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From field to yield: Insights into agronomic practices of farmers in Punjab division

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Abstract
India stands as a major contributor to global agriculture, With the second-largest agricultural landholding in the world, the sector sustains a large share of employment and positions farmers at the core of the nation's food security and sustenance. Agriculture has long been a key driver of India's economy by ensuring food production, generating rural employment, and supporting GDP growth. However, its role has gradually shifted over the years under the influence of industrialization, urbanization, technological advancement, and government interventions. Currently, the agriculture and allied sectors provide livelihood to about 42.3% of the population and contribute approximately 18.2% to India's GDP at current prices. Agronomic practices include all operations from sowing to harvesting and storage of crops. A survey was carried out to study the agronomic practices of 60 farmers across seven villages—Barauli, Dumcheri, Nogawan, Fatehpur Jatta, Gandhuan, Thablan, and Dholan Majra—in the Kharar block of SAS Nagar district, Punjab. Data was collected through a structured questionnaire and farmer interviews, then analyzed using suitable statistical methods.
The study revealed that 89.13% of farmers cultivated rice, while wheat was grown by 88.04% of farmers. Besides these major cereal crops, 76.09% of farmers cultivated maize, and 92.39% raised sorghum and 78.26% berseem for fodder. Additionally, sugarcane and potato are also cultivated by farmers. It was also noted that the majority of farmers used higher-than-recommended doses of fertilizers and pesticides. The average yields were 22 q/acre for wheat and 25 q/acre for paddy. In wheat cultivation, 90% of farmers reported *Phalaris minor* as the most problematic weed. Major diseases identified were blast and sheath blight in paddy and rust in wheat, while the main pests were stem borer and grasshoppers in rice and aphids in wheat.

Keywords: Agronomy; pests; fertilizer; nutrients, yield

Introduction
Agriculture forms the backbone of the Indian economy and remains one of its most critical sectors. It serves as the main source of livelihood for nearly 58% of the population, with about 70% of rural households relying exclusively on it [1]. Over the past two decades, it has undergone rapid transformation due to globalization and liberalization policies, which have created new opportunities for growth. It is one of the most established and vital financial sectors in India. Development strategies vary across districts, but agriculture and its allied activities remain the largest source of employment, particularly in rural areas, while also serving as a key contributor to the Gross Domestic Product (GDP) [2]. It also contributes around $400 billion to India's economy, second only to China in scale [3].
Punjab in particular, has played a pivotal role in strengthening India's food security, supported by skilled human resources and rapid advancements in agricultural science and technology. The availability of competent labor and collective efforts have enabled remarkable agricultural progress [4].
Traditionally, agriculture was practiced for subsistence, but with advancements in agronomic practices and the adoption of new technologies, it has evolved into a major income-generating activity. This transformation, however, has also brought socio-economic challenges and environmental concerns [5, 6]. Agricultural technology is a cornerstone of sustainable food systems [5]. The Green Revolution is a prominent example, of how scale-independent technologies revolutionized productivity by increasing yields, reducing poverty, improving

infrastructure, enhancing food availability, and lowering food prices [7].

Agronomic practices—which include all activities from seed sowing to harvesting and storage—are directly linked to crop productivity. Such practices have been fundamental in enhancing agricultural productivity in India and addressing concerns of food shortages due to population growth [8]. To achieve good harvests, farmers must adopt practices suited to the season and agro-climatic zone, as these vary regionally. Despite accounting for only a small share of the world's agricultural land, India ranks second globally in agricultural production, underscoring its key role in ensuring food security worldwide [2]. Punjab is divided into six agro-climatic zones, with SAS Nagar situated in the Undulating Plain Zone. This region experiences cold winters, humid to sub-humid and semi-arid to humid conditions, with annual rainfall ranging from 165 mm to 1000 mm. Its soils are well-suited for wheat, maize, rice, sorghum, berseem and vegetables [9]. Farmers in this region typically follow basic agronomic practices for cultivation. Such practices have been crucial in sustaining agricultural productivity in India and addressing concerns of population growth outpacing food production.

Objectives

The objectives of the study are:

- To examine how agronomic practices influence crop production.
- To identify the common practices adopted by farmers in the study area.
- To analyze the agronomic methods followed by the respondent farmers.
- To evaluate farmers' knowledge regarding the appropriate use of pesticides, fertilizers, and seeds.

Materials and Methods

The study was undertaken in the Kharar block of SAS Nagar district, Punjab, where SEVEN villages— Barauli, Dumcheri, Nogawan, Fatehpur Jatta, Gandhuan, Thablan, and Dholan Majra were selected. A total of 60 farmers were interviewed. From these, 8 respondents were from Barauli, 5 from Dumcheri, 9 from Nogawan, 8 from Fatehpur jatta, 12 from Gandhuan, 5 from Thablan and 13 from Dholan majra.

Table 1: Total selected farmers

S. No.	Village Name	Total no. of farmers (n=60)
1	Barauli	8
2	Dumcheri	5
3	Nogawan	9
4	Fatehpur Jatta	8
5	Gandhuan	12
6	Thablan	5
7	Dholan Majra	13

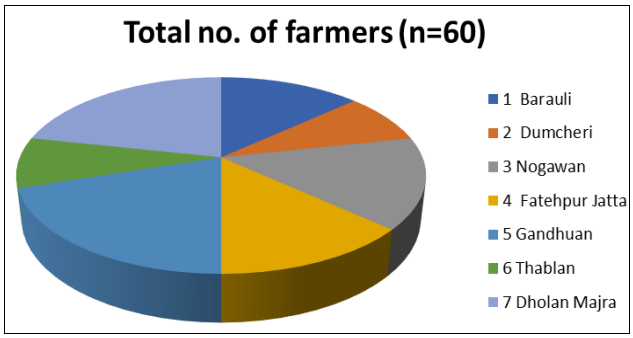

Fig 1: Total selected farmers

Comprehensive interactions were held with the farmers to collect information on their socio-economic status and the agronomic practices they followed throughout the year. Interviews were conducted both at the farmers' homes and in their fields. A well-structured questionnaire was designed to systematically assess each parameter and ensuring the coverage of all aspects of their farming operations. The data collected from the farmers were compiled, categorized and analyzed using appropriate statistical methods. Percentages, bar graphs, pie charts, and other visual tools were employed to present the findings in a clear and comprehensive manner.

Results and Discussion

Agronomic practices form the foundation of farming systems, as they aim to improve soil quality, optimize water usage, manage crops effectively, and contribute to environmental sustainability [8]. Through discussions with farmers from the villages of Barauli, Dumcheri, Nogawan, Fatehpur Jatta, Gandhuan, Thablan, and Dholan Majra in Punjab, information was gathered regarding the crops grown and the practices followed. The findings revealed that rice was the predominant crop during the Kharif season, while wheat dominated in the Rabi season. Some farmers also cultivated sorghum (chari) and berseem for fodder purposes. Additionally, maize, sugarcane and potato were also cultivated by the farmers.

Major Crops Grown by Farmers

The data revealed that wheat is cultivated by 88.04% of the farmers, while nearly 89.13% of the farmers grow rice in their fields. In addition to these two major crops, other crops such as potato & sugarcane are grown on a smaller scale in this region. Sorghum and berseem emerged as the predominant fodder crops, with approximately 92.34% of farmers cultivating sorghum and 78.26% cultivating berseem.

