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Analysing agricultural practices in the Rupnagar district of Punjab, India: A comparative study

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Abstract
Nearly half of India's work force is employed in agriculture, which accounts for 20.2% of the country's GDP and makes a significant economic contribution. This research focuses on the distinct farming methods used in the Rupnagar District of Punjab, also referred to as the "Granary of India." We explore the complex connection that determines the future of agriculture in the region between agronomic practices and crop productivity.150 farmers are interviewed over a period of six different villages in this study with the goal of understanding their farming practices and their socioeconomic status. The results show that wheat and paddy are widely farmed, with sugarcane, maize, barseem, and sorghum enhancing the variety of crops. Problems like uneven fertilizer application and weed resistance highlight the necessity of precise treatments. Seed treatment preferences are impacted by knowledge and resources, with 79.3% preferring hybrid seeds. The overuse of urea and DAP in fertilizer methods indicates the need for balanced fertilization techniques. The importance of tube wells for irrigation is highlighted, underscoring the necessity of sustainable water management. The Wheat-Paddy paradigm dominates crop patterns, which presents problems including insect infestation and weed resistance. While rice varieties that prioritize grain quality continue to be harvested manually, the harvesting of cereal crops is streamlined by combine harvesters. In order to conserve water, the study's conclusions advocate for crop diversity, direct-seeded rice techniques, increased knowledge of soil testing, and balanced fertilizer use. For the agricultural community of Rupnagar, this change holds potential for greater production, resilience, and financial well-being while combining innovation and tradition for a sustainable future.

Keywords: Agronomic practices, farmer, production, crop, land

Introduction
India's agricultural history dates back to the Neolithic era and is an essential aspect of the country's historical and modern foundations. This sector has not only kept the country going, but it has also been significant in building its socioeconomic structure. According to the Indian Economic Survey for 2020–21, the agricultural sector employed over 50% of India's labour force and made for a considerable 20.2% of the nation's GDP. Although these figures demonstrate the industry's ongoing significance, in order to fully understand the subtle differences in agricultural contributions, it is important to go further into each region.

India implemented major policy changes aimed at achieving food grain self-sufficiency. The Green Revolution in India began as a result. The first step toward increasing production was the adoption of higher yielding, disease-resistant varieties of wheat together with improved agricultural practices. Leading India's green revolution and known as the nation's breadbasket which is the state of Punjab (Anonymous, 2022) [5].

Punjab, also referred to as the "Land of the Five Rivers," has a special place in Indian agriculture. The State has observed a tremendous increase in agricultural production, since the 1960's Punjab has occupied an important position in Indian agriculture. Despite the small geographical area (1.5 percent of the total geographical area of the country, the Gross State Domestic Product from agriculture increased by 5.61 percent per annum in the period from 1971-72 to 1985-86, which is more than double 2.31 percent of all-India grow lhen the same period (Human Development Report, Punjab, 2004) [8]. But the period after the nineties proved to be a stagnating for Punjab's agricultural economy, as agriculture growth falls sharply to just 1.6 percent per annum during 2005-06 to 2014-15 (Gulati, *et. al*,2017) [3], which was almost less than half of all-India agricultural growth *i.e.* 3.6 percent over the same period.

During the early years of the Green Revolution, the economy thrived. The Green Revolution helped India's economy as a whole by significantly increasing the state's agricultural output in Punjab, where it was originally implemented.

Punjab produced 70% of the nation's food grains by 1970, and farmer incomes increased by more than 70%. (Sandhu *et al.* 2014) [7].

The study and technique of growing and utilizing plants through agriculture for food, fuel, fibre, chemicals, leisure, or land preservation is known as agronomy. Plant physiology, soil science, meteorology, and plant genetics studies are now all included in agronomy. It is the application of a number of scientific disciplines, economics, ecology, and earth science (Anonymous, 2023) [6].

In order to maintain the sustainability of the food chain, agricultural technology is essential. One of the best examples of how technology, regardless of size, has changed agricultural output is the Green Revolution. Among the many benefits of this revolution are higher yields, less poverty, improved food availability, infrastructural development, and lower food prices (Mc Cullough *et al.* 2012) [4].

