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The Mechanization Deficit in Sudan: A Multi-Dimensional Analysis of Agricultural Machinery Gaps and Their Economic Implications

Farid Eltom Abdallah,^{1,2*} , Gatwech Koak Nyuon^{1,3}, Yasir Fadlella^{1,4} and Mohammed Dawood^{1,2}

¹Yellow River Delta Intelligent Agricultural Machinery Equipment Industry Research Academy, Dongying, China

²Africa City of Technology, Khartoum, Sudan

³Ministry of Agriculture, Animal Resources, Juba, South Sudan

⁴Ministry of Agriculture, Animal Resources, and Irrigation, Khartoum State, Sudan

***Corresponding Author:**

Farid Eltom Abdallah, Yellow River Delta Intelligent Agricultural Machinery Equipment Industry Research Academy, Dongying, China; Africa City of Technology, Khartoum, Sudan.

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Abstract

This report emphasizes on academic and institutional research to provide a comprehensive analysis of the agricultural mechanization gap in Sudan. Despite possessing huge potential of 84 million hectares of arable land, Sudan's agricultural sector is constrained by significant gap. Key findings of this report indicate that mechanization is highly lacking, with heavy reliance on manual labor for many staple crops. The ongoing conflict has terribly widened these pre-existing gaps, destroying infrastructure, disrupting supply chains, and creating a hostile economic environment. Primary barriers to adoption include fluctuated costs and an underdeveloped market for machinery services. This report concludes that overcoming the mechanization gap requires integrated interventions. These should include adopting locally-customized machinery relevant to local crops, leveraging strategic international partnerships for technology transfer and implementing coordinated policy reforms to foster a resilient and productive agricultural sector.

Keywords: Agricultural Mechanization Gap, Agricultural Productivity, Sustainable Agriculture Food Security and Rural Development

Introduction

Sudan's agricultural sector is characterized by a mixed contrast between its vast potential and its current operational reality. With an estimated 84 million hectares of arable land and only 17 million hectares under cultivation, the opportunity for large-scale agricultural development is significant [1]. Cultivating diverse crops like cereals, oilseeds, and horticultural products requires specialized machinery. Advanced planters, combine harvesters, and processing equipment are essential to boost productivity and reduce post-harvest losses. However, the realization of this potential is hindered by a mechanization gap, a situation severely affected by current socio-political instability. This report analyzes the dimensions of this gap, its economic consequences, and proposes some recommendations toward sustainable mechanization.

There is a significant gap in agricultural machinery in Sudan due to the destruction of infrastructure and the impact of conflicts on supply chains and labor, which limits actual demand and makes it difficult to meet agricultural needs. The lack of modern machinery leads to decreased land productivity, especially given the vast areas of uncultivated farmland, and increases the need for machinery appropriate to the scale of production and the type of crops [2]. In 2021, the agriculture sector in Sudan contributed over 26.1% of the country's GDP [3]. It is important to note that data on Sudan can vary significantly between sources due to difficulties in data collection, the sizeable informal economy, and the effects of recent conflicts. The figures below are based on data from before 2023 (i.e. before the current war). The current conflict has caused widespread disruption to agriculture, rendering nationwide data unavailable.

Pre-Existing Structural Gaps in the Mechanization Sector

Even before the current crisis, scholarly assessments identified fundamental weaknesses within Sudan's agricultural mechanization framework. Abdallah et al. (2016) highlight a significant mechanization gap characterized by limited power availability, a shortage of advanced machinery, and weak support systems, including inadequate training and policy frameworks [4]. These pre-existing gaps include:

- Low mechanization levels in traditional and pastoral sectors [1].
- Use of basic technology in nominally "mechanized" schemes.
- Deficient support infrastructure (e.g., maintenance, spare parts).
- Heavy reliance on imported machinery and inputs.
- A critical lack of post-harvest and processing technologies.

Empirical research from the Gezira Scheme highlights the uneven application of existing machinery. While wheat production is highly mechanized (96.7%), essential crops like groundnut (20.4%), cotton (25%), and onion (26.1%) remain predominantly dependent on manual and animal labor [5]. This incomplete mechanization leads to suboptimal productivity, high production costs, and overall operational inefficiency, undermining the Scheme's potential as a flagship agricultural project.

