Original Research Article

Farmers' awareness and adoption level of farmers about millet production in Haryana

Abstract

Despite growing awareness and efforts to promote millet cultivation, the millet remains underutilized due to limited specific awareness and adoption about millets. and their benefits and efforts to promote research, improve market access, and raise awareness. Hence there is a need to promote research, improve market access, and create awareness about the benefits and efforts of millet production. The aim of the study is to evaluate the farmers' farmer's awareness level about millet production, assess the farmers' farmer's adoption level of millet production and find out the constraints encountered by farmers in millet production. The investigation was carried out in the districts of Hisar and Mahendergarh within the state of in Haryana, India. Four villages were chosen randomly and a random sampling technique was employed to choose 30 farmers from each of the selected villages. The statistical tools such as the mean, frequency, percentage, and rank order, were used to draw meaningful conclusions for analysis of the data. The data pertaining to socio-personal attributes indicated that 52.50 per cent of respondents belong to the middle age group followed by old age group and young age group. A vast Majority of farmers have adopted pearl millet/guar/green gram-mustard crop rotation followed by cotton-wheat, guar-wheat and pearl millet/guar/green gram-wheat crop rotations. The findings concluded that farmers possess a moderate level of awareness about millet production, with a significant percentage of respondents being familiar with different types of millets, associated challenges and benefits of improved varieties.

Introduction:

Millets, a group of small seeded grasses, have been cultivated for thousands of years and are increasingly recognized for their potential to contribute to sustainable agriculture. Their resilience to harsh environmental conditions, nutritional richness, and low resource requirements makes made them ideal candidates crops for sustainable farming practices. Millets are highly adaptable to diverse climatic conditions, including drought and poor soil fertility which making makes them suitable for cultivation in semi-arid and rain fed regions (Singh *et al.*, 2024) (Jyrwa *et al.*, 2024) (Raut *et al.*, 2023). When compared to staple crops like rice and wheat, millet require requires significantly less water and fertilizers, reducing the environmental impact of their cultivation (Vidhya *et al.*, 2023). Millet cultivation promotes biodiversity and enhances soil fertility. Their deep root systems improve soil structure and reduce erosion, contributing to healthier ecosystems (Choudhary *et al.*, 2023). Also, millets are rich in essential nutrients, including proteins, dietary fiber, vitamins, and minerals such as iron, calcium, and zinc. So this makes them a an ideal food source for combating malnutrition and hidden hunger (Chaudhary *et al.*, 2024). Millet cultivation can provide diversified income sources for

smallholder smallscale farmers, particularly in rural and marginalized communities marginal farmers. This can lead to economic empowerment and improved livelihoods of the farming community. With increasing awareness of their benefits, there is a growing market for millet-based products. This trend can drive economic growth and support sustainable agricultural practices (Karli *et al.*, 2024) (Srikanth, 2023). Innovations in millet breeding, processing technologies, and climate smart agricultural practices present opportunities to enhance their role in sustainable agriculture (Raut *et al.*, 2023). The awareness level of farmers in Haryana regarding the benefits of millets cultivation is influenced by the various factors, including government initiatives, climate resilience practices, energy use patterns etc. While the International Year of Millets in 2023 aims to boost awareness and consumption, and specific studies on millets indicate varying level of awareness (Mani *et al.*, 2024). In Haryana, Pearl Millet is a significant crop, and studies on its energy use patterns showed that it is produced using various energy sources, especially fertilizer application is being the most energy-intensive operation (Kargwal *et al.*, 2023). Similarly, the adoption of millet production among farmers in Haryana is influenced by the various factors including, economic, cultural, institutional, and biophysical aspects. The decline in millet cultivation area by 60% over the last seven decades, despite a 200% rise in productivity, highlights the economic challenges faced by the farmers (Yadav *et al.*, 2024). Also, the complexity of loan processes and repayment difficulties due to crop failures hinder farmers adopting new practices, including millet cultivation (Sonia *et al.*, 2022). Additionally, the government initiatives and policies have played a significant role in influencing the awareness and adoption of millet production among farmers in Haryana. The Haryana government has implemented digital platforms such as E-Portals and mobile applications to enhance agricultural productivity and sustainability, which are crucial for adopting new crops like millets and indirectly supporting millet adoption by providing necessary information and resources. The preference for wheat and rice, driven by government incentives and policies, has overshadowed the millet cultivation. To enhance millet production, similar support and investment in research and development are necessary to make millets competitive with other staple crops (Yadav *et al.*, 2024). Millets are recognized for their climate resilience and nutritional benefits, making them a strategic choice for sustainable agriculture in Haryana (Jadhav & Londhe, 2023) (Shehrawat *et al.*, 2023). Promoting millets as a sustainable crop can enhance their adoption, especially in regions facing water scarcity and climate variability (Dwivedi *et al.*, 2023). Despite a general awareness and adoption of millets cultivation and practices, the millet remains underutilized due to limited specific awareness and adoption about millets and their benefits and efforts to promote research, improve market access, raise awareness and adoption of millets are crucial to for unlocking their full potential. Thus, the study of farmers' farmer's awareness and adoption of millet production in Haryana was most needed essential. The study was conducted with the following objectives:

