International Journal of Agriculture and Allied Sciences: January-June 9(1); 46-51, 2024

PERFORMANCE EVALUATION AND PARTICIPATORY WHEAT VARIETAL SELECTION: AN OPTION FOR IDENTIFYING FARMERS PREFERRED VARIETY IN BARDIBAS MAHOTTARI

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ABSTRACT: Wheat is a stable food crop, shares about 7.14 % in GDP but has low productivity due to lack of niche specific varieties and other agronomic practices. Selection of varieties takes long time and based on yield become challenge to adapt them in different socio-economic aspect. So, the experiment was laid-out using Randomized Complete Block Design, with varieties (Gautam, Zinc, Borlaug 2020, Banganga, NL 1349, NL1386, BL 4814 BL 4341) with 2 replication. Yield, Biomass and Harvest Index were observed and 12 morphological agronomic traits were evaluated by participatory preference. Among 12 traits, six traits were predominately observed by the participants. Participants prioritized yield followed by earliness, drought tolerance, plant height, grain size, grain color and other traits. Among varieties, Banganga (3.752 ton) demonstrated higher yield followed by NL 1349((3.39t/ha) and Borlaug (2.79t/ha) showed the least yield. Among 20 people surveyed, 15 prefer earliness while 5 favors intermediate and none prefer late maturing one. Over 80% prefers white and 20% prefers light yellow grain color likewise 50%, 35%, 15% prefer oval, large and spherical grain shape respectively. 40% males and 50% female prefer short stature. Gautam was preferred mostly by male and Banganga was preferred by females. Majority of the farmer were drawn attention to the zinc wheat variety for its exceptional nutritional value. Usually the farmers prioritized crop yield however after subsequent field visit they recognized significance of unique characters of each varieties. So, selection of varieties should be based on participatory approaches for sustainable adaptation in different socio-sector.

Keywords: Wheat, productivity, varieties, yield, traits

Wheat (Triticum aestivum) is a self pollinated annual hexaploid species with (2n=6x = 42) having AABBDD with AB and D genome of the family Gramineae (Poaceae) (Gebeyehu et al. 2022) . It is one of important crop of global important. It is native to Middle East and is one of the oldest domesticated grain crops for 8000 years. It is grown on larger area than any other crops (220.7 million hectares). It is one of the third most important staple food crop with 15% of total caloric intake after corn (19.5%) and rice (16.5%). In the marketing year of 2023/24 the total production of wheat amounted to 784.91 million metric ton globally (FAO 2023).China, India and Russia are the 1st , 2nd and 3rd major wheat producer with production of 136,946,000 t, 109,600,000 t and 76,057,258 t respectively (FAO 2023) .

Wheat is the third most important cereal crop of Nepal in terms of area and productivity. Nepal rank on 38th position on total wheat production in the world. Wheat is grown at an altitude ranging from 60 to 2500 masl, between 26.3° to 27.0° N latitude and 80.0° to 88.2° E longitude in Nepal, the most suitable agro-ecological zones fall between 1500 and 2500 masl The total production area of wheat is 716,978 ha with production of 2144568mt (2.99 mt/ ha) where Madesh province (628,909 mt) was the highest producer. Dhanusa is the district with highest wheat production of 3.34 ton/ha, greater than the national average (2.99 ton/ha) (Agriculture Census 2021/22 2021). The yield of current situation is below than the neighboring countries India(3.37 ton/ha) and Cina(5.48 ton/ha) (Bhatta, Gupta, and Joshi 2022).Wheat has contributed to 6.98% in AGDP and 2.30 % in GDP. It is grown on terai, mid hills and high hills in the winter season. In terms of production and consumption, wheat rank on 3rd most important cereal in hills and mountains regions and rank on 2nd position in terai region of Nepal. 25% of the cultivated land of Nepal is utilized for wheat production and almost about 60% of wheat is produced in Terai region but the production has slightly decreased over the last pas years (Statistical Information on Nepalese Agriculture 2078).Nepal export raw wheat grains, different wheat products from different countries like India, Mexico, Australia, Turkey etc.

