



Custom Hiring Centers in Indian Agriculture: Evolution, Impact, and Future Prospects

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJAEES/2023/v41i112276

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/109376>

Review Article

Received: 14/09/2023
Accepted: 19/11/2023
Published: 23/11/2023

ABSTRACT

The evolution of Custom Hiring Centers (CHCs) in the context of Indian agriculture represents a century-long journey towards farm mechanization and inclusivity. This article delves into the pivotal role played by CHCs in promoting farm mechanizations and unearths the entrepreneurial ventures that have led to their significant ascent within the Indian agricultural landscape. Furthermore, it provides insights into the establishment of CHCs across various states and the government schemes in place to support their growth and development. By exploring the challenges and opportunities associated with Custom Hiring Centers, the abstract highlights the crucial role of technology in enhancing their operations. The potential of advanced technologies, including

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Artificial Intelligence (AI), Machine Learning (ML), and the Internet of Things (IoT), in revolutionizing CHC operations is also discussed. Overall, this article aims to provide a comprehensive understanding of the multifaceted aspects of CHCs and their impact on Indian agriculture.

Keywords: Custom Hiring Centers (CHCs); agricultural mechanization; sustainable farming; government schemes; farm machinery.

1. INTRODUCTION

Agriculture, a foundational pillar of human civilization, has witnessed significant transformations over time. From rudimentary hand tools of ancient times to today's advanced machinery, farming's evolution reflects humanity's quest for enhanced efficiency and productivity. As global populations grow, the pressure on food supply chains intensifies, necessitating both increased yields and sustainability. Farm mechanization, which has seen a shift from 93% animate power sources in 1960–61 to an estimated 4.1% by 2032–33 [1, 2], stands central to this challenge.

Mechanization, while pivotal in enhancing agricultural productivity, brings its own set of challenges. The high costs associated with modern machinery often make it inaccessible to individual farmers, especially those with limited resources. This is particularly evident in the Indian agricultural landscape. Despite the clear advantages of mechanization, a significant number of farmers, especially the small and marginal ones, struggle to access timely modern farming tools [3]. Fragmentation of farm land holdings further complicates the scenario, with the average size of farm holdings decreasing from 2.82 ha in 1970–71 to 1.1 ha in 2010–11 [2].

These Custom Hiring Centers (CHCs), emerging as a solution, offer farm implements for hire, making advanced farming technologies accessible and affordable. In India, where 63% of total holdings are below 1 ha, CHCs bridge the gap between the need for state-of-the-art machinery and the financial constraints of farmers. However, the success of CHCs isn't just about their economic viability. Farmers' perceptions and attitudes towards these centers are crucial. Positive perceptions can lead to wider adoption, while misconceptions can hinder their potential impact [4].

The debate between owning versus hiring farm equipment is also pertinent. While ownership has its merits, custom hiring, especially through CHCs, often presents a more economical and

adaptable solution for many [5]. The global agricultural sector navigates the balance between tradition and innovation, CHCs offer a promising avenue. They have the potential to democratize access to cutting-edge farming technologies, paving the way for a future that ensures both food security and sustainability.

2. EVOLUTION AND IMPACT OF CHCS IN INDIAN AGRICULTURE: A CENTURY-LONG JOURNEY TOWARDS FARM MECHANIZATION AND INCLUSIVITY

Custom hiring in the agricultural sector of India traces its roots back to the early 20th century, with its inception in Punjab in 1912 through the use of a steam thresher for custom hiring (Fig 1). The mid-20th century, specifically the 1960s, marked the establishment of 141 Agro-Industries Corporations (AIC), which promoted the multi-farm use of agricultural machinery. By this period, Custom Hiring Centers (CHCs) had become a common occurrence due to these developments.

The initiative received a further boost in 1971 when the Government of India launched a scheme to set up agro-service centers across the country. As a result, Agro Services Centers were established in the northern states of Punjab, Haryana, and Rajasthan to provide custom hiring services for the use of tractor-operated machinery, to sell farm equipment, and other agricultural inputs. The scheme also outlined various criteria for setting up an agro service center, including the provision of on-farm maintenance and repair facilities for all types of agricultural machinery, machinery custom hire service particularly to the small and medium farmers, sale of spare parts, fuel, oil, lubricants, and agricultural machinery and equipment, supply of agricultural inputs such as seeds, fertilizers, and pesticides, and provision of facilities for soil testing.