Table 2: Represents the crop distribution in percentage of respondents(farmers)

S.no.	Parameters	Barauli (n=8)	Nogawan (n=9)	Fatehpur jatta (n=8)	Dumcheri (n=5)	Thablan (n=5)	Dholan majra (n=13)	Gandhuan (n=12)	Overall
	Crops	No.of farmers [%]	No.of farmers [%]	No.of farmers [%]	No.of farmers [%]	No.of farmers [%]	No.of farmers [%]	No.of farmers [%]	Percentage [%]
1	Wheat	8 (100%)	6 (66.67%)	7 (87.5%)	5 (100%)	4 (80%)	12 (92.31%)	11 (91.67%)	53 (88.04%)
2	Rice	7 (87.5%)	9 (100%)	5 (62.5%)	5 (100%)	5 (100%)	11 (84.62%)	12 (100%)	54 (89.13%)
3	Maize	6 (75%)	7 (77.78%)	8 (100%)	5 (100%)	3 (60%)	9 (69.23%)	8 (66.67%)	46 (76.09%)
4	Sugarcane	5 (62.5%)	8 (88.89%)	6 (75%)	3 (60%)	3 (60%)	8 (61.54%)	4 (33.33%)	37 (63.04%)
5	Sorghum	7 (87.5%)	8 (88.89%)	8 (100%)	5 (100%)	5 (100%)	12 (92.31%)	11 (91.67%)	56 (92.39%)
6	Berseem	7 (87.5%)	8 (88.89%)	7 (87.5%)	4 (80%)	3 (60%)	9 (69.23%)	9 (75%)	47 (78.26%)
7	Potato	3 (37.5%)	4 (44.4%)	3 (37.5%)	1 (20%)	1 (20%)	4 (30.8%)	4 (33.3%)	20 (32.6%)

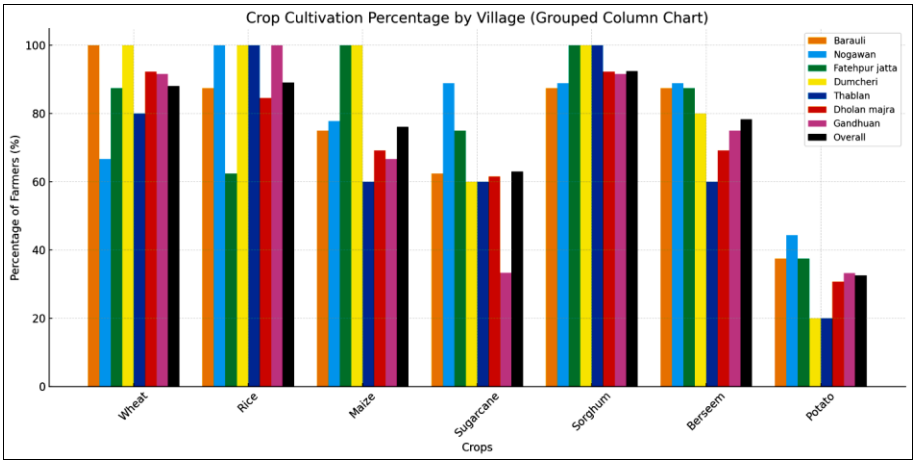

Fig 2: Depicts the crop distribution percentage of various crops grown by the respondents

Rice Varieties Grown

Table 3 presents the adoption of different rice varieties by farmers in the study villages. Among these, Basmati 1121 is least adopted variety and was grown by 9 farmers only, with an overall percentage of 14.78%. On the other hand, PR-126 is the leading and most dominant variety of rice adopted by farmers with overall percentage of 49.13%.

Table 3: Rice variety grown

S.no.	Rice Variety	Barauli (n=8)	Nogawan (n=9)	Fatehpur jatta(n=8)	Dumcheri (n=5)	Thablan (n=5)	Dholan majra(n=13)	Gandhuan (n=12)	Overall% (n=60)
1	PR 126	4 (50%)	5 (55.56%)	3 (37.5%)	3 (60%)	2 (40%)	6 (46.15%)	7 (58.33%)	30 (49.13%)
2	IR 64	2 (25%)	2 (22.22%)	1 (12.5%)	2 (40%)	2 (40%)	2 (15.38%)	4 (33.33%)	15 (24.35%)
3	Basmati 1121	1 (12.5%)	2 (22.22%)	1 (12.5%)	0	1 (20%)	3 (23.08%)	1 (8.33%)	9 (14.78%)

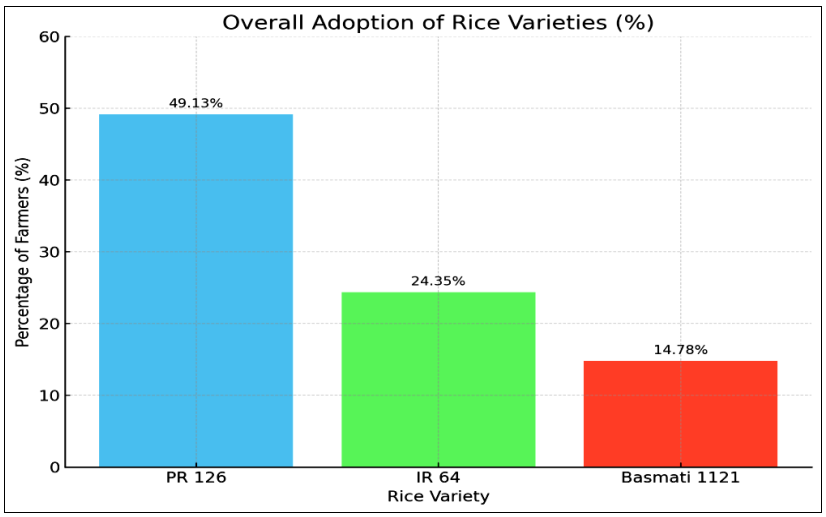

Fig 3: Rice variety grown

Wheat Varieties Grown

Table 4 presents the adoption of different wheat varieties by farmers in the study villages. Among these, HD-2967 is least adopted variety and was grown by 10 farmers only, with an overall percentage of 16.52%. On the other hand, PBW-725 is the leading and most dominant variety of wheat adopted by farmers with overall percentage of 43.48%.

Table 4: Wheat variety grown

S.no.	Wheat variety	Barauli (n=8)	Nogawan (n=9)	Fatehpur jatta (n=8)	Dumcheri (n=5)	Thablan (n=5)	Dholan majra (n=13)	Gandhuan (n=12)	Overall%
1	PBW 725	4 (50%)	3 (33.33%)	3 (37.5%)	3 (60%)	2 (40%)	6 (46.15%)	5 (41.67%)	26 (43.48%)
2	HD-2967	1 (12.5%)	2 (22.22%)	2 (25%)	0	1 (20%)	2 (15.38%)	2 (16.67%)	10 (16.52%)
3	DBW-303	3 (37.5%)	1 (11.11%)	2 (25%)	2 (40%)	1 (20%)	4 (30.77%)	4 (33.33%)	17 (26.09%)

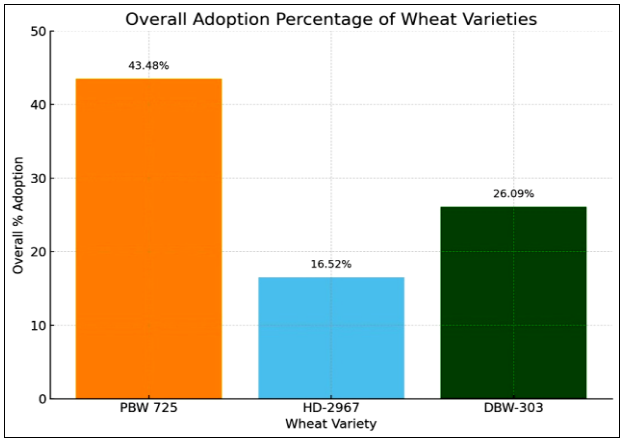

Fig 4: Wheat variety grown

Other Crops varieties

In maize, both Ganga-5 and PMH-1 varieties are cultivated; however, PMH-1 is the predominantly adopted variety in the surveyed region, as reported by local farmers. Punjab Chari-1 is widely grown as the major fodder variety of sorghum. For sugarcane, CoJ 64 is the dominant variety under cultivation, while Kufri Jyoti and Kufri Bahar are the most commonly adopted potato varieties, according to field observations and regional cultivation records.