1. To study the farmers' farmer's awareness level about millet production
2. To assess the farmers' farmer's adoption level about millet production
3. To find out the constraints encountered by farmers in millet production

Materials and Methods:

The current investigation was carried out in the districts of Hisar and Mahendergarh within the state of in Haryana. Four villages, Dubeta and Nalwa from Hisar and Satnali and Madhogarh from Mahendergarh district, were chosen randomly. In order to gather the necessary data, a random sampling technique was employed to choose 30 farmers from each of the selected villages. The result was that 120 farmers were chosen to be respondents for this study. The study looked at many things about the farmers, such as their was focused on socio-personal traits of the farmers, such as their age, education, caste, and the amount area of land they owned; their socio-economic traits, such as their

crop rotation practices, and irrigation sources; and their communicational traits, such as regular contact with extension agents and mass media exposure. Farmers' Farmer's use of the Kisan Credit Card (KCC) and Soil Health Card (SHC), as well as their overall awareness and adoption of millet production, were also taken into account in the study. Using a two-point continuum, the study evaluated farmers' farmer's awareness of millet production for the purpose of achieving sustainable crop production. A value of "1" denoted awareness, while a value of "0" denoted lack of awareness. The study also evaluated the participants' adoption level of millet production, classifying it as either "Adopted" (coded as "1") or "Not adopted" (coded as "0"). Data was gathered generated from the sampled respondents using an interview schedule that was carefully planned out and tested before it was used. The right statistical tools, like the mean, frequency, percentage, and rank order, were used to draw meaningful conclusions for analysis of the data.

Results and Discussion:

Table 1: Profile of respondents **(n=120)**

SI.No.	Variable	Category	Frequency	Percentage
1.	Age	Young (20-35 years)	25	20.83
		Middle (36-50 years)	63	52.50
		Old (above 50 years)	32	26.67
2.	Education	Primary	03	2.50
		Middle	14	11.67
		Matriculation	44	36.67
		Higher secondary/Diploma	39	32.50
		Graduate	17	14.17
		Postgraduate	03	2.50
3.	Caste	General Caste	72	60.00
		Backward class (BC)	44	36.67
		Scheduled Caste (SC)	04	3.33
4.	Landholding	Marginal farmers (up to 2.5acres)	24	20.00
		Small farmers(>2.5 – 5 acres)	57	47.50
		Medium farmers(>5 - 10 acres)	32	26.67
		Large farmers(>10 acres)	07	5.83
5.	Irrigation sources*	Water Tank/Pond	04	3.33
		Tube well /submersible pump	82	68.33
		Canal	45	37.50
		Both (Tube well and Canal)	48	40.00
6.	Crop rotation*	Guar-Wheat	21	17.50
		Cotton-wheat	38	31.67
		Pearl Millet/Guar/Green Gram- Mustard	86	71.67
		Pearl Millet/Guar/Green Gram- wheat	15	12.50