Post the 1990s, the government schemes led to an increase in custom hiring services, paving the way for more structured and institutionalized custom hiring models. A significant leap was

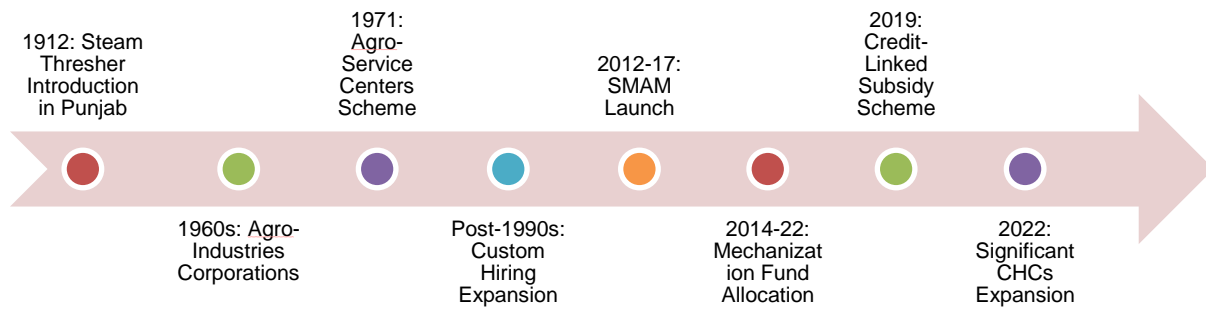


Fig. 1. Timeline of key milestones in the evolution of CHCs in Indian agriculture

made during the XII Plan (2012-17) with the launch of the Special Sub-Mission on Agricultural Mechanization (SMAM) by the Indian government. The mission emphasized 'Small and Marginal Farmers' and promoted 'Custom Hiring Services' through a 'rural entrepreneurship' model. A key component of SMAM was the establishment of agricultural implement banks for Custom Hiring Services, aiming to cater to the adverse economies of scale faced by small farmers [2].

Agricultural mechanization is extremely vital to modernize agriculture and reduce the drudgery of farming operations. During the period from 2014-15 to March 2022, an amount of Rs. 5490.82 crore was allocated for agricultural mechanization. The number of machines and equipment provided to farmers on subsidy increased from 13,78,755 till January 2022 to 13,88,314 in December 2022. Furthermore, the provision of CHCs, high-tech hubs, and farm machinery banks significantly expanded. By December 2022, there were 18,824 CHCs, 403 high-tech hubs, and 16,791 farm machinery banks functioning, compared to 16,007 CHCs, 378 high-tech hubs, and 16,309 farm machinery banks available till January 2022. These facilities play a crucial role in making agricultural machines and equipment available to farmers on a rental basis, thereby promoting agricultural mechanization and inclusivity across the farming community.

In 2019, the government introduced a credit-linked subsidy scheme for the establishment of agricultural machinery banks and hi-tech high productive equipment hubs for custom hiring services, aiming to improve the reach of farm mechanization to small and marginal farmers, and to regions where farm power availability was low. Fast forward to 2022, a significant expansion

of CHCs was noted with the establishment of 1,000 new centers, reflecting the government's recognition of the critical role CHCs play in mechanizing various farm operations and providing machinery and equipment support to small and marginal farmers.

The journey of Custom Hiring Centers over the century embodies a concerted effort to modernize agricultural practices, making them more accessible and affordable, especially for small and marginal farmers. The continuous expansion and governmental support towards CHCs and related facilities reflect a strong commitment to alleviating the core challenges faced by the agricultural sector in the 21st century. Through the provision of modern machinery and equipment on a rental basis, CHCs are playing a pivotal role in reducing the drudgery of farming operations, enhancing productivity, and fostering a more inclusive and sustainable agricultural framework in India.

