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Adoption Status of Improved Paddy Varieties and Fertilizer Use in Moga District of Punjab

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Abstract

Paddy is a major food crop having significance for millions of farmers. It is grown under paddy-wheat cropping system on a vast area in India. In Punjab state continuous need is felt to increase area under short duration (SD) paddy varieties for better crop yield and to save irrigation water. Thus, adoption of these SD varieties and optimal fertilizer use are major factors that can contribute to enhanced paddy productivity in short time span. The present study was carried out in district Moga of Punjab state for five consecutive years i.e., 2017-18 to 2021-22 using the interview method for data collection from 30 respondents from each of the five blocks of the district. Analysis revealed that paddy cultivation is diversified in the district as basmati and non-basmati types along with different varieties that are being cultivated here. The area under recommended varieties has increased significantly among non-basmati paddy, unrecommended long duration variety Pusa 44 is the most preferred throughout the study period followed by Dogar Pusa due to high yield. SD varieties occupy only about 18 per cent paddy area. Only about 2 to 4 per cent of the total paddy area was transplanted before 10th of June each year except during 2020-21 Covid 19 pandemic period. Further, excessive use of fertilizer-Nitrogen by farmers in the form of urea was observed. A rise in the proportion of farmers (69% to 73%) in a span of five years which discontinued the practice of applying phosphorus to the paddy crop was also observed. The data on adoption status may help the extension agencies to focus on bridging the gap to enhance the yield of paddy and basmati and thus, income of farmers along with conservation of natural resources.

Keywords: Fertilizers, Recommended, Paddy, Short duration, Variety

Introduction

Developing and promoting the adoption of yield increasing crop varieties in a sustainable manner helps to improve the livelihood of rural farmers (Asfaw *et al.*, 2012) by improved crop production (Singh *et al.*, 2018; Adeyemi *et al.*, 2020) and thus higher per capita monthly household expenditure (Bannor *et al.*, 2020). Education along with implementation of suitable policies enhances farm productivity in the case of adopters of modern technology (Paltasingh and Goyari, 2018). Varietal characteristics, extension activities, package of practices of a variety and marketing are important factors in adoption of a newly released variety in a particular area (Ghimire *et al.*, 2015, Manan *et al.*, 2018, Campenhout, (2021). Thus, the adoption of recommended improved varieties and production technologies is of utmost importance.

Paddy productivity varies widely depending on climatic conditions, water availability, soil fertility, fertilizers applied and other technological factors. This emphasizes the need for more agricultural information for farmers concerning the advantages of

using good agricultural practices in paddy production (Oo and Usami, 2020). Along with improved paddy varieties, fertilizer use is one of the key factors for increasing the paddy production. Paddy is one of the input intensive crops in the world and input of nutrients contributes approximately 20–25 per cent to the total input costs of paddy (Shankar *et al.,* 2021). At present paddy production alone consumes nearly 24.7 Mt of fertilizer which accounts for approximately 14 per cent of total global fertilizer consumption in a year. Scientists have predicted that a hike of at least 60 per cent in paddy yield is essential in order to ensure food and nutritional security of 9 billion populations that are expected to inhabit the globe by 2050. With increasing demand for food production, demand for nutrients is likely to increase further.

Paddy, the largest crop industry in South Asia has special significance and economic importance in agricultural development and poverty reduction (Gumma *et al.*, 2011). In India, paddy (*Oryza sativa L.*) is the staple food crop for more than 70 per cent of people and accounts for 40-45 per cent of the total area covered by cereal crops. Paddy is grown in a paddy-wheat cropping system and this cropping system occupies more than 26 million hectares of cultivated land in the Indo-Gangetic Plains of India (Singh *et al.,* 2019). Therefore, increasing paddy productivity and production is essential to ensure national food security, reduce poverty, and safeguard against the volatility of the paddy market.