The Impact of Conflict on Supply Chains and Infrastructure

The ongoing conflict has worsened the pre-existing weak mechanization in the country. A recent assessment documents the looting and destruction of agricultural machinery, particularly in key hubs such as Khartoum, El Obeid, and Wad Medani [6]. Critical infrastructure, including storage facilities and supply chains for spare parts, has been destroyed, leading to a massive loss of capital stock. The business environment has collapsed, with reports indicating that approximately 90% of agricultural input companies in regions like Darfur and Kordofan have ceased operations. The macroeconomic fallout includes rampant inflation, soaring fuel prices, and a severe foreign currency shortage. The proliferation of illegal checkpoints has increased transport costs, created widespread insecurity, and forced a strategic shift among farmers and agribusinesses from production to survival, the report added.

Economic and Market Barriers to Adoption

Beyond the immediate physical destruction, significant economic barriers obstruct mechanization adoption. The high initial capital investment required is a primary obstacle. A micro-economic study found that farmers' willingness to pay for a tractor was approximately 31% below its market price, creating a prohibitive financial barrier for smallholders and perpetuating labor-intensive methods [2]. This underscores that the fundamental challenge is not only a lack of machinery but an underdeveloped and inefficient market for machinery services [7]. Despite these challenges, analysis from the Gezira Scheme demonstrates that machinery ownership can be profitable. A viable solution is to limit the ownership hurdle by fostering private sector-led machinery services.

Crop	Estimated cultivated area (ha) - pre-2023	Key mechanized operations	Estimated level of mechanization	Notes & context
Sorghum (Guinea Corn)	$6 - 8 \times 10^6$	Land Preparation, Sowing, Weeding (partial)	60-70%	The backbone of Sudanese agriculture. Dominates the mechanized rainfed sector.
Mil	$2 - 3 \times 10^6$	Land Preparation (partial)	20-30%	Grown mainly in traditional rainfed sectors with low levels of mechanization.
Wheat	$0.3 - 0.5 \times 10^6$	Land Prep, Sowing, Harvesting, Irrigation	90-95%	Almost fully mechanized. Grown almost entirely under irrigated schemes.
Cotton	$0.2 - 0.3 \times 10^6$	Land Prep, Sowing, Spraying (Harvesting manual)	70-80%	Highly mechanized except for the harvesting stage, which is manual for quality.
Groundnuts (Peanuts)	$1.5 - 2 \times 10^6$	Land Preparation, Shelling	50-60%	Mechanization is common in land prep in large farms, but harvesting is often manual.
Sesame	$4 - 5 \times 10^6$	Land Preparation	40-50%	Area has expanded rapidly. Mechanization is growing in land prep, but harvesting is manual.

Table 1: Detailed Analysis by Crop

This model provides the benefits of mechanization, including timeliness and efficiency, without placing the full financial burden on individual farmers, table one showed the detailed Analysis by Crop; however, the ongoing war has severely damaged this infrastructure, disrupting fuel supplies, spare parts, and financing, leading to a catastrophic decline in mechanized farming and threatening the country's food security. Therefore, while the percentages above reflect a "before" picture Fig 1, the current reality is one of severe disruption.



Figure 1: The Importance of Agriculture in Sudan

Recommendations

According to successfully addressing Sudan's mechanization gap requires a holistic, well-coordinated effort that targets several areas simultaneously:

- Reform and fund agricultural extension services, financial credit providers, and seed systems to make them more effective and farmer-centric [8].
- Create innovation platforms that promote dialogue and problem-solving among all stakeholders in the agricultural value chain.
- Encourage and support the growth of private sector-led machinery rental and custom-hire services to enhance access and efficiency.
- As suggested by Abdallah et al. (2016), view the mechanization challenge as an opportunity for collaboration with international partners like China [4]. Effective partnerships must prioritize technology transfer and local capacity building over mere equipment sales to unlock Sudan's potential as a major food producer.
- Offer hands-on training that focuses not only on machinery operation but on its integration into a complete package of practices that maximizes yield and profit.

Conclusion

The mechanization gap in Sudan is a problem rooted in long-standing inefficiencies and catastrophically worsened by ongoing conflict. While the country's agricultural potential remains, its realization depends on addressing critical gaps in machinery availability, market functionality, and support infrastructure. The way forward requires creating a supportive business environment and developing sustainable machinery service markets. Success also depends on strategic international cooperation for capacity building and the implementation of integrated, farmer-centric support systems. Strategic investment in these areas is essential for building a resilient, productive, and modern agricultural sector in Sudan.

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