After the introduction of semi-dwarf varieties of wheat in Nepal in 1960s there was an increment in the production of

wheat (almost doubling the productivity) (Bhatta et al. 2022) .43 improved wheat varieties have been released so far in Nepal and among this 26 varieties are recommended for Terai region. (Statistical Information on Nepalese Agriculture 2078) and 13 varieties are identified and only 30 varieties are used for cultivation (Timsina et al. 2018). NL-971, WK-1204, Aditya, Vijay, Gautam, and Bhrikuti are the most widely used wheat varieties in Nepal.(Bhatt, Bist, and L. N. Ojha 2020) . Different resources are being continuing for releasing varieties but still it is lacking behind for increasing its productivity. Many resource poor farmers in Mahotary face low productivity because of multiple interconnected problems. A lack of variety options and inadequate communication between researchers and farmers frequently result in the adoption of technologies that are inappropriate for the environment in the area. Farmers preferences for different genotypes are often disregarded by researchers, leading to a mismatch between the needs of the farmers and the varieties developed. The issue is made worse by the top-down method used in seed production and variety selection.

The difficulties faced by farmers are not addressed by traditional research methods, which are mainly carried out on stations that do not accurately represent the farming environments of Mahotary. As a result, many of the suggested technologies are still inefficient or underutilized. Older varieties which are vulnerable to both biotic and abiotic stresses are still being grown continuously reducing productivity. Maintaining consistent yields is also severely hampered by the effects of climate change, which include variations in temperature and rainfall patterns. In addition, reducing genetic diversity using local varieties and the continuous cultivation of a single improved variety leaves crops more susceptible to pests and diseases. The assessment and selection of varieties also has a big gap, which prevents the development of potential high-yield crops. Because they lack confidence or knowledge, farmers frequently choose varieties that are easily found in their area and disregard research recommendations. Others likely reasons for the low uptake of newly released varieties include their poor compatibility with the growing conditions of most farmers, their lack of knowledge about the varieties, the absence of varieties that are specifically suited to their needs, and their use of conventional and readily available production techniques. Socioeconomic considerations are also very important in this matter. Many farmers do not have access to basic supplies like high-quality seeds, fertilizer, and instruction in contemporary farming methods. These issues are made worse in rural regions by inadequate extension services and inadequate infrastructure. Additionally, farmers are unable to invest in better farming practices due to a lack of funding and credit options.

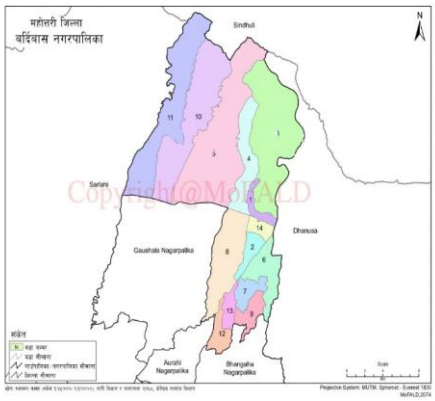
In developing nations such as Nepal, the implementation of Participatory Variety Selection (PVS) has demonstrated significant effectiveness in addressing various kinds of agricultural challenges and problems. Farmers are able to overcome the obstacles that compel them to grow land races or out-of-date varieties by using PVS to find new varieties that they are willing to grow. PVS effectively utilizes farmer's knowledge to retain the seeds of selected varieties from year to year by offering them a range of genotypes that coincide with their selection criteria. By empowering farmers to identify problems, choose varieties, and distribute seeds to address those problems, this project seeks to improve selection efficiency. In order to choose and promote improved agricultural technologies, farmer participation is essential. Farmers must be involved in the assessment and selection process,