Time of Sowing

Table 5: Time of Sowing

CROP	Time of sowing (season)
Rice	June - July (Kharif season)
Wheat	November - December (Rabi season)
Maize	March - April (Zaid/early Kharif season)
Sugarcane	February - March (spring season)
Sorghum	June - July (Kharif season)
Berseem	September - October (Rabi season)
Potato	October- November (Rabi season)

Source of Seed

Farmers primarily procured seeds either from local dealers or from cooperative agencies to meet their crop cultivation needs. In addition to these formal sources, a portion of the farmers also rely on saved seeds from previous harvests for sowing in subsequent seasons. This practice of using both purchased and retained seeds reflects a combination of market dependence and traditional seed-saving strategies, ensuring seed availability while maintaining varietal continuity across seasons.

Method of Sowing

Table 6: Method of Sowing

Crop	Method of sowing
Wheat	Seed drilling using a seed drill or broadcasting manually; recommended row spacing 20-22 cm.
Rice	Transplanting seedlings (25-30 days old) in puddled fields or direct-seeded in rows; spacing 20 × 15 cm.
Maize	Manual dibbling or seed drilling in rows; recommended spacing 60 × 25 cm.
Sugarcane	Setts planted manually or mechanically in furrows; spacing 90 × 45 cm.
Sorghum	broadcasting; row spacing 30-45 cm.
Berseem	Broadcasting of seeds uniformly is done.
Potato	Planting of tubers in furrows or ridges; spacing 60 × 20-25 cm.

Seed Rate Followed by the Respondents

A large majority of farmers (71.30%) follow the recommended seed rate, while a smaller proportion (19.13%) apply seeds above the recommended level. Only a minor fraction of farmers (9.57%) sow below the recommended seed rate.

Table 7: Recommended seed rate followed by the farmers in percentage

Sr. No	Seed Rate	Barauli (n=8)	Nogawan (n=9)	Fatehpur jatta (n=8)	Dumcheri (n=5)	Thablan (n=5)	Dholan majra (n=13)	Gandhuan (n=12)	Overall%
1	Below recommended rate	2 (25%)	0	1 (12.5%)	0	1 (20%)	2 (15.38%)	0	6 (9.57%)
2	Recommended rate	5 (62.5%)	7 (77.78%)	6 (75%)	3 (60%)	4 (80%)	7 (53.85%)	10 (83.33%)	42 (71.30%)
3	Above recommended rate	1 (12.5%)	2 (22.22%)	1 (12.5%)	2 (40%)	0	4 (30.77%)	2 (16.67%)	12 (19.13%)

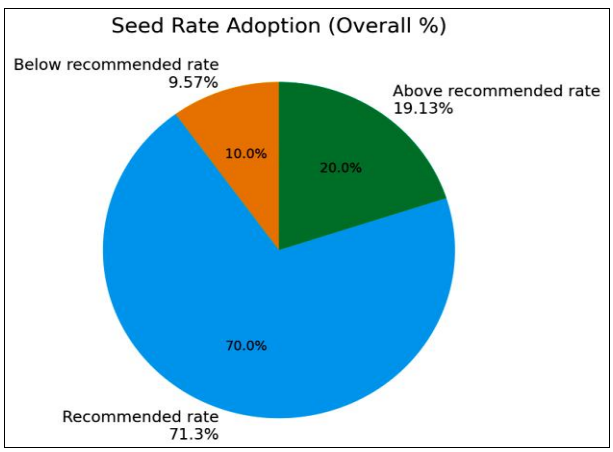

Fig 5: Recommended seed rate followed by farmers in percentage

Seed Treatment

Seed treatment was not common among farmers, as many believed their purchased seeds were pre-treated or were hybrids. Although, Seed treatment practices varied across crops and farmers in the study area. In rice, most farmers used treated seeds, primarily with chemical fungicides such as Carbendazim, Captan, Thiram, or Bavistin at doses ranging from 2 to 3 g/kg seed. For wheat, all farmers applied treated seeds, mainly using Vitavax or Carbendazim at 2.5 g/kg seed. In maize, treated seeds were commonly used with fungicides like Metalaxyl + Mancozeb, Captan, or Thiram at doses of 2-3 g/kg.

Sorghum (Chari) seed treatment was less consistent, with some farmers using chemical fungicides such as Thiram/Captan, while others applied organic treatments like Rhizobium culture, with doses of 2.5-3 g/kg seed. Sugarcane seed setts were occasionally treated with chemical fungicides or hot water + Bavistin

treatments, with doses of 0.10-0.20% while, Potato seed tubers were treated chemically with Mancozeb at 2.5 g/kg seed. No seed treatment was reported for Berseem in the surveyed fields. Overall, the data indicate a predominant use of chemical seed treatments, particularly for rice, wheat, maize, and potato, reflecting the adoption of disease management practices to improve crop establishment and yield.

Irrigation

Table 8: Irrigation given

Crop	Source of irrigation	No of Irrigations	Stage/DAS of irrigation
Wheat	Canal / Tube well	3-4	Crown root initiation (20-25 DAS), Tillering (35-40 DAS), Booting (55-60 DAS), Grain filling (75-80 DAS)
Rice	Canal / Tube well	4-6 & at regular intervals	Land preparation, Tillering (20-25 DAS), Panicle initiation (35-40 DAS), Flowering (50-55 DAS), Grain filling (70-75 DAS), Maturity (90-100 DAS)
Maize	Canal / Tube well	3-4	Vegetative stage (20-25 DAS), Tasseling (40-45 DAS), Silking (50-55 DAS), Grain filling (65-70 DAS)
Sugarcane	Canal / Tube well	8-12	Initial (10-15 DAS), Tillering (30-35 DAS), Grand growth (60-75 DAS), Maturity (120-150 DAS), Pre-harvest (180-210 DAS)
Sorghum	Canal / Tube well	2-3	Tillering (20-25 DAS), Flowering (50-55 DAS), Grain filling (70-75 DAS)
Berseem	Canal / Tube well	3-4	Sowing (0 DAS), Early vegetative (15-20 DAS), Mid vegetative (30-35 DAS), Pre-cut (45-50 DAS), After first cut (55-60 DAS)
Potato	Canal / Tube well	6-8	Sowing (0 DAS), Emergence (15 DAS), Tuber initiation (25-30 DAS), Mid tuber development (40-45 DAS), Tuber bulking (55-60 DAS), Pre-harvest (70-75 DAS)

Fertilizer Dose Applied by the Respondents

The results indicate that, on average, farmers apply fertilizer doses higher than the recommended levels. The recommended fertilizer dose for wheat is 120N:60P:40K [10], for sugarcane 300N:100P:200K and for rice 125N:30P:30K [11]. However, the data reveal an imbalance in nutrient use: potassic fertilizers are applied in minimal quantities, whereas nitrogenous fertilizers receive the highest emphasis, followed by phosphatic fertilizers. Most farmers lacked awareness of the actual N, P, and K requirements of the soil, leading to imbalanced nutrient application.