3. THE ROLE AND IMPORTANCE OF CHCS IN PROMOTING FARM MECHANIZATIONS

Democratizing Access to Technology: One of the primary roles of CHCs is to democratize access to modern farming technologies. For many small and marginal farmers, the high costs of advanced machinery are prohibitive. CHCs bridge this gap, ensuring that even farmers with limited resources can benefit from the latest innovations in farm mechanization [5].

Promoting Sustainable Farming: With access to modern machinery, farmers can adopt more sustainable farming practices. Precision farming, efficient water usage, and reduced manual labor are some of the benefits that come with

mechanization, all of which contribute to sustainable and environmentally-friendly agriculture.

Addressing Labor Shortages: Many agricultural regions face acute labor shortages during peak farming seasons. CHCs, by providing machinery like harvesters and planters, can help farmers overcome these challenges, ensuring timely sowing and harvesting [4].

Economic Benefits: For small and marginal farmers, the economic burden of purchasing, maintaining, and storing machinery can be overwhelming. By utilizing CHCs, they can significantly reduce their operational costs, leading to better profit margins [5].

Encouraging Innovation: As centralized hubs, CHCs can also play a role in introducing and promoting innovative farming techniques and machinery. Farmers can experiment with new technologies on a rental basis before deciding on their utility and efficiency.

Enhancing Productivity: With timely access to machinery, farmers can ensure that their farming operations, be it sowing, fertilizing, or harvesting, are done at the optimal time. This timely intervention can lead to better yields and higher productivity [3].

Addressing the Needs of Small Holdings: In regions like Punjab, agriculture is characterized by an abundance of small holdings. Despite this, it is highly mechanized. However, the ownership of machinery is determined by economic viability, leading to the development of custom-hiring services [6].

Government's Role in Promoting CHCs: Governments can play a pivotal role in promoting CHCs. By developing Primary Agricultural Cooperative Societies as Agro-Service Centers and taking steps like fixing custom hiring rates, reducing fuel costs, and creating awareness, governments can ensure that even small farmers benefit from the advantages of farm mechanization [6].

CHC's represent a paradigm shift in the way farm mechanization is approached, especially in regions with a significant population of small and marginal farmers. By providing a platform where advanced machinery is not just a luxury but a readily available resource, CHCs are paving the

way for a more inclusive, productive, and sustainable agricultural future.

4. UNEARTHING ENTREPRENEURIAL VENTURES: THE ASCENT OF CHCS IN INDIAN AGRICULTURE

The agricultural sector has perennially been a fertile ground for entrepreneurial endeavors due to its vast expanse and diverse needs. The advent and ascension of Custom Hiring Centers (CHCs) have unveiled new avenues for entrepreneurs, amalgamating technological innovation with service provision. The demand for farm mechanization is continually growing, especially in regions with a high concentration of small and marginal farmers. As delineated by Sukhpal and Kingra [6], areas like Punjab, despite an abundance of small holdings, are significantly mechanized, as reported by Singh and Kisku [3]. However, the economic viability often determines the ownership of machinery, which has led to the burgeoning growth of custom-hiring services. With only about 40% of farm households owning a tractor, the remaining majority rely on CHCs for their mechanization needs, highlighting the vast market potential for CHCs.

Furthermore, an exploratory study conducted in Punjab by Kumar, Meena [7] revealed that most respondents had a favorable attitude towards CHCs. However, a shortfall of CHCs was noted, particularly during peak seasons, indicating a clear market opportunity for the expansion and establishment of more CHCs. Establishing a CHC comes with a multitude of benefits. Financially, CHCs, operating on a rental model, ensure a steady stream of income during peak farming seasons. The high costs associated with purchasing machinery make the rental model a preferred choice for many farmers, leading to consistent demand and revenue for CHCs. Socially, CHCs are pivotal in democratizing access to technology. By providing small and marginal farmers with essential tools, CHCs contribute to social equity, ensuring that modern farming practices benefit farmers irrespective of their economic status. Environmentally, modern farming machinery often encapsulates sustainable and eco-friendly technologies. By promoting the use of such machinery, CHCs indirectly contribute to environmentally-friendly farming practices, leading to reduced carbon footprints and sustainable agriculture.