For variety adaptation, introduction, and dissemination, farmers participation in the evaluation and selection process is essential. PVS, which involves the selection of finished or nearly-finished products by farmers on their fields, ensures faster adoption of new cultivars compared to formal crop improvement methods. Good adoption rates are ensured by the local seed system, which makes it easier for these varieties to spread quickly from farmer to farmer. PVS also enhances varietal diversity on farm and speeds up varietal replacement and scaling up by enabling farmers to assess materials according to the qualities that are important to them. In view of this, the current research was conducted to address the following objectives:

- To evaluate and recommend high-yielding, early-maturing, disease-resistant, and drought tolerant wheat varieties through PVS.
- To assess farmers' selection criteria for improved wheat varieties.
- To identify key criteria for future bread wheat improvement in the study area

Figure 1: Map of Nepal showing Mahottari district

Figure 2: Map of Bardibas municipality showing study area



RESEARCH METHODOLOGY

Description of experimental sites

The study was conducted in ward no.6 of Bardibas municipality of Mahottari district. . It is situated at latitude 26°52′22.08″ North, longitude 85°49′42.96″ East. It covers an area of 1002 square kilometer. The Bardibas municipality is bordered by Dhalkebar of Mithila municipality, Dhanusha District in the east, and Ishworpur of Sarlahi District in the west. Kamalamai of Sindhuli District, Bagmati Province, is in the north, and Bhangaha, Aurahi, and Gaushala are in the south. Also, the population of this area is 7436. It lies on the lap of Churia Hills at an elevation of 254 m (883 ft). The average annual temperature of Bardibas municipality is 32°C along with average annual rainfall of 691mm. Rice, wheat, maize, lentils, and vegetables like tomatoes and potatoes are the most important crop grown in this municipality. 8 varieties in total were used as experimental treatment. The trial experiment was laid out by randomized complete block design with three replication in Kishannagar village of ward no.6. In each field plot the varieties were assigned randomly and each of them was planted on the plot of 6m 2 (2m×3m) having 1m and 0.5m spacing between block and plot respectively. From the plot net area Biomass and Yield data were taken and then, converted to ton/ha.

Participatory Varietal Selection Procedure

Farmers were interviewed using focus group discussions (FGDs) and participative procedures (direct and paired matrix ranking) to gather qualitative data on wheat types in bardibas, including routine checks. Farmers were chosen based on their experience raising bread wheat and the participation of actual representative groups (aged, young, men, and women) who were willing to engage in the study. As a result, a total of twenty (M = 10 and F = 10) farmers from each of the two study locations were employed to establish farmer selection criteria. Matrix ranking was very beneficial for identifying key qualities of interest. Pair-wise ranking was also an effective tool for exploring and discussing decision-making criteria between and among trait options.

Farmer's evaluation of wheat varieties on Trials

Trials were examined using two replications. The wheat types were evaluated based on farmer selection criteria. An evaluation was conducted at the mature stage. Farmers were given the opportunity to create their own selection criteria at this stage, and male and female participants individually prioritized and agreed on the most essential characters at the final maturity stage of trials. The data was organized in a matrix scoring table, and each selection criterion was compared

pair-wise. Performance rating scores were assigned to each variety based on the selection criteria (5=excellent, 4=very good, 3=good, 2=poor, and 1=very poor). During direct matrix ranking, farmers rated the importance (a relative weight) of a selection criterion on a scale of 1 to 3 (3 = very important, 2 = important, and 1 = less important), and a rating of a variety's performance for each trait of interest (selection criteria) was given based on a common agreement among evaluators. The score of each variety was multiplied by the relative weight of a particular character to obtain the final result, which was then added to the results of other characters to calculate the total score of a given variety. Scoring and ranking were done based on consensus, and disagreements were settled through discussion.

Yield, biomass and HI was calculated.

The mathematical method of HI:

$HI = EY / BY \times 100\%$

Where, HI =Harvest Index, EY=Economic yield, BY =Biological yield

Statistical Analysis

Data was entered in Microsoft Excel analyzed through Genestat ver 2015. DMRT was done for mean separation.

