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Farmers' Preference for IARI Wheat Varieties in North Western Plain Zone (NWPZ) and Central Zone (CZ) of India

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HIGHLIGHTS

- Higher grain yield was selected as the most preferred attribute among farmers followed by higher straw yield and bold grain size.
- The eleventh combination was the most preferred in the study with utility scores of 19.079 for NWPZ farmers, and 16.617 for CZ farmers.
- Plant height was the least significant factor having 3.925 per cent contribution in NWPZ and 3.507 per cent in CZ.

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ABSTRACT

This research work was conducted in 2023 to identify preferred traits of *Triticum aestivum* and *Triticum durum* wheat among farmers in North-Western Plain Zone (NWPZ) and Central Zone (CZ) of India, respectively. The method of sampling used for choosing 120 farmers was multi-stage random sampling, of which 60 farmers were from Aligarh, Uttar Pradesh, and 60 farmers were from Dewas, Madhya Pradesh. SPSS was used to perform quantitative conjoint analysis of the preferences for plant height, crop duration, irrigation requirement, pest attack, grain yield, grain size, and straw yield. From observations taken during the interviews, farmers preferred early maturity, species or hybrids with high grain and straw yield, large grain size, high market price, low water usage through irrigation, and disease or pest attack rating. Grain yield and straw yield, grain size, and market rate had a very high influence on preference, while plant height had the least influence. These insights can inform future wheat breeding programs aligned with preferences by farmers to improve food production in the NWPZ and CZ regions. Understand what these preferences are and formulate varieties that will meet the requirements for better food production.

INTRODUCTION

Cereals are essential for meeting the world's expanding population's food needs, especially in developing countries (Nikos & Jelle, 2012). The Levant originated cereal is among the most important global food crops, following rice and maize (Acevedo et al., 2018), contributing 20 per cent of the daily calorie and protein intake globally (Shiferaw et al., 2013). India is the second largest producer of wheat in the world, producing 110.5 million tonnes in 2021-22 (Goyal et al., 2024). However, the situation in the past was not at all like that; from 1947 to 1960, India had to import wheat (Nelson et al., 2019), but with the help of the Green Revolution in the sixties, it had achieved surplus production of wheat (Sharma et al., 2015). Amidst the varied agro-ecological zones of India, North Western Plain Zone and Central Zone are the most wheat-producing parts of the nation (Gupta et al., 2023). Punjab, Haryana, western Uttar Pradesh, and Rajasthan make up the North West Plain Zone (NWPZ) (Singh et al., 2014), which is the most productive wheat belt in India and accounts for 70–75 per cent of the country's annual wheat production (Singh et al., 2019). Whereas the Central Zone consists of Madhya Pradesh, Chhattisgarh, Gujarat, Kota and Udaipur divisions of Rajasthan, and Jhansi division of Uttar Pradesh (Prasad et al., 2024). CZ is prominent for its Triticum durum variety of wheat (Saini et al., 2023), whereas

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NWPZ is famous for its Triticum aestivum variety, which is used for Roti/Chapatti (Mohan et al., 2023). Despite the prominence of these regions in wheat production, there are still various bottlenecks associated with wheat production, e.g., there is a variation in wheat production in the NWPZ region, with average yields of 4.2 t ha^{-1} in Punjab, 3.9 t ha^{-1} in Haryana, and 2.7 t ha^{-1} in Uttar Pradesh, despite guaranteed irrigation and other management aids (Saikia et al., 2011). Along with low fertility of soil and weather aberrations, overuse of groundwater resources, decrease in the response to applied fertilizers, emergence of micronutrient deficiencies and herbicide-resistant weeds, and growing pressure from pests and diseases (Bhatt et al., 2016; Bhatt et al., 2021). So, preferring a good quality of seed is the most essential part for the cultivation of wheat cultivation since seed quality solely can contribute 15-20 per cent to the overall production of crops (Jethi et al., 2022). Preference is defined as evaluative judgment, involving liking or disliking an object commonly used in social sciences and cognitive sciences (Scherer, 2005). Varietal characteristics such as maximum yield, pest and disease resistance, grain quality, number of irrigations required, etc., influence a farmer's decision on accepting or rejecting a particular variety of wheat. This paper aims to capture the preference of varietal traits of the *Triticum aestivum* and *Triticum durum* among the farmers of NWPZ and CZ, respectively, using conjoint analysis. Understanding the farmer's preference regarding the varietal traits of wheat is crucial for improving the wheat productivity as well as the economic conditions of the farmers associated with it.

