice.

The awareness of pest and disease management in mixed orchards is somewhat lower compared to cultivation practices, with awareness scores ranging from 52 to 58. Notably, "Mixed orchards can provide better pest and disease management compared to monoculture orchards" had 58 farmers aware, indicating recognition of the benefits of mixed orchards in managing pests and diseases. However, there is room for improvement in awareness about the benefits of natural pest control and reduced chemical inputs, as these statements had lower awareness levels (52 and 54 farmers, respectively). This highlights a potential area for targeted educational initiatives.

Farmers' awareness of the productivity and harvest benefits of mixed orchard farming is fairly high, with scores ranging from 52 to 58. The statement "Mixed orchards can provide a continuous harvest over a longer period compared to monoculture orchards" was particularly well-known (58 farmers), reflecting an understanding of the extended harvest benefits. However, the awareness of mixed orchards providing a stable income and reducing market fluctuation risks was slightly lower (52 to 54 farmers), suggesting that these economic advantages could be better communicated to farmers.

Awareness regarding the environmental benefits of mixed orchard farming is moderate, with scores between 48 and 58. Farmers are most aware that mixed orchards can improve water use efficiency (58 farmers) and promote biodiversity (55 farmers). However, awareness of the potential for mixed orchards to reduce synthetic fertilizer use and greenhouse gas emissions is lower (48 and 50 farmers, respectively). These findings indicate that while some environmental benefits are well-recognized, others, particularly those related to broader ecological impacts, need greater emphasis in farmer education programs.

Farmers demonstrate a good understanding of the knowledge and management requirements for mixed orchard farming, with awareness levels ranging from 52 to 58. High awareness scores for statements like "Proper planning is essential for successful mixed orchard farming" (58 farmers) and "Practicing mixed orchard farming should be aware of the nutritional requirements of different fruit trees" (58 farmers) show that farmers recognize the importance of thorough planning and species-specific knowledge. However, the need for understanding market demands and nutritional needs at various growth stages had slightly lower awareness (52 farmers), indicating areas where additional training and support may be beneficial.

The overall mean awareness score calculated was 56.10. This high level of awareness (70.12%) indicates a solid foundation of knowledge among the farmers surveyed, though there are specific areas where further education and support could enhance their understanding and adoption of mixed orchard farming practices.

Table 7: Adoption level of farmers about different practices of Mix Orchard farming (n=80)

Sr. No.	Statements	Adoption level			
		Adopted	**%age**	**Not Adopted**	**%age**
Agro ecological Practices:					
1.	I have established a diverse range of fruit tree species in my orchard.	15	18.75	65	81.25
2.	I have integrated fruit trees with other crops or livestock in my orchard.	33	41.25	47	58.75
3.	I practice agro forestry systems such as alley cropping or silvopasture in my orchard.	24	30.00	56	70.00
4.	I have incorporated fruit trees with timber or fuel wood	15	18.75	65	81.25