Various successful CHC models have significantly impacted the agricultural landscape. For instance, the initiative by the government in Punjab to develop Primary Agricultural Cooperative Societies as Agro-Service Centers stands as a testament to the potential of CHCs [6]. By setting custom hiring rates, reducing fuel costs, and creating awareness, these centers have ensured even small farmers benefit from the advantages of farm mechanization. A study by Singh and Kisku [3] delved into farmers' perceptions regarding custom hiring services under Indian conditions, providing insights into the associated factors, constraints, and suggestions related to CHCs, highlighting their significance in the Indian agricultural landscape. Additionally, the role of CHCs in providing machinery to help mitigate the stubble burning issue, a significant environmental concern in regions like Punjab, was emphasized in a study conducted in 2021, further underscoring the environmental benefits of CHCs [7].

5. STATE WISE – CHC'S ESTABLISHED

The data illustrates the distribution of CHCs across various states in India until October 30, 2023 (Table 1). Punjab leads with a total of 11,133 centres, followed by Andhra Pradesh and Haryana with 8,471 and 8,253 centres respectively. On the lower end, regions like Daman and Diu, Chandigarh, and Andaman and Nicobar Islands have significantly fewer centres, with Daman and Diu having just one. The collective total of CHCs across all states stands at 74,144. This establishment of centres indicates a structured initiative to possibly bolster agricultural or other sectoral efficiency and accessibility to essential resources or services across the states.

The breakdown of CHCs registrations into categories reflects a notable engagement from different sectors of the community. The majority of registrations come from farmers, accounting for 44,178 centres (Fig. 2), which underscores the significant involvement of the agricultural sector in this initiative. Societies also contribute a substantial number with 25,011 registrations, demonstrating a collective effort possibly aimed at communal or regional development. Entrepreneurs, although registering a lesser total of 4,955 centres, show a growing interest in leveraging these establishments, potentially for business or innovative solutions within local frameworks. The cumulative registrations across all categories tally up to 74,144 CHCs, indicating

a broad-based approach to fostering resource accessibility and possibly boosting sectoral efficiencies across regions.

Table 1. State wise - CHCs established till 30 oct 2023

S. No.	State	Total
1	Punjab	11133
2	Andhra Pradesh	8471
3	Haryana	8253
4	Telangana	6579
5	Tamil Nadu	6294
6	Nagaland	5238
7	Kerala	4866
8	Uttar Pradesh	4518
9	Madhya Pradesh	3194
10	Chhattisgarh	2996
11	Gujarat	2467
12	Rajasthan	1690
13	Maharashtra	1604
14	Uttarakhand	1215
15	Odisha	1025
16	Karnataka	937
17	Jharkhand	787
18	Bihar	685
19	Assam	435
20	West Bengal	417
21	Sikkim	402
22	Meghalaya	381
23	Tripura	192
24	Himachal Pradesh	129
25	Goa	76
26	Mizoram	62
27	Manipur	47
28	Delhi	20
29	Jammu and Kashmir	11
30	Arunachal Pradesh	9
31	Andaman and Nicobar Islands	5
32	Chandigarh	5
33	Daman and Diu	1
Total		74144

Department of agriculture and farmers welfare, ministry of agriculture and farmers welfare, govt. of India; accessed on 30.10.2023
(<https://agrimachinery.nic.in/GraphReport/SMAMFmtti/SMAMFmtti.aspx>)

6. GOVERNMENT SCHEMES TO SUPPORT CHCS

- National Mission on Agricultural Mechanization (NMAM):** As part of the Department of Agriculture, Cooperative and Farmers Welfare's initiative during the 12th plan, NMAM was envisaged to

streamline all Agricultural Development Schemes into one integrated mission. This mission aims at catalyzing an accelerated, yet inclusive growth of agricultural mechanization in India. NMAM continues three ongoing interventions from the 11th plan, such as promoting agricultural mechanization through training, testing, and demonstrations, advancing post-harvest technology, and providing financial assistance for machinery procurement. Moreover, several new interventions have been proposed, including the establishment of farm machinery banks for custom hiring, setting up Hi-Tech, High Productive Equipment Centers, and promoting ownership of appropriate farm equipment among small/marginal farmers, particularly in the eastern/north eastern region. A budget of 3500 crores has been earmarked for this mission during the 12th plan period [8].