METHODOLOGY

A systematic multi-stage random sampling method was used to conduct the study between 2022 and 2023. It started by targeting Uttar Pradesh as a favourable Triticum aestivum production locality, followed by selection of Aligarh district and villages at Bhamraula and Madhola. For the Triticum durum variety, Madhya Pradesh was the selected state with emphasis on Dewas district and the villages of Mendki Dhakar and Sarola. A total of 120 farmers across the two zones were sampled, and 60 respondents in each zone were interviewed in person and analysed using conjoint analysis. Upon review of literature and expert/key informant interviews, eight attributes were finally selected. The attributes for *Triticum aestivum* and *Triticum durum* included grain yield and straw yield, classified into three levels: less than 40 q/ha, 40-50 q/ha, and more than 50 q/ha. Grain size was divided into small and bold. Market rate at the same or higher than other non-IARI varieties. Pest incidence was assessed as more or less susceptible. Plant height was classified as tall and dwarf, and irrigation requirements were categorized into 3-4 or 5-6 irrigations. Using SPSS, an orthogonal design with sixteen combinations of eight attribute were generated. The farmers ranked the combinations, from which total scores and utility estimations of each attribute were collected. Finally, additive conjoint model was used to find the most preferred attribute, which expressed as:

$$U = \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \varepsilon$$

Whereas, U = Product's overall utility, β_1, β_2, β_n = part worth utilities related to each trait. X_1, X_2, … X_n = level of each attributes, ε = error term

RESULTS

Preference in this context operationalized as the farmers' inclination for certain characteristics of the various IARI wheat varieties in terms of grain yield, grain size, market rate, incidence of pests and diseases, crop length, as well as irrigation requirements and straw output.

A conjoint model with eight attributes with various levels as discussed above was developed to identify the preference for attributes for IARI wheat varieties. Afterwards, utility estimate for different levels of attributes calculated using SPSS software, utility estimate indicates degree of preference of a particular level in each attributes, with higher values indicating higher preference and lower values indicating lower preference. The utility estimates of various levels of attributes presented in Table 1.

Table 1. Attributes of wheat varieties favoured mostly in the entire study area

Attributes	Levels	NWPZ Utility estimate	CZ Utility estimate
Grain yield	<40 q/ha	4.425	4.613
	40-50 q/ha	8.851	9.226
	>50 q/ha	13.276	13.838
Grain size	Small	1.264	0.870
	Bold	2.528	1.741
Market rate	Similar to non-IARI varieties	0.340	0.120
	Higher than non-IARI varieties	0.679	0.241
Plant height	Tall	0.042	-1.713
	Dwarf	0.085	-3.426
Pest and disease incidence	More	0.189	0.178
	Less	0.377	0.344
Crop duration	<110 days	-1.111	-0.572
	110-130 days	-2.223	-1.145
	>130 days	-3.334	-1.717
Irrigation number	5-6	0.495	0.199
	3-4	0.991	0.344
Straw yield	<40 q/ha	0.902	1.170
	40-50 q/ha	1.804	2.340
	>50 q/ha	2.707	3.510
Constant		-2.373	-2.514

From Table 1 it can be seen that grain yield's preference in terms of varietal traits is quite similar amongst the farmers of NWPZ and CZ. In NWPZ and CZ, highest grain preference was shown in the grains yielding more than 50 q/ha with utility estimate of 13.276 and 13.838 respectively. Bold grains were preferred to small grains with utility estimate of 2.528 and 1.741 in NWPZ and CZ respectively. Farmers of NWPZ and CZ preferred the varieties with higher market rates with utility estimate of 0.679 and 0.241 respectively. Most farmers of NWPZ preferred dwarf to tall ones in relation to plant height with utility estimate of 0.085 and it is

Table 2. Utility scores for different combinations of characteristics of IARI wheat varieties ranked the in study area