Punjab with 3.1 million hectares of land under paddy during the *kharif* season accounts for nearly seven per cent of the total area under paddy cultivation in India. The state comprising only 1.5 percent of the total geographical area of country contributes 13-14 percent towards the total food grain production of the country and has annual contributions of around 36 per cent of wheat and 26 per cent of paddy to the national pool (Anonymous, 2020). Paddy is sown in about 31 lakh hectares in Punjab and controlling the use of urea could result in saving nearly Rs 200 crore. Urea consumption registered for the same is about 10 lakh tonnes which is 3.15 lakh tonnes over and above the recommended quantity (BS, 2018). The data on adoption status may help the extension agencies to focus on bridging the gap to enhance the yield of paddy and basmati and thus, income of farmers along with conservation of natural resources. In this backdrop, the present study was conducted to assess the adoption status of improved varieties and fertilizer use practices in Punjab.

Materials and Methods

District Moga from the Western agro-climatic zone of Punjab state having 1.81 lakh Ha under paddy was selected for the study. Data were collected using the interview method for five consecutive years i.e., 2017-18 to 2021-22 from 30 respondents selected by simple random sampling method from each of the five blocks of the district namely Moga-I, Moga-II, Kot-Ise-Khan, Bagha Purana and Nihal Singh Wala. Thus, total sample consisted of 150 respondents for each year. Using a pre-tested questionnaire, data were collected regarding different paddy varieties grown, area under the varieties, variety-wise transplanting dates and fertilizer use (N, P_2O_5) was collected from the selected farmers for five years. Further, the data was analyzed using simple statistical tools like averages, percentages etc.

Results and Discussion

A. Socio-personal characteristics of the farmers: The results of the study revealed that the majority of the farmers (51.5%) were above the age of 45 years. About one-third of the respondents (35.3%) were educated up to middle followed by matriculation (29.4%), senior secondary (11.8%), graduation (6.5%) while about six per cent were unable to read and write. The family size of the majority (60.0%) was 5-8 members, however, about one third (29.7%) were having family size with more than 8 members. In most of the sampled farmers, the family members involved in farming were two **(Table 1)**.

Table 1. Social-personal characteristics of the selected respondents

S. No.	Particulars	No. of respondents	Percentage
1.	**Age (years)**		
	< 25	5	3.6
	25-35	18	12.1
	35-45	48	32.3
	>45	78	52
2.	**Family size**	150	
	1 to 4	15	10.3
	5 to 8	90	60.0
	>8	45	29.7
3.	**Family members involved in agriculture**		
	One	41	27.1
	Two	66	44.1
	Three	43	28.8
4.	**Education**		
	Illiterate	8	5.3
	Upto middle	53	35.3
	Upto matric	44	29.4
	Senior secondary	18	11.8
	Graduation	10	6.5

B. Adoption status of recommended practices

Area under recommended paddy varieties

The study revealed that among different varieties, the maximum area during the entire study period i.e., 2017-18 to 2021-22 remain occupied by long duration variety Pusa 44 (51 % in 2017-18 to about 41 % in 2021-22) due to comparatively high yield than other varieties though it needs more water, fertilizer and pesticides and is not recommended by PAU. Also, easy availability of ground water, coupled with the government's policy of supplying free electricity are the contributing factors to this finding. The private benefits obtained from higher yields of Pusa 44 compared to other varieties, far exceed its immediate costs, as the use of ground water resources is easy and inexpensive (Joshi *et al.*,2018) The next preferred variety was again unrecommended non-basmati Dogar Pusa which occupied 16.1 to 11.8 per cent of the paddy area during the study. Another major observation was that the area under unrecommended non-basmati paddy varieties has declined with time i.e., from 70.6 per cent in 2017-18 to 57.2 per cent in 2021-22 **(Table 2)**. Among recommended non-basmati varieties, PR 114 (8.8%) and PR 126 (8.3%) were the most preferred ones during 2021-22 though it was so for PR 122 (9.2%) during 2019-20. It was also observed that with time, the area under short duration (SD) varieties which require comparatively less time to mature and give farmers 20-25 days to clear the field in October-November after the kharif season harvest remained almost constant i.e., 18 per cent during the study period though it varied among different SD varieties. It was so as the yield for the SD varieties is comparatively less than Pusa 44 and Dogar Pusa in Moga district.

The area under recommended basmati varieties has almost doubled from 4.5 per cent in 2017-18 to 7.9 per cent in 2021-22 though only 0.2 per cent were under unrecommended basmati variety Muchhal during 2019-20. Among basmati paddy varieties, Pusa 1121 remained the most preferred one and it had a share of about 6 per cent in the total paddy area during 2021-22 (**Figure 1**).

