

Sustainability Assessment of Agricultural Mechanization in the Gezira Scheme, Sudan

Lotfie A. Yousif^{*1}, Shaker B. Ahmed²

1. National Coordinator for Agricultural Engineering Research Program, Agricultural Research Corporation (ARC), Wad Medani, Sudan,

2. Department of Agricultural Engineering, Faculty of Agriculture, Omdurman Islamic University, Sudan.

*Corresponding E-mail: shaker@oiu.edu.sd; <https://orcid.org/0000-0001-6112-5796>

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ABSTRACT

Gezira Scheme covering about 0.9 million hectares, located in a semi-arid region. It is one of the biggest gravity-irrigation schemes in Africa and the Arab world. Crops grown in this scheme include cotton, groundnut and sorghum for summer period and wheat for the winter period. Over 130,000 farmers are enrolled in this irrigation scheme with different levels of mechanization and availability of agricultural inputs. This paper assesses the sustainability of agricultural mechanization in Gezira Scheme through quantitative and qualitative data analysis. Field surveys, stakeholder interviews, publications and government documents served as information sources. The SWOT and PESTLE analyses were conducted to identify internal strengths and weaknesses as well as external opportunities and threats in terms of the sustainability of agricultural mechanization. Results revealed that the average power availability was low to moderate (0.41 hp/ha), while tractor density reached about one tractor per 200 hectares. The presence of a substantial difference in the level of mechanization among different crops with wheat being the most mechanized (96.7%) and groundnut the least (20.4%). Mechanization constituted 26.3% of the cost of wheat production; while harvesting was the costliest mechanized activity, taking up 29.7% of the cost. Although there are some problems in terms of very high

machinery cost, shortage of fuel, and availability of suitable implements. One of the most important suggestions raised by this study is that it is necessary to increase the efficiency of implements used in the scheme. Mechanization has significantly contributed to increasing crop productivity especially wheat, but its use is still low for groundnut and cotton.

Keywords: Agricultural mechanization; sustainability; SWOT; PESTEL; Gezira scheme and Sudan.

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INTRODUCTION

Agricultural mechanization is a cornerstone for achieving sustainable intensification and food security in irrigated systems, particularly in low- and middle-income countries. It plays a vital role in increasing land and labor productivity. Without proper mechanization, agricultural productivity in the smallholder sector is likely to stagnate or even decline, especially due to rising labor constraints (FAO, 2006).

Mechanization encompasses a range of activities, from identifying suitable farm operations for mechanization and ensuring the availability of appropriate implements, to creating an enabling policy environment that supports markets, finance, and capacity building along the entire agricultural value chain (Baudron et al., 2015). The demand for mechanization is influenced by factors such as the intensity of farming operations, market access for produce, labor availability, the ability to utilize implements efficiently, and access to complementary technologies (IFPRI, 2016). Moreover, the full benefits of mechanization are closely linked to the availability and use of complementary inputs like improved seeds, fertilizers, and irrigation water. Successful sustainable intensification requires a reliable supply of machinery (Mrema et al., 2018).

Sustainable Agricultural Mechanization (SAM) offers a pathway to modernize

production systems by improving water productivity, reducing costs, and increasing profitability while maintaining ecological balance. To foster a supportive environment for SAM, macroeconomic factors such as exchange rates, privatization, and commercialization must be reviewed. Support for local equipment manufacturers and dealers is also essential. The role of government should be focused on creating enabling conditions, regulation, and monitoring (Ugwuishiwu and Onwualu, 2009). Daum, T. (2023) reported that, the rapid dissemination of agricultural mechanization in various regions of the Global South, coupled with its prominent position on the policy agenda in numerous other regions, signifies a pivotal shift in the nature of agri-food systems within the Global South. This transformation is characterized by a multifaceted array of consequences, encompassing both favorable and unfavorable outcomes.

