Original Research Article

Factors affecting knowledge and adoption of Integrated Nutrient Management (INM) practices in Rice Wheat Cropping System (RWCS)

Abstract

The study was conducted in 2022 in Haryana. This study assessed the profile characteristics of farmers practicing the Rice-Wheat Cropping System (RWCS) and their knowledge and adoption of Integrated Nutrient Management (INM) practices. The majority of respondents were middle-aged, with a significant portion possessing education up to the higher secondary level. Most respondents belonged to the general category and practiced farming as their primary occupation. The analysis revealed that larger landholdings positively influenced socio-economic status, leading to better adoption of INM practices. While the knowledge and adoption of INM practices varied among respondents, education, landholding, farming experience, social participation, and extension contacts were significantly correlated with higher awareness and adoption levels. The findings suggest the need for targeted educational and awareness programs to enhance the adoption of INM practices among farmers, particularly focusing on younger and more educated individuals.

Keywords: Integrated Nutrient Management (INM), Rice-Wheat Cropping System (RWCS), farmer profile, adoption, Knowledge.

1. Introduction

The Rice-Wheat Cropping System (RWCS) is vital to India's food security but is highly dependent on fertilizers, leading to environmental and soil health issues. Intensive rice and wheat farming, with an overreliance on chemical fertilizers and limited use of organic and bio-fertilizers, has degraded soil fertility and reduced the effectiveness of nitrogen (N) fertilizers (Singh *et al.* 2010). This issue is particularly evident in Haryana's Panipat, Karnal, and Kurukshetra districts, where RWCS dominates, and fertilizer use is extensive. For example, in 2018-19, Karnal alone consumed 121.36 thousand tonnes of fertilizers, with similar trends in neighboring districts(Anonymous, 2018-19). This intensive fertilizer use has resulted in declining soil productivity.

The intensification of crop production has also led to a depletion of essential macro and micronutrients, including potassium (K), sulfur (S), and iron (Fe). The gap between nutrient addition and removal is widening, calling for urgent interventions to restore soil

health. Despite awareness campaigns, the imbalance in fertilizer use persists, with the recommended N:P:K ratio of 4:2:1 often being exceeded, particularly in Haryana, where it reached 27.7:6.1:1 in 2014-15(Pavithra, 2021). To address these issues, Integrated Nutrient Management (INM) is recommended. INM combines the use of organic manures, crop residues, green manuring, and bio-fertilizers with balanced chemical fertilizers based on soil tests. This approach not only enhances soil productivity, water retention, and fertilizer efficiency but also reduces cultivation costs. INM is crucial for bridging the gap between nutrient consumption and removal, ensuring sustainable crop production.INM or Integrated Nutrient Supply System (INSS) aims to optimize the use of all available nutrient sources to maintain soil fertility and crop productivity. Long-term studies have shown that combining chemical fertilizers with organic manures improves crop yields compared to using fertilizers alone(Mahajan and Sharma, 2005). The success of INM depends on understanding and improving farmers' awareness of these practices. Enhanced awareness and adoption of INM can lead to better resource management, increased productivity, and long-term food security, benefiting both farmers and the environment.

In this context, studying the socio-economic characteristics of farmers engaged in the Rice-Wheat Cropping System (RWCS) in Haryana was essential for understanding their livelihoods, decision-making processes, and the challenges they face. These characteristics, including income levels, education, landholding size, access to resources, and farming practices, directly influence the adoption of sustainable agricultural practices like Integrated Nutrient Management (INM). Analyzing these factors can reveal disparities in resource access, the effectiveness of extension services, and potential barriers to adopting improved farming techniques. Additionally, understanding socio-economic conditions can help tailor policies, training, and support programs to meet the specific needs of different farmer groups, ultimately leading to enhanced productivity, better resource management, and improved economic outcomes for farmers in Haryana. Such insights are crucial for designing interventions that promote sustainable agriculture while ensuring food security and economic resilience in the region.

2. Methodology

The study was conducted during 2021-22 using the ex-post facto research design. A multistage sampling was done to derive the sample for this study. Three districts of Haryana state *viz.*, Panipat, Karnal and Kurukshetra, were purposively selected as these districts had

maximum cropping intensity of RWCS in Haryana in North-Eastern Agro-Climatic Zone. Again, two blocks from each of the three districts were selected randomly *viz.*, Sanauli Khurd and Ishrana from Panipat district**,** Karnal and Nilokheri from Karnal district and Shahbad and Ladwa from Kurukshetra district were selected randomly. A list of rice and wheat growers was prepared with the help of Agricultural Development Officers (ADOs), Scientists of Krishi Vigyan Kendras (KVKs), and sarpanches of selected villages. Ten farmers from each village were selected randomly for personal interview from the prepared list, making the total sample size of 120 for the study.