Card no.	Grain yield	Grain size	Market rate	Plant height	Pest & disease incidence	Crop duration	Irrigation number	Straw yield	NWPZ Total score	NWPZ Rank	CZ Total score	CZ Rank
1	<40 q/ha	Bold	Similar to non-IARI varieties	Dwarf	More	>130 days	3-4	>50 q/ha	7.931	XII	7.13	IX
2	<40 q/ha	Bold	Similar to non-IARI varieties	Tall	More	<110 days	3-4	40-50 q/ha	9.589	IX	6.906	X
3	40-50 q/ha	Bold	Higher than non-IARI varieties	Tall	Less	110-130 days	3-4	>50 q/ha	13.834	V	12.403	V
4	>50 q/ha	Small	Higher than non-IARI varieties	Tall	More	<110 days	5-6	>50 q/ha	18.369	II	14.838	II
5	<40 q/ha	Small	Similar to non-IARI varieties	Dwarf	Less	<110 days	5-6	>50 q/ha	8.582	X	5.587	XI
6	<40 q/ha	Bold	Higher than non-IARI varieties	Dwarf	Less	<110 days	5-6	<40 q/ha	8.380	XI	4.509	XIV
7	<40 q/ha	Small	Similar to non-IARI varieties	Tall	Less	110-130 days	5-6	40-50 q/ha	6.902	XIV	3.915	XV
8	<40 q/ha	Bold	Higher than non-IARI varieties	Tall	Less	>130 days	5-6	<40 q/ha	6.312	XVI	3.165	XVI
9	40-50 q/ha	Small	Higher than non-IARI varieties	Dwarf	More	>130 days	5-6	40-50 q/ha	10.033	VIII	8.110	VIII
10	40-50 q/ha	Bold	Similar to non-IARI varieties	Tall	More	<110 days	5-6	<40 q/ha	12.614	VI	8.636	VII
11	>50 q/ha	Bold	Higher than non-IARI varieties	Dwarf	Less	<110 days	3-4	40-50 q/ha	19.079	I	16.617	I
12	40-50 q/ha	Small	Similar to non-IARI varieties	Dwarf	Less	<110 days	3-4	<40 q/ha	11.699	VII	9.843	VI
13	<40 q/ha	Small	Higher than non-IARI varieties	Dwarf	More	110-130 days	3-4	<40 q/ha	6.492	XV	4.612	XIII
14	<40 q/ha	Small	Higher than non-IARI varieties	Tall	More	<110 days	3-4	<40 q/ha	7.759	XIII	4.986	XII
15	>50 q/ha	Bold	Similar to non-IARI varieties	Dwarf	More	110-130 days	5-6	<40 q/ha	16.042	III	12.874	IV
16	>50 q/ha	Small	Similar to non-IARI varieties	Tall	Less	>130 days	3-4	<40 q/ha	14.866	IV	13.111	III

vice versa for CZ with utility estimate of -1.713 of tall varieties. In relation to incidence of pest and disease, in both NWPZ and CZ majority of the farmers preferred low incidence of pests and diseases with a utility estimate of 0.377 and 0.344. Furthermore, farmers in both regions also preferred crop durations to be shorter than the longer crop durations with utility estimate of -1.111 and -0.542. They also preferred straw yields where the higher straw yields (>50 q/ha) were preferred to the lower yields (40-50 q/ha). Altogether, the farmers of both regions (NWPZ and CZ) preferred the varieties which required 3-4 irrigations compared to 5-6 irrigations, with a utility estimate of 0.991 and 0.344. Furthermore, utility ratings were used to construct rankings for the different combinations. The combination with the highest ratings represents the farmers' desire at the highest level, and the combination with the lowest values represents their preference at the lowest level. Using this technique, researchers could ascertain, based on farmers' choices, which set of factors they preferred. The rankings offer insightful information about the factors that farmers consider most crucial when choosing crops. The overall utility scores for various combination of IARI wheat varieties in NWPZ and CZ are presented in Table 2.

Farmers in both regions, NWPZ and CZ had quite similar preferences; the eleventh combination was the most favoured combination, followed by fourth and fifteenth combination was selected equally by farmers in both regions with a utility estimate of 19.079, 18.369 and 16.042 in North West Plain Zone. In Central Zone, eleventh combination was most favoured combination among farmers followed by fourth and sixteenth combination with an overall utility score of 16.617, 14.838 and 13.111 respectively. Finally, 8th combination was the least favoured combination among farmers of North West Plain Zone and Central Zone with and overall utility score of 6.312 and 3.165 in NWPZ and CZ respectively.

Furthermore, among the eight attributes selected for inspecting preference of farmers on varietal traits, average important percentage scores for different attributes representing percentage rankings of preferred attributes taken into account. Higher the percentage scores represent greater level of preference among the sample and vice versa. The relative importance values of different attributes of IARI wheat varieties in both regions of NWPZ and CZ are presented in the Table 3.