Transplanting

Transplantation time for paddy starts in mid-June. The survey results indicated that only about 2 to 4 per cent of the total paddy area was transplanted before 10th of June each year (**Figure 2**) except during 2020-21 when about 9 per cent of the area was transplanted before 10th June. This happened because of the prevailing Covid-19 pandemic which forced the farmers to manage with available local labour. Across different farm operations, transplanting of paddy is the only operation in which 62.9 per cent farmers prefer migrant labour to local labour as it is manual operation to be performed well in time to avoid loss in productivity thus leading to manifold rise in demand for short-term migrant labour (Kaur *et al*., 2011). Further, during *kharif* 2021, the farmers resorted to the use of casual migrant labour which arrived in

Table 2. Trend in the area under recommended paddy varieties in Moga district of Punjab (%)

S. No.	Variety	2017-18	2018-19	2019-20	2020-21	2021-22
1.	**Recommended non-basmati varieties**					
	PR 111	0.0	0.0	0.2	0.8	0.2
	PR 112	0.0	0.0	0.0	0.0	0.7
	PR 114	3.5	2.3	6.7	7.8	8.8
	PR 118	2.6	4.3	3.3	3.6	6.4
	PR 121	6.8	5.5	2.8	1.7	2.2
	PR 122	4.1	10.0	9.2	6.6	5.7
	PR 123	0.0	0.0	0.4	0.0	0.0
	PR 124	0.0	0.0	0.0	1.4	0.0
	PR 124	2.5	1.2	2.8	0.0	1.4
	PR 126	5.3	6.7	5.5	7.7	8.3
	PR 127	0.0	0.7	1.6	0.8	0.0
	PR 128	0.0	0.0	0.0	0.7	0.4
	PR 129	0.0	0.0	0.0	0.8	0.8
	Sub total A	24.9	30.8	32.3	32.8	34.9
2.	**Unrecommended non-basmati varieties**					
	Pusa 44	51.1	34.6	47.6	45.2	40.6
	Dogar Pusa	16.1	21.4	8.3	11.1	11.8
	LR 212	0.0	0.0	0.0	0.0	2.7
	Supreme 110	0.0	0.0	0.0	0.0	0.2
	P 65	0.0	0.0	0.0	0.0	0.8
	Neelam	0.0	0.0	0.0	0.0	0.3
	SV/Sawa 27	0.7	0.4	0.5	0.2	0.0
	202	2.0	2.5	1.7	2.5	0.2
	Super 212	0.0	0.0	0.6	0.0	0.7
	777	0.7	0.4	0.2	0.0	0.0
	Sub total B	70.6	59.3	58.9	59.0	57.2
3.	**Recommended Basmati varieties**					
	Pusa Basmati 1121	3.3	6.9	7.8	5.1	6.0
	Punjab Basmati 5	1.2	0.4	0.0	0.0	0.2
	Pusa Basmati 1509	0.0	1.4	1.0	1.7	1.2
	Basmati 1718	0.0	0.8	0.0	1.0	0.4
	Pusa Basmati 1637	0.0	0.2	0.0	0.4	0.0
4.	**Unrecommended basmati (Mucchal)**	0.0	0.0	0.2	0.0	0.0
	Sub total C	4.5	9.8	8.8	8.2	7.9
	Total (A+B+C)	100.0	100.0	100.0	100.0	100.0