This research focuses on the survey that has been conducted in Rupnagar District of Punjab, which has an interesting agricultural environment with hot summers and freezing winters due to its arid climate. The soils of the district, which range from loam to silty clay loam, are perfect for growing a wide variety of crops, including as vegetables, wheat, maize, rice, sugarcane, and sorghum. With an average of 775.6 mm of rainfall per year, the area presents both unique potential and problems for agricultural practises.

The purpose of the research is to explain the complex relationship that exists in the Rupnagar District between crop productivity and agronomic practises. We hope to learn more about the common practises used by the farmers in the area and how they affect crop yields, which will be important information for the future of agriculture in the area.

Materials and Methods

The research was carried out in Punjab, India, particularly in the Rupnagar district. For the purpose of this research, six individual villages—Choti Mandauli, Ramgarh Manda, Rattanagarh, Bhadwali, Bari Mandauli, and Bhateri were selected. Random sampling was used to select 150 farmers in total for interviews. Twenty-two respondents from Choti Mandauli, fifteen from Ramgarh Manda, twenty-eight from Rattanagarh, twenty-five from Bhadwali, twenty-seven from Bari Mandauli, and thirty-three from Bhateri were included in this sample.

Interviews were carried out as part of the research with the selected farmers to find out more about their socioeconomic status and the all-year long farming practices they implement. These interviews were conducted on the fields or in the houses of the farmers.

A standardized questionnaire was designed for the interviews in order to inquire about every aspect of the farming methods used by the farmers. After the respondents' data was obtained, it was arranged and subjected to the proper statistical techniques, which included percentage calculations and the use of graphical displays like pie charts and bar graphs to convey the results.

Result and Discussion

Crops Cultivated by Farmers throughout the Year

The information obtained suggests that every farmer in the research region grows wheat, and that almost all of the respondents—roughly
100%—cultivate paddy crops on their farms. In addition, about 42% of the farmers plant sugarcane in addition to these main crops, and about 54% grow maize as a secondary crop.

Moreover, the area is distinguished by the noteworthy production of two primary fodder crops that are unique to each season: berseem and sorghum. About 32.6% of the respondents grow berseem as a fodder crop in their fields, whereas about 41.3% of them grow sorghum

Table 1: Crops which are cultivated all year round in Rupnagar district

Crop	Choti mandauli	Rattanagrh	Ramgarh Manda	Bhadwali	Bari Mandauli	Bhateri	Overall Percentage
Wheat	21	28	15	25	27	33	150 (100%)
Rice	21	28	15	25	27	33	150 (100%)
Sugarcane	9	11	6	10	12	15	63 (42%)
Barseem	6	8	5	9	10	11	49 (32.6%)
Maize	11	14	10	13	14	19	81 (54%)
Sorghum	8	9	6	11	13	15	62 (41.3%)

Seed Treatment Practices among Survey Respondents

The selection of whether or not to use seed treatment in agriculture depends on a number of variables, including knowledge and land holdings. Large-scale and marginal farmers choose to use chemicals or hybrid seeds, whereas farmers with limited land and skill frequently skip seed treatment.

With their better yields, hybrid seeds are chosen by the majority, 79.3% of them. 16.6% of individuals treat their own seeds, which may indicate experience or a preference for standard methods. Among farmers, only 0.03% do not treat their seeds.

These selections demonstrate how knowledge and resources determine seed treatment options, directing focused agricultural interventions for increased sustainability and production.

Table 2: Seed treatment practices which are followed by the farmers of Ropnagar district

Method	Choti mandauli	Rattanagrh	Ramgarh Manda	Bhadwali	Bari Mandauli	Bhateri	Overall Percentage
Hybrid	17	25	10	18	21	28	119 (79.3%)
Treated by farmer	4	3	4	5	6	3	25 (16.6%)
Not treated	-	-	1	2	-	2	5 (0.03%)

Irrigation Practises: The study focuses on rice and wheat, two major crops, in the context of irrigation systems in the Rupnagar District.

Tube wells and Flood irrigation are the main source of irrigation used in rice farming. The rice fields in the area are kept at the ideal moisture levels by the frequent and constant irrigation schedules used by the farmers. Additionally, the critical period of rice irrigation falls on the first planting,

indicating the need of water management strategies at this critical point.

In case of wheat cultivation, tube wells continue to be the main irrigation source. Farmers irrigate wheat four to five times during its growth cycle, paying particular attention to the developmental stage that begins to emerge between 20 and 21 days after sowing (DAS). This specific irrigation approach meets the crop's development needs and shows an extensive knowledge of water management techniques in wheat farming.