Table 9: Represents mean value of N:P:K amount applied by the respondents

Sr. No	Parameters	Barauli	Nogawan	Fatehpur jatta	Dumcheri	Thablan	Dholan majra	Gandhuan	Average	Recommend ed dose/ha
Wheat										
1	Urea/ha	320 kg/ha	315 kg/ha	290 kg/ha	293 kg/ha	280 kg/ha	326 kg/ha	340 kg/ha	309.1kg/ha	120kg/ha
2	DAP/ha	180 kg/ha	178 kg/ha	158 kg/ha	166 kg/ha	170 kg/ha	180 kg/ha	200 kg/ha	176 kg/ha	60kg/ha
3	Potassium/ha	-	-	-	-	-	-	-	-	40kg/ha
Rice										
1	Urea/ha	210 kg/ha	193 kg/ha	184 kg/ha	170 kg/ha	186 kg/ha	220 kg/ha	225 kg/ha	198.3kg/ha	125kg/ha
2	DAP/ha	180 kg/ha	175 kg/ha	184 kg/ha	159 kg/ha	186 kg/ha	188 kg/ha	166 kg/ha	176.9kg/ha	30kg/ha
3	Potassium/ha	-	-	-	-	-	-	-	-	30kg/ha
Maize										
1	Urea/ha	278 kg/ha	190 kg/ha	199 kg/ha	269 kg/ha	196 kg/ha	230 kg/ha	325 kg/ha	241 kg/ha	150kg/ha
2	DAP/ha	149 kg/ha	178 kg/ha	165 kg/ha	174 kg/ha	162 kg/ha	195 kg/ha	153 kg/ha	168 kg/ha	60kg/ha
3	Potassium/ha	133 kg/ha	145 kg/ha	122 kg/ha	119 kg/ha	150 kg/ha	173 kg/ha	158 kg/ha	142.9kg/ha	40kg/ha
Sugarcane										
1	Urea/ha	440 kg/ha	320 kg/ha	368 kg/ha	376 kg/ha	355 kg/ha	478 kg/ha	525 kg/ha	408.9 kg/ha	300kg/ha
2	DAP/ha	300 kg/ha	252 kg/ha	261 kg/ha	245 kg/ha	286 kg/ha	267 kg/ha	288 kg/ha	271.3kg/ha	100kg/ha
3	Potassium/ha	216 kg/ha	226 kg/ha	243 kg/ha	234 kg/ha	270 kg/ha	320 kg/ha	295 kg/ha	257.7kg/ha	200kg/ha
Sorghum										
1	Urea/ha	230 kg/ha	222 kg/ha	253 kg/ha	247 kg/ha	232 kg/ha	275 kg/ha	264 kg/ha	246.1 kg/ha	100kg/ha
2	DAP/ha	138 kg/ha	148 kg/ha	185 kg/ha	170 kg/ha	134 kg/ha	140 kg/ha	160 kg/ha	153.6kg/ha	40kg/ha
Berseem										
1	Urea/ha	143 kg/ha	139 kg/ha	154 kg/ha	162 kg/ha	175 kg/ha	159 kg/ha	178 kg/ha	158.6 kg/ha	20kg/ha
2	DAP/ha	156 kg/ha	149 kg/ha	165 kg/ha	170 kg/ha	186 kg/ha	197 kg/ha	193 kg/ha	173.7kg/ha	60kg/ha
Potato										
1	Urea/ha	340 kg/ha	355 kg/ha	339 kg/ha	364 kg/ha	315 kg/ha	398 kg/ha	360 kg/ha	353 kg/ha	150kg/ha
2	DAP/ha	222 kg/ha	238 kg/ha	253 kg/ha	230 kg/ha	252 kg/ha	279 kg/ha	260 kg/ha	247.7kg/ha	100kg/ha
3	Potassium/ha	210 kg/ha	198 kg/ha	162 kg/ha	175 kg/ha	188 kg/ha	212 kg/ha	194 kg/ha	191.3 kg/ha	100kg/ha

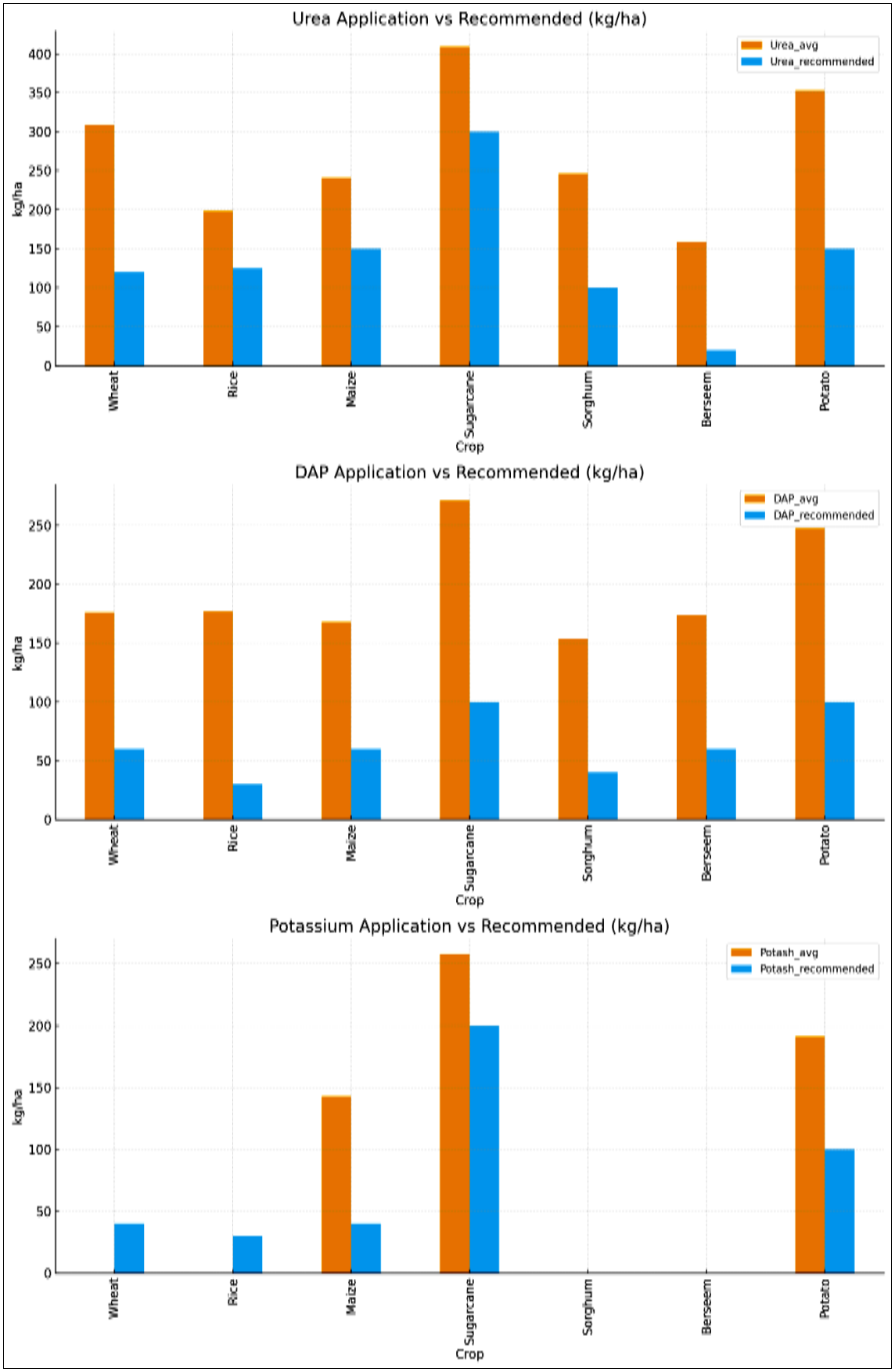

Fig 6: Represents mean value of N:P:K amount applied by the respondents

Major Weeds, Diseases, and Pests Observed

Weed Management

Weed management aims to minimize the harmful effects of weeds while safeguarding the environment. Early weed control done ideally within 21 days after crop establishment, was emphasized as crucial, as weeds at this stage cause the most yield losses.