In Sudan, the Gezira irrigated scheme represents a historically significant model of planned agricultural development and is among the largest irrigation projects in Africa and the Arab world. Ishag (2026) explained that the Sudan Gezira Scheme (SGS) is a 2.1-million-feddan, gravity-fed irrigation system utilizing approximately 35% of Sudan's Nile water allocation. However, several challenges limit its full potential. Despite its strategic importance, mechanization in the scheme remains suboptimal. Small landholdings, diverse cropping patterns, labor shortages, and limited access to modern machinery have constrained mechanization adoption. Nevertheless, labor scarcity and the need for timely, efficient operations have increasingly motivated farmers to mechanize.

This study aims to assess the sustainability of current mechanization practices in the Gezira Scheme using a multidisciplinary framework. By integrating field-level data, cost analyses, and institutional assessments through SWOT and PESTEL frameworks, the study identifies gaps, opportunities, and actionable strategies toward a more sustainable and inclusive mechanization system that aligns with the local agroecological and socio-economic context.

MATERIALS AND METHOD

Study area

The Gezira Irrigated Scheme is located between the Blue Nile and White Nile rivers, south of Khartoum. It is one of the largest irrigation systems in the region, covering approximately 0.9 million hectares. The area lies within a semi-arid climate zone and receives annual rainfall ranging between 150 and 300 mm, primarily between July to September. The predominant soil type is Vertisol, characterized by a high clay content of 50–60%.

Administratively, the scheme is divided into sections, each comprising multiple blocks or "offices," which are further subdivided into units called "Numbers." Each Number typically covers about 38 hectares, cultivated by a group of farmers. On average, a single farmer manages 8.4 hectares, divided among five equal subplots.

Irrigation system

The scheme uses surface irrigation sourced from the Sennar Dam on the Blue Nile, which has been in operation since 1925. The irrigation infrastructure consists of two main canals that feed into major and minor canals, eventually delivering water to farm-level channels known locally as Abu Ishreen (Abu XX) and Abu Sitta (Abu VI) (Elshaikh *et al.*, 2018).

Crops and crop rotation

Crop diversity is a defining feature of the Gezira Scheme. Summer crops include cotton, groundnut, and sorghum, while winter crops are primarily wheat and chickpea. Historically, various crop rotation strategies have been implemented (Mahgoub, 2014). Currently, approximately 80% of the total area is cultivated once per year under a five-course rotation system, while the remaining 20% is left fallow.

Farmers

More than 130,000 farmers are officially registered within the scheme, each with varying levels of access to agricultural inputs and mechanization. For analytical purposes, farmers can be broadly classified into four groups:

- Full-resource farmers: Own registered land and have access to all essential production inputs, including machinery and mechanization services.
- Partially equipped farmers: Own registered land and some inputs, but rely heavily on family labor due to capital constraints.
- Resource-poor farmers: Have registered land but lack both labor and capital; and therefore, often rent their land to others.
- Investor-farmers: Typically, do not own registered land but have a sufficient capital to acquire advanced machinery and inputs.

Understanding these classifications is crucial for developing targeted mechanization strategies.

Manual labor

Manual labor remains essential for many agricultural operations; however, its availability is becoming increasingly constrained due to labor shortages and ongoing rural–urban migration. Labor within the scheme is generally categorized into family, local, or migrant labor groups (Yousif and Ahmed, 2025). Compared with mechanized alternatives, manual operations are typically more time-consuming, consequently, Seasonal labor shortages have accelerated the gradual adoption of mechanization across various farming activities.

Tractors implement

Some farmers own tractors (mostly 75–80 hp) along with basic implements. Seedbed preparation is the only operation that is fully mechanized (Awadalla et al., 2019). Primary and secondary tillage tools are widely used. Although tools such as seed drills, row planters, and sprayers have been introduced in recent years, their adoption remains limited.

Government and private sector roles

Both the public and private sectors play essential roles in supporting mechanization. Government contributions include tax exemptions on agricultural inputs and the establishment of quality standards for machinery and services. Public institutions also provide training programs for machine operators and technical personnel. The private sector is actively involved in importing machinery and offering mechanization services.

