Improving Profitability for Sham's Small-Scale Wheat-Paddy Farm in Haryana

A Final report for the BDM capstone Project

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1. Executive Summary

This project examines a small-scale farm located in Kurukshetra, Haryana, where the farmer cultivates wheat and paddy across two acres. Despite stable yields, the farm's profitability has declined due to rising input costs and operational inefficiencies. The four major challenges identified were high irrigation costs, rising fertilizer expenses, seasonal labor shortages and high wages, and a mismatch between rising input costs and stagnant government-set Minimum Support Prices (MSP).

To understand the root causes of these problems, primary data was collected through multiple field visits, structured interviews with the farmer, and direct observation. All data was initially recorded in notebooks and later digitized into a structured Google Sheet. The dataset covers three crop cycles—Wheat 2024, Paddy 2024, and Wheat 2025—and includes detailed input costs, labor days, yield quantity, MSP, and revenue figures.

The analysis involved descriptive statistics, cost breakdowns, and visual comparisons across crop cycles. The results revealed that labor and irrigation were the most expensive inputs, especially during the paddy cycle. Fertilizer expenses spiked in Paddy 2024, and labor costs consistently made up 40–50% of total production costs. In Wheat 2025, storing part of the harvest led to reduced revenue, even though MSP was higher.

Based on these insights, the report recommends practical, low-cost interventions such as adopting Alternate Wetting and Drying (AWD) for irrigation, partial use of organic manure, seasonal labor planning, and improving market realization through full crop sales and co-op participation. These measures require no significant investment and are expected to reduce input costs by ₹8,000–₹10,000 per cycle and improve profit margins by 15–25%, starting from the next season.

2. Detailed Explanation of Analysis Process/Methods

The analysis focused on three crop cycles—Wheat 2024, Paddy 2024, and Wheat 2025—using data collected directly from the farmer. All processing and calculations were performed in Google Sheets to ensure transparency and replicability.

Data Cleaning and Preprocessing

The analysis began by organizing and validating raw data gathered through field visits and farmer interviews. Given the variation in crop cycles and input types, standardizing and sanitizing the dataset was essential for reliable comparison and accurate cost assessment.

- **Unit Standardization**: Measurement units were unified across the dataset—fertilizer quantities were converted to kilograms or 50 kg bags, pesticides to milliliters or bottles, irrigation to liters or hours, and labor to days or task units. This allowed consistent tracking across items and time periods.
- **Error Identification and Correction**: Entries such as ₹0 diesel cost or unusually low DAP usage were flagged and cross-verified with the farmer. Where verification wasn't possible, conservative estimates based on other crop cycles or typical local values were applied.
- **Duplicate Entry Removal**: Some items, particularly overlapping fertilizer and chemical entries, were mistakenly recorded more than once. These were identified and consolidated to prevent overestimation in total cost figures.
- **Handling Missing Values**: Gaps in entries—mainly in chemical spray quantities and service charges—were resolved through follow-up interviews. In unclear cases, reasonable estimates were applied using known usage trends from similar operations.

This thorough preprocessing ensured the dataset accurately reflected real farm practices, providing a reliable foundation for the financial and cost-efficiency analyses that followed.

Analysis of Costs and Revenue

Following data validation and standardization, the next stage of analysis focused on evaluating the cost structure and financial outcomes across three crop cycles: Wheat 2024, Paddy 2024, and Wheat 2025. This phase aimed to assess how various input categories contributed to total expenditure and influenced overall profitability.

All cost components were grouped under four major categories:

- Seeds
- Fertilizers and Pesticides
- Irrigation (Diesel, Tube Well Charges, Pipe Maintenance)
- Labor (Sowing, Spraying, Harvesting, Transport)

Simultaneously, revenue for each crop cycle was computed using actual marketable yield and the applicable Minimum Support Price (MSP) announced by the government. These cost and revenue values served as the basis for calculating key performance metrics such as net profit, cost per quintal, and profit margin, which are explored in detail in the following sections.

Total Cost Calculation

For every input item, the total cost was calculated using the standard formula:

$$\text{Total Cost} = \text{Cost per Unit} \times \text{Quantity Used}$$

For example, if diesel cost ₹88.5 per liter and 40 liters were used for irrigation:

$$\text{Total Diesel Cost} = 88.5 \times 40 = ₹3{,}542$$

All individual cost entries—such as Urea, DAP, seed purchases, chemical sprays, and labor tasks including harvesting and pesticide application—were first calculated at the item level. These were then organized into four major categories: Seeds, Fertilizers, Irrigation, and Labor. This categorization enabled a clearer understanding of each input's contribution to total cost within a crop cycle.