	species.				
5.	I have integrated fruit trees with aquaculture or fish farming.	5	06.25	75	93.75
6.	I have integrated fruit trees with medicinal or aromatic plants.	24	30.00	56	70.00
7.	I use crop rotation or diversification techniques in my orchard.	22	27.50	58	72.50
8.	I practice natural or organic methods for weed control in my orchard.	24	30.00	56	70.00
9.	I use companion planting techniques in my orchard.	22	27.50	58	72.50
10.	I have implemented measures to promote beneficial insects and birds in my orchard.	29	36.25	51	63.75
11.	I have established windbreaks using diverse tree species in my orchard.	28	35.00	52	65.00
12.	I have implemented measures to conserve and enhance natural habitats within my orchard.	16	20.00	64	80.00
13.	I use green manure or cover crops to improve soil fertility in my orchard.	46	57.50	34	42.50
14.	I use biological indicators to assess soil health in my orchard.	22	27.50	58	72.50
15.	I have implemented measures to reduce soil compaction in my orchard.	24	30.00	56	70.00
16.	I use native or drought-tolerant fruit tree species in my orchard.	36	45.00	44	55.00
17.	I have implemented measures to improve the water holding capacity of soils in my orchard.	46	57.50	34	42.50
18.	I use natural predators for pest control in my orchard.	34	42.50	46	57.50
Resource Management and Efficiency:					
1.	I have adopted measures to enhance soil structure and water retention in my orchard.	46	57.50	34	42.50
2.	I use local or indigenous knowledge in managing my mixed orchard.	38	47.50	42	52.50
3.	I use livestock grazing or manure application to improve soil fertility in my orchard.	37	46.25	43	53.75
4.	I use renewable energy sources (e.g., solar) in my orchard.	36	45.00	44	55.00
5.	I have adopted measures to reduce erosion from wind in my orchard.	24	30.00	56	70.00
6.	I have adopted measures to improve the carbon sequestration potential of my orchard.	32	40.00	48	60.00
7.	I have implemented measures to reduce the use of synthetic fertilizers in my orchard.	14	17.50	66	82.50
8.	I have adopted practices to enhance the resilience of my orchard to climate change.	36	45.00	44	55.00
9.	Drip irrigation or other efficient irrigation systems are used in my orchard.	48	60.00	32	40.00
10.	I use agrochemicals only as a last resort in managing pests and diseases in my orchard.	46	57.50	34	42.50
Community Engagement and Knowledge Sharing:					
1.	I use participatory approaches involving community members in orchard management decisions.	36	45.00	44	55.00
2.	I use participatory monitoring and evaluation approaches for assessing the performance of my orchard.	38	47.50	42	52.50
3.	I actively participate in knowledge-sharing and training programs related to orchard farming.	46	57.50	34	42.50
4.	I participate in certification programs for sustainable orchard management.	22	27.50	58	72.50
Technology and Innovation:					
1.	I use digital technologies for orchard management (e.g., farm management apps, sensors).	32	40.00	48	60.00
2.	I use mobile applications for market information and price forecasting.	34	42.50	46	57.50
3.	I have adopted modern technologies for harvesting and post-harvest management.	36	45.00	44	55.00
4.	I use precision agriculture techniques in my orchard for efficient resource utilization.	38	47.50	42	52.50
5.	I use precision planting techniques for optimal spacing and arrangement of trees	46	57.50	34	42.50
Post-Harvest and Quality Management:					
1.	I have adopted measures to reduce post-harvest losses in my orchard.	46	57.50	34	42.50
2.	I have implemented proper record-keeping and documentation for my orchard operations.	42	52.50	38	47.50
3.	I use trained or skilled labour for orchard management tasks.	36	45.00	44	55.00
4.	I have diversified my orchard crops to improve resilience and income.	22	27.50	58	72.50

5.	I have implemented proper pruning and training techniques for my orchard trees.	36	45.00	44	55.00
6.	I have adopted measures to improve the quality and shelf life of my orchard produce.	48	60.00	32	40.00
Mean Adoption level		**32.09**	**40.12**	**40.11**	**50.15**

The data presented in the table 7 provides insights into the adoption level of farmers regarding agro-ecological practices, resource management, community engagement and knowledge sharing, technology and innovation, and post-harvest and quality management in mixed orchard farming. The discussion of these findings can help understand the current practices and areas where improvement or support may be needed to enhance sustainable orchard management.

From the data, it is evident that the adoption levels vary across different agro ecological practices. Practices such as using green manure or cover crops to improve soil fertility and using native or drought-tolerant fruit tree species have higher adoption rates, with 46% and 36% adoption, respectively. However, practices like integrating fruit trees with aquaculture or fish farming and windbreak establishment have lower adoption rates, with only 5% and 28% adoption, respectively. This indicates a need for more promotion and awareness programs to encourage farmers to adopt these practices, which can contribute to sustainable orchard management.

In terms of resource management and efficiency, farmers have shown good adoption of measures such as enhancing soil structure and water retention (46% adoption) and using renewable energy sources (36% adoption). However, there is a need for more adoption of practices like reducing erosion from wind (24% adoption) and using agrochemicals only as a last resort (46% adoption). These practices are crucial for improving soil health, reducing environmental impact, and enhancing the sustainability of orchard farming.

The data indicates moderate adoption levels in community engagement and knowledge sharing practices. Farmers (36%) use participatory approaches involving community members in orchard management decisions, and 46 per cent actively participate in knowledge-sharing and training programs. However, there is a need for more adoption of participatory monitoring and evaluation approaches (38% adoption) and certification programs for sustainable orchard management (22% adoption). Strengthening these practices can enhance collaboration among farmers and improve the dissemination of best practices in orchard farming.