***** *Multiple responses*

The data pertaining to socio-personal attributes of respondents presented in Table 1 indicated that 52.50 per cent of respondents belong to middle age group followed by old age group (26.67%) and young age group (20.83%). Maximum numbers of respondents (36.67%) were educated up to metric while 32.50 per cent respondents were having educational qualifications up to higher secondary whereas more than 16 per cent of respondent farmers were having graduate and post graduate educational qualifications. A Majority (60%) of respondents belongs to general caste followed by backward class (36.67%) and scheduled castes (3.33%). As far as land holding is concerned, large number of respondents (47.50%) belongs to small farmer category followed by medium farmer category (26.67%) and marginal farmer category (20%). Only 5.83 per cent of respondents belong belongs to large farmer category on the basis of land holding capacity. Majority (68.33%) of respondents had submersible/tube well as a source of irrigation followed by canal water (37.50%). Whereas 40 per cent respondents had both the sources of irrigation i.e. canal and tube well. A vast Majority of farmers (71.67 %) has adopted pearl millet/guar/green gram- mustard crop rotation

followed by cotton- wheat (31.67%), guar-wheat (17.50%) and pearl millet/guar/green gram- wheat (12.50%) crop rotations.

Table 2: Extension contact **(n=120)**

SI. No.	Extension contact	Frequency of Contact					Total score	WMS	Rank
		Weekly (4)	Fortnightly (3)	Monthly (2)	Whenever needed (1)	Never (0)			
1.	Progressive farmer	41	35	14	28	02	325	2.71	I
2.	ADO/HDO	28	34	18	24	16	274	2.28	III
3.	SDAO/SMS/DHO/DDA	10	16	21	44	29	174	1.45	IV
4.	Scientists (KVK/Univ.)	04	15	23	42	36	149	1.24	V
5.	Private Agencies (Input dealers/ sales rep. etc.)	19	44	37	14	06	296	2.47	II

The data regarding extension contact of respondents presented in Table 2 revealed that contacts with progressive farmers emerged as most popular extension contact with weighted mean score of 2.71 followed by private agencies with weighted mean score of 2.47. ADOs/HDOs, SDAO/SMS/DDA and Scientists ranked third, fourth and fifth, respectively.

Table 3 Mass Media Exposure **(n=120)**

SI.No.	Mass media	Extent of utilization			Total Score	WMS	Rank
		Regular (2)	Occasional (1)	Never (0)			
1.	Newspaper	62	16	42	140	1.17	III
2.	TV	68	28	24	164	1.37	II
3.	Radio	06	15	99	27	0.23	VI
4.	Farm magazine	25	19	76	69	0.58	IV
5.	Mobile	98	15	07	211	1.76	I
6.	Internet	11	13	96	35	0.29	V

It was depicted from Table 3 that mass media exposure through mobile ranked first with mean score of 1.76 followed by watching television (WMS = 1.37), reading newspaper (WMS=1.17), farm magazine (WMS=0.58), internet (WMS=0.29) and Radio (WMS=0.23) which ranked second, third, fourth, fifth and sixth respectively.

Table 4 Farmers' Farmer's knowledge regarding Kisan Credit Card **(n=120)**

SI.No.	Statements	Frequency	Percentage
1.	Awareness about Kisan Credit Card (KCC)	120	100.00
2.	Availed KCC facility	98	81.67
3.	Knowledge regarding renewal period of KCC	82	68.33
4.	Knowledge about interest rate	75	62.50
5.	Knowledge about credit limit of KCC	42	35.00
6.	Adequacy of credit sanctioned under KCC	81	67.50
7.	KCC is hassle free card	76	63.33

The data pertaining to farmers' farmer's knowledge regarding Kisan Credit Card (KCC) presented in Table 4 revealed that cent per cent of respondents have awareness about KCC and majority of respondents (81.67%) had availed the KCC facility. The data further revealed that more than two third (68.33%) of respondents knows about renewal period of KCC, 62.50 per cent had knowledge regarding interest rate and only 29.17 per cent respondents have knowledge regarding credit limit of KCC. A large number of respondents (67.50%) have opinion that credit limit sanctioned under KCC is adequate and majority (63.33%) of farmers has opinion that it is hassle free card.

