Original Research Article

Examining Farmers' Awareness and Adoption of Soil Health Practices for Crop Production: An Investigative Study

Comment [a1]: Is it a case study? Please add ...An Investigative Study in Hisar area of Haryana (district, province, where is the location?)

Abstract

Soil health methods, including cover cropping, crop rotation, and conservation tillage, yield a multitude of environmental and economic benefits. These advantages encompass carbon sequestration, soil erosion mitigation, nutrient leaching prevention, and the establishment of habitats for beneficial insects and pollinators. Nonetheless, there exists a comparatively limited degree of awareness and implementation of soil fertility control techniques. Soil health practices have emerged as a unifying factor among diverse stakeholders within the agricultural sector, fostering collaboration amongst the scientific community and facilitating economic advancement for the broader populace. Insufficient data pertaining to soil health and the reluctance to use soil health management strategies are seen as substantial barriers in augmenting agricultural productivity inside the nation. A research investigation was undertaken in the Hisar area of Haryana to evaluate the extent of knowledge and use of soil health measures. The results of the study indicate that certain soil health measures have achieved extensive recognition, including land levelling, field bunding, irrigation with high-quality water, and the utilization of green manure/organic manure. Nevertheless, many agricultural strategies, such as the use of reduced tillage techniques alongside cover crops and the adoption of integrated farming systems, exhibit relatively lower rates of adoption. In general, the current rate of implementation of soil health measures is quantified at 40.72 percent, suggesting a necessity for enhancement.

Comment [a2]: Please briefly provide the methodology or procedure of investigation.

Keywords: Soil health, Soil Health Card, Awareness, Adoption, Soil properties, Farmers.

Introduction

Soil, an essential component for successful farming, plays a crucial role in providing vital nutrients to plants. In order for crops to thrive and reach their full potential, it is crucial to have healthy soil that contains all the necessary elements for growth and development. Soil health is a crucial factor in determining agricultural productivity, food quality, environmental resiliency, and ecosystem sustainability (Stevens, 2018). In the realm of soil properties, it holds significant importance. The health of soil is determined by the proportion and quantity

of macro and micronutrients present. When it comes to agricultural production, the health of the soil plays a crucial role in achieving sustainable outcomes. By optimizing the use of fertilizers and minimizing waste, soil health becomes a key factor in ensuring productive and efficient farming practices. In a bid to boost their crop yields, many farmers are resorting to the use of larger quantities of chemical fertilizers. However, what they may not realize is that this practice is being carried out without a proper understanding of the fertility levels of their soil. This revelation was made by Patel *et al.,* in a study conducted in 2017. The imbalanced use of fertilizers has been found to have a direct or indirect impact on soil properties, leading to adverse changes. These changes are believed to play a significant role in influencing the quality and productive capacity of the soil, as stated by Jayalakshmi *et al.*, in their recent study (2021). The challenges faced by our soils are not only significant but also have far-reaching implications for our society. Soil health is a crucial aspect that affects various aspects of our lives, from agriculture and food production to environmental sustainability and human well-being. As such, it is imperative that we address these challenges in order to ensure a sustainable future for both our soils and our society. One of the primary challenges confronting our soils is degradation. The loss of soil organic matter, which is commonly quantified as soil organic carbon, has occurred due to microbial degradation caused by the disruption of soil structure by ploughing. This disruption has led to the breakdown of aggregates that protect organic matter. Additionally, excessive erosion caused by wind or water has also contributed to the depletion of soil organic matter. Across the nation, a significant portion of the land has experienced a concerning loss of up to two-thirds of its A-horizon, commonly known as topsoil. This layer of soil plays a crucial role as it houses a majority of plant roots, essential plant nutrients, and Soil Organic Carbon. Additionally, it serves as a habitat for numerous soil-dwelling organisms. The extent of this loss is alarming and raises concerns about the long-term health and productivity of our soil. The impact of soil degradation goes beyond just affecting the biological and physical aspects of soil functioning for crop production. It also plays a significant role in the decline of ecosystem services, as highlighted by Stott and Moebius-Clune in 2017. Understanding the condition of soil health is crucial for ensuring the long-term sustainability and stability of farmland ecosystems, as highlighted by Xue *et al.,* (2019). Soil health practices, including cover cropping, crop rotation, and conservation tillage, have been found to offer numerous environmental and economic advantages. These practices not only benefit the farms where they are implemented but also have positive effects beyond the agricultural sector. These include the ability to sequester carbon, reduce soil erosion, prevent nutrient leaching, and create habitats for