Results and Discussion

Among the varieties examined, Banganga(3.752 ton/hac) exhibited the highest yield followed by NL 1349(3.39 ton/hac).Other notable varieties include Gautam,Zinc, NL 1386, and BL 4818, BL 4341 each demonstrating varying levels of productivity. Banganga consistently outperformed others, with Barlaug recording the lowest yield.

Table-1 : Yield differences in economic yield among different farmers in ton/hac

variety	Farmer 1	Farmer 2	Farmer 3	Farmer 4	Farmer 5	Farmer 6	Average	Standard deviation
Gautam	2.6	3.8	3.33	2.6	2.33	3.15	2.968333	±0.553946
Zinc	3.2	4.1	3.5	2.8	2.83	3.2	3.271667	±0.482925
NL 1386	3.71	4.15	4.1	2.51	2.26	2.8	3.255	±0.833565
BL 4814	2.95	3.95	3.13	2.35	2.81	3	3.031667	±0.524306
BL 4341	2.48	3.9	3.5	2.7	3.03	3.4	3.168333	±0.531278
Banganga	4.03	3.98	4.2	2.6	4.2	3.5	3.751667	±0.619884
Borlaug	1.9	2.9	3.1	2.38	3.58	2.9	2.793333	±0.583872
NL 1349	3.65	4.1	4.1	1.98	3.45	3.1	3.396667	±0.793893

Table-2: Yield differences in biological yield among different farmers in ton/hac

variety	Farmer 1	Farmer 2	Farmer 3	Farmer 4	Farmer 5	Farmer 6	Average	Standard deviation
Gautam	6.233	8.63	7.48	7.05	5.883	8.016	7.215333	1.046883
Zinc	7.35	9.7	9.33	7.15	7.583	9.066	8.363167	1.124527
NL 1386	7.56	9.556	9	6.31	5.833	7.516	7.629167	1.454364
BL 4814	9.63	8.266	17.563	6.21	7.083	7.466	9.369667	4.177388
BL 4341	8.116	9.266	9.633	8.2	10.633	9.5	9.224667	0.949393
Banganga	8.9	10.19	10.016	6.816	9.916	9.133	9.161833	1.259192
Borlaug	5.516	7.35	7.016	6.333	9.033	8.15	7.233	1.256961
NL 1349	3.65	9.96	9.08	5.05	7.85	7.5	7.181667	2.403642

Among the varieties examined, BL 4814(9.36 ton/hac) exhibited the highest biological yield followed by BL 4341(9.224ton/hac) whereas NL 1349(7.18 ton/hac) exhibit lowest biological yield .our findings are similar to other studies, the field experiment conducted to identify high yielding superior wheat genotypes for Rupandehi district showed the higher grain yield of BL 3978 among ten wheat genotypes.(Pandey 2017).

Similarly the study conducted in kailai district of Nepal for the preference of farmers towards different wheat varieties showed higher preference of farmers to varieties Vijay, Nl-971, HD- 2967, Gautam and Aditya respectively(Bhatt, Bist, and L. Ojha 2020).

In like manner, smallholder farmers receiving input subsidies, frequent consulting and extension services, interactive training programs pertaining to the adoption of better practices, and timely access to improved seeds were the major problems studied in the Kanchanpur district for adoption of wheat genotype with respect to farmers preference(Bhatta et al. 2022)

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Table- 3: Harvest index

variety	Biological yield	Economic yield	Harvest index
Gautam	7.21	2.96	41.05
Zinc	8.36	3.27	39.11
NL 1386	7.62	3.25	42.65091864
BL 4814	9.36	3.03	32.37179487

BL 4341	9.22	3.2	34.70715835
Banganga	9.16	3.7	40.3930131
Borlaug	7.233	2.8	38.71146136
NL 1349	7.18	3.4	47.35376045