Analytical frameworks

Both quantitative and qualitative approaches were employed in this study. Quantitative measures included key mechanization performance indicators, cultivated areas, crop yields, and cost analysis of wheat production. Qualitative analysis was conducted using the SWOT and PESTEL frameworks to assess internal and external factors influencing agricultural mechanization.

Data collection

Primary data were gathered through field visits, direct observation, and semi-structured interviews with machinery operators. Secondary data were obtained from published literature and reports issued by agricultural institutions.

RESULTS AND DISCUSSION

Quantitative analysis

Crop-specific mechanization

The status of mechanization across four major crops, cotton, groundnut, sorghum, and wheat, revealed substantial disparities (Table 1). Ditching is consistently mechanized across all crops, reflecting a strong integration in water management stage. Efficient ditching is crucial for the gravity-fed irrigation system of Gezira. Primary tillage (disk or chisel plowing) is mechanized for wheat and cotton but is not practiced for groundnut and sorghum. This variation reflects differences in crop value and land preparation methods. Secondary tillage is widely mechanized. Cotton, groundnut, and sorghum involve harrowing and ridging, whereas wheat

requires harrowing and leveling to ensure a uniform seedbed. Bashir et al., (2015) recommended minimum tillage (ridging only) for sorghum as it is less expensive. Seeding operations vary among the four crops; wheat is sown using drills and wide-level disks in a high degree of mechanization. Groundnut remains manually seeded. Row planters are occasionally used for cotton and sorghum, but adoption is limited. The lack of mechanization in groundnut planting highlights the need for localized innovations in planter design. Fertilizer application is mostly manual, except in wheat production where distributors are occasionally used. Expanding mechanical application methods to other crops would improve nutrient distribution, increase yields and reduce environmental impacts. Weed control is well-mechanized across all crops, employing field sprayers, green ridging, and knapsack sprayers. Field and knapsack sprayers are increasingly used for herbicide application. This consistency indicates a high level of technology adoption and acceptance among farmers. Harvesting operations exhibit the greatest disparities in mechanization. Wheat harvesting is fully mechanized through the use of combine harvesters, whereas, Sorghum harvesting is partially mechanized. Groundnut employs digger-shakers, though labor is still essential. In contrast, Cotton harvesting remains entirely manual due to crop structure and lack of efficient mechanical pickers. The adoption of appropriate harvesters could improve efficiency, reduce post-harvest losses and mitigate seasonal labor shortages. For sustainability purposes, it is essential to assess the current land preparation and crop husbandry practices, particularly with regard to the types of implements used (FAO and AUC, 2019).

Table 1. Mechanized operations for the major crops in the Gezira irrigated scheme

Operation	Cotton	Groundnut	Sorghum	Wheat
Farm water channels	Ditchers	Ditcher	Ditcher	Ditchers
Primary tillage	Dis /Chis	-	-	Dis /Chis
Secondary tillage	Harr + Rid	Harr + Rid	Harr + Rid	Harr + Lev
Seeding	Man/ RP	Man	Man/ RP	SD/ WLD
Fertilizer application	Manual	Manual	Manual	Distributor
Weed control	Man/FS/GR	Man/FS/KS	Man/FS/KS	FS/KS
harvesting	Manual	Manual/DS	ST/CH	CH

Dis. = disk plow, Chi = chisel plow, Harr = harrow, Rid = ridger, Lev =Leveler, Man = manual, RP = row planter, SD = seed drill, WLD = wide level disk, FS = field sprayer, GR = green ridging, KS = knapsack, DS = digger shaker, ST, = stationary thresher, CH = combine harvester.

Key performance indicators for mechanized farm operations

Table 2 outlines the key indicators used to evaluate the mechanization practices within the scheme. These indicators help assess the adequacy of power sources, the level of mechanization, and the diversity of implements employed across various farming operations.

Tractors horsepower ranges from 70 to 220 hp, enabling a broad spectrum of field operations, from light-duty tasks to more demanding tasks, like Abu XX ditcher.