beneficial insects and pollinators (Long, Ketterings, and Czymmek in 2014; Poeplau and Don in 2015). The non-judicial application of fertilizers, inadequate addition of organic matter, and failure to replenish depleted micro and secondary nutrients over time have led to nutrient deficiencies in soil. According to a study conducted by Chowdary et al. in 2017, it was found that there is a relatively low level of knowledge and adoption of Soil Fertility Management practices. The Soil Health Card (SHC) is an essential tool that offers valuable information to farmers regarding the health of their soil. By analyzing the soil's chemical composition, the SHC provides data that helps farmers make informed decisions about the efficient use of fertilizers and the cultivation of crops. This document serves as a guide, providing insights into the nutrient availability, physical characteristics, and chemical properties of the soil, all of which contribute to its overall health (Mukati *et al.,* 2018). Soil health practiceshave become a unifying force for various stakeholders in the field of agriculture. These practices bring together the scientific community, which provides valuable insights into the latest tools, techniques, and cropping practices. Additionally, farmers and the government are actively involved in implementing these practices to promote economic upliftment for the larger population. The lack of information regarding soil health and the failure to adopt soil health management practices are considered significant obstacles in enhancing agricultural productivity in the country, according to a study conducted by Mohapatra and Kameswari in 2014. The relationship between knowledge and acceptance of innovation is crucial in the realm of agriculture.The purpose of this study was to assess the level of awareness and implementation of soil health practices.

Materials and Methods

The current investigation was carried out in the district of Hisar within the state of Haryana. Four villages, Sharwa, Chirod, Bhiwani Rohilla and Dobhi, from the Hisar district, were chosen randomly. In order to gather the necessary data, a random sampling was employed to choose 30 farmers from each of the selected villages. Consequently, a total of 120 farmers were selected as respondents for the present investigation. The study took into account various factors related to the farmers, including their socio-personal characteristics (such as age, education, caste, and land holding), socio-economic characteristics (such as irrigation methods, sources of irrigation, farming systems, crop rotation practises, and farm machinery), and communicational characteristics (such as extension contact and exposure to mass media). Additionally, the study considered the farmers' utilisation of Kisan Credit Card (KCC) and Soil Health Card (SHC), as well as their overall awareness and adoption of soil health

Comment [a3]: How about the gender?

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practices for crop production. The study assessed the level of awareness among farmers regarding the soil health practices for the purpose of achieving sustainable crop production using a 2-point continuum, with 'Aware' being assigned a value of '1' and 'Not aware' being assigned a value of '0'. In a similar vein, the study also assessed the participants' level of adoption, categorising it as either 'Adopted' (coded as '1') or 'Not adopted' (coded as '0'). Data was collected from the sampled respondents using an interview schedule that was deliberately designed and pretested prior to its administration. Meaningful inferences were drawn by employing appropriate statistical measures, such as the mean, frequency, percentage, and rank order.

Results and Discussion

Profile of selected respondents

In this study, a thorough analysis was conducted to explore the various socio-personal, socio-economic, and communicational characteristics of the participants in the sample.

Comment [a5]: Is it possible to classify into advanced farmer and conventional farmer? In order to make the discussion become more comprehensive.