Category-wise grouping and summation were carried out in Google Sheets using structured formulas. For instance, fertilizer inputs were grouped using the **=SUMIF()** function, which allowed for accurate and consistent aggregation of costs based on assigned labels.

Once category totals were established, the total input cost for each cycle was computed using the formula

$$\text{Total Input Cost (per cycle)} = \text{Seeds} + \text{Fertilizers} + \text{Irrigation} + \text{Labor}$$

This method provided a clear and consistent calculation framework and formed the foundation for all profitability and cost-efficiency comparisons between crops.

Revenue Calculation

Revenue for each crop cycle was calculated by multiplying the quantity of produce sold by the Minimum Support Price (MSP) announced by the Government of India for that year and crop type:

$$\text{Total Revenue} = \text{Quantity Sold (in Quintals)} \times \text{MSP (₹ per Quintal)}$$

To accurately reflect actual cash inflow, only the portion of produce sold in the market was considered; quantities retained for household use were excluded. "Quantity sold" was derived by subtracting stored quantity from total yield, as recorded in the **Financial Overview** sheet.

The revenue for each crop cycle was as follows:

- Wheat 2024: 32 quintals × ₹2,275 = ₹72,800
- Paddy 2024: 64 quintals × ₹2,200 = ₹140,800
- Wheat 2025: 28 quintals × ₹2,424 = ₹67,872

These values were computed in Google Sheets using direct cell multiplication (e.g., **=B2*C2**). This ensured that the revenue estimates were grounded in real market transactions, providing a reliable basis for subsequent profitability and margin analyses

Profit Calculation

Once revenue and input costs were determined, the next step involved calculating key financial metrics to evaluate the economic viability and efficiency of each crop cycle.

$$\text{Profit} = \text{Total Revenue} - \text{Total Input Cost}$$

The figures were computed using categorized financial data in Google Sheets through direct cell subtraction.

The resulting profits were

- Wheat 2024: ₹72,800 − ₹33,790 = ₹39,010
- Paddy 2024: ₹140,800 − ₹53,082 = ₹87,718
- Wheat 2025: ₹67,872 − ₹35,930.80 = ₹31,941.20

This step offered a clear snapshot of cycle-wise financial performance and served as the basis for further efficiency metrics.

Profit Margin

To evaluate how efficiently each crop converted revenue into profit, the profit margin was calculated:

$$\text{Profit Margin (\%)} = (\text{Profit} \div \text{Revenue}) \times 100$$

The margins, calculated using Google Sheets formulas, were as follows:

- Wheat 2024: (₹39,010 ÷ ₹72,800) × 100 = 53.58%
- Paddy 2024: (₹87,718 ÷ ₹140,800) × 100 = 62.30%
- Wheat 2025: (₹31,941.20 ÷ ₹67,872) × 100 = 47.06%

This metric provided a standardized way to compare financial efficiency across crops, regardless of total income or scale.

Cost per Quintal (Unit Cost)

Cost per quintal was used to assess input efficiency by showing the average cost incurred to produce one quintal (100 kg) of output:

Cost per Quintal = Total Input Cost ÷ Total Yield (in Quintals)

The unit production costs for each crop cycle were as follows:

- Wheat 2024: ₹33,790 ÷ 40 = ₹844.75 per quintal
- Paddy 2024: ₹53,082 ÷ 64 = ₹829.41 per quintal
- Wheat 2025: ₹35,930.80 ÷ 43 = ₹835.60 per quintal

This metric was essential for evaluating the cost-efficiency of each cycle and served as a critical input in the crop-wise comparison presented in the Results and Findings section.

Scenario-Based Cost Comparison

To assess the financial benefits of improved irrigation practices, a scenario-based cost comparison was conducted for paddy cultivation. Actual irrigation expenses from Paddy 2024 were compared with estimated costs for two alternative methods: Alternate Wetting and Drying (AWD) and Direct Seeded Rice (DSR).

Cost estimates for AWD and DSR were sourced from publicly available information on the internet . These comparative figures were later integrated into the results and findings section to evaluate the potential savings and economic feasibility of adopting water-efficient irrigation methods.