Power density is approximately 0.41 hp/ha, classifying the scheme as having a low-to-moderate level of mechanization.

Tractor availability showed roughly one tractor per 200 hectares, which is relatively low and highlights the need for better access and distribution. However, the required number of tractors to treat a given amount of works increases in direct proportion to the increase in the volume of works (Khafizov, et al., 2021).

Table 2. Indicators for mechanized farm operations in the Gezira irrigated scheme

Particular	Description
Farm power (tractors)	70-80 hp, 100-140 hp, 180 -220 hp
Power/ area (hp/ha)	0.41
Tractor/ area	One tractor/200 ha

Source: Dahab and Saeed (2022).

Implement work rate and fuel consumption

Table 3 presents practical data on work rate (ha/h) and fuel consumption (L/h) for key implements used in the Gezira scheme. This data is critical for scheduling operations, estimating operational costs, and evaluating the environmental and economic sustainability of mechanization.

Ditcher for Abu XX exhibited an extremely high work rate (37.82 ha/h) with high fuel use (26.1 L/h), due to the use of high-power tractor. Ditcher for Abu VI showed a more balanced performance at 2.52 ha/h and 11.4 L/h, and is compatible with 70-80 hp tractors.

Disk plow operates at low work rate of 0.42 ha/h with high fuel consumption of 10 L/h, reflecting the high energy demand. Chisel plow offers better field capacity (0.84 ha/h) and slightly lower fuel consumption (9 L/h), making it suitable for conservation tillage. These results suggest that adopting chisel plows could reduce fuel costs and minimize soil disruption, aligning with long-term sustainability goals.

Disk harrow covers 1.47 ha/h and consumes 9.5 L/h, offering a good balance of efficiency and power. representing one of the most fuel-efficient options, Levelers achieve 1.68 hectare per hour with only 8.8 L/h of fuel consumption. Ridgers match levelers in area coverage (1.68 ha/h) with slightly higher fuel consumption (9.6 L/h).

Seed drills operate at 1.89 ha/h and consume 9.9 L/h, offering high productivity. Row planters give slightly lower work rate (1.68 ha/h) and reduced fuel

consumption (8.8 L/h). Both tools are essential for improving sowing accuracy and input efficiency.

Fertilizer distributor delivers a high work rate of 2.52 ha/h at 7.8 L/h fuel use. Field sprayers are among the most efficient, operating at 4.20 ha/h with only 7.5 L/h fuel use.

Harvesting implements vary in work rate depending on their function and crop type. Stationary threshers reveal a lower work rate (0.63 ha/h) and moderate fuel consumption (10.1 L/h). Digger shakers show moderate work rate (0.84 ha/h) and fuel use (11.2 L/h). FAO (1994) mentioned that tractor fuel consumption varies depending on engine type and design, operating speed and loading. Combine harvesters achieve a work rate of 2.1 ha/h but with high fuel consumption (18 L/h), reflecting the complexity of their functions.

Table 3. Work rate and fuel consumption for some implements used in the Gezira scheme

Implements	Work rate (ha.h ⁻¹)	Fuel (L.h ⁻¹)
Disk plow	0.42	10
Chisel plow	0.84	9
Disk harrow	1.47	9.5
Leveler	1.68	8.8
Ridger	1.68	9.6
Ditcher Abu XX	37.82	26.1
Ditcher Abu VI	2.52	11.4
Fertilizer distributor	2.52	7.8
Seed drills	1.89	9.9
Row planter	1.68	8.8
Field sprayer	4.20	7.5
Stationary thresher	0.63	10.1
Combine harvester	2.1	18
Digger shaker	0.84	11.2

Source: Yousif *et al.* (2025)

Mechanization level for some crops

Figure 1 illustrates the mechanization levels (%) for the four major crops cultivated in the Gezira irrigated scheme (Yousif et al., 2025). The results revealed considerable variations in mechanization levels among the crops. Wheat exhibited

the highest mechanization level (96.7%), indicating that nearly all farming operations are mechanized. Sorghum demonstrated a moderate mechanization level (61.4%), with tillage and spraying fully mechanized while weeding and harvesting remain partially manual. Cotton showed low mechanization (25%), indicating a continued reliance on manual labor, particularly for planting and harvesting. Groundnut recorded the lowest mechanization level (20.4%), reflecting a significant dependence on manual seeding, weeding and harvesting.