Farmers have shown moderate adoption levels in technology and innovation practices. For example, 32% of farmers use digital technologies for orchard management, and 34% use mobile applications for market information. However, there is potential for further adoption of modern technologies for harvesting and post-harvest management (36% adoption) and precision agriculture techniques (38% adoption). These technologies can help improve efficiency, reduce resource use, and increase productivity in orchard farming.

Farmers have shown good adoption of measures to reduce post-harvest losses (46% adoption) and improve the quality and shelf life of orchard produce (48% adoption). However, there is a need for more adoption of proper record-keeping and documentation practices (42% adoption) and diversified orchard crops (22% adoption). These practices are essential for ensuring food safety, traceability, and market access for orchard farmers.

The mean adoption level score of farmers for mixed orchard farming is 40.12%, indicating a moderate adoption level. This suggests that while farmers have adopted certain practices, there is still scope for improvement and adoption of more sustainable practices in various aspects of mixed orchard farming.

Table 8: Strategic measures adopted by respondents about mix orchard farming (n=80)

Sr. No.	Statements	Strategies			
		Agree	**%age**	**Disagree**	**%age**
1.	Integrated Pest Management (IPM) practices to control pests and diseases in orchard.	48	60.00	32	40.00
2.	Crop rotation to improve soil health and prevent pest build-up.	44	55.00	36	45.00
3.	Cover cropping to improve soil fertility and prevent erosion.	36	45.00	44	55.00
4.	Agroforestry techniques (Alley cropping or Silvopasture) to enhance biodiversity and productivity.	32	40.00	48	60.00
5.	Organic farming practices to reduce chemical inputs and promote soil health.	44	55.00	36	45.00
6.	Water conservation techniques such as drip irrigation or rainwater harvesting.	48	60.00	32	40.00
7.	Renewable energy sources, such as solar power, for orchard operations.	46	57.50	34	42.50
8.	Community-Supported Agriculture (CSA) or direct marketing to enhance market access and farm income.	48	60.00	32	40.00
9.	Farmer cooperatives or associations for collective marketing and resource sharing.	52	65.00	28	35.00

10.	Climate-Smart agriculture practices to mitigate and adapt to climate change.	54	67.50	26	32.50
11.	Precision agriculture technologies to optimize inputs and improve efficiency.	48	60.00	32	40.00
12.	Diversify orchard crops to spread risk and maximize returns.	54	67.50	26	32.50
13.	Soil conservation measures such as contour ploughing or terracing.	54	67.50	26	32.50
14.	Integrated Nutrient Management to ensure balanced soil fertility.	50	62.50	30	37.50
15.	Agroecological principles to enhance ecosystem services and farm sustainability.	54	67.50	26	32.50
Strategic measures adopted by the respondents (%)		**47.47**	**59.34**	**32.53**	**40.66**

The analysis of farmers' strategic measures in mixed orchard management reveals significant insights into the adoption of various sustainable agricultural practices. The data presented in the table 8 reflects the preferences and priorities of farmers in enhancing productivity and sustainability in their orchards. With 48 farmers agreeing to the adoption of IPM practices and 32 disagreeing, it is evident that a majority recognize the importance of IPM in controlling pests and diseases. However, there is still a considerable proportion that does not employ these practices, indicating a need for further education and support to increase adoption. Similar to IPM, crop rotation practices are adopted by 44 farmers, while 36 do not employ this strategy. The close ratio suggests that while crop rotation is appreciated for its benefits in soil health and pest prevention, barriers to its adoption still exist, such as a lack of knowledge or resources. A smaller number of farmers (36) agree with using cover crops to improve soil fertility and prevent erosion, compared to 44 who disagree. This indicates a lower adoption rate for cover cropping, possibly due to limited awareness or perceived complexity in implementation.

The adoption of agroforestry techniques, such as alley cropping or silvopasture, is relatively low, with 32 farmers agree and 48 disagree. This suggests a significant gap in the adoption of agroforestry, highlighting the need for increased awareness and demonstration of its benefits in enhancing biodiversity and productivity. Organic farming practices are adopted by 44 farmers, while 36 do not use these methods. This split demonstrates a growing interest in reducing chemical inputs and promoting soil health, yet challenges remain in fully embracing organic methods. With 48 farmers agreeing to use water conservation techniques like drip irrigation or rainwater harvesting and 32 disagreeing, it is clear that water conservation is a priority for many farmers. However, the adoption rate could be improved with better access to technology and resources.