Table 3: Irrigation methods for main cereal crops done by farmers

Crop	Method of irrigation	No. of irrigation	Stage / DAS
Paddy	Tubewell	6 to 25 times(regular)	At the interval of 20 DAS
Wheat	Tubewell	4-6 times	20-21DAS

Fertilizer Utilization Patterns

This section presents an extensive overview of the fertiliser practises observed among the surveyed farmers in the Rupnagar District, with an emphasis on rice and wheat crops.

The suggested fertiliser dosage for paddy cultivation is 125N: 30P: 30K (Anonymous 2022) [5]. In the same way, 120N: 60P: 40K is the suggested fertiliser dose for wheat crops (Anonymous 2022) [5]. But the research shows that most responders go beyond these recommendations, suggesting that imbalanced fertilisers are often used. Potassic fertilisers are given relatively less attention than nitrogenous fertilisers, which are prioritised and followed by phosphoric fertilisers. Furthermore, only a small percentage of farmers add micronutrients to their fields, such as zinc, iron, and sulphur. It is important to note that a significant number of people are still ignorant of the particular requirements of the soil for phosphorus (P), potassium (K), and nitrogen (N), which highlights a knowledge gap in optimal fertilizer application. None of the farms had had their soil tested in previous years.

Table 4: Patterns of fertilizer utilization followed by the farmers

Parameters	Choti Mandauli (n=4)	Rattangarh (n=4)	Ramgarh Manda (n=2)	Bhadwali (n=4)	Bari Mandauli (n=5)	Bhateri (n=6)	Overall (kg/ha)	Recommended
Wheat								
Urea/ha	300 kg/ha	275 kg/ha	324 kg/ha	300 kg/ha	315 kg/ha	306 kg/ha	302.8	120N
DAP/ha	250 kg/ha	187 kg/ha	200 kg/ha	170 kg/ha	200 kg/ha	210 kg/ha	201.4	60P
Potash/ha	-	-	-	-	-	-	-	40K
Paddy								
Urea/ha	325 kg/ha	300 kg/ha	300 kg/ha	315 kg/ha	325 kg/ha	310 kg/ha	313	120N
DAP/ha	187 kg/ha	150 kg/ha	125 kg/ha	185 kg/ha	150 kg/ha	190 kg/ha	159.4	30P
Potash/ha	-	-	-	-	-	-	-	30K

Approaches of Harvesting

According to data obtained, farmers generally favor using combine harvesters to harvest cereal crops, particularly wheat and paddy. The efficiency of combine harvesters, which save time and do not require a lot of physical effort, is the reason behind this choice. Notably, nearly 74% of respondents prefer combine harvesters for certain cereal crops, while just 26% prefer manual harvesting.

It's essential to note that farmers clearly prefer hand harvesting when it comes to paddy agriculture, especially for types like Basmati 1121, 1509, etc. Such varieties are preferred because of their long, thin grains. Farmers choose the careful method of hand harvesting in order to preserve grain quality since they are aware that mechanized harvesting may cause harm to the grains.

This knowledge of harvesting techniques shows the increasing dependence on combine harvesters for efficiency. It also emphasizes the careful consideration that goes into selecting manual harvesting for certain crops with distinctive grain properties. These kinds of things fall in with the larger idea of maximizing farming methods for preservation of quality and output.

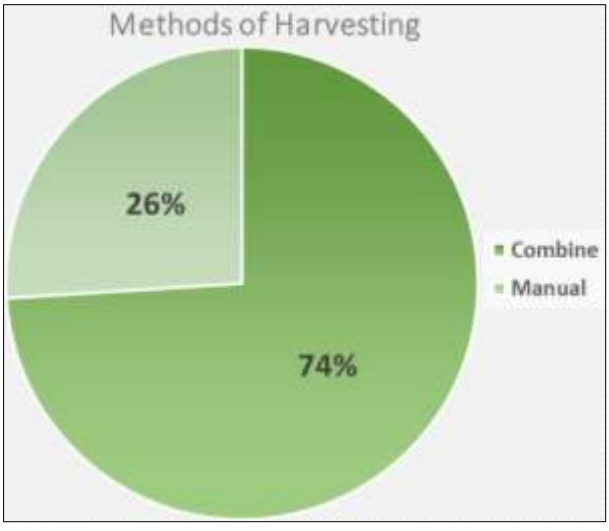

Fig 1: Pie chart which shows percentage share of different harvesting methods

Weed Challenges across Crops

A thorough analysis of weed-related issues reveals an ongoing issue that impacts agricultural production in the Rupnagar District. Throughout the year, farmers tackle a range of weeds specific to various crops, with *Phalaris minor* emerging as the most common weed, as reported by a significant 98% of respondents. Concerns are raised by *Phalaris minor's* resistance to conventional herbicides, especially during the Rabi season, which affects wheat fields and significantly lowers yields.