According to Table 10 multiple crop-specific weeds were reported in the fields throughout the year. *Phalaris minor* emerged as the predominant weed in wheat, reported by 88.33%

of respondents. This weed is resistant to many herbicides, making its management difficult. It significantly reduces wheat yields during the Rabi season and remains a major concern among farmers. Another prevalent weed was *Echinochloa crus-galli* (Swank), observed by about 90% of respondents in paddy fields during the Kharif season.

Table 10: Major weeds observed by the respondents

S.no.	Weed name	Crop affected	Barauli (n=8)	Nogawan (n=9)	Fatehpur jatta (n=8)	Dumcheri (n=5)	Thablan (n=5)	Dholan majra (n=13)	Gandhuan (n=12)	Overall%(n=60)
1	*Phalaris minor*	Wheat	8 (100%)	6 (66.67%)	7 (87.5%)	5 (100%)	4 (80%)	11 (84.62%)	12 (100%)	53 (88.33%)
2	*Avena ludoviciana*	Wheat	6 (75%)	4 (44.44%)	6 (75%)	3 (60%)	2 (40%)	8 (61.54%)	9 (75%)	38 (63.33%)
3	*Echinochloa crusgalli*	Rice	7 (87.5%)	9 (100%)	5 (62.5%)	5 (100%)	5 (100%)	11 (84.62%)	12 (100%)	54 (90%)
4	*Cyperus rotundus*	Rice	7 (87.5%)	7 (77.78%)	4 (50%)	3 (60%)	5 (100%)	8 (61.54%)	11 (91.67%)	45 (75%)
5	*Chenopodium album*	Maize	6 (75%)	7 (77.78%)	8 (100%)	5 (100%)	3 (60%)	9 (69.23%)	7 (58.33%)	45 (75%)
6	*Convolvulus arvensis*	Potato	3 (37.5%)	4 (44.44%)	3 (37.5%)	1 (20%)	1 (20%)	4 (30.77%)	4 (33.33%)	20 (33.33%)
7	*Parthenium hysterophorus*	Sugarcane	5 (62.5%)	8 (88.89%)	6 (75%)	3 (60%)	2 (40%)	7 (53.85%)	3 (25%)	34 (56.67%)

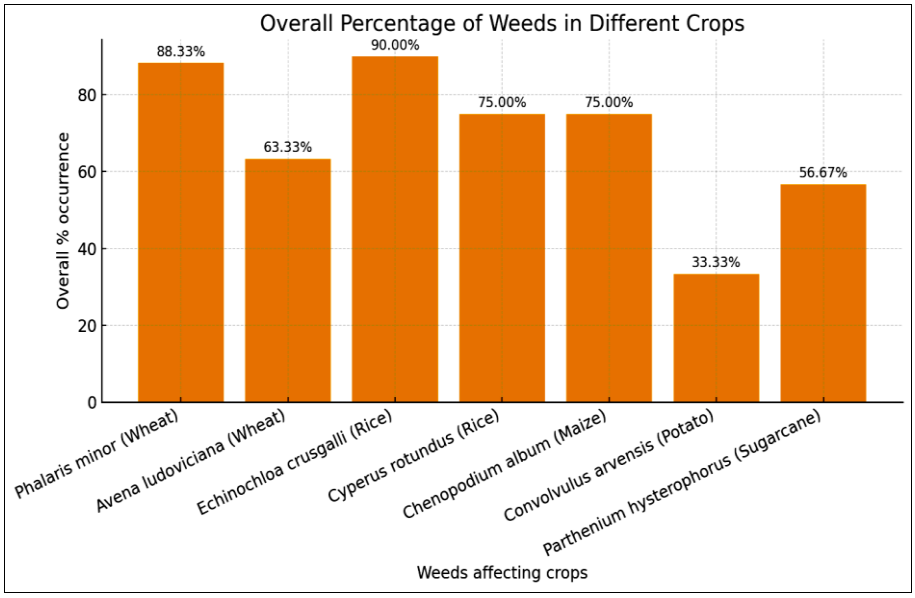

Fig 7: Major weeds observed by the respondents

Disease Management

Table 11 shows that sheath blight affected about 73.3% of rice growers, while yellow rust was a concern for 70% of wheat farmers. These diseases not only reduced yield but also affected grain quality. Leaf spot of rice plants were another major issue, observed by 68.3% of respondents, causing yield reductions and heavy financial losses.In maize, 61.7% of farmers observed sheath blight. Sugarcane growers reported red rot (55%) and in Potato late blight (28.3%) was the major disease.

Table 11: Major diseases observed by the respondents

S.no.	Disease name	Crop affected	Barauli (n=8)	Nogawan (n=9)	Fatehpur jatta (n=8)	Dumcheri (n=5)	Thablan (n=5)	Dholan majra (n=13)	Gandhuan (n=12)	Overall% (n=60)
1	Yellow Rust	Wheat	6 (75%)	6 (66.67%)	5 (62.5%)	4 (80%)	2 (40%)	9 (69.23%)	10 (83.33%)	42 (70%)
2	Powdery mildew	Wheat	3 (37.5%)	4 (44.44%)	2 (25%)	2 (40%)	2 (40 %)	4 (30.77%)	9 (75%)	26 (41.7%)
3	Sheath Blight	Rice	7 (87.5%)	5 (55.56%)	5 (62.5%)	4 (80%)	3 (60%)	10 (76.92%)	11 (91.67%)	45 (73.3%)
4	Brown leaf spot	Rice	5 (62.5%)	8 (88.89%)	4 (50%)	3 (60%)	4 (80%)	7 (53.85%)	9 (75%)	40 (68.3%)
5	Sheath blight	Maize	6 (75%)	6 (66.67%)	6 (75%)	4 (80%)	2 (40%)	6 (46.15%)	6 (50%)	36 (61.7%)
6	Late blight	Potato	2 (25%)	3 (33.33%)	3 (37.5%)	1 (20%)	1 (20%)	4 (30.77%)	3 (25%)	17 (28.3%)
7	Red rot	Sugarcane	4 (50%)	7 (77.78%)	5 (62.5%)	2 (40%)	3 (60%)	6 (46.15%)	4 (33.33%)	31 (55%)

