

Leveraging Agricultural Mechanization and Service Expansion to Drive Rural Economies

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Introduction

Bangladesh's agricultural sector, a major contributor to the national economy and the primary source of livelihood for nearly half of its population (World Bank (2016); ADB (2023)), confronts escalating challenges in the 21st century to meet the rising demand for food production amid a growing population. Yet, this demand is at odds with a dwindling supply of agricultural labor, influenced by various factors. Traditional land inheritance contributes to parcel fragmentation, diminishing individual farm sizes and impeding the economies of scale achievable with larger operations, thus discouraging investments in labor-saving technologies. Concurrently, urbanization and labor migration contribute to the depletion of agricultural workforce in rural areas. This trend is evident in Bangladesh, where a significant proportion (66% of all migration) comprises rural-to-urban internal migration (Afsar and Hossain

(2020); Alam and Mamun (2022)), further exacerbating agricultural labor shortages. Moreover, climate-induced displacements triggered by natural disasters like floods and cyclones further disrupt agricultural labor supply. The escalating trend of overseas migration exacerbates this scenario, leading to a drain of skilled labor from the agricultural sector, thereby reducing its workforce availability.

Resultant labor scarcities drive up agricultural production costs, notably for hired labor, often constituting over half of total production expenditure. This economic strain compels farmers to expedite harvests quickly, potentially compromising yield and profit margins.

Challenges Faced by Bangladesh's Agriculture



Growing Population:
Rising demand for food strains agricultural output.

Shrinking Landholdings:
Inheritance practices reduce available land per capita.



Climate & Disaster Displacement: Floods displace millions annually, worsening labor shortages.

Labor Scarcity: Urbanization and higher urban wages trigger rural exodus. (66% of internal migration is rural-to-urban)



Overseas Migration:
0.4 million Bangladeshi workers seek jobs abroad each year. (ADB & ILO, 2016)

The Costly Squeeze:

Labor scarcity has a direct economic impact on agriculture production in Bangladesh. The escalating costs of hired labor, which account for over half of a farmer's total production expenditure, pose a significant threat. This issue is compounded by the dwindling pool of available workers, forcing farmers to pay ever-increasing wages. This squeeze on profit margins compels farmers to expedite harvests, potentially compromising both yield and income.

Transforming Bangladesh's Agriculture Through Mechanization

Amidst the diverse challenges confronting Bangladesh's agricultural landscape, a strategic shift towards agricultural mechanization emerges as a fundamental solution to ensure its long-term sustainability. In the pursuit of sustainable mechanization options

for Bangladesh's agricultural sector, the indispensable role of Transforming Agrifood Systems in South Asia ([TAFSSA](#))'s work package 2 and the Cereal Systems Initiative for South Asia- Mechanization and Extension Activity ([CSISA](#)-MEA) cannot be understated. Modern machinery holds tremendous potential to revolutionize land preparation, planting, and harvesting processes, thereby reducing dependency on manual labor and potentially facilitating the expansion of farm sizes through economies of scale. This transition not only enhances productivity but also mitigates reliance on a diminishing labor force, laying the groundwork for sustainable agricultural practices and economic stability. As Bangladesh progresses, the adoption of agricultural mechanization becomes an essential trajectory, pivotal for overcoming sectoral challenges and ensuring food security and economic resilience.

In the realm of Bangladesh's cereal systems, a transformative shift is underway, fueled by the integration of modern agricultural machinery into farming practices. This evolution signifies more than mere technological advancement; it represents a holistic amalgamation of training, extension, and learning activities led by the CSISA-MEA initiative. Through this initiative, the objective is to elevate production levels, minimize losses, and foster agricultural prosperity rooted in scientific principles within farming communities. By embracing agricultural mechanization, Bangladesh can surmount its agricultural hurdles, resulting in increased productivity, reduced labor costs, and the emergence of new rural service ventures. This not only enhances farm incomes and ensures food security but also invigorates a more dynamic and resilient rural economy, providing economic opportunities for both existing farmers and aspiring entrepreneurs.

