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**S Rohith**  
Division of Agricultural  
Economics, ICAR - Indian  
Agricultural Research Institute,  
New Delhi, India

**Nalini Ranjan Kumar**  
National Institute of Agricultural  
Economics and Policy Research  
(ICAR - NIAP), New Delhi, India

**Pramod Kumar**  
Division of Agricultural  
Economics, ICAR - Indian  
Agricultural Research Institute,  
New Delhi, India

**Venkatesh P**  
Division of Agricultural  
Economics, ICAR - Indian  
Agricultural Research Institute,  
New Delhi, India

**Girish Kumar Jha**  
Division of Agricultural  
Bioinformatics, ICAR - Indian  
Agricultural Statistics Research  
Institute, New Delhi, India

**Roaf Ahmad Parrray**  
Division of Agricultural  
Engineering, ICAR- Indian  
Agricultural Research Institute,  
New Delhi, India

**Corresponding Author:**  
**S Rohith**  
Division of Agricultural  
Economics, ICAR - Indian  
Agricultural Research Institute,  
New Delhi, India

## An economic evaluation custom hiring models of farm machineries and constraints faced by farmers in Punjab

**S Rohith, Nalini Ranjan Kumar, Pramod Kumar, Venkatesh P, Girish Kumar Jha and Roaf Ahmad Parrray**

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### Abstract

This study assessed the economic viability and performance of four models of farm machinery Custom Hiring Centres (CHCs) in Punjab those operated by farmer-producer organizations (FPOs), primary agricultural credit societies (PACS), self-help groups (SHGs), and individual farmers in the districts of Ludhiana and Gurdaspur. Financial ratio analysis was employed to evaluate profitability, while Garrett ranking was used to identify farmer-perceived constraints. The results showed that CHCs, on average, operated at a loss (mean net return  $\approx$  ₹1.63 lakh, about -13% of total costs), indicating weak overall sustainability. However, performance varied by model: CHCs run by FPOs and individual farmers demonstrated relatively better economic efficiency (e.g., FPO-led CHCs had an average operating ratio of 0.92). In contrast, SHG-run centres recorded the highest operating ratios, indicating significant cost overruns. The most critical constraints reported by farmers included machinery shortages during peak seasons and inconsistent service pricing. These findings suggested that targeted interventions particularly related to machinery availability and pricing transparency were essential to improving the operational and financial viability of CHCs in the region.

**Keywords:** Custom hiring centres, economic viability, financial ratio analysis, Garrett ranking, Agricultural machinery, Punjab

### Introduction

Farm mechanization has been shown to increase farmers' productivity and yield; however, small and marginal farmers are unable to purchase farm equipment because of the high fixed costs as well as the high operating and maintenance costs. Mechanization is mostly seen among large farmers and is still out of reach for small and marginal farmers, who make up about 80% of the farming community. Owning any farm equipment or implements on a small farm alone is not financially feasible. These farmers can turn to hiring machines on a custom basis from cooperatives or big organizations that offer such services.

Although these custom hiring services are economical for small and marginal farmers, they are limited in terms of coverage due to the unavailability of machinery, non-availability of machinery during peak times, high initial cost, high maintenance cost, and high hiring cost during peak times. Improvements in agriculture hold the key to achieving the fundamental Sustainable Development Goals of 'No Poverty' (SDG 1) and 'Zero Hunger' (SDG 2). For agriculture to be sustainable and profitable, farmers must obtain better returns that can act as an incentive for them to continue and do well in farming. Since major sources of income for farmers are crop and livestock farming, income enhancement from agriculture should come from an increase in income as well as a reduction in costs (Satyasai & Mehrotra, 2020) [5] Evidence from successive input surveys shows that the level of farm machinery use has increased in both penetration and diversity and we need to work on different models and formats of enhancing the adoption of farm mechanization to suit land holding structure (Satyasai & Balanarayana, 2018) [4]. At present, a large number of custom hiring models are operating in the field to cater to the need of farm machinery for farmers. All models have some strengths and weaknesses and therefore there is a need to understand which model is more suited for any region. Very few studies comparing different models of CHCs were found.