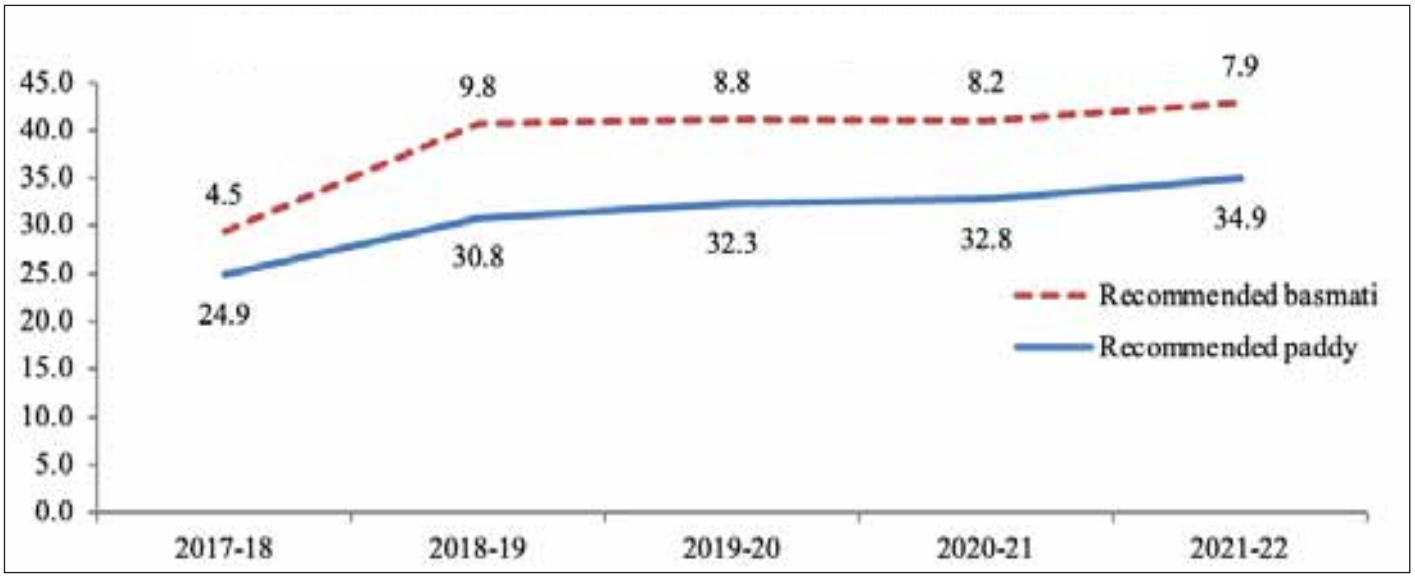

Figure 1: Trend in the area under recommended paddy varieties in Moga

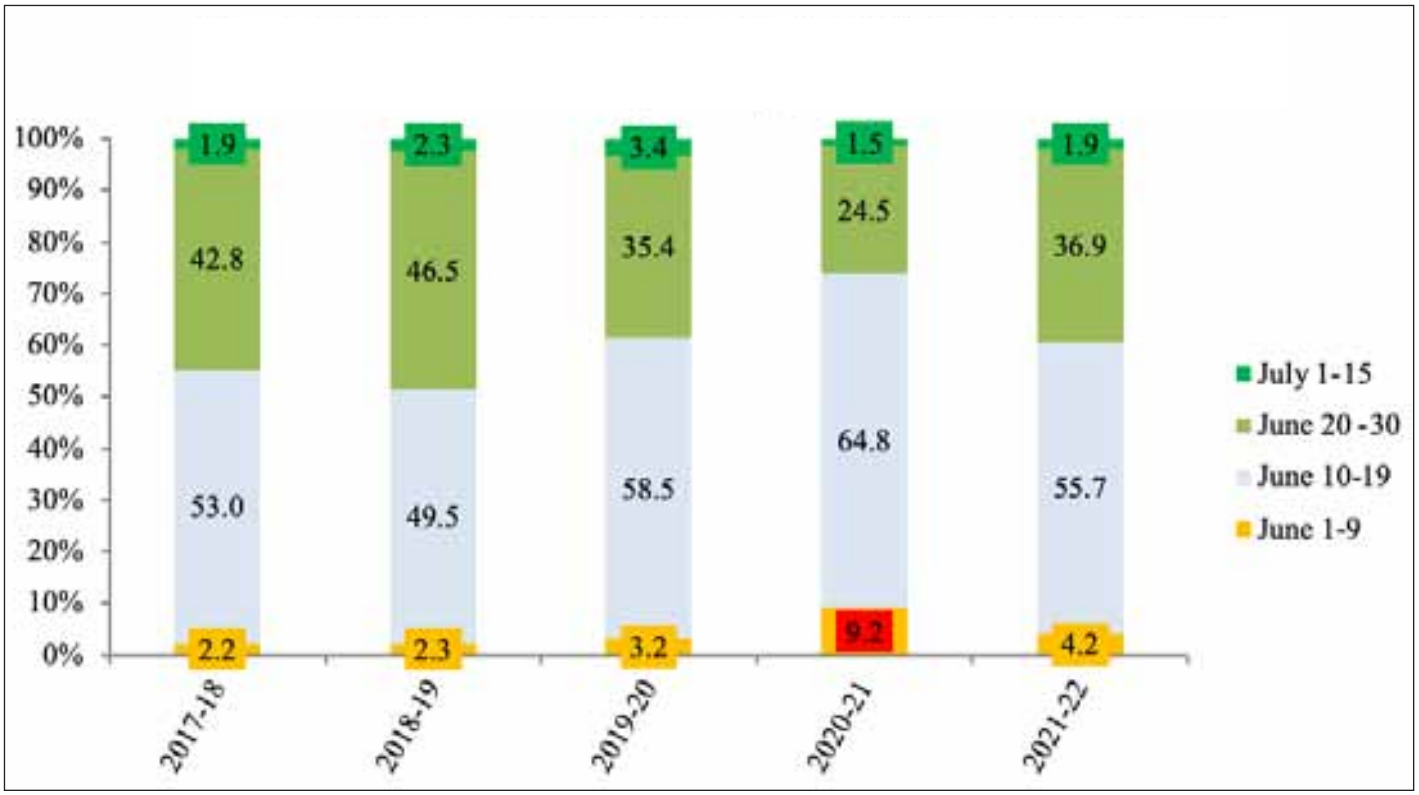

Figure 2: Paddy area transplanted during different time intervals (% share)

huge numbers in *kharif* 2021 along with use of family labour in place of highly waged local labour.

Punjab government had passed the Punjab Preservation of Sub-Soil Water Act in 2009 under which it was mandated to start paddy transplantation from June 20th to conserve subsoil water which fulfils 85 per cent of irrigation needs in the state. During *Kharif* 2020, due to the pandemic, the government relaxed these norms and advanced the paddy sowing and transplantation dates (ET, 2020). The paddy nursery sowing and transplantation operations commenced on May 10th and June 10th, respectively which also

helped the farmers in the timely completion of paddy transplanting. A large share of area under paddy (50 to 65%) was transplanted between 10-19th of June followed by about 25 per cent (2020-21) to 47 per cent in 10-20th June and the rest about 2 to 3 per cent in the beginning of July (1-5th July).

The majority of the farmers had also adopted the recommended transplantation time i.e., second fortnight of June except during *Kharif* 2020. The highest area was transplanted between 1-15th of July in case of basmati during 2017-18 (39.9%) to (67.7%) in 2021-22 (**Figure 3**).