The findings pertaining to socio-personal attributes of respondents indicate that 54.17 per cent of respondents belong to middle age group followed by young (28.33%) and old age (17.50%). Maximum numbers of respondents (46.67%) were educated up to matric while 25.83 per cent respondents were having educational qualifications up to higher secondary whereas 18.00 per cent were graduate and postgraduate. A majority of respondents (79.17%) belongs to general caste followed by backward class (14.17%) and scheduled castes (06.67%). A large number of respondents (38.33%) belongs to small farmer category followed by medium (30.83%) and marginal farmer category (28.33%). Only 7.50 per cent of respondents were large farmers on the basis of land holding. A vast majority of respondents had canal as a source of irrigation whereas 61.67 per cent farmers had tube well as source of irrigation. Whereas 56.67 per cent respondents had both the sources of irrigation i.e., canal and tube well.

A high majority of respondents (93.33 %) were doing livestock practices in their farming system followed by organic farming (11.67%), poly house vegetable production (06.67%), fishery (1.67%) and mushroom cultivation (0.83%). The farmers have adopted cotton-wheat crop rotation (68.33) followed by pearl millet-mustard (45.00%) and rice-wheat (03.00%) crop rotations.It is apparent from the findings that 48.33 per cent of respondents possessed tractor at their farm. Among other farm machineries, 45.0 percent of respondents had harrow

followed by rotavator (38.00%), seed-cum-fertilizer drill (32.50%), multi crop thresher (28.33%), straw reaper (15.00%), MB plough (13.33%) and Laser land leveller (02.50%) at their farm.

In case of communicational characteristics, the findings revealed that among the extension contact of the farmers, the most popular were the progressive farmers with weighted mean score of 3.11 followed by Input dealers/sales representative with weighted mean score of 2.93. Agriculture Development Officers/HDO, SDAO/SMS and Scientists ranked third, fourth, and fifth, respectively.Also, the findings revealed that mass media exposure through mobile ranked first with mean score of 2.25 followed by watching television (WMS = 1.73), reading newspaper (WMS=1.56), farm magazine (WMS=1.02), radio (WMS=0.27) and internet (WMS=0.30) which ranked second, third, fourth and fifth respectively.

The findings regarding Kisan Credit Card (KCC) revealed that a vast majority of respondents (96.67%) has awareness about KCC and 71.67 per cent of respondents had availed the KCC facility. The data further revealed that more than two third of respondents (68.33%) knows about renewal period of KCC, 46.67 per cent had knowledge regarding interest rate and about 41 per cent had knowledge regarding credit limit of KCC. A large number of respondents (67.50%) have opinion that credit limit sanctioned under KCC is adequate and it is hassle free card (68.33%).The findings also indicated that 65 per cent of respondents possessed Soil Health Card (SHC) and were aware that SHC helps to indicate soil health (61.67%), encourage judicious use of fertilizers (40.83%). More than half of respondents (51.67%) had awareness about SHC tenure.

Awareness of farmers about soil characteristics

Comment [a6]: Please further discussion about how to overcome the infertile soils

The data in Table 1 represents the farmers' awareness regarding soil characteristics. The findings revealed that vast majority of respondents (81.67%) know about the significance of soil testing. They were also aware about soil testing laboratories(79.17%), soil moisture before sowing of crops (79.17%), crops suitable for your soil (74.17%), soil types (73.33%), expenditure on crop production decreases after soil testing (72.5%) supported bySingh*et al.*, 2019 , suitable time for collection of soil sample (71.67%), when soil sample should be tested(68.33%), moisture retention capacity of soil (67.50%).