The independent variables such as age, education, family size, family type, occupation of respondent, caste, land holding/ farm size, farming experience, social participation, farm power, mass media exposure, extension contacts and risk orientation were included in investigation. Knowledge and adoption were taken as depend variables. The respondents were categorised based on the scores obtained into three categories *i.e.,* 'low' ($\bar{x}$ - SD), 'medium' ($\bar{x} \pm$ SD) and 'high' ($\bar{x}$ + SD) by using mean score ($\bar{x}$) and standard deviation (SD) as checks.

3. Results and Discussion

3.1 Profile of the respondents

The profile characteristics is given in Table 1. It was found in results that nearly half of respondents (47.50%) were middle aged. Average age of respondent farmers was found to be 43.44 years. Middle-aged farmers are usually more active, efficient at work and interested in participating in farm activities. Furthermore, it could also be concluded that middle-aged people are more physically capable with addition to having greater sense of family duty than young and old age people. This finding is in concurrence with the finding of Priyanka (2016) and Gautam (2021).

The findings revealed that nearly two-fifth of the respondents (39.16%) had education up to higher secondary level followed by graduate and matric level (20.00%) each. Educational status of an individual plays a vital role in enhancing one's knowledge level by motivating oneself towards knowing new things and understanding the new technologies or practices. It is presumed that higher educational status is directly proportional to the adoption level. This study clearly revealed that a major proportion of the farmers following RWCS were educated up to senior secondary level. This could be due to the level of awareness

towards the need for education among the families living in villages. Similar results were reported by Chikkalaki*et al.* (2024).

Results revealed that more than half (52.50%) of the respondents had joint families and 47.50 per cent families were nuclear families.It was found that more than half of the families (50.84%) had medium sized family having 5-7 members labelled as medium size of family This may be because nuclear families can have 5 or 6 and joint families can also have 6 to 7 family members.

The study revealed that about 88.33 per cent of the respondents were found to be practicing only farming as their occupation while 11.67 per cent of respondents were having their own business or job along with farming, which includes dairy, agrochemical or seed dealers, etc. The probable reason may be that more than 60.00 per cent farmers were having land holding more than 5 acres. Large land holding needs more attention towards farm practices and its management. The findings have been supported by Sharma (2017).

The results revealed that about three-fourth of respondents (74.16%) were from General Category followed by 21.67 per cent from Other Backward Class (OBC) while farmers belonging from Schedule Caste were only 4.17 per cent. The probable reason may be that,in Haryana generally majority of land holders belongs to general category and area of study was also dominated by general category and OBC category.

Analysis revealed that nearly one-third of respondents (30.83%) falls under medium farmers category possessing 5-10 acre of land. Land holding has direct effect on socio-economic status and influence many innovative decisions, their compatibility and adaptability of new technologies or practices thus leading to better adoption of technologies (Diederen*et al.,* 2003). The findings were also partially supported by Bhatia (2016) who stated that majority of farmers (62.00%) had possessed 5.1-10 acres of land holdings.

Majority of respondents (50.83%) were found having farming experience of more than 20 years. Probable reason for having farming experience more than 20 years is that more than 70 percent respondents were found having age more than 35 years and almost start working on farm at age of 18-20 years.

It was found that about two-fifth respondents (42.50%) were member of one social institution or cooperative society followed by 41.67 per cent respondents with no membership or social participation. It was found that participation in the social capital networks not only significantly influence the farmer's decision to adopt but also influences the choice of strategies/ alternatives adopted by farmers. Results of present study were

supported by findings of Patel *et al.* (2017) study on farmers' perception on use of bio-fertilizers in Gujarat.

The analysis of data revealed that about two third of respondents (65.83%) possessed medium level of farm power. These results are in conformity with above discussion that large land holding leads to higher socio- economic status that also implicates the higher level of farm implements assets, which was backed by findings of Kumar (2019).

Mass media plays major role in transfer of technology from technocrats to farmers. Particularly, farmer having frequent exposure to media brings the required information to them.

The findings revealed that more than half of respondents (55.83%) had medium level of mass media exposure.The findings were supported by Sharma (2017) who in his study revealed that majority of farmers fall in medium category of mass media exposure and concluded that higher exposure of farmers to mass media would lead to gain in knowledge and information.