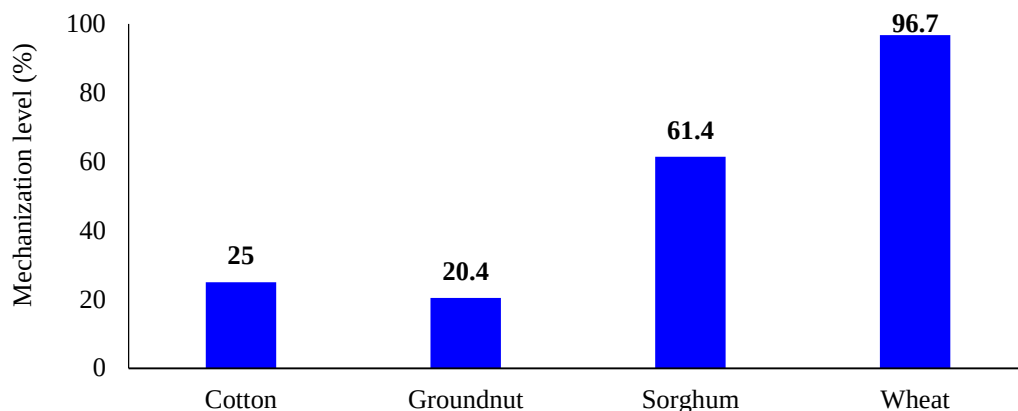


Fig. 1. Level of mechanization for selected crops in the Gezira irrigated scheme (Yousif *et al.*, 2025)

Cultivated areas and yields of major crops (2014–2020)

Table 4 presents data on the four major crops cultivated in the Gezira scheme over six consecutive growing seasons. These crops represent the agronomic, economic and food security foundation of the scheme. The analysis reveals key patterns in land use, yield performance and mechanization linkages.

Cotton revealed considerable fluctuation in cultivated area, ranging between 30,000 to 156,000 feddans. Although yields improved modestly from 7.1 to 10.5 q/fed, harvesting remains largely labor-intensive. Sorghum occupied the largest cultivated area (256,000–412,000 feddans), its yield improved from 0.7 to 1.3 ton/fed, however, productivity remains below its potential under irrigated conditions. increased mechanization could further enhance productivity by ensuring timely field operations.

Wheat showed notable growth in both cultivated area (312,000 - 414,000 feddans)

and yield (1.2 -1.6 ton/fed), which is strongly associated with its high level of mechanization. Wheat therefore represents a successful model of mechanized crop production within the scheme. Groundnut cultivation varied between 153,000 and 230,000 feddans. Despite its value as a cash and oilseed crop, productivity remained stagnant ranging approximately from 0.85–1.06 ton/fed, mainly due to continued reliance on manual operations.

Table 4. Cultivated areas and yields of major crops in the Gezira scheme (2014–2020)

Season	Cotton		Sorghum		Wheat		Groundnut	
	Area, fed	Yield, q /fed	Area, fed	Yield, t/fed	Area, fed	Yield, t/fed	Area, fed	Yield, t/fed
2014/2015	45000	7.1	412000	0.7	312000	1.2	204000	1.06
2015/2016	53000	10.0	412000	0.9	338000	1.5	230000	1.00
2016/2017	30000	10.5	401000	1.1	417000	1.2	187000	0.85
2017/2018	116000	9.5	256000	1.2	269000	1.0	169000	1.05
2018/2019	156000	9.0	301000	1.3	381000	1.2	172000	0.92
2019/2020	151000	10.0	304000	1.2	414000	1.6	153000	1.00

Source: General directorate of agricultural production, agricultural statistics, Gezira scheme administration, Barakat (2021).

q /fed = Qantar per feddan

t/fed = Ton per feddan

Cost of wheat production

Figures 2 and 3 present detailed costs of wheat production in the scheme, with particular emphasis on mechanized operations. Understanding the distribution of production cost is essential for evaluating the economic efficiency, identifying cost-saving opportunities, and formulating sustainable mechanization strategies.