Table 5 Knowledge of the farmers regarding Soil Health Card (n=120)

SI.No	Particulars	Frequency	Percentage
1.	Have Soil Health Card	86	71.67
2.	SHC helps to indicate soil health	91	75.83
3.	SHC encourage judicious use of fertilizers	76	63.33
4.	Awareness regarding SHC tenure	59	49.17

The data presented in Table 5 indicated that 71.67 percent respondents possessed Soil Health Card (SHC) and were aware that SHC indicates the soil health (75.83%), encourage judicious use of fertilizers (63.33%). Only 49.17 per cent respondents had awareness about SHC tenure.

Table 6 Awareness level of farmers on millets production (n=120)

SI.No.	Awareness statements	Awareness Level			
		Aware		Not aware	
		F	%	F	%
1.	How familiar are you with the different types of millets? (e.g., pearl millet, finger millet, foxtail millet, sorghum etc.)	120	100.00	0	0.00
2.	Do you know the nutritional value of millets compared to other cereals?	73	60.83	47	39.17
3.	Are you aware of the environmental benefits of growing millets (e.g., drought resistance, soil improvement)?	82	68.33	38	31.67
4.	Have you heard about the potential economic benefits of millet production?	43	35.83	77	64.17
5.	Do you know which regions or climates are suitable for growing millets?	74	61.67	46	38.33
6.	Are you aware of any government schemes or subsidies related to millet production?	84	70.00	36	30.00
7.	Have you heard about any successful millet farming practices or case studies?	89	74.17	31	25.83
8.	Do you know about any challenges or risks associated with millet production?	95	79.17	25	20.83
9.	Are you familiar with any innovative millet processing or value-added products?	51	42.50	69	57.50
10.	Have you ever attended any workshops or seminars on millet production?	66	55.00	54	45.00
11.	Do you follow any specific millet-related publications or websites?	61	50.83	59	49.17
12.	Are you aware of any on-going research or developments in millet farming techniques?	33	27.50	87	72.50
13.	Have you discussed millet production with other farmers in your community?	85	70.83	35	29.17

14.	Do you think millet production can play a role in sustainable agriculture?	68	56.67	52	43.33
15.	Are you aware of any cultural or traditional uses of millets?	71	59.17	49	40.83
16.	Do you know how millet production contributes to food security?	81	67.50	39	32.50
17.	Are you familiar with any pest or disease management strategies specific to millet crops?	70	58.33	50	41.67
18.	Are you aware of any marketing opportunities for millet products?	49	40.83	71	59.17
19.	Do you think there is a need for more promotion and awareness campaigns for millet production?	88	73.33	32	26.67
20.	Are you familiar with the use of conservation agriculture techniques, such as minimum tillage, land levelling and crop rotation, in millet production?	79	65.83	41	34.17
21.	Are you aware of the benefits of using improved millet varieties developed through biotechnology or conventional breeding?	93	77.50	27	22.50
22.	Awareness about weather forecasting technologies to optimize your millet planting and harvesting times?	71	59.17	49	40.83
23.	Are you familiar with the use of mobile apps or online platforms for accessing market information or agricultural extension services related to millet production?	77	64.17	43	35.83
24.	Have you heard about the potential of using organic farming practices in millet production?	75	62.50	45	37.50
25.	Do you know about any machinery or equipment specifically designed for millet harvesting and processing?	88	73.33	32	26.67
26.	Do you know about any innovative storage technologies for preserving millet grains?	66	55.00	54	45.00
27.	Are you familiar with the use of bio pesticides or bio fertilizers in millet cultivation?	45	37.50	75	62.50
28.	Do you know about any mobile-based advisory services or decision support tools for millet farmers?	64	53.33	56	46.67
Mean Awareness Score		**17.01**			
Overall Awareness (%)		**60.74**			