It was found that about two-third of the respondents had a medium level of extension contacts followed by 20.00 and 16.17 per cent had low and high level of extension contacts, respectively. The results of study found in conformity with the fact that farmers having higher extension contact would be more aware and equipped with better decision making, knowledge and adoption of new technologies or practices regarding INM.Findings were supported by Kumar (2019) andSreekanth *et al.* (2019). Both of them found that majority of farmers had medium level of extension contacts.

It was observed that majority of respondents (54.17%) were aware and willing to take medium level risks while 27.50 and 18.33 per cent were oriented towards high and low level of risk to adopt INM practices, respectively. This could be concluded as mostly young and interested respondents with medium level of innovativeness agreed to take risk in case of implementing the various INM practices. These findings were supported the results of Gautam (2021) with basmati grower farmers.

Table 1: Profile characteristics of the respondents (n=120)

S. No.	Variable	Category	Range	Frequency	Percentage
1.	Age	Young	≤ 35 years	32	26.67
		Middle	36-50 years	57	47.50
		old	>50 years	31	25.83
		Illiterate		3	2.50

2.	Education	Primary		8	6.67
		Middle		12	10.00
		Metric		24	20.00
		Higher Secondary		47	39.16
		Graduate		24	20.00
		Post Graduate and above		2	1.67
3.	Family type	Nuclear		63	52.50
		Joint		57	47.50
4.	Family size	Small	≤ 4 members	25	20.83
		Medium	5-7 members	61	50.84
		Large	>7 members	34	28.33
5.	Occupation	Only Farming		106	83.33
		Business/job + Farming		14	11.67
6.	Caste	General		89	74.16
		Other Backward Class (OBC)		26	21.67
		Scheduled Caste (SC)		5	4.17
7.	Land Holding	Marginal Farmers	≤ 2.5 Acres	15	12.50
		Small Farmers	2.6-5 Acres	32	26.67
		Medium Farmers	5.1-10 Acres	37	30.83
		Big Farmers	>10 Acres	36	30.00
8.	Farming Experience	Less than 10 Years		15	12.50
		10 - 20 Years		44	36.67
		More than 20 Years		61	50.83
9.	Social Participation	Not a member of any organization		50	41.67
		Member of one organization		51	42.50
		Member of More than one organization		19	15.83
10.	Farm Power	Low	≤ 13	11	9.17
		Medium	14-17	79	65.83

		High	>17	30	25.00
11.	Mass Media Exposure	Low	≤ 4.53	18	15.00
		Medium	4.54-8.89	67	55.83
		High	>8.89	35	29.17
12.	Extension Contacts	Low	≤ 14.3	24	20.00
		Medium	14.4-27.29	76	63.33
		High	>27.29	20	16.17
13.	Risk Orientation	Low	≤ 12.34	22	18.33
		Medium	12.35-20.97	65	54.17
		High	>20.97	33	27.50

3.2 Overall knowledge and adoption of INM practices among respondents

The results given in Table 2 reveals that about three-fifth of respondents (59.17%) had medium level of knowledge about INM practices in RWCS while more than one-fifth respondents (22.50%) were having high level of knowledge and remaining 18.33 per cent of respondents had low level of knowledge about INM practices.

It was found that their knowledge was found to be very good about use of organic manure, good knowledge about soil testing and balanced use of fertilizers, average knowledge about green manuring practices and very poor knowledge about use of bio-fertilizers. This is the reason for majority of farmers in medium category. Probable reason for low knowledge may be lack of education, low social participation, low risk orientation and lack of awareness campaigns or less efficient extension services.Similar findings were reported by Chandangiriwar*et al.*(2021).This suggests that more emphasis should be given by the extension staff on educating and creating awareness among farmers about the Integrated Nutrient Management practices in RWCS and its advantages.

Table 2: Overall knowledge level of farmers towards various INM practices(n=120)

Category	Range	Frequency	Percentage
No Knowledge	≤75.76	22	18.33
Partial Knowledge	75.77-102.58	71	59.17
Full Knowledge	>102.58	27	22.50

The results given in Table 3 revealed that majority of respondents (54.13%) had medium level of adoption about INM practices while 15.87 per cent respondents were having high level of adoption and remaining 30.00 per cent respondents had not adopted the practices INM.It was also found that adoption level was very good about use of organic manure, good adoption about balance use of fertilizers, poor adoption about green manuring and soil testing practices and very poor adoption about use of bio- fertilizers. The respondents faced many shortfalls in adoption of INM practices due to their complexity of practices and non-availability of resources. These may have led to majority of respondents belonging to medium adoption category. These findings were supported by Kaur (2019).