Figure 2 categorizes the total cost of wheat production into four major components. Input costs represent the largest share of total production expenses accounting for 49.7% of the overall cost. These expenses include seeds, fertilizers, herbicides and other inputs. Mechanization constitutes the second largest cost component recording 26.3% of total production costs. Despite increasing levels of mechanization, manual labor remains necessary for certain operations such as

irrigation and field supervision, accounting for 16.4% of the total costs. The remaining 7.6% comprises other costs including Zakat, administrative charges, irrigation water fees, and post-harvest handling costs.

Figure 3 further breakdowns mechanized costs associated with wheat production. Harvesting represents the most expensive mechanized operation (29.7%), this may be attributed to the capital intensity, maintenance requirements, and fuel consumption associated with combine harvesters. Chiseling and harrowing combined account for 37.5% of mechanization costs, indicating a strong reliance on tillage operations. the adoption of minimum tillage or conservation agriculture practices could potentially reduce these costs. Seeding accounts for 14.9%, whereas, land leveling a relatively smaller share of 9.9%. Ridging operations of Abu VI and Abu XX account for only 5.0% and 3.0% of mechanization costs respectively, representing a minor portion of the overall mechanization budget.

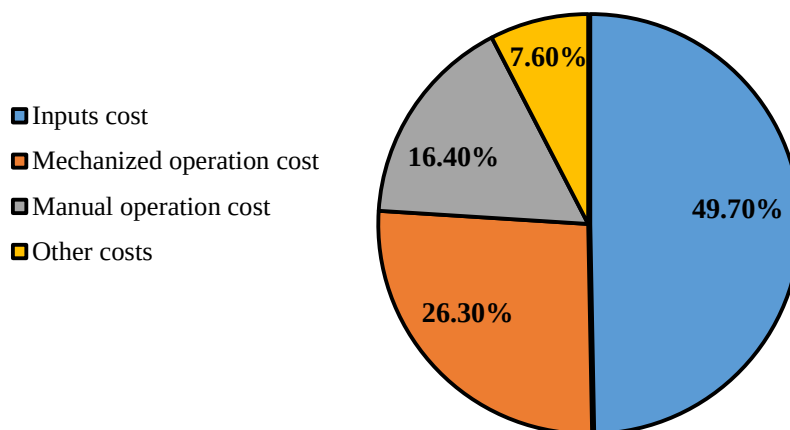


Fig. 2. Relative contribution of mechanized operation for wheat production costs in the Gezira irrigated scheme

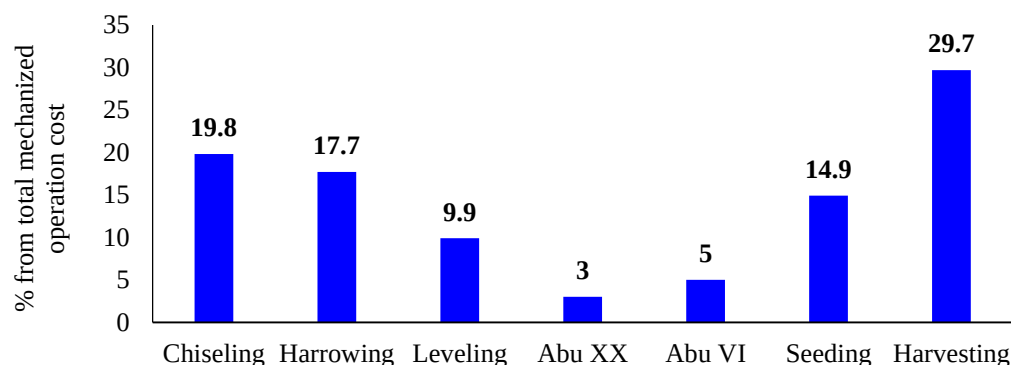


Fig. 3. Breakdown of mechanized operation costs for wheat production in the Gezira irrigated scheme

