POLICY BRIEF 60

Farm Mechanization in India
The Crucial Role of Custom Hiring Services

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The mechanization of agricultural operations can significantly contribute to enhancing the efficiency and sustainability of agriculture. It offers numerous advantages, including the mitigation of labour scarcity during peak periods of sowing and harvesting, reduction in the cost of cultivation and crop losses, and improvements in productivity and resilience in agriculture, resulting in increased incomes for farmers and more affordable access to food for consumers. The benefits of mechanization extend beyond economic gains. By reducing the need for manual labour, mechanization reduces the drudgery due to the arduous nature of traditional farming methods, particularly for women who often bear a disproportionate burden of agricultural work. Furthermore, the utilization of advanced tools and automated systems in agriculture makes it attractive to educated rural youth, encouraging them to remain in the sector.

In India, smallholder farmers cultivating landholdings of less than or equal to two hectares comprise more than 86% of the total farm households. They face numerous challenges in transitioning from traditional to modern agriculture, especially regarding the adoption of machines, implements and equipment, because of the high initial capital required for acquiring agricultural machinery, tools, and equipment. The high costs of tractors, harvesters, and other modern implements often prove prohibitive, particularly considering their small scale, which renders investments difficult to justify. Consequently, smallholder farmers predominantly rely on traditional labour-intensive farming methods, potentially limiting their productivity.

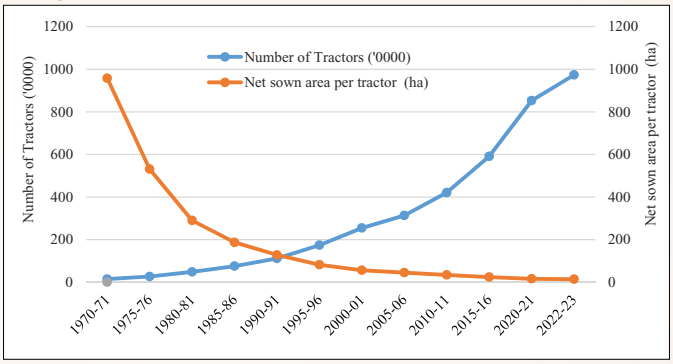
Acknowledging the potential advantages of mechanization, the Government of India has undertaken several initiatives to promote agricultural mechanization on small farms over the past five decades. The notable one is the implementation of the Sub-Mission on Agricultural Mechanization (SMAM) in 2014-15 which aims to enhance the accessibility and affordability of expensive machinery by smallholder farmers through custom hiring centres (CHCs).

This brief communication investigates the trend in mechanization in Indian agriculture, examines disparities in it across farm classes, assesses the effect of custom hiring services on farm economy, and identifies key constraints encountered by farmers in accessing mechanization services from CHCs.

Trend in farm mechanization

Since the inception of the Green Revolution in the mid-1960s, the energy portfolio in agriculture has undergone a significant transformation. The number of tractors increased from approximately 147 thousand to 9.7 million, resulting in a decline in potential area coverage from 958 hectares to 14 hectares per tractor during 1970-71 to 2022-23 (Figure 1). This transformation has occurred mainly because of increasing wage rates and the division of land holdings, resulting in the reduction of their size from 2.28 hectares in 1970-71 to 1.08 hectares in 2015-16. Consequently, farmers have found it progressively challenging to rationalize the cost of maintenance of draught animals. Simultaneously, the government

Figure 1. Trend in numbers of tractors in India



Source: Singh and Singh (2023)[3]

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[3]Singh, S.P. and Singh, K.K. (2023). Status and prospects of farm mechanization for sustainable agriculture, *Journal of Science for Society* 5(1): 35-47.

encouraged the adoption of farm machinery by offering financial incentives and facilitating easier access to loans from banks for various agricultural implements including tractors, power tillers, threshers, and other equipment.

However, there is considerable heterogeneity in the mechanization across farm size classes. Evidently, land size is an important determinant of farm machinery ownership, with larger farmers demonstrating higher rates for all types of machines and equipment (Table 1). This pattern is particularly pronounced in the case of tractors, where only 5.3% of marginal farmers (those with land ≤1ha) own these machines, compared with 39.3% of large farmers (those with land >10ha).

Nevertheless, there exists a market for machine-hire services in the agricultural sector. Farmers from all classes depend on mechanization services for agricultural operations. Tractor hiring is common among all farm categories but more common among smallholders. Power tillers, though less frequently hired than tractors, follow a similar pattern of higher usage. Larger farmers play a unique role as users and providers of machine hire services, strategically utilizing expensive machines and distributing high fixed costs across a broader user base. This approach maximizes machine use and makes investment more feasible.