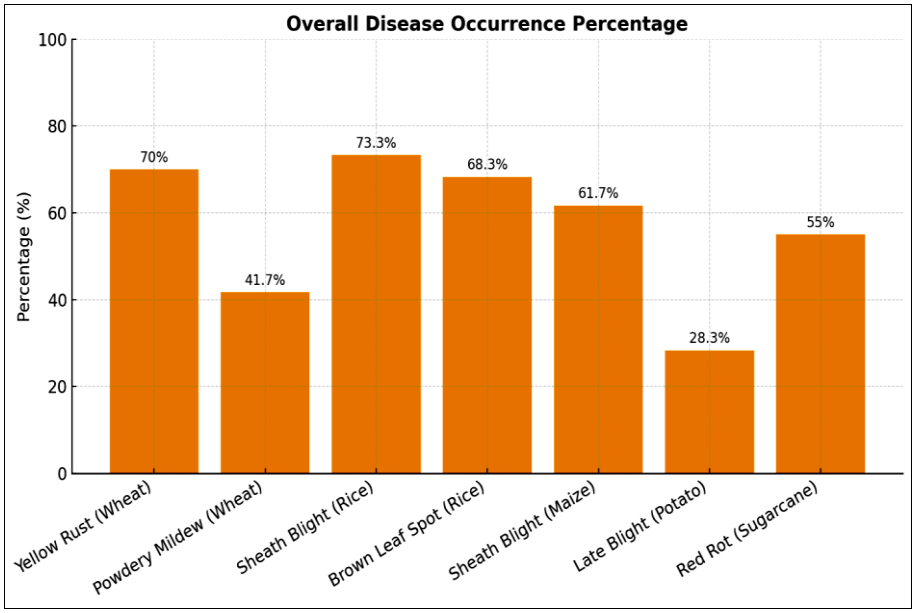

Fig 8: Major diseases observed by the respondents

Insect and Pest Incidence

As shown in Table 12, insect and pest infestations were widespread. In paddy, 60% of farmers reported grasshoppers with the highest incidence (75%) in Gandhuan. In wheat, aphids were observed by 60% of farmers and termites by 28.03% with 69.23% of respondents from Dholan majra specifically noting yield losses due to aphid infestation. In maize, 28.3% reported mites and 50% stem borer. For sugarcane, 41.7% reported top shoot borer and 20% termites. In Potato, tuber moth (28.3%)was common.

Table 12: Depicts the major insects and pests observed by respondents

S.no.	Pest name	Crop affected	Barauli (n=8)	Nogawan (n=9)	Fatehpur jatta (n=8)	Dumcheri (n=5)	Thablan (n=5)	Dholan majra (n=13)	Gandhuan (n=12)	Overall% (n=60)
1	Aphids	Wheat	5 (62.5%)	4 (44.44%)	4 (50%)	4 (80%)	3 (60%)	9 (69.23%)	7 (58.33%)	36 (60%)
2	Termites	Wheat	3(37.5%)	2(22.22%)	3(37.5%)	1(20%)	1(20%)	3(23.08%)	4(33.33%)	17 (28.3%)
3	Grasshopper	Rice	4 (50%)	5 (55.56%)	4 (50%)	3 (60%)	3 (60%)	8 (61.54%)	9 (75%)	36 (60%)
4	Rice Hispa	Rice	3 (37.5%)	4 (44.44%)	1 (12.5%)	2 (40%)	2 (40%)	3 (23.08%)	3 (25%)	18 (30%)
5	Stem borer	Maize	4 (50%)	5 (55.56%)	5 (62.5%)	3 (60%)	2 (40%)	6 (46.15%)	5 (41.67%)	30 (50%)
6	Mites	Maize	2 (25%)	2 (22.22%)	3 (37.5%)	2 (40%)	1 (20%)	3 (23.08%)	3 (25%)	16 (28.3%)
7	Tuber moth	Potato	3 (37.5%)	3 (33.33%)	3 (37.5%)	1 (20%)	1 (20%)	3 (23.08%)	3 (25%)	17 (28.3%)
8	Top shoot borer	Sugarcane	3 (37.5%)	5 (55.56%)	4 (50%)	3 (60%)	2 (40%)	5 (38.46%)	3 (25%)	25 (41.7%)
9	Termites	Sugarcane	2 (25%)	3 (33.33%)	2 (25%)	0	1 (20%)	3 (23.08%)	1 (8.33%)	12 (20%)

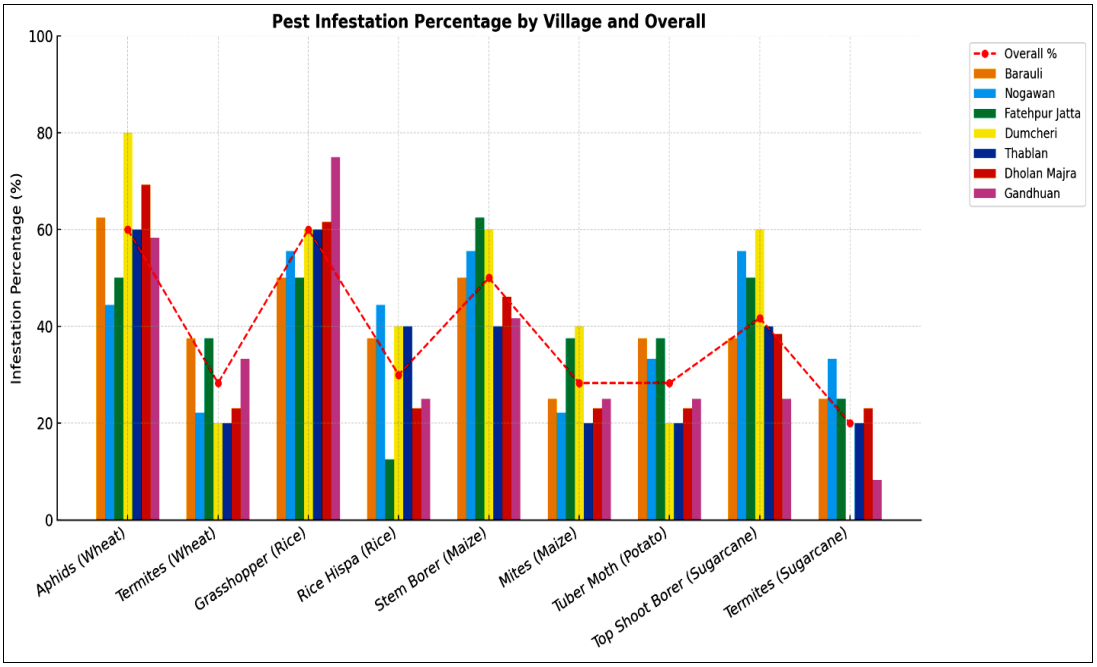

Fig 9: Depicts the major insects and pests observed by respondents

Availability of Storage Structures

As shown in Table 13, storage facilities were inadequate across all villages. About 36.7% of farmers reported having no proper storage units, exposing them to challenges such as spoilage, pest attacks, and post-harvest losses.

Table 13: Availability of storage structures

S. no.	Storage	Barauli (n=8)	Nogawan (n=9)	Fatehpur jatta (n=8)	Dumcheri (n=5)	Thablan (n=5)	Dholan majra (n=13)	Gandhuan (n=12)	Overall% (n=60)
1	1-2 units	3 (37.5%)	3 (33.33%)	3 (37.5%)	2 (40%)	1 (20%)	4 (30.77%)	4 (33.33%)	20 (33.3%)
2	3-4 units	2 (25%)	2 (22.22%)	3 (37.5%)	1 (20%)	2 (40%)	4 (30.77%)	4 (33.33%)	19 (31.7%)
3	None	3 (37.5%)	4 (44.44%)	2 (25%)	2 (40%)	2 (40%)	5 (38.46%)	4 (33.33%)	22 (36.7%)