Table 3: Overall adoption level of respondents about INM practices(n=120)

Category	Range	Frequency	Percentage
No Adoption	≤40.38	36	30.00
Partial Adoption	40.39-61.11	65	54.13
Full Adoption	>61.11	19	15.87

3.3 Association of independent variables and knowledge and adoption of respondents towards INM practices in RWCS

Table 4 and 5 give the correlation between independent variables and knowledge and adoption, respectively. These two tables share a lot of similarities in the correlation between dependent and independent variable. From computed correlation coefficients it was revealed that age was found negatively correlated with knowledge and adoption of INM practices under RWCS. Education, land holding, farming experience, social participation, farm power, extension contacts, mass media exposure and risk orientation were found to be positively and significantly correlated with knowledge and adoption level of respondent farmers. Analysis also showed that family size, family size, occupation and caste were found non-significantly at any of significant level of 0.01 or 0.05 with farmers' awareness, knowledge and adoption level of INM practices.These findings were partially supported by findings of Naik *et al.* (2009), Rohila*et al.* (2017), Bunkar (2018), andGautam (2021).

Table 4: Pearson correlation between farmers' Knowledge level and various independent variables

S. No.	Independent variables	Correlation coefficient
1.	Age	-0.385**
2.	Education	0.360**

3.	Family type	0.061 ^{NS}
4.	Family size	0.040 ^{NS}
5.	Occupation	0.025 ^{NS}
6.	Caste	0.640 ^{NS}
7.	Land holding	0.299**
8.	Farming experience	0.199*
9.	Social participation	0.264**
10.	Farm power	0.192*
11.	Mass media exposure	0.417**
12.	Extension contacts	0.516**
13.	Risk orientation	0.296**

** -Significant at the 0.01 level

* -Significant at the 0.05 level

^{NS} -Non-Significant

The negative correlation between age and the adoption of Integrated Nutrient Management (INM) practices likely stems from younger respondents typically having higher levels of education. As education increases, so does their understanding of complex agricultural practices, which in turn facilitates better adoption. Younger farmers, who are generally more educated and often have larger landholdings, tend to have a higher tolerance for risk, making them more willing to experiment with and adopt new farming practices.Moreover, factors such as social participation, mass media exposure, and extension contacts are crucial in the spread of information among farmers. These elements play a significant role in raising awareness and enhancing knowledge about new agricultural technologies. Social participation allows farmers to share ideas and learn from each other, while mass media provides access to a wide range of information on the latest farming techniques. Extension contacts serve as a bridge between research and practical application, helping farmers understand and implement new practices like INM. Therefore, the younger, more educated, and socially engaged farmers are, the more likely they are to adopt INM practices due to their greater understanding and higher risk tolerance. Their involvement in social networks, exposure to mass media, and frequent interactions with extension services strongly correlate with increased knowledge and adoption of INM practices.

Table 5: Pearson correlation between farmers' Adoption level and various independent variables

S. No.	Independent variables	Correlation coefficient
1.	Age	-0.218*
2.	Education	0.274**
3.	Family type	0.160 NS
4.	Family size	0.114 NS
5.	Occupation	0.071 NS
6.	Caste	0.108 NS
7.	Land Holding	0.255**
8.	farming Experience	0.388**
9.	Social Participation	0.422**
10.	Farm Power	0.217*
11.	Mass Media Exposure	0.183*
12.	Extension Contacts	0.291**
13.	Risk Orientation	0.398**

** -Significant at the 0.01 level

* -Significant at the 0.05 level

NS-Non-Significant

4. Conclusion

The profile of the respondents reveals significant insights into the demographic and socio-economic characteristics influencing their knowledge and adoption of Integrated Nutrient Management (INM) practices in Rice-Wheat Cropping Systems (RWCS). Most respondents were middle-aged, suggesting an active and physically capable group with a strong sense of responsibility toward family and farm activities. Education levels varied, with nearly two fifth of the respondents having completed higher secondary education, which plays a crucial role in the adoption of new farming practices. The majority of respondents were primarily engaged in farming, with only a small percentage having secondary occupations and about one third were medium sized farmers. The findings also highlight that a substantial proportion of respondents had better years of farming experience, which correlates with higher adoption levels of INM practices. Social participation, mass media exposure, and extension contacts were identified as significant factors positively influencing both knowledge and adoption of INM practices. The study underscores the importance of these factors in promoting awareness and understanding of innovative agricultural practices, particularly among younger and more educated farmers. These findings suggest targeted

interventions focusing on education, social engagement, and media exposure could enhance the adoption of INM practices in similar agricultural settings.

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