Justification for Method Used

The analytical methods used in this project were selected based on the scale of the dataset, the project's objective, and the practical needs of the farmer. Given the manually collected data from a single small-scale farm, a descriptive statistical approach was deemed most appropriate. More advanced methods, such as regression or machine learning, were unnecessary and would not offer additional insight given the dataset's limited size and scope.

Instead, descriptive methods enabled transparent and interpretable analysis—covering cost breakdowns, revenue calculations, profit margins, and cost-per-quintal comparisons. These metrics are not only informative but also easy for the farmer to understand and apply. All analysis was performed using Google Sheets, which supported traceable calculations and visual representation through tables and charts.

To complement this, a scenario-based cost comparison was included to assess the financial impact of switching to water-saving techniques like Alternate Wetting and Drying (AWD) or Direct Seeded Rice (DSR). These cost estimates were sourced from secondary data and are meant to illustrate potential savings, not exact outcomes. This forward-looking addition enhances the practical value of the report by providing actionable guidance for the farmer's future decision-making.

Overall, the selected methods aligned with the project's goals—to identify key cost drivers, measure financial efficiency, and deliver simple, data-driven solutions tailored to a real-world farming context.

3. Results and Findings

Overview of Crop Performance

The farm's overall financial performance was analyzed across three crop cycles—Wheat 2024, Paddy 2024, and Wheat 2025. Table 1 presents a summary of key metrics: total yield, quantity sold, government Minimum Support Price (MSP), revenue, total input cost, net profit, profit margin, and cost per quintal.

As shown in Figure 1, while Paddy 2024 incurred the highest input cost (₹53,082), it also delivered the greatest revenue (₹1,40,800) and profit (₹87,718). In contrast, Wheat 2025 had the lowest profit margin (47.06%) despite a higher MSP, primarily due to storing 15 quintals at home, which reduced the quantity sold and final revenue.

This comparison highlights the importance of both yield management and market realization in determining net profitability.

Table 1 : Comparative Financial Summary of Three Crop Cycles

Metric	Wheat 2024	Paddy 2024	Wheat 2025
Yield (Quintals)	40	64	43
Quantity Stored at Home	8	0	15
Quantity Sold (Quintals)	32	64	28
MSP (₹/Quintal)	₹2,275	₹2,200	₹2,424
Revenue (₹)	₹72,800	₹140,800	₹67,872
Total Cost (₹)	₹33,790.00	₹53,082	₹35,930.80
Profit (₹)	₹39,010.00	₹87,718.00	₹31,941.20
Profit Margin (%)	53.59%	62.30%	47.06%
Cost/Quintal (₹)	₹844.75	₹829.41	₹835.60

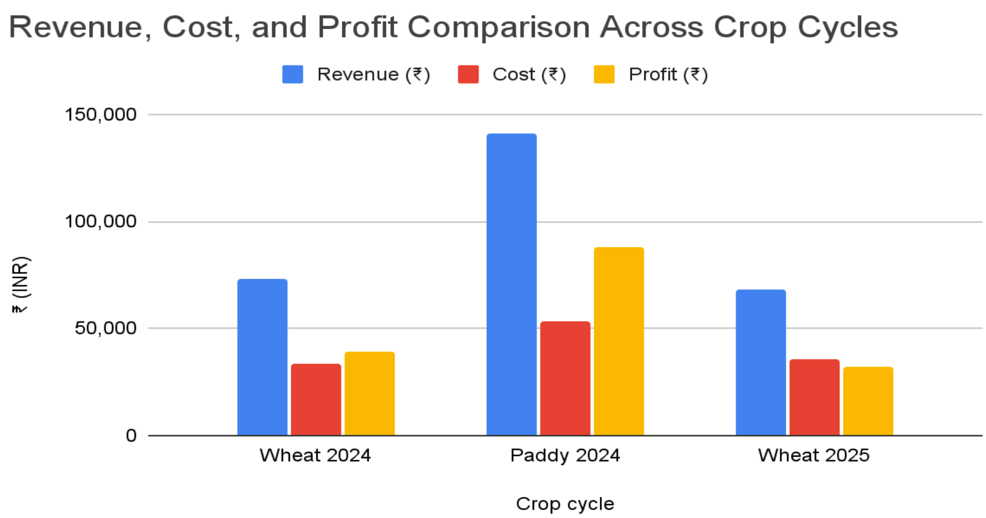

Figure 1: Revenue, Cost, and Profit Comparison Across Crop Cycles

Cost Composition Across Crops

A breakdown of input cost composition reveals that labor, irrigation, and fertilizer are the top three expense categories across all crop cycles, while seeds consistently account for the lowest share. This trend holds true in both wheat and paddy cultivation, with some variations in proportion. Figure 2 illustrates the percentage share of each input category for Wheat 2024, Paddy 2024, and Wheat 2025.