Table-:4: Farmer's preference by direct matrix scoring and ranking

VARIETY	GY	DR	GC	PH	EM	TOTAL SCORE	RANK
Gautam	5(9)	6(8)	3(7)	4(7)	3(8)	39	3rd
Zinc	2(6)	1(7)	3(5)	1(7)	2(9)	34	6th
NL 1386	1(7)	2(6)	4(7)	2(9)	1(6)	35	5th
BL 4814	1(5)	2(6)	1(8)	3(8)	3(7)	34	6th
BL 4341	1(8)	2(9)	1(5)	2(7)	1(8)	37	4th
Banganga	6(10)	3(8)	4(9)	2(10)	5(9)	46	1st
Borlaug	2(8)	2(5)	2(7)	5(6)	1(7)	33	last
NL 1349	2(9)	2(8)	2(7)	2(10)	4(9)	43	2nd

Where, GY =Grain Yield, DR=Drought Resistance, GC=Grain Color, PH=Plant Height, EM=Early Maturity

Note: number written in the bracket indicates the total score of a variety as per each selection criteria.

Additionally, Harvest index was found highest in NL 1349 (47.35 ton/hac) Followed by NL 1386 (42.65 ton/hac) whereas BL 4814 (32.37 ton/hac) has the lowest

Drought Resistance

As indicated in table 3 of direct matrix results BL 4341 ,Banganga, Gautam, NL 1349 showed better resistance to drought than other varieties. The reason for farmer consideration of drought resistance as selection criteria is due to ability of these varieties to withstand period of low water availability, maintain yield stability during dry periods, and exhibit resilience to drought stress.

Plant Height

In the trial Banganga, NL 1349 showed the longest plant height while Borlaug was the shortest followed by Gautam, BL 4341, Zinc. Farmers choose taller plant species for animal feed and easier harvesting. The growers felt that the shortest types were particularly difficult to harvest. The tillers could not be gathered properly due to the plant's small height from the ground and were lost as residue. Besides the varieties height, the participant farmers had considered the straw color of the longest varieties but, the varieties had unfortunately whitish color. Such whitish color is much more preferable for animal feed as of their rearing experience.

Grain color.

In trials variety Banganga, BL 4814, and Gautam were best preferred by their grain color because they had white grain color whereas, zinc, BL 4341, had reddish grain color and due to this, they were the least preferred varieties but the rest varieties showed moderate grey color (Table 4). The women participants preferred varieties that have the color grey to white was due to their perspective of good baking, dough color, and the final product local light amber color could be best. They believed that whitish seeds would produce a whitish flour color that makes the bread color whitish. Due to this Banganga, BL 4814, Gautam and Borlaug were preferred by the participant farmers over the other varieties. On the other hand, the participants responded that varieties that have whitish grain color are also the main determining criteria in the market, and whitish grain seeds are preferred and sold with high price than varieties which have reddish grain color.

Early Maturity

In the direct matrix (Table 4) of the trial, Banganga, Zinc and NL 1349 were an early maturing type whereas Borlaug was late maturing followed by BL 4814, NL 1386.

Conclusion and Recommendation

To promote new varieties and improve extension services, farmers should be involved in variety evaluation and selection. This was confirmed by the

study in assessing the performance of trials. Farmers employed several characteristics and methodologies to evaluate tested wheat cultivars. Farmers evaluated varieties based on grain yield, drought resistance, color, plant height, and early maturity. Plant height, early maturity, and grain yield were the most important traits, while drought resistance and grain color were less important. Banganga, NL1349, and Gautam varieties were more popular than others.

The study indicated that Banganga, NL1349, BL4341, and Gautam outperformed the other eight evaluated varieties in terms of yield potential, plant height, early maturity, drought resistance, and other agronomic features. Farmers became more interested in farming preferred wheat types after participating in varietal selection.

As a result, these selected cultivars will be planted for the upcoming cropping season in the evaluated region and similar agroecology. Farmers and customers' preferences play a crucial role in the rapid adaption and transmission of new kinds. Otherwise, the producing community may be less likely to accept them.

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