Keeping this point in view the present study is an attempt to analyse the performance of different models to identify the best model to be adopted by the government to reach out to maximum farmers in a more efficient way. Although multiple models of CHCs are operating in Punjab the current study exclusively focuses on 4 main models selected based on their wide presence across the state and popularity among farmers. The four models chosen are CHCs operated by farmer-producer organizations (FPOs), Primary agricultural co-operative societies (PACS), Self-help groups (SHG), and individual farmers-owned CHCs. The study will also analyse the constraints faced by farmers in adopting machinery rental services from CHCs and the factors responsible for its restriction with in-depth analysis at the farm level in the study area.

## Materials and Methods

### Study area, study design, sampling method, and sample size

A combination of purposive sampling, and multi-stage stratified random sampling technique have been employed in the current study. The purposive sampling approach is used to choose Punjab as the study area as it has the largest number of CHCs, 22,899 as of 31.03.2021. After conducting a pre-visit in July 2023 and collecting the required secondary data regarding

selected models of CHCs distribution and location, all the districts of Punjab are categorized into high-density and low-density groups based on the number of custom hiring centres corresponding to the total gross cropped area of the district. The two groups are then assigned random numbers in Microsoft Excel software and two districts, Ludhiana and Gurdaspur from the high-density group and low-density group are randomly selected for data collection respectively.

$$\text{Density of CHC} = \frac{\text{Total CHC operating in district}}{\text{gross sown area of the district}} \quad (3.2.1)$$

Using random sampling, 2 CHCs of each of the selected models from high CHC density district and low CHC density district were selected. To understand the constraints faced by farmers for each of the selected CHCs, 10 beneficiaries who are availing farm machinery services from selected CHCs and 10 farmers who are not availing machinery services from CHC are chosen randomly from whom the data is collected (Figure 1)

A pre-prepared semi-structured interview schedule has been used to collect relevant data from operators of CHCs and farmers.