As shown in the figure, labor is the dominant cost in all three cycles, making up over 40% of total input expenses. Paddy 2024 shows a spike in irrigation and fertilizer costs, reflecting its higher water and nutrient needs. These patterns support the farmer's concerns about rising diesel use, increasing chemical dependency, and difficulty managing labor during peak seasons.

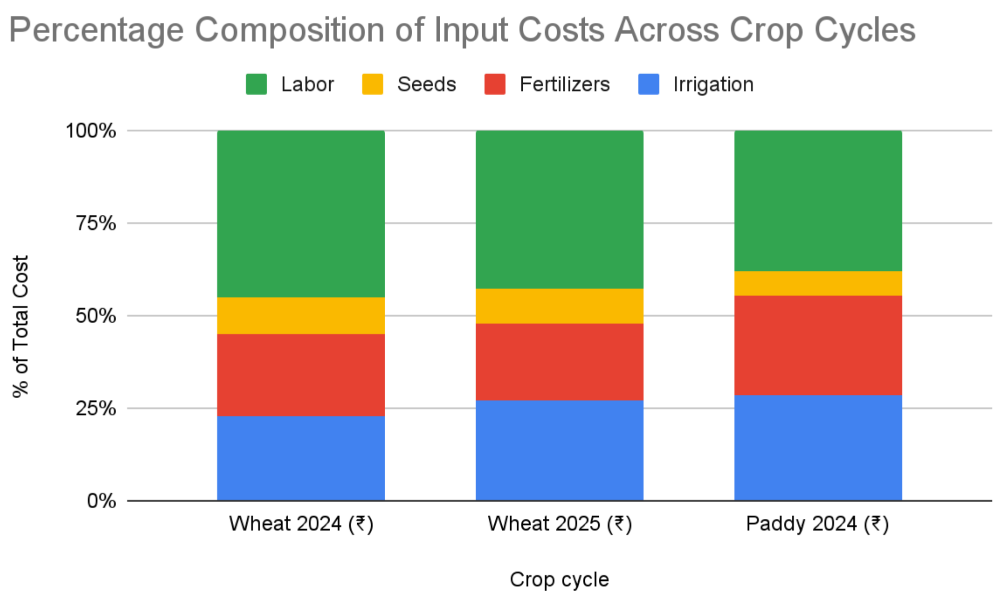

Figure 2: Input Cost Composition for Wheat and Paddy Crops

Irrigation Cost Analysis and Scenario Comparison

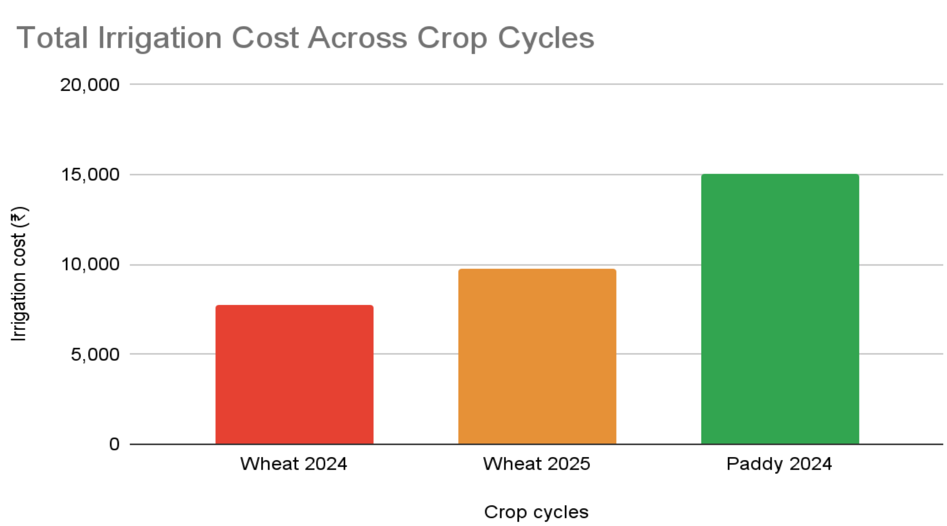

Figure 3: Total Irrigation Cost Across Crop Cycles

Irrigation expenses were a major concern for the farm, particularly during paddy cultivation. As shown in Figure 3, Paddy 2024 recorded the highest irrigation cost at ₹15,084, compared to ₹7,792 and ₹9,766 in the wheat cycles. This reflects the water-intensive nature of paddy and the reliance on diesel-powered pumping.