The use of renewable energy, such as solar power, is supported by 46 farmers, while 34 do not employ these sources. This shows a positive trend towards sustainable energy in orchard operations, but further incentives and support may be needed to increase adoption. CSA and direct marketing strategies are adopted by 48 farmers, with 32 disagree. This reflects recognition of the benefits of enhancing market access and farm income through community-supported models. Farmer cooperatives for collective marketing and resource sharing have the highest adoption rate, with 52 agreeing and 28 disagreeing. This indicates strong support for cooperative approaches to enhance market presence and efficiency.

Climate-smart practices are agreed upon by 54 farmers and 26 farmers were disagreeing. This highlights a proactive approach among farmers to mitigate and adapt to climate change, showing an understanding of the long-term benefits of such practices. Precision agriculture technologies are adopted by 48 farmers and 32 farmers not using these methods. This adoption rate suggests a growing interest in optimizing inputs and improving efficiency, although further education and resources are needed. Diversification to spread risk and maximize returns is agreed upon by 54 farmers and 26 farmers disagree. This shows a strategic approach by many farmers to enhance resilience and profitability through crop diversification.

Soil conservation measures like contour ploughing or terracing are also highly adopted, with 54 agreeing and 26 disagreeing. This reflects a strong understanding of the importance of soil conservation for long-term productivity. Integrated nutrient management practices are supported by 50 farmers, with 30 disagreeing. This indicates recognition of the need for balanced soil fertility management, though there is still room for increased adoption. Agro-ecological principles are adopted by 54 farmers, with 26 disagreeing, showing strong support for enhancing ecosystem services and farm sustainability through ecological approaches.

The mean score of strategic measures adopted by respondents, with a mean score of 47.47 for adoption and 32.53 for non-adoption. The overall percentage of strategic measures adopted by respondents is 59.33%, compared to 40.67% for non-adoption. This indicates a majority of farmers are adopting sustainable practices, but there is still significant potential for increasing the adoption rates of these strategies. Efforts should focus on providing education, resources, and support to address the barriers preventing the widespread implementation of these sustainable practices in orchard management.

Table 9: Constraints faced by Farmers' in Mix Orchard Farming in Haryana (n=80)

Sr. No.	Statements	Constraints			
		Agree	%age	Disagree	%age
1.	Lack of access to reliable water sources for irrigation.	58	72.50	22	27.50
2.	Limited availability of suitable land for orchard expansion.	65	81.25	15	18.75
3.	High cost of inputs such as fertilizers and pesticides.	62	77.50	18	22.50
4.	Lack of access to affordable credit for orchard investments.	58	72.50	22	27.50
5.	Unpredictable weather patterns affecting orchard productivity.	62	77.50	18	22.50
6.	Pest and disease pressure impacting orchard health.	58	72.50	22	27.50
7.	Labour shortages during critical orchard management activities.	64	80.00	16	20.00
8.	Limited market access and price fluctuations for orchard produce.	58	72.50	22	27.50
9.	Lack of technical knowledge and extension services for orchard management.	64	80.00	16	20.00
10.	Insufficient infrastructure for post-harvest handling and storage.	62	77.50	18	22.50
11.	Competition from larger orchard operations affecting market share.	54	67.50	26	32.50
12.	Inadequate access to information and technologies for orchard management.	56	70.00	24	30.00
13.	Inadequate access to reliable and affordable farm equipment and machinery for orchard operations.	62	77.50	18	22.50
14.	Limited availability of suitable fruit tree varieties for diverse orchard systems.	52	65.00	28	35.00
15.	Difficulty in accessing skilled labour for specialized orchard tasks.	54	67.50	26	32.50
16.	Lack of support for sustainable and environmentally friendly orchard practices.	52	65.00	28	35.00
17.	Challenges in integrating fruit trees with other crops or livestock effectively.	48	60.00	32	40.00
18.	Social and cultural factors influencing orchard management decisions.	48	60.00	32	40.00
19.	Lack of infrastructure for value addition and processing of orchard produce.	54	67.50	26	32.50
20.	Issues related to land tenure and ownership affecting orchard management decisions.	50	62.50	30	37.50
Mean constraints score in mix orchard farming		57.05	**71.31**	22.95	**28.69**

The data presented in the table 9 provides valuable insights into the constraints faced by farmers engaged in mixed orchard farming. The analysis reveals that a significant majority of the farmers (71.31%) agree that they encounter various constraints in their orchard farming activities, while a smaller portion (28.69%) disagrees.