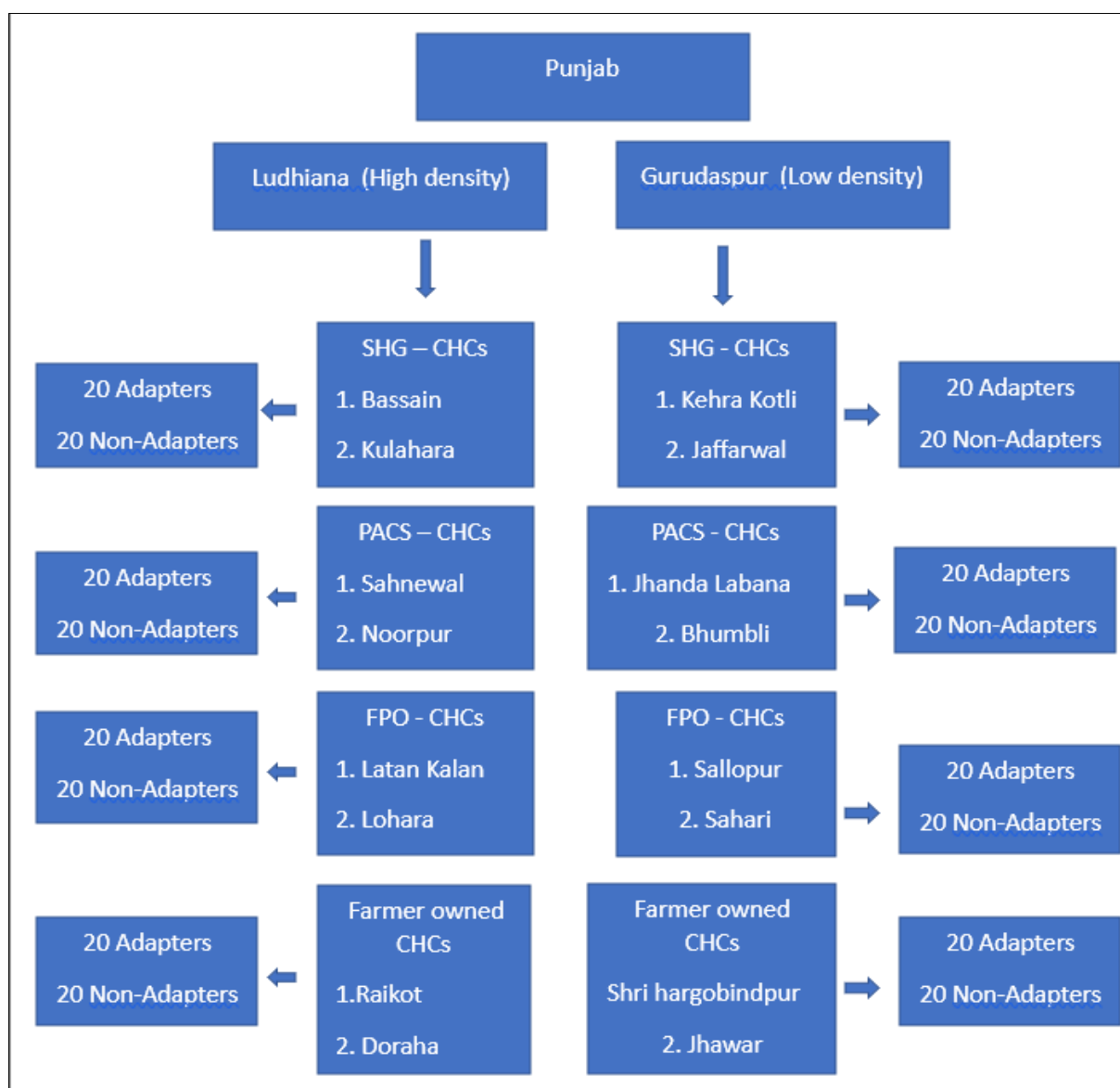


Fig 1: Sampling plan

## Empirical Framework

### Ratio analysis

To investigate the CHCs from a financial management perspective Operation ratio, Fixed ratio, and Gross ratios have been calculated. These ratios provide a unique opportunity to compare the financial performance of sample CHCs with other CHCs operating in the country (Rohith *et al.*, 2021) [3].

$$\text{Operating Ratio} = \frac{\text{Total operating expenses}}{\text{Gross Income}} \quad (3.3.4)$$

$$\text{Fixed Ratio} = \frac{\text{Total fixed expenses}}{\text{Gross income}} \quad (3.3.5)$$

$$\text{Gross Ratio} = \frac{\text{Total expenses}}{\text{Gross Income}} \quad (3.3.6)$$

**Variable costs:** Variable expenses include those costs that change with a change in the level of output. The variable costs in agriculture can be classified into three broad categories namely inputs costs primarily consisting of costs of seeds, fertilizers, plant protection chemicals (weedicides, pesticides, farm yard manure, etc), Labor costs, and machinery costs. The cost of machinery includes two components i.e. fixed and variable costs. The variable machinery costs consist of labor, repairs, expenditure on spare parts, fuel and maintenance costs, etc, these costs increase proportionally with the operational use, while fixed costs more or less remain the same independent of the machinery usage. The annual fixed costs covered depreciation, interest on the investment, and insurance.

**Fixed costs:** Fixed costs are those that do not differ from the production level in the short run. Fixed costs in this study cover costs of depreciation, interest on the investment, and the cost of insurance, taxes, etc.

**Depreciation:** Depreciation also called capital consumption allowance is the amount by which the value of a machinery decreases with the passage of time and use. This decrease in the value of the asset is because of the wearing out of the parts or the reduced capacity of the machine with use over time. Since in the study area, different CHCs had machinery and equipment brought at different times considering the difficulties in the application of other methods, the straight-line method was considered for the present study taking into account the annual depreciation of 10 per cent.