2. **National Innovations in Climate Resilient Agriculture (NICRA):** The NICRA project, through mechanization, significantly improves the timeliness and precision of agricultural operations, ensuring cost-effectiveness and efficient resource utilization. In 100 NICRA-designated villages, CHC's have been established to provide farm implements, thus empowering the local farming community. Each centre was inaugurated with a capital investment of Rs. 6.25 lakhs, which was financed by the NICRA project.
3. **Sub-Mission on Agricultural Mechanization (2014-15):** With a primary objective of raising the national average from 2.02 kW/ha to 2.50 kW/ha by 2022, and further to 4.0 kW/ha by 2030, this mission focuses on creating awareness among stakeholders. It supports subsidy disbursement through state agricultural departments for the acquisition and distribution of farm implements. Moreover, it orchestrates training, testing, and demonstrations of farm machinery and equipment to bolster the adoption of mechanization [9].

SMAM scheme, operational across all states, aims to promote farm mechanization and increase the farm power ratio to 2 kW/ha in cultivable areas. Under the broader National Mission on Agricultural Extension & Technology, SMAM focuses on extending the reach of

farm mechanization to small and marginal farmers, especially in the Eastern and North Eastern regions with low farm power availability. It encourages the establishment of CHCs for agricultural machinery, sharing the benefits of hi-tech, high-value, and high-productive agricultural machinery with farmers by creating equipment hubs. Through demonstrations and capacity-building activities, it aims to promote farm mechanization and awareness among stakeholders, ensuring quality control of newly developed agricultural machinery at designated testing centers across the country [10].

4. **National Food Security Mission (NFSM):** NFSM offers assistance, covering up to 50% of the cost of crucial machinery like pump sets, tractor-mounted sprayers, seed drills, and zero till seed drills, with varying subsidy rates. The funding structure includes a 60% contribution from the Central government and a 40% contribution from the state.
5. **Rashtriya Krishi Vikas Yojana (RKVY):** Under RKVY, a subsidy of up to 50% is provided for procuring large equipment such as tractors, combine harvesters, sugarcane harvesters, and cotton pickers, aimed at establishing CHCs. The subsidy is funded with a 60% share from the Central government and a 40% share from the state.
6. **Mission for Integrated Development of Horticulture (MIDH):** MIDH aids in the procurement of power-operated machines and tools, and also supports the import of new machines. Associations, farmer groups, Self Help Groups (SHGs), and women farmer groups (comprising more than 10 members) engaged in horticulture crop cultivation are eligible. They can avail a subsidy of up to 50%, with 60% of the assistance rendered by the Central government and 40% by the state.

7. CHALLENGES AND OPPORTUNITIES OF CHCS

1. The emergence of Custom Hiring Centers offers a plethora of entrepreneurial opportunities. With the right amalgamation of technology, service, and understanding of the agricultural landscape, entrepreneurs can tap into this burgeoning market, delivering solutions that are not

- just profitable but also socially and environmentally impactful.
2. The establishment of CHCs embodies a notable initiative within the agricultural sector, albeit with its set of challenges and opportunities (Fig. 3). A study conducted by Nagaraj, Srilatha [11] explored the feasibility of instituting a model CHC, delineating potential challenges encompassing machinery maintenance, fluctuating demand, and burgeoning competition. Concurrently, the study accentuated the substantial opportunities present, especially in regions populated predominantly with small and marginal farmers.
 3. The inception of a Custom Hiring Center necessitates a blend of strategic planning, a nuanced comprehension of the local agricultural landscape, and an unwavering commitment to service excellence. Employing a well-orchestrated approach, CHCs possess the potential to evolve into profitable ventures, while simultaneously playing a pivotal role in modernizing agriculture within the region. The evolutionary trajectory of the agricultural sector has witnessed the emergence of CHCs as a quintessential solution to cater to the mechanization needs of farmers. However, akin to other entrepreneurial ventures, CHCs encapsulate a range of challenges. Entrepreneurs venturing into