The data in Table 6 indicated the level of awareness among farmers regarding millet production. The findings revealed that cent percent of respondents have familiarity with the different types of millets. Among millets, they know only pearl millet and sorghum while for other millets; they had heard their names only. A vast majority Most (79.17%) of the respondents have awareness about challenges or risks associated with millet production. They were also aware of benefits of using improved millet varieties developed through biotechnology or conventional breeding (77.5%), heard about successful millet farming practices or case studies (74.17%). They also think that there is a need for more promotion and awareness campaigns for millet production (73.33%) and had discussed regarding millet production with other farmers in their community (70.83). Furthermore, more than two third of respondents were aware about government schemes or subsidies related to millet production, environmental benefits of growing millets (e.g., drought resistance, soil improvement), millet production contributes to food security and were familiar with the use of conservation agriculture techniques, such as minimum tillage, land levelling and crop rotation in millet production. More than 60 per cent of respondents were familiar with the use of mobile apps or online platforms for accessing market information or agricultural extension services related to millet production (64.17%), knew about the potential of using organic farming practices in millets production 962.5%), awareness about regions or climates that are suitable for growing millets (61.67) and know the

nutritional value of millets compared to other cereals (60.83%). More than half of the respondents had awareness about weather forecasting technologies to optimize the millet planting and harvesting times, pest or disease management strategies specific to millet crops, role of millet production in sustainable agriculture, workshops or seminars on millet production and innovative storage technologies for preserving millet grains.

However, the respondents were less aware of practices such as millet processing or value-added products (42.5%), marketing opportunities for millet products (40.83%), use of bio pesticides or bio fertilizers in millet cultivation (37.5%), potential economic benefits of millet production (35.83%) and awareness regarding going research or developments in millet farming techniques (27.5%). Overall, the respondents' awareness level was found to be 60.74 per cent, indicating the need for improvement in their knowledge regarding innovative practices of millet production. The results aligned with the study conducted by Bhabhor *et al.*, (2024); Patel *et al.*, (2024); Lekha *et al.*, (2024); Sarkar & Padaria, (2016) and Singh *et al.*, (2011) which indicated that conventional farming practices consistently hinder the acceptance of new agricultural technologies and practices, especially in millets. Additionally, farmers generally have limited awareness regarding the effects of climate change on crop production.

Table 7 Adoption level of farmers towards millet production **(n=120)**

SI.No.	Statements	Adoption level			
		Adopted		Not adopted	
		F	%	F	%
1.	Have you actively sought information on different types of millets (e.g., pearl millet, finger millet, foxtail millet) to incorporate them into your farming practices?	78	65.00	42	35.00
2.	Have you integrated the knowledge of millets' nutritional value compared to other cereals into your farming decisions?	70	58.33	50	41.67
3.	Have you implemented practices that leverage the environmental benefits of growing millets, such as drought resistance and soil improvement, on your farm?	81	67.50	39	32.50
4.	Have you explored and utilized the potential economic benefits of millet production in your farming operations?	38	31.67	82	68.33
5.	Have you adapted farming practices to suit the regions or climates suitable for growing millets?	93	77.50	27	22.50
6.	Have you availed any government schemes or subsidies related to millet production to enhance your farming activities?	77	64.17	43	35.83
7.	Have you applied successful millet farming practices or case studies to improve your millet production?	83	69.17	37	30.83
8.	Have you adopted innovative millet processing or value-added products of millets?	10	8.33	110	91.67
9.	Have you integrated the latest research or developments in millet farming techniques into your farming practices?	26	21.67	94	78.33
10.	Have you adopted any cultural or traditional use of millets?	65	54.17	55	45.83
11.	Have you adopted pest or disease management strategies specific to millet crops in your farming practices?	54	45.00	66	55.00
12.	Have you integrated millet production into your crop rotation plan to improve soil health and productivity?	98	81.67	22	18.33
13.	Have you explored marketing opportunities for millet products to enhance the profitability of your millet production?	46	38.33	74	61.67
14.	Have you actively supported or participated in promotion and awareness campaigns for millet production in your community?	81	67.50	39	32.50