$$\text{Depreciation} = p-s/L*H, \text{ Rs/h} \quad (3.3.7)$$

Where,

D= Depreciation

P = Purchase price, Rs

S = salvage Value, Rs

L = Economic machine life, years

H = Working hours per year

**Interest:** Interest is considered a fixed cost calculation because the funds used to purchase a machine are not available for any other productive purposes. For the survey respondents in the farming industry, the cost of the capital investment was calculated at a 10% interest rate.

$$I = \frac{P+S}{2} \times i \quad (3.3.8)$$

Where,

I = Interest cost, Rs

i = % rate of the interest

p = Purchase price, Rs

s = Salvage value, Rs

**Taxes, insurance, and housing:** Although taxes, insurance, and housing costs are typically smaller compared to depreciation and interest, they must still be taken into account. It is recommended to factor in an estimated 1.0% of the purchase price for these costs. (Nagaraj *et al.*, 2020) [2].

### Ranking of Constraints

Garret ranking was used to evaluate the problems faced by farmers in accessing machinery hiring services from CHCs. In this method, farmers are asked to rank the constraints faced by them while looking to rent machinery based on the magnitude of the problem. These orders of merit given by respondents are then converted into percent positions by using the formula

$$\text{Percent position} = 100*(R_{ji}-0.5) / N_j \quad (3.3.9)$$

Where  $R_{ji}$  = Rank given for the  $i^{\text{th}}$  variable by the  $j^{\text{th}}$  respondent,  $N_j$  = Number of variables ranked by the  $j^{\text{th}}$  respondent.

By using the Garrett table (Garrett, 1969) [1] the scores were developed using percent position values. These scores for each constraint by all respondents were added together and then divided by the respondents to attain average values. These average values were arranged in increasing order, the factor with the highest average score is ranked first. To challenges faced by CHC operators in establishing and maintaining CHCs are captured through focus group discussions and net process mapping sessions.

## 3. Results and Discussions

### 3.1 Economic viability of CHC in Punjab

The successful operation of CHC is crucial to reduce the burden of high investment and maintenance costs of farm machinery. However, for the long-term sustainability of the machinery hiring services provided by these CHCs, it is essential to maintain economic viability. Table 1. Shows the net return per CHCs in both Gurudaspur and Ludhiana across selected models of CHCs. The average annual gross income across CHCs in the sample area is found to be ₹8.37 lakhs whereas the average annual expenditure is around ₹10.00 lakhs per CHC in the sample. The average value of net returns was negative at -1.63 lakhs which makes up -12.98 per cent of total expenditure. This paints a grim picture of the operation of CHCs in Punjab. The profit-making CHCs in the sample are Sahari (₹4,25,560), Lohara (₹3,06,500), Sahnewal (₹2,82,494), Latan Kalan (₹1,81,656), Sallopur (₹1,80,332). The loss making CHCs are Kulahara (₹-4,97,108), Kehra Kotli (₹-4,66,037), Bhumbli (₹-4,57,490), Jaffarwal (₹-4,19,971), Raikot (₹-3,51,130), Jhanda Labana (₹-3,39,368), Doraha (₹-2,65,522), Jhawar (₹-1,65,068), Noorpur (₹-52,357), Shri hargobindpur (₹-42,615), Bassain (₹-29,137).

Ratio analysis has been conducted to get a better understanding of the economics of CHCs. Although the net returns were discouraging and is the common case across CHCs, the ratio analysis provides some relief. Ratio analysis is an important tool to know about the profitability of the CHCs and to understand other financial implications. These ratio measures indicate what percent of gross income is spent for meeting different types of expenditure. Gross ratio values of less than one indicate the