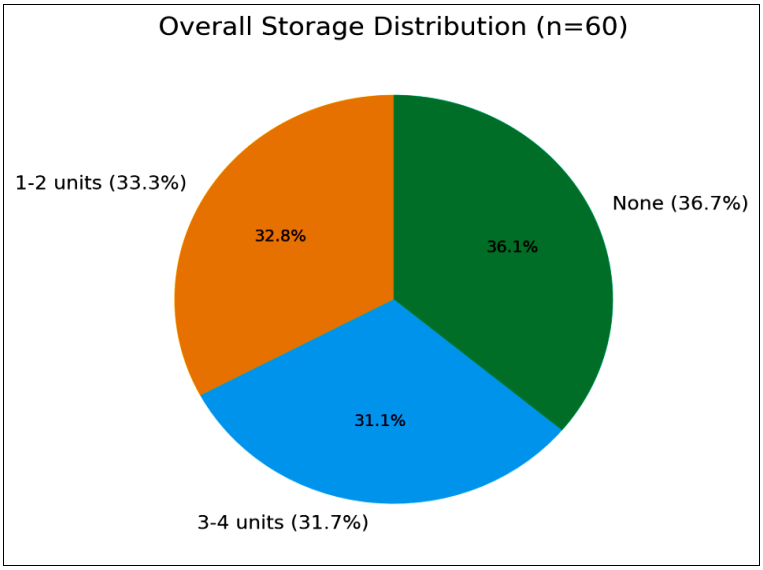

Fig 10: Availability of storage structures Harvesting

Table 14: Maturity indices for Harvesting

S. No.	Crop	Maturity indices for harvesting
1	Wheat	Harvest when grains are hard, and straw turns yellow. Moisture content ~20-25%.
2	Rice	Harvest when 80-85% grains are mature, leaves turn yellow, and grains harden.
3	Maize	Harvest when husks turn brown, kernels hard, and milk line reaches the base.
4	Sugarcane	Harvest when brix (sugar content) reaches peak, internodes are firm, and leaves start drying.
5	Sorghum	Harvest when grains are hard, moisture content 20-25%, and panicle droops naturally.
6	Berseem	Cut for fodder at 10-12 leaves stage, before flowering for best quality.
7	Potato	Harvest when tops yellow and die back, and tubers reach desired size (usually 70-90 days after planting).

The majority of farmers preferred combine harvesters for wheat and paddy, citing efficiency and reduced labor requirements. Around 66.7% of respondents used combines, while 20% relied on manual harvesting in case of wheat. For long-grain paddy varieties such as Basmati 1121, manual harvesting was often preferred to prevent grain damage. as these varieties have long and slender grains. For crops such as maize and sugarcane manual harvesting remained dominant, with 63.04% of sugarcane, and 76.09% of maize growers harvesting manually.

Table 15: Represents the data of farmers following different harvesting methods

S. No.	Crops	Parameters	Barauli (n=8)	Nogawan (n=9)	Fatehpur jatta (n=8)	Dumcheri (n=5)	Thablan (n=5)	Dholan majra (n=13)	Gandhuan (n=12)	Overall% (n=60)
1	Wheat	Combine harvester	6 (75%)	5 (55.6%)	5 (62.5%)	3 (60%)	2 (40%)	10 (76.9%)	9 (75%)	40 (66.7%)
2	Wheat	Manually	2 (25%)	1 (11.1%)	2 (25%)	1 (20%)	2 (40%)	2 (15.4%)	2 (16.7%)	12 (20%)
3	Rice	Combine harvester	5 (62.5%)	7 (77.8%)	4 (50%)	3 (60%)	4 (80%)	8 (61.5%)	8 (66.7%)	39 (65%)
4	Rice	Manually	2 (25%)	2 (22.2%)	1 (12.5%)	2 (40%)	1 (20%)	3 (23.1%)	4 (33.3%)	15 (25%)
5	Maize	Manually	6 (75%)	7 (77.78%)	8 (100%)	5 (100%)	3 (60%)	9 (69.23%)	8 (66.67%)	46 (76.09%)
6	Sugarcane	Manually	5 (62.5%)	8 (88.89%)	6 (75%)	3 (60%)	3 (60%)	8 (61.54%)	4 (33.33%)	37 (63.04%)
7	Sorghum	Manually	7 (87.5%)	8 (88.89%)	8 (100%)	5 (100%)	5 (100%)	12 (92.31%)	11 (91.67%)	56 (92.39%)
8	Berseem	Manually	7 (87.5%)	8 (88.89%)	7 (87.5%)	4 (80%)	3 (60%)	9 (69.23%)	9 (75%)	47 (78.26%)
9	Potato	Manually	3 (37.5%)	4 (44.4%)	3 (37.5%)	1 (20%)	1 (20%)	4 (30.8%)	4 (33.3%)	20 (32.6%)

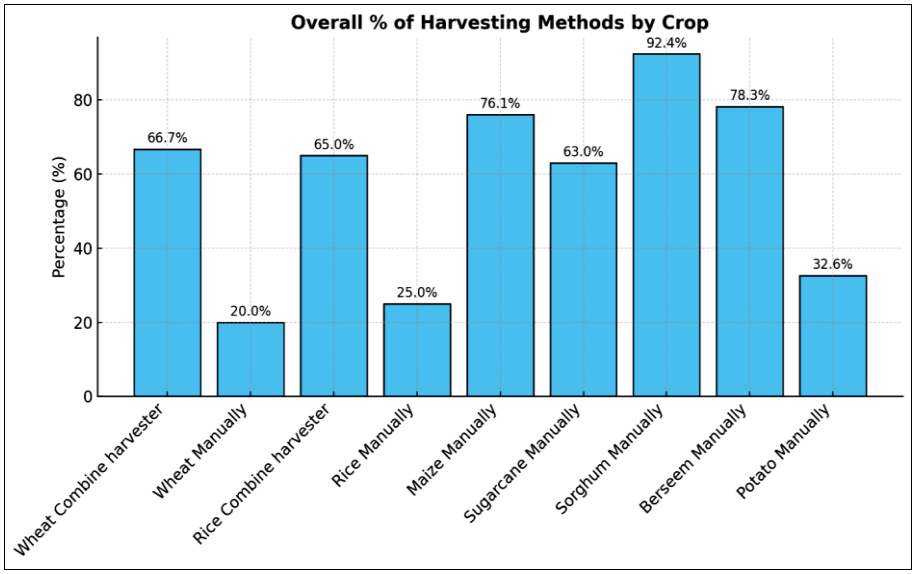

Fig 11: Represents the farmers following different harvesting methods

Yield Records

As presented in **Table 16**, the average wheat yield was approximately 43 quintals per hectare (QTL/ha). Among villages, Nogawan recorded the highest wheat productivity (46 QTL/ha), while Dumcheri reported the lowest (40 QTL/ha). Conversely, Dumcheri had the highest paddy productivity(64QTL/ha), whereas Thablan recorded the lowest (60 QTL/ha), with the overall average yield being about 62 QTL/ha.

For maize, the average productivity was 36.86 QTL/ha, with Dholan majra leading at 39 QTL/ha. Sugarcane recorded an average yield of 802.14 QTL/ha, ranging from 790 QTL/ha in Barauli to 830 QTL /ha in Dholan majra. Potato yields averaged 269.6 QTL /ha, with the highest in Thablan (279QTL/ha) and the lowest in Barauli (260QTL/ha).

Table 16: Depicts the Yield of the major crops grown by the respondents

S.no	Crop	Barauli	Nogawan	Fatehpur jatta	Dumcheri	Thablan	Dholan majra	Gandhuan	Average production
1	Wheat	45 quintals/ha	46 quintals/ha	44 quintals/ha	40 quintals/ha	42 quintals/ha	43 quintals/ha	41 quintals/ha	43quintals/ha
2	Rice	62 quintals/ha	61 quintals/ha	62 quintals/ha	64 quintals/ha	60 quintals/ha	63 quintals/ha	62 quintals/ha	62 quintals/ha
3	Maize	37 quintals/ha	36 quintals/ha	35 quintals/ha	38 quintals/ha	35.5 quintals/ha	39 quintals/ha	37.5 quintals/ha	36.86quintals/ha
4	Sugarcane	790 quintals/ha	780 quintals/ha	820 quintals/ha	785 quintals/ha	800 quintals/ha	830 quintals/ha	810 quintals/ha	802.14 quintals/ha
5	Sorghum	455 quintals/ha	460 quintals/ha	467 quintals/ha	470 quintals/ha	480 quintals/ha	495 quintals/ha	500 quintals/ha	475.29quintals/ha
6	Berseem	520 quintals/ha	540 quintals/ha	495 quintals/ha	490 quintals/ha	500 quintals/ha	560 quintals/ha	530 quintals/ha	517.5 quintals/ha
7	Potato	260 quintals/ha	272 quintals/ha	268 quintals/ha	275 quintals/ha	279 quintals/ha	277 quintals/ha	256 quintals/ha	269.6 quintals/ha