Qualitative =analysis

SWOT analysis

The SWOT framework was used to assess the internal and external factors influencing the sustainability of agricultural mechanization in the Gezira Scheme.

Strengths

- The large land area necessitates timely operations that are impractical to perform manually.
- Dual cropping seasons generate year-round demand for machinery.
- Crop diversity promotes demand for various machinery types, encouraging specialization and market growth.
- Simultaneous field operations and increased urbanization have created cultural and logistical drivers for mechanization.
- There is political and administrative willingness to support mechanization as a productivity-enhancing tool.

Weaknesses

- Small and fragmented landholdings make individual machinery ownership uneconomical.
- Limited financial capacity among smallholders results in reliance on service providers or manual labor, in line with FAO, (2016).

- The dense irrigation canal system restricts machinery movement, especially for larger equipment.
- Diverse cropping patterns hinder standardized mechanization scheduling, especially in the absence of synchronized cropping calendars.

Opportunities

- Growing awareness among farmers regarding the benefits of mechanization.
- Several companies offer machinery sales and after-sale services.
- Existing training centers help enhance operator skills and service quality.
- The Gezira Research Station provides technologies tailored to local needs.
- Availability of local workshops and experienced technicians reduces machinery downtime.
- Universities contribute skilled graduates to the labor pool.

However, these opportunities make agricultural mechanization available and reachable to the farmers to maximize production (Sanaullah, *et al.*, 2021).

Threats

- Inconsistent cropping patterns within blocks complicate machinery scheduling.
- Seasonal production variability reduces the economic incentive for machinery investment.
- High input costs and price instability shrink profit margins, especially for smallholders.
- Limited access to credit hinders capital investment in machinery.
- Availability of cheap family labor may reduce demand for mechanized services.
- Irregular supply of fuel, lubricants, and spare parts affects machinery reliability and timeliness of operations.

PESTEL ANALYSIS

The PESTEL framework provided insights into macro-level influences on mechanization in the Gezira Scheme.

Political factors

- The scheme has historically been state-managed, with mechanization policies shaped by government.
- Civil unrest and shifting leadership disrupt long-term planning.
- Public-Private Partnerships (PPPs) are gaining support but are slowly implemented.
- Conflicts hinder the transport of machinery, fuel, and services.
- Institutional changes significantly impact productivity (Abdelgalil and Adeeb, 2015).

However, to accelerate mechanization, requires political and financial commitment (FAO and AUC, 2018).

Economic factors

- Rising fuel and machinery prices, along with fluctuating exchange rates, increase production costs.
- There is a lack of dedicated credit and leasing systems for mechanization.
- Dependence on imported machinery exposes the sector to international market disruptions.
- Most schemes lack reliable cost-tracking systems for decision-making (Mohamed *et al.*, 2017).

Social factors

- Mechanization helps address labor shortages during peak seasons.
- Farmers show willingness to adopt new technologies.
- However, youth lack training in machinery operation.
- Women's participation in mechanized farming is almost nonexistent

Technological factors

- Modern implements like laser land levelers and inter-row cultivators are scarce.
- Most machinery is imported, with minimal local manufacturing.
- Technologies for machinery scheduling and performance monitoring are rarely used.
- Declining service efficiency is a concern (Ibrahim *et al.*, 2022).

Environmental factors

- Though no direct studies exist on environmental impacts of machinery in Gezira, heavy tillage likely contributes to soil compaction and degradation.
- Conservation agriculture and minimum tillage offer environmentally sustainable alternatives.
- Sustainable mechanization must avoid environmental harm (FAO and UNIDO, 2008).