The disparities in mechanization across farm size classes highlight the challenges faced by smallholder farmers in adopting expensive machines. While larger farmers have financial resources and economies of scale to invest in a greater range of farm machinery, including tractors, threshers, power tillers, and small equipment, smallholder farmers find it difficult to justify the high upfront costs relative to their scale of operation.

Custom hiring services for farm mechanization

The issue of small farm mechanization can be addressed through CHCs. These centres facilitate cost-effective access to expensive machinery, equipment and implements for smallholder farmers, without the need for ownership. The CHCs operate on a rental basis, enabling farmers to utilize machinery, thereby addressing both technological and financial constraints. By offering a diverse range of machinery services including those of tractors, harvesters, threshers, laser land levellers, and other implements, CHCs enable farmers to perform farm operations on time. Furthermore, by enhancing the efficiency of resource usage and decreasing the downtime of costly machinery, CHCs contribute to the reduction of farmers' capital expenses while maximizing the deployment of other available technologies. Moreover, such arrangements result in more effective land utilization, and lower environmental footprint.

The Government of India's initiatives to promote farm mechanization have evolved since the beginning of the Green Revolution. It established Agro Services Centres in 1971 to provide farmers an easy access to farm machinery, particularly tractors. Launching the SMAM in 2014-15 was a significant step towards small farm mechanization.

It provides substantial financial support to various stakeholders, including rural youth, farmers, cooperatives, and panchayats for the establishment of CHCs and hi-tech hubs. The financial assistance provided under SMAM is structured to address the varying needs of different regions. While the general financial aid is set at 40% of the project cost, the government provides higher

Table 1. Farmers owning and hiring agricultural machinery by farm size groups in India during 2016-17

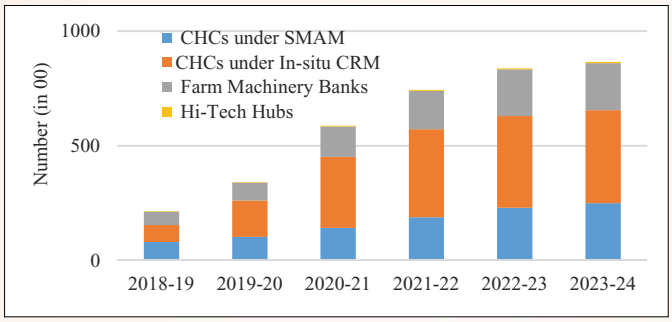
Farm machines & implements	Marginal (< 1.0 ha)	Small (1-1.99 ha)	Medium (2-9.99 ha)	Large (>10 ha)	Overall
Share of farmers who own farm machinery (%)					
Tractor	5.3	10.2	20.5	39.3	8.4
Power tiller	2.0	3.5	5.4	6.7	2.8
Combine harvester	0.4	0.7	1.8	6.1	0.7
Zero-till seed-cum-fertilizer drill	0.1	0.2	1.1	3.8	0.3
Happy seeder	0.1	0.2	0.5	1.5	0.2
Laser land leveller	0.1	0.3	0.9	2.8	0.3
Share of farmers who hire farm machinery (%)					
Tractor	41.6	43.0	28.5	32.4	41
Power tiller	10.4	10.8	7.7	5.3	10.1
Combine harvester	6	9.1	7.5	13.6	7.2
Zero-till seed-cum-fertilizer drill	0.5	0.9	4.3	2.2	0.7
Happy seeder	0.2	0.5	0.6	1.7	0.4
Laser land leveller	0.7	1.1	1.8	4.6	1.0

Source: GoI (2021)[4]

[4]GoI (2021). *All India Report on Input Survey 2016-17.* Agriculture Census Division, Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, New Delhi, pp 52-57.

financial aid of 80% for areas with lower mechanization levels to encourage the adoption of mechanical technologies in areas where traditional farming methods still predominate. The cumulative number of CHCs increased from a mere 1113 in 2014-15 to 21499 in 2018-19 and further to 86548 in 2023-24. These include 516 Hi-tech hubs and 20497 farm machinery banks too. (Figure 2)

Figure 2. Cumulative number of CHCs in India



Source: GOI (2024)[5]

Accessibility, affordability and impact of custom hiring services

Custom hiring services for agricultural machinery have shown promising results in India, contributing to improved productivity and reduced cultivation costs for farmers.[6],[7],[8] The findings of a case study conducted in Uttar Pradesh by the authors provide valuable insights into the impact of CHCs on the accessibility and affordability of mechanization services, and consequently on crop yield, cost of cultivation and net returns. It may be noted that the average landholding size in Uttar Pradesh is 25% less than the national average (0.76 ha vs 1.08 ha), and nearly a quarter of all CHCs established under the SMAM.