Rural Employment and Income Opportunities: Key Insights from survey

A group of machinery service providers and farmers was surveyed to analyze the costs of agri-machinery service business and mechanical agricultural operations. The data from Table 1 highlights significant cost savings associated with machine harvesting compared to manual labor across various machinery types. For example, the Power Tiller Operated Seeder (PTOS) offers a cost reduction of \$50-55 per hectare, representing a substantial benefit of 45-50% over manual methods. Machinery such as the Reaper and Combine Harvester show remarkable efficiency gains, with benefits over manual labor exceeding 50%. These machines not only save costs but also streamline harvesting processes, enabling farmers to maximize their productivity. Additionally, the analysis underscores the economic viability of investing in agricultural machinery. For instance, the Fodder Chopper presents an

impressive benefit-cost ratio, with an efficiency gain of 85-90% over manual chopping methods, indicating a lucrative business opportunity for machinery service providers. By adopting mechanized harvesting methods, farmers can enhance their profitability, with substantial cost savings translating into higher net profits per hectare. Encouraging the adoption of modern agricultural machinery also promotes technology transfer and innovation in the agricultural sector, fostering a culture of continuous improvement and adaptation among farmers. Extension projects focused on agricultural machinery play a crucial role in supporting farmers by providing access to modern machinery and training on its use, contributing to sustainable agriculture and economic development. Collaborative partnerships between Machinery Service Providers, farmers, government agencies, and research institutions are essential for scaling up machinery adoption and maximizing its benefits, driving positive change in the agricultural landscape.

Agricultural operations carried out by the machines indicated in table 1:

- Power Tiller Operated Seeder : Tilling, seeding and levelling
- Rice Transplanter : Transplanting of rice seedlings
- Reaper : Harvesting/cutting of the matured crop, mainly rice and wheat
- Combine Harvester : Harvesting and threshing of the crop, mainly rice, wheat, maize
- Fodder Chopper : Chopping fodder into finer pieces for easy consumption by livestock

Table 1: Rural Employment and Income Opportunities: Cost-Benefit Analysis of Machinery Service Provision

Benefits and costs (per annum basis)	Power Tiller Operated Seeder*	Rice Transplanter	Reaper	Combine Harvester	Fodder Chopper*
Price (without subsidy)	\$300-350	\$4,000-5,000	\$1,500-2,000	\$30,000-32,000	\$300-350
Price (with subsidy)	\$350-360	\$1,500-1,600	\$800-900	\$15,000-16,000	\$300-350
Annual Income (USD)	\$2,000-3,000	\$2,500-3,000	\$1,500-1,700	\$20,000-22,000	\$700-800
Income per hectare (USD)	\$50-60	\$80-85	\$60-65	\$100-200	\$4-5
Annual Expense (USD)	\$1,000-1,500	\$800-900	\$700-750	\$8,000-9,000	\$300-400
Expense per hectare (USD)	\$30-40	\$20-30	\$20-30	\$60-70	\$2-4*
Annual Profit (USD)	\$900-1,000	\$1,500-2,000	\$900-1,000	\$10,000-15,000	\$300-400
Net profit per hectare (USD)	\$20-25	\$50-55	\$30-40	\$80-85	\$2-4*
Return on Investment without subsidy	250-300%	35-40%	50-60%	40-45%	100-120%
Return on Investment with subsidy	250-300%	100-120%	100-120%	80-90%	100-120%

Notes:

Data sourced from surveys conducted with Machinery Service Providers (MSPs) in Faridpur, Jashore, and Cox's Bazar.

*For the fodder chopper, the benefit-cost analysis is presented on a per ton basis.

*For the PTOS and fodder chopper, subsidy not applicable. For PTOS, only the 'Seeder attachment' is considered in the analysis.

Abdur Rahman's Success Story

Abdur Rahman's journey from traditional farming to becoming a successful Machinery Service Provider (MSP) for combine harvesters in Magura district of southwestern Bangladesh, exemplifies the transformative potential highlighted in Table 1. In 2020, Rahman's strategic decision to invest in two combine harvesters, leveraging a government subsidy and his savings, aligns with the data indicating significant cost savings and efficiency gains associated with mechanized harvesting. His success came from the technical support, extension services, and training he received through the Cereal Systems Initiative for South Asia–Mechanization and Extension Activity (CSISA–MEA), part of the Transforming Agrifood Systems in South Asia (TAFSSA) Initiative.