15.	Have you adopted conservation agriculture techniques, such as minimum tillage, levelling, and crop rotation, in millet production?	73	60.83	47	39.17
16.	Have you adopted improved millet varieties developed through biotechnology or conventional breeding?	89	74.17	31	25.83
17.	Have you implemented water-saving technologies in your millet cultivation?	72	60.00	48	40.00
18.	Have you utilized weather forecasting technologies to optimize your millet planting and harvesting times?	66	55.00	54	45.00
19.	Have you used mobile apps or online platforms for accessing market information or agricultural extension services related to millet production?	77	64.17	43	35.83
20.	Have you implemented organic farming practices in your millet production?	11	9.17	109	90.83
21.	Do you utilize machinery or equipment specifically designed for millet harvesting and processing?	68	56.67	52	43.33
22.	Do you utilize innovative storage technologies for preserving millet grains?	58	48.33	62	51.67
23.	Have you integrated bio pesticides or bio fertilizers into your millet cultivation?	34	28.33	86	71.67
24.	Do you use mobile-based advisory services or decision support tools for millet farming?	49	40.83	71	59.17
Mean adoption score		12.48			
Overall adoption level (%)		51.98			

The data in Table 7 displayed the extent to which farmers have adopted millets production practices. The data revealed that there were certain practices which gained widespread adoption among the respondents. These include integration of millet production into crop rotation plan to improve soil health and productivity (81.67%), adoption of farming practices of millets to suit the regions or climates suitable (77.5%), adoption of improved millet varieties developed through biotechnology or conventional breeding (74.17%), adoption of successful millet farming practices or case studies to improve your millet production (69.17%), implemented practices that leverage the environmental benefits of growing millets, such as drought resistance and soil improvement (67.5%).

Furthermore, respondents have also adopted other millets production practices, albeit to a lesser extent. These practices include availing of government schemes or subsidies related to millet production (64.17%), utilization of mobile apps or online platforms for accessing market information or agricultural extension services related to millet production (64.17%), adoption of conservation agriculture techniques (60.83%),water-saving technologies in millet cultivation (60.00%), integration the knowledge of millets' nutritional value compared to other cereals into your farming decisions (58.33%), use of machinery or equipment specifically designed for millet harvesting and processing (56.33%), adoption of weather forecasting technologies to optimize millet planting and harvesting times (55%) and adoption cultural or traditional use of millets (54.17%).

However, several practices have reported adoption rates of less than 50 per cent. These include utilization of innovative storage technologies for preserving millet grains (48.33%), adoption of pest or disease management strategies specific to millet crops (45%), use of mobile-based advisory services or decision support tools for millet farming (40.83%), exploring marketing opportunities for millet products to enhance the profitability of millet production and utilization of the potential economic benefits of millet production in farming operations (38.33%).

It is worth noting that certain practices, for instance, adoption of bio -pesticides or bio – fertilizers (28.33%), integration of latest research or developments in millet farming techniques(21.67%), organic farming practices (09.17%) and innovative millet processing or value-

addition in millet production (08.33%) have been adopted by only few of the respondents. The overall adoption level was calculated to be 51.98 %. These findings emphasize the need for targeted efforts to promote and enhance the adoption of practices that have not acquired significant acceptance among the respondents. The results were consistent with the research findings of Patel *et al.*, (2024); Patel *et al.*, (2023); *Singh et al.*, (2023); Kemekar & Salunkhe, (2023); Dubey & Srivastava, (2016) and Yadav & Yadav, (2009) indicating improved millet production technologies show increased yield; but adoption is limited by lack of awareness and access. Additionally, mobile apps for agricultural methods are becoming popular since they offer useful knowledge on market trends and agricultural methods as well as on. Adoption level are favourably influenced by scientific orientation and social involvement; higher social participation and access to extension services help farmers to adopt shown technologies more effectively.