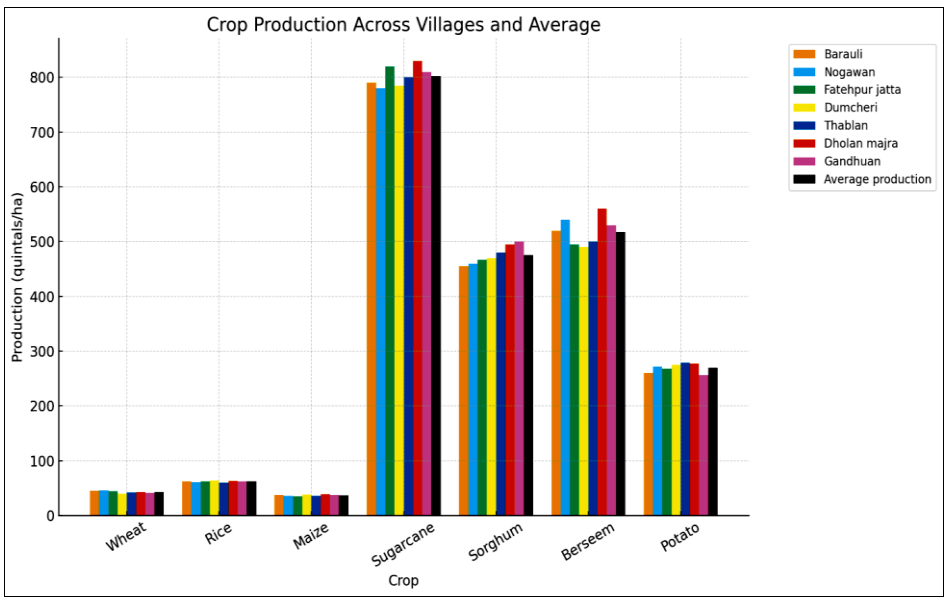

Fig 12: Depicts the Yield of the major crops grown by the respondents

Problems faced by farmers

Table 17 presents data on the percentage of farmers experiencing different agricultural problems across various villages. The issues are arranged in order according to the overall percentage of farmers affected. The major problem is High market price (91.7%), followed by Seed cost (45%) and Variety selection / Lack of knowledge (38.3%).

Table 17: Problems

S. No.	Problems	Barauli (n=8)	Nogawan (n=9)	Fatehpur jatta (n=8)	Dumcheri (n=5)	Thablan (n=5)	Dholan majra (n=13)	Gandhuan (n=12)	Overall% (n=60)
1	Lack of credit	4	5	2	2	2	3	4	22 (36.7%)
2	Crop selection	3	2	2	2	0	4	5	18 (30%)
3	Variety selection	2	2	1	3	2	7	6	23 (38.3%)
4	Seed cost	4	3	5	2	2	5	6	27 (45%)
5	High market price	8	8	8	5	5	11	10	55 (91.7%)
6	Lack of knowledge of management of diseases, pest, weed etc.	3	4	5	2	3	3	3	23 (38.3%)
7	Lack of resources	4	1	4	1	2	3	4	19 (31.7%)
8	Insufficient yield	5	3	3	2	1	5	3	22 (36.7%)

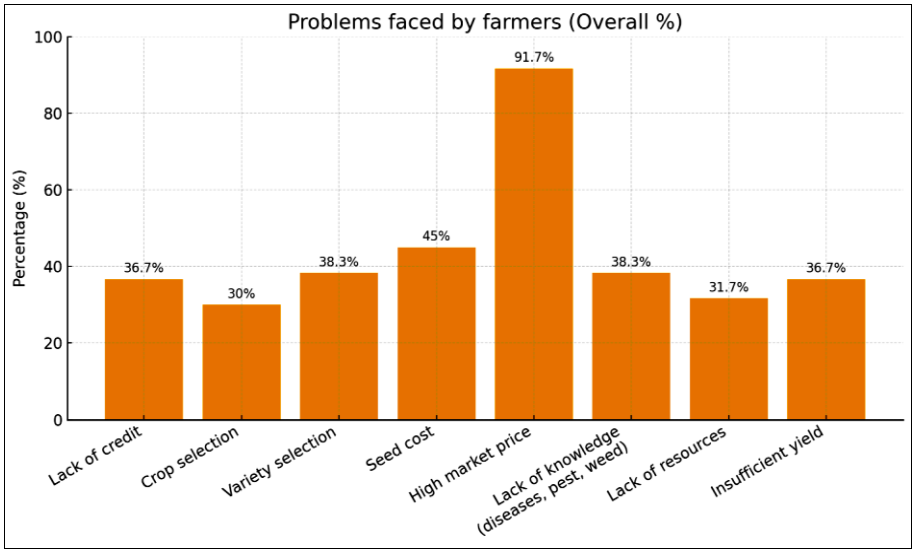

Fig 13: Represents the overall percentage of problems that are being faced by the farmers.

Conclusion

From the findings, it is evident that farmers in this region cultivated a diverse range of crops including wheat, paddy, sugarcane, maize, sorghum, berseem & potato,. Among these, wheat and paddy are the major cereal crops, and sorghum is the leading fodder crop.

Farmers applied seed at the recommended rate in only 71.30% of cases, while many tended to use higher seed rates. About 80% of farmers used fungicide-treated seeds, and crops typically received 3-4 irrigations per season. Irrigation mainly relies on tube wells & canals. Fertilizer application was also generally above the recommended levels, except for MOP, as the soils already contained a surplus of potash. Fertilizer management, however, shows a marked imbalance, with farmers giving higher importance to nitrogen- and phosphorus-based fertilizers while paying less attention to potassium.

Weed management was a major issue, The most problematic weed is Phalaris minor (Gulli danda), which mainly results from the absence of crop rotation. Farmers attempt to manage this weed through both manual practices and herbicide use. Disease occurrence is also significant, with sheath blight in rice (78%) and yellow rust in wheat (83%) being the most common. Farmers rely largely on chemical treatments for disease management. To manage these, almost all farmers relied on Nativo, while some also used mancozeb and propiconazole. Additionally, Pest infestation by grasshoppers and aphids were identified as the major pests damaging rice and wheat.

Harvesting practices vary, with cereals like wheat and rice mostly harvested using combine harvesters, whereas crops such as maize, sugarcane, potato, sorghum and berseem are harvested manually. Yields are relatively good, ranged from 30 to 65 q/ha for wheat and paddy. To enhance farm productivity, profitability, and sustainability in this region, farmers are encouraged to adopt the diverse cropping systems, efficient water management, and soil-health-based nutrient application. Moreover, Water-saving practices such as the direct-seeded rice (DSR) method is recommended as it requires less water compared to traditional transplanting. [12] Crops like maize can be promoted as alternatives, as they serve food, fodder, and value-addition purposes (e.g., pickles), offering better income opportunities.

Another concern is the low adoption of soil testing, leading to unbalanced fertilizer use. Awareness of soil testing is also limited. Regular soil testing can help maintain soil health, ensure balanced nutrient application, and improve long-term sustainability Regular soil testing would help farmers to assess macro- and micronutrient levels, to maintain soil health, ensure balanced nutrient application, and improve long-term sustainability. The adoption of such scientific agronomic practices can significantly enhance the crop productivity and

strengthen the economic condition of farmers.

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