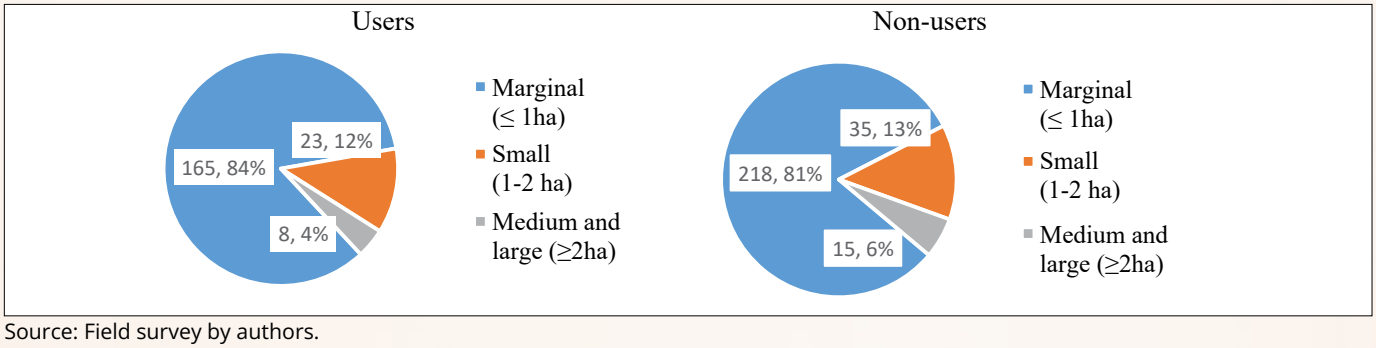
A comparison between those farmers who purchased mechanization services from the government-supported CHCs and those who purchased from independent service providers has been presented in figure 3. In both groups, marginal farmers constitute the vast majority, accounting for 81-84%, with small farmers making up the next largest segment at 11-13%.

Affordability is examined in terms of hiring rates of different kinds of machines. The hiring rates for services like harrowing, field preparation, and harvesting are 10-25% cheaper from CHCs than independent service providers (Figure 3) which is consistent with previous studies. This encourages farmers who might otherwise be unable to afford expensive machinery for farm mechanization. Nonetheless, there is a concern about the potential for price discrimination in the absence of fixed rental rates and sufficient competition. Farmers reported that CHC operators favour large farms due to the ease of operation.

Convenience in accessing services is a significant factor in choosing services from government-supported CHCs as reported by almost half of the farmers. The timeliness of service delivery is another critical aspect. Two-thirds of CHC users reported that their work is typically attended promptly. However, occasional delays in service delivery, even with prior bookings, were also reported, particularly during peak agricultural seasons. This occurs because CHC operators, who are often farmers themselves with limited machinery, prioritise their own agricultural operations. Furthermore, there are instances of dissatisfaction regarding the quality of rental services stemming from inadequately skilled machine operators. Non-availability of services on credit from CHCs is also an issue because CHC operators often lack funds to provide services on credit as they must manage their own costs associated with fuel and maintenance of machinery. This lack of credit is particularly burdensome for marginal farmers who are acutely liquidity-constrained.

Accessing services from CHCs, compared to independent service providers, has a notably positive impact on crop economics.[9] The CHC users experienced a modest 2% increase in paddy yield (Figure 4).

Figure 3. Distribution of users and non-users of CHCs



Source: Field survey by authors.

[5]GOI (2024). Annual Report 2023-24. Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India.

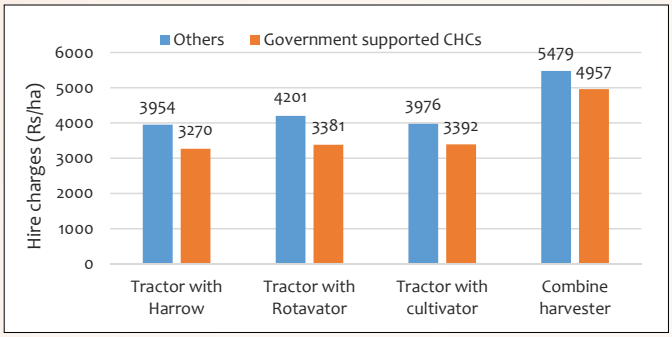
[6]Sidhu, R.S. and Vatta, K. (2012). Improving economic viability of farming: A study of cooperative agro machinery service centres in Punjab. *Agricultural Economics Research Review 25 (Conf.):* 427–434.