A substantial 58 out of 80 respondents (72.50%) agree that unreliable water sources are a significant constraint. This underscores the critical need for improved irrigation infrastructure and water management practices to support orchard productivity. The constraint of land availability is affirmed by 65 respondents (81.25%), highlighting the challenge of finding and utilizing appropriate land for expanding orchard operations. This suggests a potential need for land-use policy reforms and strategic land allocation to support orchard expansion. The high cost of inputs is a concern for 62 respondents (77.50%). This point to the need for measures to reduce input costs, such as subsidies, bulk purchasing programs, or the promotion of organic farming practices that reduce reliance on chemical inputs. Financial constraints are significant, with 58 respondents (72.50%) agreeing that affordable credit is not readily accessible. This suggests a need for targeted financial services and credit schemes to support orchard investments. Weather-related challenges are a concern for 62 respondents (77.50%), indicating the importance of developing climate-resilient farming practices and enhancing access to weather forecasting services.

Pest and disease issues are noted by 58 respondents (72.50%). This emphasizes the need for effective pest and disease management strategies, including integrated pest management (IPM) and access to quality pest control products. Labor shortages are highlighted by 64 respondents (80.00%), indicating a critical need for addressing labor availability through training programs, mechanization, and labor-saving technologies. Market access and price stability concerns are noted by 58 respondents (72.50%). These points to the necessity for improved market linkages, cooperative marketing strategies, and price stabilization mechanisms. A lack of technical knowledge and extension services is reported by 64 respondents (80.00%), suggesting a need for enhanced agricultural extension services and farmer training programs focused on orchard management. Post-harvest infrastructure issues are a concern for 62 respondents (77.50%), highlighting the need for investments in storage facilities, processing units, and transportation infrastructure to reduce post-harvest losses.

Competition from larger operations is noted by 54 respondents (67.50%), indicating the need for policies that support small and medium-sized orchard enterprises to remain competitive. Information and technology access issues are reported by 56 respondents (70.00%), underscoring the importance of improving

access to modern technologies and information dissemination. Equipment and machinery access issues are a concern for 62 respondents (77.50%), suggesting the need for more affordable and reliable farm machinery solutions. Variety availability is noted by 52 respondents (65.00%), indicating a need for breeding programs and nurseries to provide diverse and suitable fruit tree varieties. Skilled labor access issues are reported by 54 respondents (67.50%), emphasizing the need for specialized training programs to develop a skilled workforce for orchard management. Support for sustainable practices is a concern for 52 respondents (65.00%), highlighting the need for policies and incentives that promote environmentally friendly orchard management. Integration challenges are noted by 48 respondents (60.00%), suggesting a need for research and extension services to develop effective integrated farming systems. Social and cultural factors are reported by 48 respondents (60%), indicating the importance of considering these factors in extension programs and policy-making. Value addition infrastructure issues are noted by 54 respondents (67.50%), highlighting the need for investments in processing facilities and value chain development. Land tenure and ownership issues are a concern for 50 respondents (62.50%), suggesting the need for clear land policies and secure land tenure arrangements.

Overall, the mean constraints score of 57.05 for agreement and 22.95 for disagreement, with an overall agreement percentage of 71.31%, clearly indicates that the majority of farmers face significant constraints in mixed orchard farming. Addressing these constraints through targeted interventions and supportive policies is crucial for enhancing the productivity and sustainability of orchard farming systems.

IV. Conclusion

It is concluded that farmers exhibit a high level of awareness regarding many aspects of mixed orchard farming, targeted educational programs focusing on less understood areas such as environmental benefits and detailed pest management strategies could further enhance their knowledge and adoption of these sustainable agricultural practices. The data also highlighted the current adoption levels of farmers in different aspects of mixed orchard farming and underscores the need for targeted interventions, training, and extension services to enhance sustainable orchard management practices. Collaboration between farmers, researchers, and extension services can play a crucial role in promoting sustainable practices and improving the overall productivity and resilience of mixed orchards. Additionally, challenges related to technical knowledge, infrastructure, competition, and sustainable practices are prevalent. Addressing these constraints through targeted interventions, improved infrastructure, financial support, and enhanced extension services is crucial for the sustainable development and productivity of mixed orchard farming systems.