TAFSSA operates across South Asia to improve agrifood systems through inclusive learning platforms, public data systems, and strategic partnerships. CSISA–MEA, a key project within TAFSSA, promotes the spread of agricultural mechanization in Bangladesh by helping smallholder farmers access resource-efficient machinery for tasks such as sowing, irrigation, and harvesting, which boosts productivity and resilience.

The USAID-funded CSISA–MEA provided Rahman with essential training, empowering him to navigate challenges effectively and optimize his machinery's performance. Despite initial hurdles, Rahman's determination and the efficiency gains highlighted in Table 1 enabled him to expand operations, now employing several individuals and servicing hundreds of farmers each season with two combined harvesters.



Above: Abdur Rahman operating combine harvester in Magura, Bangladesh; photo: Asmaul Husna

Rahman's success underscores the importance of continuous learning and skill enhancement in an evolving agricultural landscape, echoing the insights provided. His story serves as an inspiration for others seeking to modernize agricultural practices, emphasizing the transformative impact of mechanization and targeted training in driving rural development and agricultural sustainability.

Cost Savings from the Farmers' Perspective

Mechanization in agriculture heralds a significant transformation, offering farmers substantial cost savings across various operations. According to data from the CSISA-MEA surveys conducted with Machinery Service Providers (MSPs) and farmers in Faridpur, Jashore, and Cox's Bazar, mechanized solutions present a compelling economic advantage over manual labor.

Analyzing the cost differentials reveals striking benefits of machinery adoption. Take, for instance, the Power Tiller Operated Seeder (PTOS). While manual operations cost \$110-120 per hectare, machine operation reduces this expense to \$65-70 per hectare, resulting in a significant saving of 45-50% on a hectare. Similar trends are observed across other machinery types.



The Rice Transplanter, excluding seedling costs, shows a reduction from \$200-205 to \$140-145 per hectare, offering a benefit of \$55-60 per hectare. Similarly, the Reaper and Combine Harvester exhibit substantial savings, with benefits of \$55-60 and \$78-85 per hectare, respectively. Notably, the Fodder Chopper stands out with remarkable cost savings. While manual operation costs \$15-20 per ton, machine operation reduces

this to \$1-3 per ton, resulting in a substantial benefit of \$12-19 per ton.

These findings presented in table 2 underscore the tangible economic advantages of mechanization for farmers. By reducing labor costs and increasing operational efficiency, mechanized solutions not only enhance profitability but also improve the economic viability of farming ventures.

Table 2. Labor Cost Savings: Machinery vs. Manual Operations

Machine	Cost of manual Operation (USD ha ⁻¹)	Cost of machine operation (USD ha ⁻¹)	Savings of Machine over Manual Labor (USD)	Savings of Machine over Manual Labor (%)
Power Tiller Operated Seeder	\$115-120	\$65-70	\$50-55	45-50%
Rice Transplanter*	\$200-205	\$140-145	\$55-60	25-30%
Reaper	\$110-115	\$55-60	\$55-60	50-55%
Combine Harvester	\$210-215	\$130-135	\$80-85	30-35%
Fodder Chopper**	\$15-20	\$1-3	\$12-19	85-90%

Notes:-

Data sourced from CSISA-MEA surveys conducted with Machinery Service Providers (MSPs) and farmers in Faridpur, Jashore, and Cox’s Bazar.

*Rice transplanter service excludes seedling costs.

**Benefit-cost analysis for the fodder chopper is presented per ton.

Challenges in Machinery Service Provision

Limited Access to Financing: Many Machinery Service Providers (MSPs) and farmers in Bangladesh, particularly smallholders, encounter difficulties in accessing affordable financing options to purchase agricultural machinery. High-interest rates and stringent loan requirements hinder their ability to invest in such equipment.

High Initial Investment: While the Bangladesh government offers subsidies for certain machinery, the initial expense associated with acquiring agricultural equipment like power tillers, rice transplanters, and

combine harvesters remains prohibitively high for small-scale Machinery Service Providers (MSPs). This financial barrier makes it challenging for them to afford these machines without sufficient financial assistance.