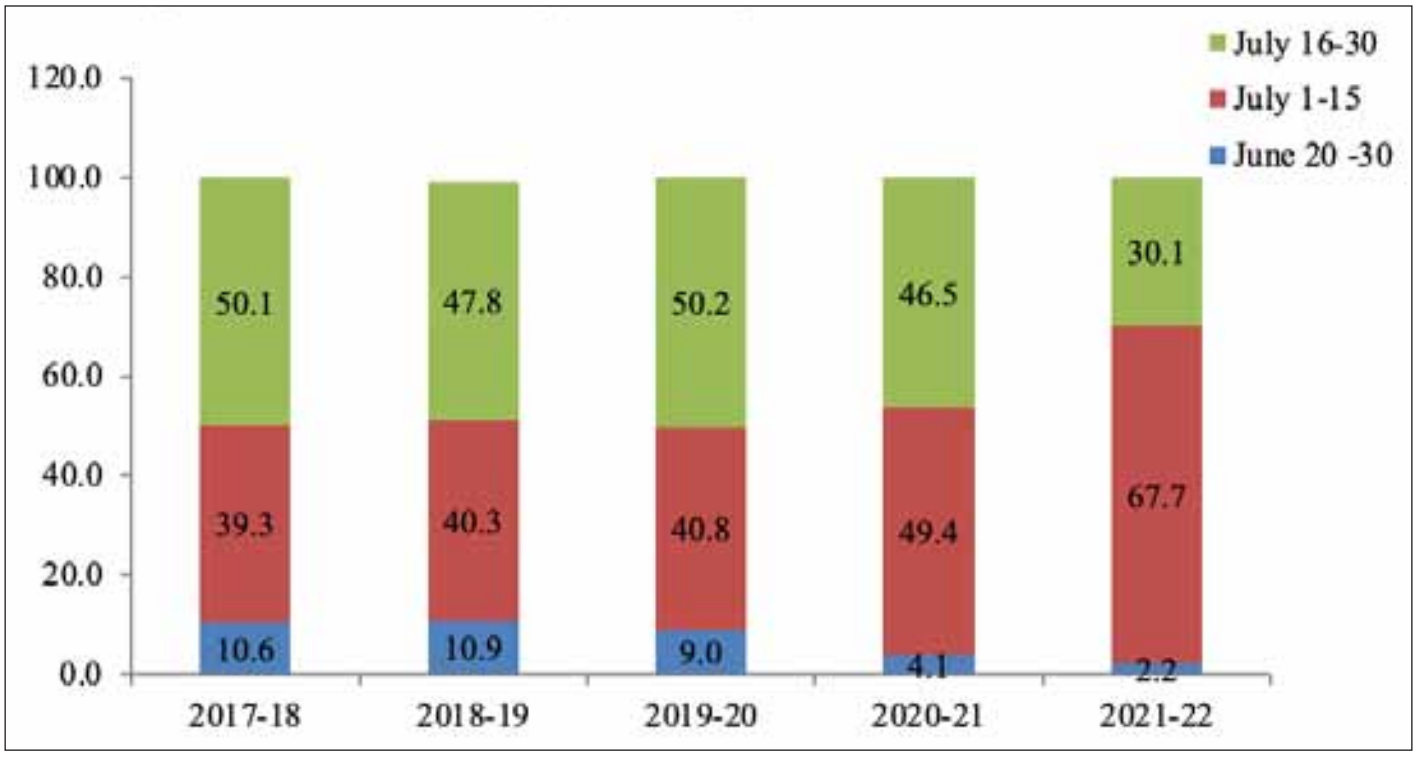

Figure 2: Basmati area transplanted during different time intervals (% share)

Fertilizer use

Punjab state ranks third at the national level for fertilizer consumption per hectare (224.49 kg/ha) with average consumption per hectare being almost one and a half times as compared to the national level of 133.12 kg/ha during 2018-19 (Anonymous, 2019). In the present study, it was found that the majority (39-44%) of the paddy farmers were applying fertilizer N in the range of 137.5-162.5 kg N/ha during different years of the survey period, while 31-37 per cent of the farmers were applying fertilizer in the range of 112.5-137.5 kg/ N/ha. The application of fertilizer N in the case of basmati paddy was in the range of 87.5-112.5 kg N/ha for a majority of the farmers. The majority of the farmers were applying fertilizer N in excess to basmati during the initial years of the survey though it has declined over the years (**Table 3**). It may be mentioned here that Integrated Nutrient Management (INM) practices lead to a significant increase in grain and straw yield of rice (Rahale, 2019) but about three-fourths of the farmers in South-Western Punjab have the second highest energy expenditure on fertilizers specifically N content after irrigation (Singh *et al.*, 2019).

Table 3. Distribution of farmers according to extent of nitrogen fertilizer use in paddy and basmati paddy in the Moga district of Punjab

Extent of nitrogen use in non-basmati paddy					
Dose of Nitrogen (Kg/Ha)	**Percentage of farmers**				
	2017-18	**2018-19**	**2019-20**	**2020-21**	**2021-22**
62.5 to 87.5	4	5	7	7	6
87.5 to 112.5	15	14	17	13	11
112.5 to 137.5	31	35	35	37	35
137.5 to 162.5	44	43	39	40	43
162.5 to 187.5	7	3	3	3	5
Extent of nitrogen use in basmati paddy					
Dose of Nitrogen (Kg/Ha)	**Percentage of farmers**				
37.5 to 62.5	11	12	13	14	13
62.5 to 87.5	33	31	35	31	33
87.5 to 112.5	39	42	42	46	47
112.5 to 137.5	17	15	10	9	7
37.5 to 62.5	11	12	13	14	13