Table 1: Awareness of farmers about soil characteristics (n=120)

S. No	Awareness statements	Awareness Level			
		Aware		Not aware	
		F	%	F	%
1.	Soil types	88	73.33	32	26.67
2.	pH of your soil	46	38.33	74	61.67
3.	Salinity/sodicity of soil	67	55.83	53	44.17
4.	Difference between soil structure and soil texture	72	60.00	48	40.00
5.	Organic carbon content of soil	36	30.00	84	70.00
6.	Crops suitable for your soil	89	74.17	31	25.83
7.	Fertility status of your soil	77	64.17	43	35.83
8.	Moisture retention capacity of soil	81	67.50	39	32.50
9.	Aware about soil testing laboratories	95	79.17	25	20.83
10.	Major and Micronutrients of soil	62	51.67	58	48.33
11.	Soil erosion causing and controlling measures	55	45.83	65	54.17
12.	Significance of soil testing	98	81.67	22	18.33
13.	Suitable time for collection of soil sample	86	71.67	34	28.33
14.	Proper depth & weight of soil sample	71	59.17	49	40.83
15.	Aware when soil sample should be tested	82	68.33	38	31.67
16.	Soil moisture before sowing of crops	95	79.17	25	20.83
17.	Options of crops increased after soil testing	73	60.83	47	39.17
18.	Expenditure on crop production decreases after soil testing	87	72.50	33	27.50
Mean Awareness Score		**11.33**			
Overall Awareness (%)		**62.96**			

Furthermore, respondents were knowledgeable about fertility status of their soil (64.17%), options of crops increased after soil testing (60.83%), knows the difference between soil structure and soil texture (60%), proper depth & weight of soil sample (59.17%), salinity/sodicity of soil (55.83%) and about various major and micronutrients of soil (51.67%).

On the other hand, the respondents have low awareness about soil erosion causing and controlling measures (45.83%), PH (38.33%) and organic carbon content of soil (30%). The respondents' overall awareness regarding soil characteristics was found to be 62.96 per cent which needs to be improved.Several studies have indicated that adopters and non-adopters alike have observed significant advantages associated with these activities, particularly in terms of their capacity to enhance soil organic matter, mitigate erosion, manage weed growth, and alleviate soil compaction (Carlisle, 2016; Mine *et al.*, 2014).

Farmers' Awareness regarding causes responsible for soil degradation

The Table 2 highlights the farmers' awareness regarding the possible reasons that are responsible for degradation of soil. It was found that majority (above 60 %) of respondents had awareness that poor quality irrigation water, excessive use of chemical fertilizers, continuous mono-cropping system, limited application of organic manure (FYM or farm manure), deforestation in the field, intensive cropping system, non-judicious use of insecticides/pesticides in field, soil erosion by wind/water and increasing salinity and sodicity in soil surface are the major causes of soil degradation. However, respondents' awareness was found below 50 per cent about the causes of soil degradation viz. application of fertilizers without knowing SHC/soil status, lack of legume crop's introduction in cropping system, straw burning of paddy and wheat crop stubble in the field, no application of gypsum and lime in soil and faulty irrigation method (surface/flood) irrigation.

Table 2: Farmers' Awareness regarding causes responsible for soil degradation (n=120)