efficient functioning of a machinery renting enterprise. As seen in the table 2-5 CHCs in Sallopur (0.90), Sahnewal (0.75), Latan Kalan (0.74), and Lohara (0.64) had gross ratios of less than one indicating their economic viability. CHCs in Kulahara (3.20), Kehra Kotli (2.92), Jaffarwal (1.98), Bhumbli (1.65), Jhanda Labana (1.62), Jhawar (1.53), Raikot (1.25), Doraha (1.22) and Sahari (1.22), Shri Hargobindpur (1.11), Noorpur (1.07) and Bassain (1.05) has gross ratio of more than one indicating their poor performance as they are unable to cover their total expenses with given gross income. Lower values of fixed ratios ranging from 0.17 in Sallopur to 0.67 in Kulahara (the overall average fixed ratio is 0.36) say that all CHCs can cover their fixed costs with the current operation level. The operating ratio is the most important ratio analysis which indicates the ability of CHC to meet immediate financial obligations in the short run (The overall average operating ratio is 1.07). The high overall operating ratio of 1.07 reveals that on average CHCs in the sample area are unable to cover their operating expenses to the tune of 7 per cent. A more detailed analysis based on the type of CHC can reveal better outcomes.

Tables 2 - 5 table show the ratio analysis conducted concerning different types of CHCs. The operating ratio is the highest for CHCs run by SHG (1.76) stating that their short-term costs are 76 percent more than their short-term incomes. This can be because of the heavy cost they incur in maintaining labor which

performs functions other than maintaining machinery in CHC. For example, CHC run by SHG in Jaffarwal also had a jaggery-making unit, and the same labor performed both jobs of jaggery-making and maintaining machinery. This is the case with almost all SHGs in Gurudaspur and Ludhiana. Because these institutions perform multiple functions renting machinery makes a small part of their operations. Assigning costs incurred in maintaining SHG on machinery renting is not appropriate. Either way, this is the case with other forms of CHCs in the sample area. The FPO in Sahari in Gurudaspur is also a sugarcane processing unit that provides machinery to member farmers on a rental basis for the cultivation of rice, wheat, and sugarcane crops. The lowest average operating cost is found in the case of an Individual farmer-operated CHC, this is expected because if the farmer is unable to collect his operational costs and some extra income from maintaining machinery and renting it, he simply would abandon the CHC for other income sources. Among all the selected models of CHCs those run by FPOs were found to be more economically efficient because of their comparatively better ratio measures (Operating ratio: 0.92 Fixed ratio: 0.23 and Gross ratio: 1.15) hence an economic point of view the FPOs are better performing than other models of CHCs in the study area. It is also found in the study area that all the above-mentioned CHCs heavily depend on subsidies provided by the government.

**Table 1:** Net returns of CHC in sample area 2022-23 (₹)

|                     | Name of the CHC   | Total income | Total expenditure | Net returns | Net returns as % expenditure |
|---------------------|-------------------|--------------|-------------------|-------------|------------------------------|
| PACS                | Sahnewal          | 11,08,250    | 8,25,756          | 2,82,494    | 34.21                        |
|                     | Noorpur           | 7,76,900     | 8,29,257          | -52,357     | -6.31                        |
|                     | Jhanda Labana     | 5,47,550     | 8,86,918          | -3,39,368   | -38.26                       |
|                     | Bhumbli           | 7,01,750     | 11,59,240         | -4,57,490   | -39.46                       |
| Individual operated | Latan Kalan       | 7,07,200     | 5,25,544          | 1,81,656    | 34.57                        |
|                     | Lohara            | 9,39,200     | 6,32,700          | 3,06,500    | 48.44                        |
|                     | Shri Hargobindpur | 3,76,000     | 4,18,615          | -42,615     | -10.18                       |
|                     | Jhawar            | 3,12,700     | 4,77,768          | -1,65,068   | -34.55                       |
| SHG                 | Bassain           | 6,36,950     | 6,66,087          | -29,137     | -4.37                        |
|                     | Kulahara          | 2,26,325     | 7,23,433          | -4,97,108   | -68.72                       |
|                     | Kehra Kotli       | 2,43,205     | 7,09,942          | -4,66,037   | -65.64                       |
|                     | Jaffarwal         | 4,39,550     | 8,71,321          | -4,19,971   | -48.20                       |
| FPO                 | Raikot            | 14,15,150    | 17,66,280         | -3,51,130   | -19.88                       |
|                     | Doraha            | 12,01,500    | 14,67,022         | -2,65,522   | -17.55                       |
|                     | Sallopur          | 16,95,000    | 15,26,168         | 1,80,332    | 11.82                        |
|                     | Sahari            | 20,74,300    | 25,24,940         | 4,25,560    | 16.85                        |
|                     | Average           | 8,37,596     | 10,00,687         | -1,63,091   | -12.98                       |