It was evident from the data (**Table 4**) that there was a rise in proportion (69% to 73%) of farmers in a span of five years who discontinued the practice of applying phosphorus to the paddy crop. During 2021-22, there was 10 per cent of farmers applied 12.5 - 37.5 kg P_2O_5 /ha. Only 6 percent of the farmers were applying P in the range of 37.5-50 kg/ha. Kaur and Sharma (2017) reported that small farmers were using fertilizers more optimally than medium and large farmers in the state. In the case of the basmati crop, discontinuance of the practice of applying phosphorus in the span of five years increased in proportion from 38 per cent of the farmers to 49 per cent during the study period. The proportion of farmers applying fertilizer-P up to 50 kg/ ha was 12 per cent only. The use of fertilizer-K in paddy crop is recommended based on soil test reports as this nutrient is generally found available in soils to meet crop needs and none of the selected farmers was doing so. Thus, the majority of farmers were following recommended practices with respect to fertilizer use. This shows that extension efforts were successful in convincing farmers to skip the dose of fertilizer-P in case recommended dose has already been applied to *rabi* season crop.

Table 4. Distribution of farmers according to extent of phosphorus fertilizer use in paddy and basmati paddy in Moga district of Punjab

Extent of phosphorus use in paddy					
Dose of Phosphorus (Kg/Ha)	**Percentage of farmers**				
	2017-18	**2018-19**	**2019-20**	**2020-21**	**2021-22**
Nil	69	70	73	77	73
12.5 to 25	5	2	0	7	10
25 to 37.5	18	21	20	10	6
37.5 to 50	8	7	7	7	11
Extent of phosphorus use in basmati paddy					
Dose of Phosphorus (Kg/Ha)	**Percentage of farmers**				
Nil	38	40	58	51	49
12.5 to 25	19	9	0	3	6
25 to 37.5	33	30	26	31	33
37.5 to 50	10	21	16	15	12

Conclusions

The data collected regarding area shift, varieties and cultivation practices in paddy revealed that the paddy cultivation is diversified in district Moga as basmati and non-basmati types along with different varieties are being cultivated here. Pusa 44 due to its high yield is the most preferred paddy variety in the district. Policy intervention is important in this setup where the natural resource cost is not fully realized, and growing environmentally unsustainable Pusa 44 is resulting in negative externalities. On the other hand, the area under recommended varieties has increased during 2017-18 to 2020-21 and the reason behind this increase in the area could be the government policy for sowing paddy after 10th June which encourage farmers to sow short-duration varieties rather than long-duration varieties. Also, continuous extension programmes led by Punjab Agricultural University, Ludhiana, and Krishi Vigyan Kendras for creating awareness among farmers regarding short-duration and water-saving varieties and technologies like tensiometer help in adopting the recommended varieties. Only about 2 to 4 per cent of the total paddy area was transplanted before the 10th of June each year except during 2020-21 when the prevailing covid19 pandemic forced the farmers to manage paddy transplanting quickly with available local labour to tackle the high scarcity of casual labour. Excessive use of Nitrogen fertilizer by farmers in the form of urea was observed during the time period. The farmers were found to be using excessive fertilizers for paddy against the recommendation of the researchers of the PAU. Development of an appropriate management strategy for enhancing nutrient use efficiency and ensuring the environmental sustainability of the paddy production system is a priority area of research. Therefore, there is a need for an intensified extension for disseminating the technology for efficient nutrient management among the paddy growers, e.g. leaf colour chart (LCC) developed by PAU for its' wider adaptability. Fertilizer application by adopting the 4R rule, that is, the right source, rate, time, and place for enhancement of efficiency of nutrients applied by increasing yield must be adopted. By conducting regular surveys and monitoring, the adoption of new varieties, techniques, and input use can be monitored regularly, and policies can be framed accordingly by the government, universities, and extension agencies. In a study from Nepal (Pokhrel *et al.,* 2021), the results revealed that membership in an agriculture group, advice from agriculture technicians, training, visit of extension workers, and paddy-cultivated land had a positive and significant effect on the adoption of various production practices. The same can be followed for better management and adoption of recommended paddy varieties and recommended fertilizer input use. Therefore, the significant role played by extension agencies, increased emphasis on information dissemination, field demonstration, and farmers' participatory research and training programs are required.

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