- this domain frequently navigate through a myriad of hurdles, spanning from financial constraints to operational quandaries. This discourse delves into these challenges while proffering innovative solutions, drawing insights from best practices and contemporary research.
4. Financial constraints (Fig.3) pose a formidable challenge within the agricultural sector, particularly considering the substantial initial capital requisites for infrastructure, machinery procurement, and operational expenditures. Additionally, the sector is characterized by a fluctuating demand paradigm. This seasonality engenders periods of peak demand for machinery, interspersed with off-season lulls. Another critical dimension entails the maintenance and upkeep of machinery, necessitating regular and often financially onerous maintenance to ensure optimal working conditions. With the burgeoning concept of Custom Hiring Centers, many regions are witnessing a surge of these centers, engendering stiff competition. Furthermore, navigating through the complex maze of evolving legal and regulatory standards presents a daunting challenge. Efficient operation of machinery also necessitates skilled personnel, underlining the imperative for regular training and skill development endeavors.

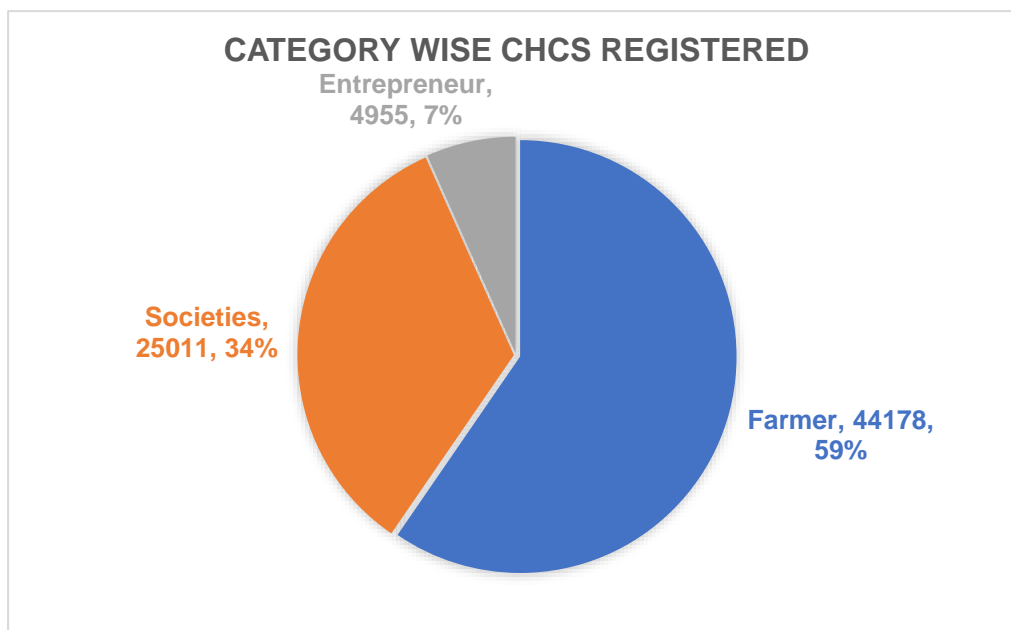


Fig. 2. Category wise CHCs registered



Fig. 3. Challenges and Opportunities of CHCs

CHCs have heralded a paradigm shift for small and marginal farmers, enabling subsidized access to costly farm machinery on a rental basis, and consequently, facilitating timely agricultural operations. A specific study conducted in the Coimbatore district of Tamil Nadu honed in on this aspect, encompassing 90 farmers from regions where Custom Hiring Service Centers were operating efficiently, and revealed a high level of satisfaction among farmers due to the accessibility of farm machinery at CHCs. However, a primary bottleneck identified was the scarcity of skilled labor for farm operations [12].