**Table 2:** Ratio analysis of CHC operated by Primary agricultural co-operative societies (PACS) 2022-23 (₹)

|      | Name of the CHC | Operating expenses | Fixed expenses | Total expenses | Gross income | Operating ratio | Fixed ratio | Gross ratio |
|------|-----------------|--------------------|----------------|----------------|--------------|-----------------|-------------|-------------|
| PACS | Sahnewal        | 6,22,916           | 2,02,840       | 8,25,756       | 11,08,250    | 0.56            | 0.18        | 0.75        |
|      | Noorpur         | 5,74,680           | 2,54,577       | 8,29,257       | 7,76,900     | 0.74            | 0.33        | 1.07        |
|      | Jhanda Labana   | 6,33,613           | 2,53,306       | 8,86,918       | 5,47,550     | 1.16            | 0.46        | 1.62        |
|      | Bhumbli         | 7,67,296           | 3,91,944       | 11,59,240      | 7,01,750     | 1.09            | 0.56        | 1.65        |
|      | Average         | 649626.25          | 275666.75      | 925292.75      | 783612.50    | 0.89            | 0.38        | 1.27        |

**Table 3:** Ratio analysis of CHC operated by Individual operators 2022-23 (₹)

|                     | Name of the CHC   | Operating expenses | Fixed expenses | Total expenses | Gross income | Operating ratio | Fixed ratio | Gross ratio |
|---------------------|-------------------|--------------------|----------------|----------------|--------------|-----------------|-------------|-------------|
| Individual operated | Latan Kalan       | 3,83,152           | 1,42,392       | 5,25,544       | 7,07,200     | 0.54            | 0.20        | 0.74        |
|                     | Lohara            | 4,58,860           | 1,73,840       | 6,32,700       | 9,39,200     | 0.49            | 0.19        | 0.67        |
|                     | Shri Hargobindpur | 2,98,375           | 1,20,240       | 4,18,615       | 3,76,000     | 0.79            | 0.32        | 1.11        |
|                     | Jhawar            | 3,20,572           | 1,57,196       | 4,77,768       | 3,12,700     | 1.03            | 0.50        | 1.53        |
|                     | Average           | 365239.75          | 148417.00      | 513656.75      | 583775.00    | 0.71            | 0.30        | 1.01        |

**Table 4:** Ratio analysis of CHC operated by Self-help groups (SHG) 2022-23 (₹)

|     | Name of the CHC | Operating expenses | Fixed expenses | Total expenses | Gross income | Operating ratio | Fixed ratio | Gross ratio |
|-----|-----------------|--------------------|----------------|----------------|--------------|-----------------|-------------|-------------|
| SHG | Bassain         | 5,32,327           | 1,33,760       | 6,66,087       | 6,36,950     | 0.84            | 0.21        | 1.05        |
|     | Kulahara        | 5,71,393           | 1,52,040       | 7,23,433       | 2,26,325     | 2.52            | 0.67        | 3.20        |
|     | Kehra Kotli     | 5,67,186           | 1,42,756       | 7,09,942       | 2,43,205     | 2.33            | 0.59        | 2.92        |
|     | Jaffarwal       | 5,96,846           | 2,74,475       | 8,71,321       | 4,39,550     | 1.36            | 0.62        | 1.98        |
|     | Average         | 566938.00          | 175757.75      | 742695.75      | 386507.50    | 1.76            | 0.52        | 2.29        |