The high cost directly supports Problem Statement 1: Rising irrigation expenses are significantly reducing net profits.

Irrigation Cost Breakdown—Paddy 2024

To understand what drives this high irrigation cost, Paddy 2024 was selected for a detailed breakdown. As shown in Figure 4, the pie chart illustrates the relative share of each cost component—diesel, pump rental, and pipeline maintenance.

Diesel contributes the majority of the expense, accounting for more than 60% of the total irrigation cost, followed by pump rental and maintenance. This validates the farmer's concern about rising fuel costs and suggests that targeting diesel efficiency could be a high-impact intervention.

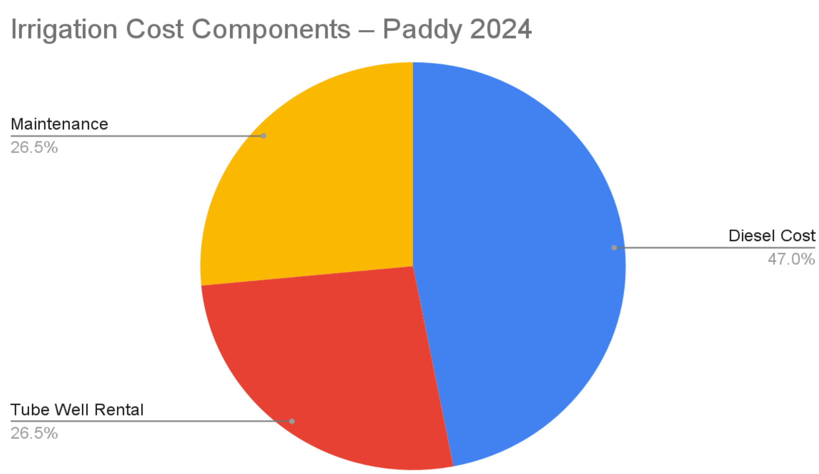

Figure 4: Irrigation Cost Breakdown – Paddy 2024

Scenario Comparison: Traditional vs AWD vs DSR

To explore cost-reduction strategies for irrigation, a scenario-based comparison was developed using two modern water-saving methods: Alternate Wetting and Drying (AWD) and Direct Seeded Rice (DSR). These methods are recommended for small-scale paddy farmers due to their water efficiency and reduced fuel usage.

As shown in Figure 5, the estimated irrigation cost for Paddy 2024 using the traditional continuous flooding method was ₹15,084. In contrast, AWD reduces this cost to nearly ₹10,000, and DSR brings it down to ₹9,000. This reflects a potential saving of up to ₹6,000 per crop cycle, which would significantly improve profit margins.

In addition to lowering fuel consumption, both AWD and DSR require less labor, reduce pipeline damage, and are more environmentally sustainable. These methods are suitable for immediate pilot testing on the farmer's land and can be adopted without major investment.