Diversification emerges as a pivotal strategy for CHCs to mitigate the impacts of fluctuating demand. By diversifying their service offerings, CHCs can maintain a level of adaptability. For instance, during off-peak seasons, machinery could be rented out for non-agricultural purposes such as construction. Strategic partnerships form another avenue; forging alliances with machinery manufacturers or other stakeholders could engender mutually beneficial arrangements. A community-centric approach is quintessential, fostering robust ties with the local farming populace, thereby gleaning insights into their specific needs. This understanding facilitates the tailoring of services more adeptly. The infusion of technology further bolsters the efficiency of CHCs, with the adoption of digital platforms for bookings, inventory management, and customer feedback refining operations and elevating the overall customer experience.

Additionally, a shift towards preventive maintenance as opposed to a reactive approach ensures machinery longevity and curtails downtime. Alliances with governmental bodies can also be advantageous, as many governments proffer subsidies or grants for initiatives aimed at promoting farm mechanization. By leveraging these resources, CHCs can mitigate some of their financial hurdles. Regular market research is indispensable, offering a lens into emerging trends and enabling CHCs to stay ahead of the curve and maintain a competitive edge. In summation, while the road to establishing and operating a CHC is laden with challenges, they are not insurmountable. With a blend of innovation, strategic planning, and a profound understanding of the local agricultural terrain, entrepreneurs in the CHC domain can not only ascertain the success of their venture but also play a pivotal role in propelling the region's agricultural modernization forward.

8. THE ROLE OF TECHNOLOGY IN CHC'S

In today's modern era, technology has become a cornerstone in reshaping various sectors, with agriculture being no exception. CHC's have risen as a vital solution to cater to the mechanization needs of farmers. The infusion of technology into CHC's has brought about a transformation, streamlining operations and elevating the overall efficiency and user experience. One of the most notable advancements in CHCs is the integration of digital platforms and applications. These platforms have redefined the operational landscape of CHCs, offering a seamless

interface for both service providers and farmers. Digital platforms have introduced a centralized booking system, allowing farmers to effortlessly book machinery based on their specific needs. With user-friendly interfaces, farmers can now check machinery availability, reserve them for desired time slots, and even handle payments online. Furthermore, these platforms have simplified inventory management for CHCs by offering real-time tracking of machinery, ensuring they are well-maintained and ready for booking. Another significant feature is the integrated feedback system, enabling farmers to rate, review, and provide suggestions, thus aiding CHCs in refining their services. Mobile applications associated with these platforms also send out timely notifications about bookings, machinery return dates, and promotional offers, ensuring farmers are consistently informed. Additionally, the built-in analytics tools in these platforms allow CHCs to discern booking trends and machinery usage patterns, facilitating a data-driven approach to optimize their operations. Modern platforms also offer integration with other digital services, such as weather forecasting and agricultural advisory services, positioning CHCs as a comprehensive hub for all agricultural needs [13-15].

A testament to the success of such technological integration is evident in Tamil Nadu. Here, CHCs have expanded cultivated land, benefiting approximately 500 to 600 farmers. The Uzhavan app, a brainchild of the Tamil Nadu government, not only provides access to subsidy schemes and information on crop insurance but also connects farmers to affordable tractor and farm equipment services offered by CHC's. Specifically, in the Coimbatore district, subsidies for various agricultural equipment have spurred entrepreneurs to engage in the Sub-Mission on Agricultural Mechanization scheme [16].

In essence, the marriage of digital platforms and apps with CHCs represents more than just a technological enhancement. It signifies a transformative shift in the operational ethos of these centers. By providing a streamlined, efficient, and user-centric interface, these platforms ensure that CHCs are primed to cater to the dynamic needs of the contemporary farmer.

9. THE POTENTIAL OF AI, ML, AND IOT IN ENHANCING CHC OPERATIONS

The integration of Artificial Intelligence (AI), Machine Learning (ML), and the Internet of

Things (IoT) into CHC's has the potential to transform the agricultural landscape. These technologies can significantly enhance the efficiency, accuracy, and user experience of CHCs. Here's a deeper dive into how AI, ML, and IoT can elevate CHC operations.

Predictive Analysis with AI and ML: AI and ML algorithms can analyze historical data related to machinery usage, weather patterns, and crop cycles to predict future machinery demand. This predictive capability ensures that CHC's can optimize their inventory, ensuring machinery availability during peak demand periods [15].