**Table 5:** Ratio analysis of CHC operated by Farmer producer organizations (FPO) 2022-23 (₹)

|     | Name of the CHC | Operating expenses | Fixed expenses | Total expenses | Gross income | Operating ratio | Fixed ratio | Gross ratio |
|-----|-----------------|--------------------|----------------|----------------|--------------|-----------------|-------------|-------------|
| FPO | Raikot          | 13,99,672          | 3,66,608       | 17,66,280      | 14,15,150    | 0.99            | 0.26        | 1.25        |
|     | Doraha          | 11,61,710          | 3,05,312       | 14,67,022      | 12,01,500    | 0.97            | 0.25        | 1.22        |
|     | Sallopur        | 12,34,312          | 2,91,856       | 15,26,168      | 16,95,000    | 0.73            | 0.17        | 0.90        |
|     | Sahari          | 20,20,460          | 5,04,480       | 25,24,940      | 20,74,300    | 0.97            | 0.24        | 1.22        |
|     | Average         | 1454038.50         | 367064.00      | 1821102.50     | 1596487.50   | 0.92            | 0.23        | 1.15        |

### 3.2 Constraints faced by farmers in accessing machinery services from custom hiring centres

Farmers face multiple challenges while accessing rental machinery services from custom hiring centres. An effort has been made to rank these constraints based on farmers' opinions so that more focus can be levied on that specific constraint that is deemed to be most severe and necessary policy actions can be suggested. To do this the common constraints faced by farmers while accessing rental machinery services are categorized into two groups which are accessibility constraints and financial constraints. A set of 5 questions from each category regarding the challenges faced were asked to farmers who then assigned ranks to those questions based on severity.

Table 4.30 shows accessibility constraints commonly faced by farmers. Column 2 shows their average garret score, and column 3 presents the corresponding Garret rank. Non-availability of machinery in peak season is found to be the major accessibility constraint faced by farmers in Punjab. This is followed by the non-availability of good-condition machinery.

Financial constraints are presented in Table 4.31. Inconsistent pricing is ranked first which can be attributed to the poor popularity of CHCs and prices charged by them in villages. This is followed by price discrimination about machinery prices among farmers and the time of hiring. Payment methods provided by CHC are not found to be a severe problem in the study area.

The challenges faced by operators of CHCs are presented in Table 4.32. The constraints were primarily categorized into 3

groups policy constraints, supply-side constraints, and demand-side constraints. 75 per cent of operators have reported tedious application processes and uncertainty regarding approval as major policy-related constraints. Among supply-side constraints, the high initial cost of the establishment was reported as a major constraint by 87.5 per cent of operators. Preference for tractors over machinery promoted by the government through subsidization is a major demand-side constraint as reported by 81.25 per cent farmers.

**Table 6:** Accessibility constraints

| S. No. | Accessibility constraints                         | Average score | Garret Rank |
|--------|---------------------------------------------------|---------------|-------------|
| 1.     | Machinery shortages during peak season            | 73.00         | 1           |
| 2.     | The poor condition of available machinery         | 56.21         | 2           |
| 3.     | Operational timings of CHC                        | 44.00         | 3           |
| 4.     | Distance of CHC from farm                         | 43.50         | 4           |
| 5.     | Difficulty in transportation of machinery to farm | 33.28         | 5           |

**Table 7:** Financial constraints

| S. No. | Financial constraints          | Average score | Rank |
|--------|--------------------------------|---------------|------|
| 1.     | Inconsistent pricing           | 71.54         | 1    |
| 2.     | Price discrimination           | 54.39         | 2    |
| 3.     | Inconvenient payment schedules | 45.51         | 3    |
| 4.     | High rental costs.             | 42.96         | 4    |
| 5.     | Limited payment options        | 35.29         | 5    |

**Table 8:** Challenges mentioned by respondents and their corresponding frequencies.

|                         | Type of challenge                                             | Interviews (16) | FGD (2) |
|-------------------------|---------------------------------------------------------------|-----------------|---------|
| Policy constraints      | Rising machinery prices                                       | 33 %            | 50 %    |
|                         | Tedious application process and uncertainty of approval       | 75 %            | 0 %     |
|                         | Limited technical support from agricultural departments       | 18.75 %         | 0 %     |
| Operational constraints | Machinery repair and maintenance issues                       | 68.75 %         | 100 %   |
|                         | Insufficient space for machinery storage                      | 12.5 %          | 0 %     |
|                         | Shortage of skilled labor                                     | 31.25 %         | 50 %    |
|                         | High initial establishment costs                              | 87.5 %          | 0 %     |
| Farmers constraints     | Low awareness among farmers                                   | 6.25 %          | 0 %     |
|                         | Poor upkeep of rented machinery by farmers                    | 25 %            | 50 %    |
|                         | Preference for tractor use over government-promoted equipment | 81.25 %         | 100 %   |
|                         | Poor repayment of rent                                        | 25 %            | 50 %    |