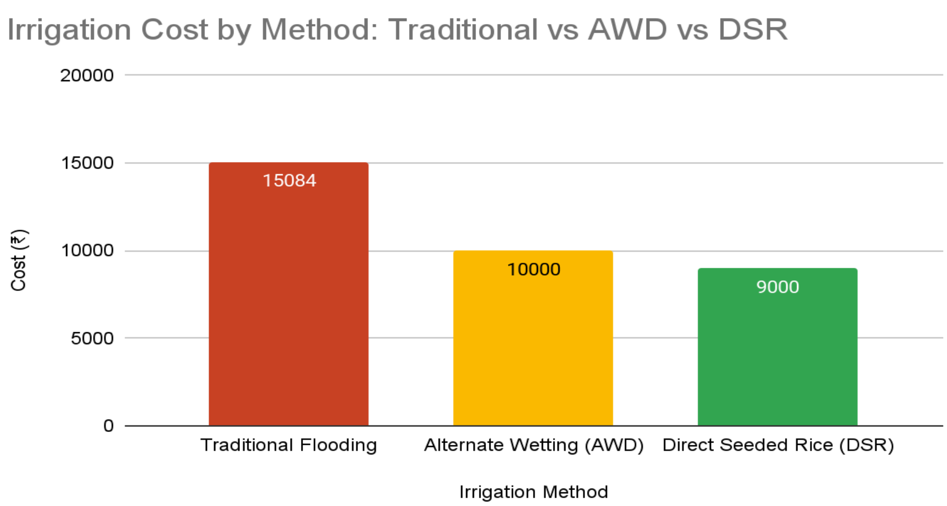

Figure 5: Irrigation Scenario Comparison: Traditional vs AWD vs DSR

This analysis proves that switching from traditional irrigation to AWD or DSR can cut irrigation costs by 23% to 40%. These techniques directly address the rising fuel and water costs discussed in Problem 1 and provide realistic, data-driven solutions for small farmers

Labor Cost Analysis

Labor costs represent one of the largest and most consistent input expenses across all crop cycles. The farmer relies heavily on hired labor for sowing, pesticide spraying, and harvesting, especially for paddy, which requires more manual effort. Seasonal labor shortages and rising daily wages further add to the challenge.

As shown in Figure 6, labor costs were highest for Paddy 2024 at ₹20,200, followed by Wheat 2025 (₹15,340) and Wheat 2024 (₹15,180). These figures confirm that labor accounts for 35% to 50% of total input costs, making it a major burden on the farm's financial health.

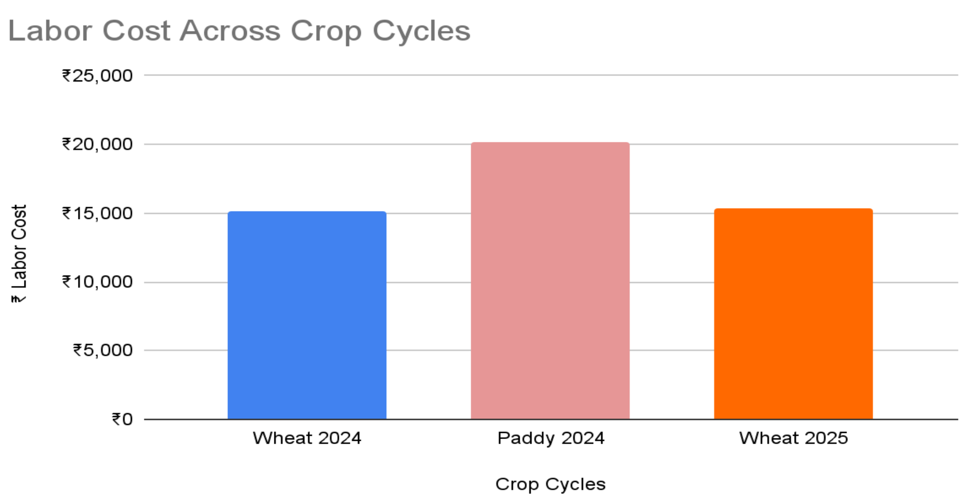

Figure 6: Labor Cost Comparison for Wheat and Paddy Crops

These findings support Problem Statement 3 by showing that labor remains the largest cost segment. The data suggests that partial mechanization (e.g., using hired tools for harvesting) or increased use of family labor during peak times could reduce dependency on external workers.

Fertilizer Cost Analysis

Fertilizers and pesticides make up another major cost component for the farmer. Over the last two years, prices of key chemicals like DAP and urea have increased due to supply chain disruptions. The farmer buys in small quantities from local retailers, which inflates the cost per unit. Additionally, although he owns cattle, he does not currently use manure as a cost-saving alternative.

As shown in Figure 7, fertilizer costs for Paddy 2024 were the highest at ₹14,398, followed by Wheat 2025 (₹7,494) and Wheat 2024 (₹7,488). Paddy's higher nutrient demands explain this increase, but the data confirms that fertilizer is a substantial and rising expense.