[7]Singh, D., Singh J., Kumar S. and Manes G.S. (2014). Economic impact of custom hiring services of machinery on farm economy in Punjab. *Agricultural Engineering Today* 38(1): 45–52.

[8]Singh, P., Choudhary, M. and Lakhera, J.P. (2014). Knowledge and attitude of farmers towards improved wheat production technology. *Indian Research Journal of Extension Education* 14(2): 54–59.

[9]The study employed multiple matching methods (Caliper; Kernel; and Nearest neighbour matching) to calculate the Average Treatment Effect on Treated (ATT), consistently revealing statistically significant benefits across all approaches.

Figure 4. Rental rates for different machinery during 2022-23 (Rs/ha)

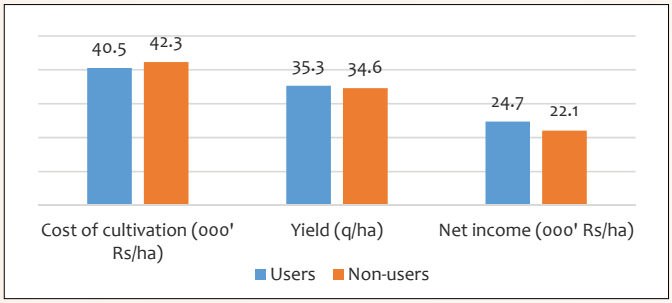


Source: Field survey by authors.

However, the more substantial effect came from a 4.5% reduction in cultivation costs. Together, the yield and cost differential effect resulted in an impressive 11.8% higher net returns for CHC service users. The primary mechanism driving these economic gains appears to be the lower rental rates offered by the CHCs for machinery and equipment. This effect is likely to be stronger than that of farmers engaged in traditional farming methods.

Affordability is examined in terms of hiring rates of different kinds of machines. The hiring rates for services like harrowing, field preparation, and harvesting are 10-25% cheaper from CHCs than independent service providers (Figure 5) which is consistent with previous studies. This encourages farmers who might otherwise be unable to afford expensive machinery for farm mechanization. Nonetheless, there is a concern about the potential for price discrimination in the absence of fixed rental rates and sufficient competition. Farmers reported that CHC operators favour large farms due to the ease of operation.

Figure 5. Cost of cultivation, yield and net income from paddy



Source: Field survey by authors.

Way forward

The adoption of mechanization in smallholder agriculture through CHCs has promising results, in terms of accessibility and affordability of different machinery, equipment and implements by smallholder farmers. The government's initiatives, particularly the SMAM, have led to the establishment of numerous CHCs across India to facilitate small farm mechanization. These centers have demonstrated positive impacts on crop yields, cost of cultivation and net returns, as evidenced in case studies in Uttar Pradesh.

However, several challenges persist, including delays in service availability during peak seasons, a lack of credit, potential price discrimination, and issues with service quality. To fully realize the potential of CHCs to promote agricultural mechanization among smallholders, policymakers should consider the following measures.

- **Expand CHCs and efficient scheduling of services**: Expanding the number of CHCs and increasing their inventory of machines, equipment, and implements can address the growing demand for mechanization in agriculture. Simultaneously, there is a need for an efficient scheduling of mechanization services to ensure timely access for all farmers, especially during the peak agricultural periods.
- **Alleviate liquidity constraints**: Smallholder farmers frequently encounter financial constraints in accessing mechanization services, whereas CHC operators are unable to provide these services on credit due to their own concurrent financial requirements. Thus, it is necessary to develop financial products that address the operational cash constraints of both CHC operators and smallholder farmers.
- **Transparent pricing mechanisms**: To ensure fair pricing of mechanization services, there is a need to evolve transparent pricing mechanisms based on factors such as operational costs, equipment depreciation, and local market conditions.
- **Skill development of machine operators**: Training machine operators associated with CHCs is essential for enhancing their competencies in operating and maintaining machines to ensure high-quality services to farmers.
- **Collective action**: Increased involvement of cooperatives and Farmer Producer Organizations (FPOs) in custom hiring services can significantly enhance fair and equitable access to farm machinery and implements. Furthermore, they can lead to better management and maintenance of agricultural equipment, and systematic scheduling of services.

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