Real-time Monitoring with IoT: IoT devices can be integrated into agricultural machinery to provide real-time monitoring of equipment health, usage, and performance. This allows CHCs to schedule timely maintenance, reduce equipment downtime, and ensure optimal machinery performance [13].

Data-Driven Decision Making: AI and ML can analyze vast amounts of data collected from various sources, such as soil sensors, weather forecasts, and machinery usage patterns. This data-driven approach enables CHCs to make informed decisions about machinery deployment, maintenance schedules, and inventory management [15].

Automated Customer Interactions: AI-powered chatbots and virtual assistants can enhance customer interactions by providing instant responses to queries, assisting in machinery bookings, and offering personalized recommendations based on past usage patterns [14].

IoT-Enabled Precision Agriculture: IoT devices can be calibrated to provide precise data on soil health, moisture levels, and other critical parameters. When integrated with AI and ML algorithms, this data can be used to calibrate machinery for optimal performance, ensuring efficient and sustainable farming practices [13].

Security and Data Protection: With the increasing digitization of CHCs, ensuring data security becomes paramount. AI and ML can be employed to detect potential security threats, unauthorized access, and data breaches in real-time, ensuring the safety and integrity of user data [17]. In conclusion, the convergence of AI, ML, and IoT technologies offers a plethora of opportunities for CHCs to enhance their

operations, provide better services to farmers, and contribute to sustainable and efficient agricultural practices.

The integration of technology into Custom Hiring Centers (CHCs) has paved the way for innovative solutions that cater to the evolving needs of farmers. Here are some notable case studies that highlight the success of tech-driven CHCs. Custom Hiring Centers in Kanker District, Chhattisgarh: The study evaluated the contribution of CHCs towards improving the economic viability of farming in the Kanker district of Chhattisgarh. The model of custom hiring proved beneficial for providing timely services of farm machinery for various agricultural operations. The CHCs utilized digital platforms for booking, inventory management, and feedback collection. Data analytics helped in understanding the demand patterns and optimizing machinery availability. The study found that a significant percentage of small and marginal farmers availed the services of CHCs. The integration of technology ensured profitability and reduced the debt burden of farmers by bringing down operational costs [16].

Attitude of Farmers Towards CHCs in Punjab: A study was conducted in Punjab to understand farmers' attitudes towards CHCs, especially in the context of stubble burning, a major environmental concern in the region. The study utilized data collection tools and analytics to gauge the attitude and perception of farmers. Digital feedback systems were employed to gather insights. The majority of respondents had a favorable attitude towards CHCs. It was observed that CHCs played a pivotal role in addressing the stubble burning issue by providing suitable machinery. The study also highlighted the need for more CHCs to meet the high demand during peak seasons [7].

Development and Standardization of Attitude Scale Towards CHCs: A standardized scale was developed to measure the attitude of farmers towards Custom Hiring Centers. Advanced data analytics and methodologies were used to develop the scale, ensuring precision and consistency in results. The scale, consisting of thirty-four statements, provided valuable insights into farmers' attitudes towards CHCs. Such tools can be instrumental in understanding farmers' needs and optimizing CHC services [4]

These case studies underscore the transformative potential of technology in CHCs.

By leveraging digital platforms, data analytics, and other tech tools, CHCs can offer more efficient, user-friendly, and sustainable solutions to farmers.

10. CONCLUSION

Custom Hiring Centers (CHCs) have played a crucial role in driving agricultural mechanization and inclusivity in India, marking a significant milestone in the sector's evolution. The widespread establishment of CHCs, supported by government schemes, has underscored their importance in enhancing accessibility to advanced agricultural machinery and fostering entrepreneurial endeavors. Despite the challenges faced, the integration of cutting-edge technologies such as Artificial Intelligence (AI), Machine Learning (ML), and the Internet of Things (IoT) has paved the way for more streamlined and efficient CHC operations, contributing to sustainable agricultural practices. This integration represents a promising trajectory towards a more resilient and productive agricultural landscape, emphasizing the enduring significance of CHCs in shaping the future of Indian agriculture.

COMPETING INTERESTS

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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