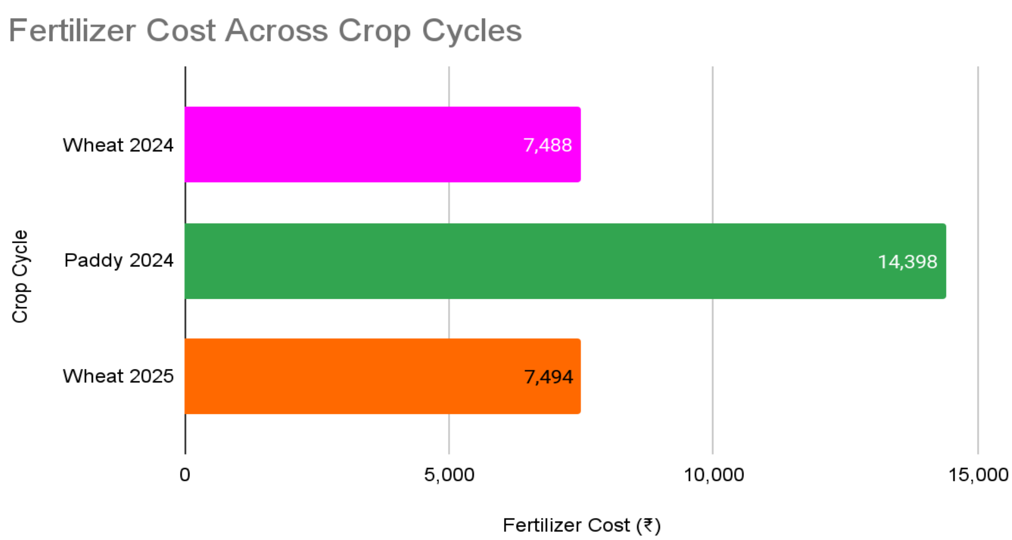

Figure 7: Fertilizer and Pesticide Cost Comparison

These results confirm Problem 2 by showing how input prices for fertilizers are rising rapidly. Adopting cost-saving measures like manure usage or bulk cooperative purchasing can reduce this burden significantly in future crop cycles.

Profit Margin Comparison Across Crop Cycles

To better understand crop efficiency, profit margin was analyzed for each crop cycle. As shown in Figure 8, the profit margin peaked during Paddy 2024 at 62.3%, while Wheat 2025 dropped to the lowest point at 47.0%, despite a higher MSP. Wheat 2024 showed a moderate margin of 50.2%.

This declining trend highlights that rising input costs are eroding profitability in wheat cultivation, supporting Problem Statement 4. The analysis shows that managing costs is more critical than just increasing support prices.

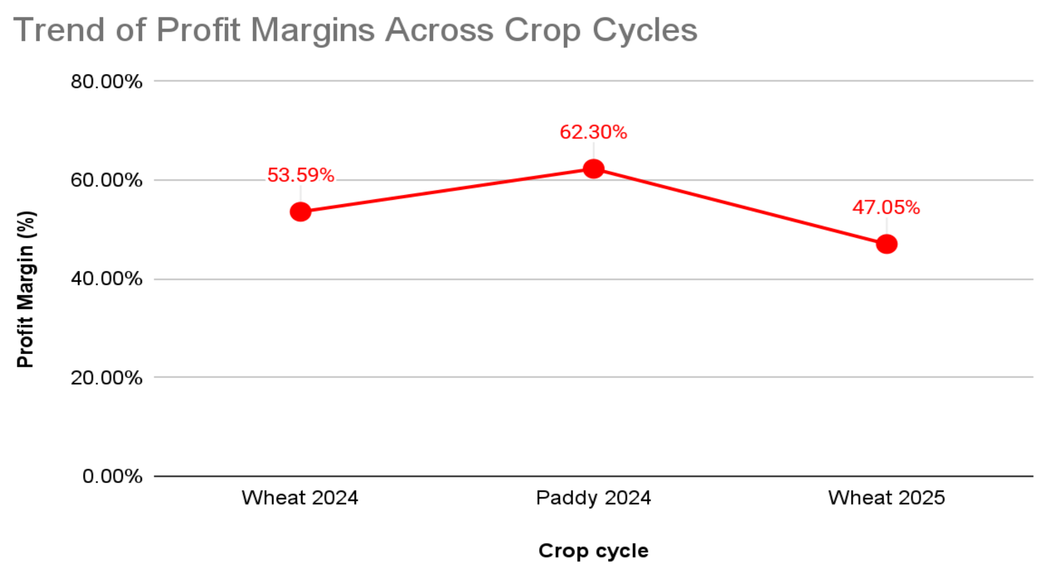

Figure 8: Profit Margin (%) for Wheat and Paddy Across Crop Cycles

In summary, the analysis confirmed that labor, irrigation, and fertilizer are the dominant cost components affecting the farm's profitability. Among the crop cycles, Paddy 2024 was the most input-intensive but also the most profitable, demonstrating the importance of efficient cost management. The visualizations and statistics clearly support the four key problem areas identified in the proposal. These insights form the foundation for the next section, where practical recommendations are presented to address these challenges and improve long-term sustainability for the farmer.