### Conclusions

The economic assessment of Punjab's custom hiring centres (CHCs) - covering FPO-, PACS-, SHG- and individual-operated

models during 2022-23 - shows that on average these units were not profitable. Sample CHCs earned about ₹8.37 lakh against ₹10.00 lakh in costs, resulting in an average loss of ₹1.63 lakh

( $\approx 13\%$  of expenditures). Only a few centres (for example one FPO-run CHC and some individual/PACS units) posted net surpluses (on the order of ₹1.8-4.3 lakh), whereas most incurred losses. Ratio analyses reflect this mixed performance: several CHCs (e.g. at Sallopur, Sahnewal, Latan Kalan and Lohara) achieved gross/operating ratios below 1 (indicating cost-covering operation), but many more had ratios well above 1. In fact, the overall average operating ratio across CHCs was  $\approx 1.07$ , implying about a 7% shortfall in covering recurring costs. By operator type, the poorest performance came from SHG-managed centres (with an operating ratio  $\approx 1.76$ ) largely because multifunctional cooperatives tended to absorb labor costs of other activities - whereas individual-run CHCs had the lowest per-unit costs. Importantly, farmer-producer organization (FPO)-managed CHCs stood out as the most efficient: they had an operating ratio of  $\approx 0.92$  (and fixed/gross ratios  $\sim 0.23/1.15$ ), indicating comparatively strong profitability. All models, however, depended heavily on government subsidies for viability.

Farmers' reported constraints reveal why uptake remains limited: shortages of machinery during peak seasons and poor equipment condition were ranked the top accessibility issues, and inconsistent or discriminatory pricing was a key financial obstacle. CHC operators themselves cited burdensome approval processes and very high start-up costs (87.5% flagged initial investment as a barrier) and noted that many farmers simply prefer using their own tractors (reported by 81% of respondents). Together these results suggest that simply establishing more CHCs will not suffice. Institutional strengthening - for example, promoting the cooperative management that underpins the stronger FPO model, clarifying cost allocation in multi-purpose SHGs, and streamlining subsidy/credit procedures - is needed to improve efficiency. Likewise, ensuring timely machine availability (especially in peak seasons), maintaining equipment quality, and standardizing rental pricing could encourage greater use of CHCs. In sum, the study's findings imply that better-tailored support (such as capacity-building for cooperatives and simplified administrative processes) would enhance the long-run viability of CHC schemes and extend mechanization benefits to smaller farmers.

## References

1. Garrett HE, Woodworth RS. Statistics in Psychology and Education. 1969. <https://cir.nii.ac.jp/crid/1130282270700092672>
2. Nagaraj B, Srilatha C, Vikram S, Venkatesh M, Prameela C. Establishing a model custom hiring center: A feasibility study at Kandi Mandal. *International Journal of Current Microbiology and Applied Sciences*. 2020;9(5):1299-1307. <https://doi.org/10.20546/ijcmas.2020.905.144>
3. Rohith S, Pradeep R, Sivaram M, Subash S. Economic sustainability analysis of Gaushalas in selected districts of Telangana state. *Indian Journal of Dairy Science*. 2021;74(6):526-532. <https://doi.org/10.33785/ijds.2021.v74i06.009>
4. Satyasai KJ, Balanarayana M. Can mechanization in agriculture help achieving sustainable development goals? *Agricultural Economics Research Review*. 2018;31(conf):147. <https://doi.org/10.5958/0974-0279.2018.00030.7>
5. Satyasai KJ, Mehrotra N. Enhancing Farmers' Income. 2020.