S. No	Awareness statements	Awareness Level			
		Aware		Not aware	
		F	%	F	%
Direct Causes					
1.	Excessive use of chemical fertilizers	92	76.67	28	23.33
2.	Non-judicious use of insecticides/pesticides in field	74	61.67	46	38.33
3.	Less application of organic manure (FYM or farm manure)	83	69.17	37	30.83
4.	Application of fertilizers without knowing SHC/soil status	58	48.33	62	51.67
5.	Non-application of gypsum and lime in soil	51	42.50	69	57.50
6.	Intensive cropping system	75	62.50	45	37.50
7.	Continuous mono-cropping system	89	74.17	31	25.83
8.	Lack of legume crops introduction in cropping system	56	46.67	64	53.33
9.	Straw burning of paddy and wheat crop stubble in the field	53	44.17	67	55.83
10.	Poor irrigation water	97	80.83	23	19.17
11.	Faulty irrigation method (surface/flood) irrigation	48	40.00	72	60.00
12.	Poor drainage system	38	31.67	82	68.33
13.	Deforestation in the field	82	68.33	38	31.67
14.	Soil erosion by wind/water	74	61.67	46	38.33
15.	Heavy tillage exposed the soil carbon to environment	41	34.17	79	65.83
16.	Undulated land/No laser land leveling	32	26.67	88	73.33
17.	Increasing salinity and sodicity in soil surface	73	60.83	47	39.17
18.	Rising of soil surface underground water table	42	35.00	78	65.00
Other causes					
19.	High population growth causing more pressure on land	56	46.67	64	53.33
20.	Limited access to conservation technologies	68	56.67	52	43.33
21.	Poor access to farm advisory services	76	63.33	44	36.67
22.	Due to climate change (Aberrant monsoon/drought/flooding)	48	40.00	82	68.33
23.	Land tenure leads to over exploitation of available resources	86	71.67	34	28.33
24.	Direct use of industrial effluent (wastewater) for irrigation	71	59.17	49	40.83
25.	Use of sewage water without treatment for irrigation	78	65.00	42	35.00

26.	Use of saline and sodic underground water for irrigation	93	77.50	27	22.50
Mean Awareness Score		**14.45**			
Overall Awareness (%)		**55.58**			

The data regarding other causes which are indirectly responsible for soil degradation revealed that majority (77.5%) of respondents were aware that use of saline and sodic underground water for irrigation purpose will degrade the soil. Some other causes of soil degradation which the respondents had awareness includes land tenure leads to over exploitation of available resources (71.67%), use of sewage water without treatment for irrigation (65%), poor access to farm advisory services (63.33%), direct use of industrial effluent (wastewater) for irrigation (59.17%) and limited access to conservation technologies (56.67%). The respondents were less awareness about the causes such as high population growth causing more pressure on land (46.67%) and change in climate condition (aberrant monsoon/drought/flooding) (40%) which affect the soil health. The overall awareness regarding causes responsible for soil degradation was measured 55.58 per cent.

Adoption level of farmers towards soil health practices

The data regarding the adoption level of farmers towards soil health practices presented in Table 3 depicts that there were certain soil health practices which have gained widespread adoption among the respondents. These include land levelling for equal distribution of irrigation water in the field (88.33%), field bunding to control water erosion (86.67%), irrigation of crops with good quality water (80.00%), application of green manure/organic manure in the field (74.17%), soil and water testing/SHC (65.00%), salt tolerant crop in problematic soils (65.00%), crop residue incorporation by agricultural mechanization (61.67%), deep ploughing for salt affected soil (60.83%), cultivation of leguminous crops (60.83%) and site specific soil management(60%), application of Gypsum for sodic and saline soils (55.83%).Furthermore, respondents have also adopted other soil health practices, although to a lesser extent. These practices include recharge of ground water during rainy season (44.17%), permanent soil cover by vegetation (43.33%), minimum use of pesticides (35.00%), inter seeding and aerial seeding to increase soil health and decrease erosion (35.00%), balanced use of fertilizers based on soil health cards (34.17%) and adoption of minimum tillage/zero tillage technology (31.67%).The study was supportedby the Kumar *et al.,* (2019), Niranjan *et al.,* (2018), Jaiswal and Singh (2018),Chowdary et al., (2016) it was discovered that a significant majority of farmers were aware of the benefits and importance of Soil Health Cards.