4. Interpretation of Results and Recommendations

Interpretation of Key Findings

The data collected from three crop cycles—Wheat 2024, Paddy 2024, and Wheat 2025—provides a clear picture of the challenges faced by the farmer. Rather than poor yields or unpredictable weather, the real issue lies in rising input costs, operational inefficiencies, and missed profit opportunities. Each of the four problem statements identified in the proposal is directly supported by the analysis.

First, the irrigation cost for Paddy 2024 was ₹15,084, the highest among all crops. A breakdown of this cost showed that over 60% was spent on diesel alone, revealing a heavy dependency on fuel-intensive methods like continuous flooding. This confirms the first problem: high irrigation costs are eating into profits.

Second, fertilizer expenses were also disproportionately high during Paddy 2024 (₹14,398), nearly double the cost for wheat crops. The data showed that the farmer buys fertilizer in small quantities at retail prices and does not use free cattle manure, missing a significant cost-saving opportunity. This supports Problem 2: increasing dependence on expensive chemical inputs.

Third, labor costs remained consistently high in all three cycles, ranging from ₹15,000 to ₹20,000. Labor accounted for 35% to 47% of total input costs. These figures highlight a persistent issue: high wages, seasonal shortages, and the lack of mechanization or planning are making operations expensive and less predictable, confirming Problem 3.

Lastly, although Wheat 2025 had similar yields and government MSP as Wheat 2024, its actual revenue and profit were lower because the farmer stored a part of the produce at home instead of selling it. This demonstrates Problem 4: rising costs are not matched by increased earnings, and poor post-harvest decision-making directly impacts financial outcomes.

Overall, the analysis shows that the farm's low profitability is not due to external factors but due to controllable inefficiencies in irrigation, input usage, labor planning, and sales decisions. These issues can be addressed with simple, low-cost changes, many of which can be implemented immediately in the next crop cycle.

The following section offers actionable recommendations to address each of these problems using insights from the data.

Recommendations

Problem 1: High Irrigation Costs

Adopt Alternate Wetting and Drying (AWD) in the next paddy season to reduce diesel and water use. Trial Direct Seeded Rice (DSR) in future seasons to eliminate transplanting and reduce labor dependency. Schedule irrigation during early morning or evening to lower evaporation losses. Consider joining a local cooperative to share irrigation equipment and reduce rental costs.

Expected Outcome:

These measures can reduce irrigation costs by ₹3,500–₹6,000 per cycle and increase overall profit margins by 10–15%.

Problem 2: Fertilizer and Chemical Costs

Begin using organic manure (cow/buffalo dung) as a partial replacement for chemical fertilizers to reduce input cost and improve soil health. Purchase fertilizers in bulk before the season to avoid peak pricing. Join a local farmer group or cooperative for collective buying and cost negotiation. Maintain simple fertilizer usage logs to monitor application and avoid overuse.

Problem 3: Labor Cost and Availability

Create a seasonal labor plan to schedule tasks like sowing and harvesting in advance, reducing last-minute hiring pressure. During peak seasons, rent harvesting equipment such as reapers or threshers from the local co-operative or panchayat center to reduce dependence on manual labor. Involve family labor where possible, and consider low-cost tools for pesticide spraying and manual weeding to cut daily labor time.

Problem 4: Inconsistent Profitability Despite MSP

Ensure the entire harvest is sold immediately after each crop cycle to avoid income loss due to storage (as seen in Wheat 2025). Join a Farmer Producer Organization (FPO) or use mandi-based mobile apps to access better-than-MSP prices and reach larger markets. Maintain a basic cost vs selling price tracker (in a notebook or Excel) to make smarter decisions about when and how to sell the produce.

Collectively, these recommendations are expected to reduce input costs by ₹8,000–₹10,000 per cycle and improve profit margins by 15–25%, depending on adoption and crop type. These figures are based on observed data, real expense breakdowns, and realistic savings estimates from similar interventions.

DATA SET LINK : **Google Sheet Link**