Table 8 Constraints faced by farmers' farmer's **in adoption of millet production** **(n=120)**

SI.No.	Constraints	Serious		Not serious	
		F	%	F	%
1.	Limited access to quality seeds	71	59.17	49	40.83
2.	Lack of knowledge on best farming practices	72	60.00	48	40.00
3.	Water scarcity or irregularity	94	78.33	26	21.67
4.	High cost of inputs	87	72.50	33	27.50
5.	Limited access to credit	59	49.17	61	50.83
6.	market access and price fluctuations	88	73.33	32	26.67
7.	Climate change and unpredictable weather patterns	68	56.67	52	43.33
8.	Lack of government support and extension services	89	74.17	31	25.83
9.	Labour shortage	45	37.50	75	62.50
10.	Lack of access to modern farming equipment and machinery	37	30.83	83	69.17
11.	Limited knowledge and skills in integrated pest management	84	70.00	36	30.00
12.	Lack of access to affordable and reliable irrigation systems	28	23.33	92	76.67
13.	Inadequate infrastructure for post-harvest handling and storage	73	60.83	47	39.17
14.	Limited access to market information and market linkages	68	56.67	52	43.33
15.	Land degradation and soil erosion	55	45.83	65	54.17
16.	Inadequate access to agricultural extension services	73	60.83	47	39.17
17.	Limited availability of organic inputs	42	35.00	78	65.00
18.	Challenges in accessing timely and affordable transportation	27	22.50	93	77.50
19.	Lack of awareness about government schemes and subsidies for millet production	91	75.83	29	24.17
20.	Lack of community support and cooperation in farming activities	24	20.00	96	80.00
21.	Limited access to training and capacity-building programs	64	53.33	56	46.67

The data regarding the constraints faced by farmers' farmer's in adoption of millets production practices presented in Table 8 revealed that majority of farmers (78.33%) perceived that water scarcity or irregularity as a "serious" constraint in adoption of millet production practices. This was closely followed by lack of awareness about government schemes and subsidies for millet production (75.83%), Lack of government support and extension services (74.17%), market access and price fluctuations (73.33%), High cost of inputs (72.5%), limited knowledge and skills in integrated pest & disease management(70%), Inadequate infrastructure for post-harvest handling and storage (60.83%), inadequate access to agricultural extension services(60.83%), Lack of knowledge on best farming practices (60%) and limited access to quality seeds (59.17%). Other constraints identified by the farmers includes climate change and unpredictable weather patterns (56.67%),

limited access to market information and market linkages (56.67%), limited access to training and capacity-building programs (53.33%).

On the other hand, constraints perceived as "not serious" in the adoption of millet production include lack of community support and cooperation in farming activities (80.00%), challenges in accessing timely and affordable transportation (77.5%), lack of access to affordable and reliable irrigation systems (76.67%), lack of access to modern farming equipment and machinery (69.17%), limited availability of organic inputs (65.00%), Labour shortage (62.00%), land degradation and soil erosion (54.17%) and limited access to credit (50.83%). The results were in similarity with the research findings of Patel *et al*., (2024); Pokiya *et al*., (2024); Tiwari & Upadhyay, (2022) and Khan *et al*., (2016).

Conclusion

On the basis of above findings, it can be concluded that farmers possess a moderate level of awareness (60.74%) about millet production, with a significant percentage of respondents were familiar with different types of millets, associated challenges and benefits of improved varieties. However, farmers' farmer's awareness is lacking in areas such as millet processing, marketing opportunities and on-going research in millets. Adoption rates of various millet production practices are varied, with an overall adoption level of 51.98 per cent, highlighting the widespread integration of soil health and climate-appropriate practices, improved millet varieties but lower adoption of millet processing, organic farming, and innovative storage and pest management strategies. It was also found that there are significant gaps in awareness and adoption of advanced practices like millet processing, marketing, and the use of bio-pesticides and bio-fertilizers. Key constraints include water scarcity, limited awareness of government schemes and high input costs, while issues like community support and transportation are perceived as less serious. These findings emphasize the need for enhanced awareness and targeted promotion to improve the adoption of millet production practices.

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