In the above Table 3, grain yield got the highest importance with a relative importance percentage of 49.369 per cent and 50.024 per cent respectively in NWPZ and CZ, followed by straw yield,

Table 3. Relative importance of various attributes of wheat varieties in the study area

Attributes	Relative importance (%)	
	NWPZ	CZ
Grain yield	49.369	50.024
Straw yield	12.412	12.70
Grain size	10.089	9.141
Market rate	9.255	8.597
Irrigation number	4.988	6.491
Crop duration	4.706	5.202
Pest and disease incidence	5.247	3.528
Plant height	3.925	3.507

grain size and market rate in both North Western Plain Zone and Central Zone of India, whereas plant height got the least importance among the attributes with relative importance percentage of 3.925 and 3.507 in NWPZ and CZ respectively.

Correlation between observed and estimated frequencies in North Western Plain Zone (NWPZ) and Central Zone (CZ) presented in the Table 4.

Table 4. Correlation between observed and estimated preferences for wheat in study area

	Correlation coefficient		Significance	
	NWPZ	CZ	NWPZ	CZ
Pearson's R	0.976	0.974	0.001	0.001
Kendall's tau	0.917	0.883	0.001	0.001

Data in the Table 4 shows the strong degree of correlation between observed and estimated preferences of IARI wheat varieties in both regions of NWPZ and CZ, which point towards accurate response by the respondents.

DISCUSSION

The study showed that there is a strong favour for quality, like higher grain and straw yield, bold seed, small plant height, and less pest and disease incidence, and a lesser irrigation number among the respondents of the study area. The findings are similar to Semahegn et al., (2021), who found that farmers in the study regions ranked high grain output as their most desired attribute, followed by early maturity, disease resistance, and stress adaptation (tolerance to heat and drought). Teferi et al., (2020), in their study on varietal preference of wheat, found that when considering the relative importance of the features, farmers are ready to spend ten times as much on a variety that is resistant to rust. This is quite evident in this research too, where farmers of NWPZ found resistance to pest and disease as a trait in wheat variety relatively more important with a score of 5.247 per cent (Table 3). However, farmers of CZ find it less important with a score of 3.528 (Table 3). Bold grains were one of the most sought-after characters among the wheat farmers of NWPZ and CZ, with utility scores of 2.528 and 1.1741, respectively (Table 1), and relative importance of 10.089 percent and 9.141 per cent in NWPZ and CZ, respectively (Table 4), primarily because it can generate more revenue in the market. Results of which are aligned with the research of Krishna et al., (2022), where they found that the colour of the mature grains (light-coloured and bold) and the quality of the wheat variety specifically suited for chapattis (taste, puffiness) were the traits favoured by the majority of the respondents. In their study on farmers' preferences for improved wheat varieties, Bhatt et al., (2020) discovered that farmers' preferences for a variety were influenced by other significant characteristics in addition to yield. Stem thickness, pest tolerance, and flour quality. Pandit et al., (2011), in their study on wheat varieties, found that farmers preferred those varieties that have an overall advantage over the one that has only a higher yield. These results are analogous with the current study where farmers of both NWPZ and CZ have chosen the combination number 11 (Table 2), having grain yield more than 50 q/ha, bold seeds, price higher than non-IARI varieties, dwarf plant height, less pest and disease incidence, crop duration less than 110 days, need 3-4 irrigations, and straw yield less than less than 40 q/ha; this result shows farmers tend to choose a combination of traits that have an overall benefit.

CONCLUSION

The purpose of this research is to determine the extent of farmers' managerial preferences for IARI wheat cultivars that are cultivated in the Central and North Western Plain Zones of India. Yield was listed as a very important grain trait; in particular, grain yield above 50 quintals per hectare was preferred. Farmers preferred traits included straw yield of 40 to 50 quintals per ha, bold grains, low plant height, low pest pressure rates, market prices above non-IARI varieties, number of irrigations (3-4), and days to maturity (less than 110). This study shows that it is not beyond the realm of possibility to conduct quality seed research that would fit farmer's needs. However, in some cases, optimism of expectations for traits does not manifest itself in positive outcomes. More future studies should be conducted exploring other crops of interest, strengthening the R-E-F linkages, and ensuring that investigated problems are relevant to farmers' priorities.

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