Approximately 93.3% of respondents reported that the swank weed (*Echinochloa crus-galli*) had a widespread impact on the production of rice during the Kharif season. As another prominent weed problem in paddy agriculture, 70% of respondents identified *Cyperus rotundus*. 84% of respondents said that *Avena ludoviciana* presents a serious weed problem for wheat agriculture.

These results highlight how urgent it is to put into practice efficient weed control techniques, particularly when dealing with herbicide-resistant weeds like *Phalaris minor*. Since these weeds are so common, crop yields are directly in danger, emphasizing the need for focused interventions and education campaigns to lessen the negative effects of weeds on the region's agricultural output.

Table 5: Types of weeds that pose a challenge to farmers

Sr. No.	Weed Name	Crop	No. of farmers (Overall Percentage)
1.	*Echinochloa crus-galli*	Paddy	140 (93.3%)
2.	*Cyperus rotundus*	Paddy	105 (70%)
3.	*Phalaris minor*	Wheat	147 (98%)
4.	*Avena ludoviciana*	Wheat	126 (84%)

Conclusion

Our extensive examination of Punjab's Rupnagar District's agricultural ground reveals a variety of farming techniques, difficulties, and possibilities. A number of significant findings arise when we examine the various aspects of this agricultural tapestry, which influencing how we see the current situation and providing insights about how farming in this area may develop in the future.

Rupnagar's agricultural landscape is covered with a wide variety of crops. The two main cereal crops, wheat and paddy, are very significant and are intricately woven into the history of the area. In addition to these main crops, sugarcane, maize, barseem, and sorghum add to the agricultural diversity and highlight the great range of farming methods in the area.

Our research reveals a surprising pattern: the information and resources available to farmers influence the seed treatment decisions they make. For higher yields, the majority (79.3%) use hybrid seeds, while just 16.6% treat their own seeds. Unexpectedly, just 0.03% do not treat seeds. These choices demonstrate how important it is to have resources and expertise to guide agricultural operations in the direction of greater productivity and sustainability.

Notable patterns emerge when fertilizer methods are examined more closely. It appears that too much DAP and urea fertilizers are being used, and not enough attention is being paid to potassium fertilizers. This points to a possible area for education and intervention to encourage the use of fertilizer in a more sustainable and balanced manner.

Tube wells emerge as the lifeline of irrigation, supporting parched rice and wheat fields. The widespread use of flood irrigation, which is a result of traditional practices rooted in localized farming traditions, can be observed in the fields. The use of tube wells emphasizes the necessity of sustainable water management techniques for ensuring the long-term availability of this essential resource. Strategic water conservation strategies are essential to maintaining agriculture's future in this shifting environment. Efficient regulations and community efforts can significantly contribute to ensuring sensible water consumption and safeguarding this vital resource for future generations.

The majority of farmers' preference for the wheat-paddy farming pattern discloses an underlying problem. Problems including weed resistance, disease prevalence, and insect infestation are caused by this trend. Because it is resistant to traditional pesticides, the weed known as *Phalaris minor* poses a serious weed threat in the Rabi season, seriously damaging wheat fields and lowering yields.

Combine harvesters, which are productive and efficient, are increasingly being used for cereal crops like wheat and rice but the intentional decision to harvest some rice varieties by hand highlights how much thought has been put into ensuring grain quality.

Our research suggests cropping patterns should change systematically. Diversifying crop yields is a solution to the problems associated with the widely accepted Wheat-paddy pattern, despite its long history. Important initiatives include encouraging the use of direct-seeded rice techniques to save water, recommending differed farming practices, and raising the general awareness of soil testing and balanced fertilizer use. In addition to increasing production, this move toward sustainable agriculture also protects the durability and economic stability of the Rupnagar District's farming community.

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Competing Interests

Authors have declared that no competing interests exist.

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