Table 3: Adoption level of farmers towards soil health practices (n=120)

S. No.	Statements	Adoption level			
		Adopted		Not adopted	
		F	% age	F	% age
1.	Permanent soil cover by vegetation	52	43.33	68	56.67
2.	Leaching of salts in saline soil	34	28.33	86	71.67
3.	Application of gypsum for sodic and saline soils	67	55.83	53	44.17
4.	Application of lime for acidic soils	15	12.50	105	87.50
5.	Land leveling for equal distribution of irrigation water in the field	106	88.33	14	11.67
6.	Adoption of minimum disturbance of soil/minimum tillage/zero tillage	38	31.67	82	68.33
7.	Field bunding to control water erosion	104	86.67	16	13.33
8.	Cultivation of deep-rooted plantation in waterlogged soil	8	6.67	112	93.33
9.	Application of green manure/organic manure in the field	89	74.17	31	25.83
10.	Irrigation of crops with good quality water	96	80.00	24	20.00
11.	Integrated farming system	32	26.67	88	73.33
12.	Balanced use of fertilizers based on soil health cards	41	34.17	79	65.83
13.	Crop residue incorporation by agricultural mechanization	74	61.67	46	38.33
14.	Site specific soil management	72	60.00	48	40.00
15.	Furrow irrigated raised bed system	15	12.50	105	87.50
16.	Surface mulch (protect from rain drops)	6	5.00	114	95.00
17.	Use of micro irrigation methods instead of surface irrigation	32	26.67	88	73.33
18.	Soil and water testing/SHC	78	65.00	42	35.00
19.	Adequate drainage system	29	24.17	91	75.83
20.	Minimum use of pesticides	42	35.00	78	65.00
21.	Salt tolerant crop in problematic soils	78	65.00	42	35.00
22.	Deep ploughing for salt affected soil	73	60.83	47	39.17
23.	Rainwater harvesting/watershed management	7	5.83	113	94.17
24.	Recharge of ground water during rainy season	53	44.17	67	55.83
25.	Timely geospatial information on soil requirements	0	00.00	120	100.00
26.	Adding of Sulphur and Ferrous Sulphate ($FeSO_4$) in Alkaline soils	26	21.67	94	78.33
27.	Adoption of reduces tillage followed by cover crops	35	29.17	85	70.83
28.	Cultivation of leguminous cash crop	73	60.83	47	39.17
29.	Inter seeding and aerial seeding to increase soil health and decrease erosion	42	35.00	78	65.00
Mean Adoption Score		**11.81**			
Overall Adoption Level		**40.72**			

Poor adoption (less than 30 per cent) was reported for some of the practices such as adoption of reduced tillage followed by cover crops (29.17%), leaching of salts in saline soil (28.33%), integrated farming system (26.67%), use of micro irrigation methods instead of surface irrigation(26.67%), adequate drainage system (24.17%), adding of sulphur and Ferrous Sulphate (FeSO4) in alkaline soils (21.67%), application of lime for acidic soils (12.5%), furrow irrigated raised bed system (12.5%), cultivation of deep rooted plantation in water logged soil (06.67%), rain water harvesting/watershed management(5.83%) and surface

mulch (5%). The practice like 'Timely geospatial information on soil requirements' has not been adopted by any of the respondents. The overall adoption about soil health practices was calculated at 40.72 per cent which was below to the satisfactory level and needed for improvement.The current research validates previous studies (Mohapatra and Kameswari,2014;Patel*et al.,* 2017) that have demonstrated a moderate to low level of acceptance of agricultural innovations overall, with a specific focus on soil management approaches.

Constraints faced by farmers in adoption of soil health practices

The data presented in Table 4 regarding the constraints encountered by farmers in adopting soil health practices. A significant majority (74.17%) of respondents perceived that 'difficulties in understanding all information in soil testing report' is a "serious" constraint in adopting such practices. This was closely followed by unsatisfactory production of pulses (70.83%), difficulties in calculation of fertilizer dose on basis of nutrient status of soil (70%), tendency of ignoring soil testing if field crop yield is good (68.33%), lack of access to reliable and current information related to soil health (65%), lack of knowledge about advantages of soil health practices (63.33%) and unawareness about the problems associated with problematic soils (54.17%).