Lack of Awareness and Training: A significant number of MSPs and farmers in Bangladesh lack awareness of the benefits of utilizing modern agricultural machinery and may not possess the necessary skills to operate and maintain them effectively. This leads to underutilization or improper use of equipment, resulting in reduced productivity and increased maintenance costs.



Inadequate Infrastructure: The presence of agriculture-based light engineering (ABLE) enterprises is scattered, and many lack the necessary infrastructure and support for machinery manufacturing. Limited availability of domestic machinery manufacturing, repair and maintenance facilities, spare parts, and servicing centers pose significant challenges for farmers in maintaining their agricultural machinery. Remote rural areas often lack access to these essential services, resulting in downtime and decreased operational efficiency.

Fragmented Market: The market for agricultural machinery in Bangladesh is fragmented, with limited availability of quality equipment and reliable suppliers. This makes it difficult for farmers to find suitable machinery that meets their specific needs and preferences.

Seasonal Demand: Agricultural machinery, such as rice transplanters and reapers, are typically in high demand during specific seasons, leading to seasonal fluctuations in demand. As a result, MSPs may struggle to maintain a consistent provision of equipment throughout the year, impacting farmers' ability to access them when needed.

Caveats of Unsynchronized Crop Management Operations: In Bangladesh, land holdings are typically smaller, and farmers often lack synchronization in crop management operations. This results

in plots and fields with crop at different stages. For example, while some fields may not be ready for harvesting, MSPs wishing to access fields ready for harvesting may need to pass their machines through fields that are not yet ready, leading to operational difficulties. Effective operation of agricultural machinery becomes feasible when a collective of farmers synchronizes their activities across adjacent farms, minimizing time gaps within the agricultural season.

Seasonal Income for Small-scale MSPs: Small-scale Machinery Service Providers (MSPs) often face the challenge of seasonality in income. Unlike well-off MSPs who can invest in a variety of machinery for different agricultural operations, small-scale MSPs may only have equipment for specific crop management operations. As a result, their income is dependent on the seasonal demand for those particular services, leading to fluctuations in earnings throughout the year.



Above: Mir Kashem with his Rice transplanter in Teknaf, Bangladesh; photo: Md Sahib Nihal

Transport Challenges in Hill Tracts and Remote Areas:

In hilly and remote regions, the logistical hurdles of transporting machinery between locations hinder the effective utilization of certain machines, exacerbating labor shortages. This limitation may lead machinery service providers to focus on specific geographical locations, restricting their operations.

CONCLUSION

Mechanization not only lessens the burdens of manual labor but also empowers rural communities by creating avenues for economic upliftment and poverty alleviation. At the intersection of prosperity and resilience, agricultural mechanization

emerges as a catalyst for transformative change. By harnessing the efficiency and precision of modern machinery, farmers can achieve higher yields and unlock new avenues of income generation. Moreover, mechanization fosters climate resilience by enabling timely planting and harvesting, mitigating the adverse impacts of climatic variability, and safeguarding agricultural livelihoods against nature's uncertainties. By leveraging technology, agricultural mechanization provides a multifaceted solution, including rural employment generation and opportunities for farmer income, to tackle Bangladesh's agricultural challenges, paving the way for a sustainable and prosperous future.



Above: Transplanting rice by machine in Teknaf, Bangladesh; photo: CIMMYT

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ABOUT TAFSSA

TAFSSA (Transforming Agrifood Systems in South Asia) is a CGIAR Regional Integrated Initiative that supports actions improving equitable access to sustainable healthy diets, that boosts farmers' livelihoods and resilience, and that conserves land, air, and water resources in a climate crisis.

ABOUT CGIAR

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ABOUT CSISA-MEA

USAID funded project CSISA-MEA aims to support the growth and expansion of agricultural mechanization in Bangladesh by making it affordable for smallholder farmers to access cost and resource-saving machinery for sowing, irrigation, harvesting, and other agricultural activities. CSISA-MEA assists various market actors across the value chain, including machinery manufacturers, importers, retailers, dealers, mechanics, spare parts vendors, and local service providers who deliver services directly to farmers.

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