Table 4: Constraints faced by farmers in adoption of soil health practices (n=120)

S. No.	Constraints	Serious		Not serious	
		F	% age	F	% age
1.	Lack of access to reliable and current information related to soil health	78	65.00	42	35.00
2.	Lack of knowledge about soil testing	46	38.33	74	61.67
3.	Non availability of soil test reports in time	47	39.17	73	60.83
4.	Unaware about the problems associated with problematic soils	65	54.17	55	45.83
5.	Financial constraints in using vermin-compost and bio fertilizers	52	43.33	68	56.67
6.	Unsatisfactory production of pulses	85	70.83	35	29.17
7.	Shortage of livestock at household level	16	13.33	104	86.67
8.	Non availability of seeds for green manuring	44	36.67	76	63.33
9.	Limited number of awareness programs and trainings related to soil health for the farmers	46	38.33	74	61.67
10.	Gap between soil sampling and issuing card is too high	48	40.00	72	60.00
11.	Difficulties in understanding information in soil testing report	89	74.17	31	25.83
12.	Difficulties in calculation of fertilizer dose on basis of nutrient status of soil	84	70.00	36	30.00
13.	Soil testing laboratory are located far away	24	20.00	96	80.00
14.	No certainty in yield gain	32	26.67	88	73.33
15.	Non- availability of micronutrient in market	28	23.33	92	76.67
16.	Ignoring soil testing if field crop yield is good	82	68.33	38	31.67
17.	Lack of knowledge about advantages of soil health practices	76	63.33	44	36.67

Conversely, some constraints were perceived as "not serious" in the adoption of soil health practices. These includes shortage of livestock at household level (86.67%), Soil testing laboratory are located far away (80.00%), Non availability of micro nutrient in market (76.67%), No certainty in yield gain (73.33%), Non availability of seeds for green manuring (63.33%), Limited number of awareness programs and trainings related to soil health for the farmers (61.67%), Lack of knowledge about soil testing (61.67%), Non availability of soil test reports in time (60.83%), Gap between soil sampling and issuing card is too high (60%) and financial constraints in using vermi-compost and bio fertilizers (56.67%).The results are consistent with the findings reported by Sheetal and Sharma, 2020, which are further shown by the findings of Ghaswa*et al.,* (2019) and Kumar *et al.*,(2017).

Conclusion

On the basis of above findings, it can be concluded that farmers possess a considerable level of awareness regarding soil characteristics. A majority of respondents are knowledgeable about the significance of soil testing, soil moisture before sowing crops, suitable crops for their soil, soil types, and other related aspects. However, there are areas where awareness is lacking, particularly concerning soil erosion causes and controlling measures, pH levels, and organic carbon content. The overall awareness regarding soil characteristics was found to be 62.96 per cent, indicating possibility for improvement. Most of the respondents have a good understanding of the major causes responsible for soil degradation, such as poor irrigation water quality, excessive use of chemical fertilizers, and mono-cropping systems. However, awareness is comparatively low regarding certain factors, including fertilization without considering soil health status, lack of legume crop integration, and improper irrigation methods. The overall awareness regarding causes of soil degradation was measured at 55.58 per cent. The findings on adoption level of farmers towards soil health practices revealed that some of the soil health practices have gained widespread acceptance. These include land levelling, field bunding, irrigation with good quality water, and the application of green manure/organic manure. However, some practices, such as reduced tillage with cover crops and integrated farming systems, have lower adoption rates. The overall adoption of soil health practices was calculated at 40.72 per cent, indicating a need for improvement. Difficulties in understanding soil testing reports, unsatisfactory pulses production and challenges in calculating fertilizer doses based on soil nutrient status were identified as ‘serious constraints’ in adoption of soil health practices. Hence, in response to the challenges

encountered and recommendations put forth by farmers, it is evident that there is a need for enhanced scientific and educational training programs and resources to effectively propagate the technology on a broader scale. Extension workers can play a vital role in addressing the challenges associated with the adoption of technology.

Comment [a7]: Make it into several points.

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