Legal factors

- While machinery imports follow quality standards, no formal licensing exists for machinery operators.
- Legal ambiguity surrounding land use discourages long-term mechanization investment.
- High import tariffs on machinery and spare parts limit accessibility.
- The absence of legal frameworks for contract farming limits private-sector growth in service provision.

CONCLUSION

The sustainability of agricultural mechanization in the Gezira Irrigated Scheme is influenced by a combination of technical, institutional, and economic factors. While mechanization has been successfully established in operations such as land preparation and wheat cultivation, substantial disparities persist among different crops. Wheat represents a model of successful mechanization, whereas groundnut

and cotton continue to rely heavily on manual labor. Key performance indicators suggest that the overall level of mechanization remains low to moderate (0.41 hp/ha), indicating considerable potential of improvement in both power availability and operational efficiency.

The SWOT and PESTEL analyses identified several enabling factors such as dual cropping seasons, active participation of the private sector, and the presence of agricultural training institutions. However, these strengths are counterbalanced by significant constraints, including high machinery costs, limited access to financing, policy uncertainties, and overreliance on conventional tillage practices. ensuring the long-term sustainability of agricultural mechanization in the Gezira scheme requires addressing both the “hardware” components such as equipment availability and infrastructure, and the “software” components including policy reform, capacity building, and financial access.

RECOMMENDATIONS

- Develop a comprehensive mechanization policy framework that aligns with national sustainability goals and addresses the specific needs of the Gezira Scheme.
- Establish accessible credit and leasing, and financial mechanisms tailored to the financial capacities of smallholder farmers and service providers.
- Strengthen capacity-building and training programs for machinery operators and technicians, with emphasis on machinery calibration, preventive maintenance, operational efficiency and sustainable mechanization practices.
- Encourage local innovation in machinery design and manufacturing to meet the unique requirements of various crops cultivated within the scheme.
- expand successful mechanization models particularly those demonstrated in wheat production to crops such as groundnut and cotton through targeted research and development of specialized seeding and harvesting equipment.

- Institutionalize monitoring and evaluation systems to regularly assess mechanization performance indicators and support evidence-based policy-making through improved data-sharing platforms

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تقييم إستدامة الميكنة الزراعية في مشروع الجزيرة، السودان

لطفی عبد الرحمن یوسف¹ وشاکر بابکر أحمد²

1. المنسق الوطني لبرنامج أبحاث الهندسة الزراعية، مؤسسة البحوث الزراعية (ARC)، ود مدني، السودان.

2. قسم الهندسة الزراعية، كلية الزراعة، جامعة أم درمان الإسلامية، السودان.

<https://orcid.org/0000-0001-6112-5796>

* المؤلف المراسل: shaker@oiu.edu.sd

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المخلص

يُعد مشروع جزيرة نموذجاً مثالياً للقطاع المروي. وهو من بين أكبر مشاريع الري في أفريقيا والعالم العربي. ويغطي المشروع مساحة تبلغ حوالي 0.9 مليون هكتار، ويُزرع في المشروع عدة محاصيل، منها القطن والفول السوداني والذرة الرفيعة كمحاصيل صيفية، والقمح كمحصول شتوي. ويبلغ عدد المزارعين المسجلين رسمياً في المشروع أكثر من 130 ألف مزارع، ويختلف مستوى حصول كل منهم على المدخلات والميكنة. تقيم هذه الدراسة استدامة الميكنة الزراعية في مشروع الجزيرة. استخدم نهج متعدد الأساليب يجمع بين التحليل الكمي والنوعي لدراسة مستويات الميكنة للمحاصيل الرئيسية، والكفاءة التشغيلية، والتكاليف، والأطر المؤسسية. وشملت مصادر البيانات الملاحظات الميدانية، والمقابلات مع أصحاب المصلحة، والأدبيات المنشورة، والتقارير الحكومية. وتم تطبيق أطر SWOT و PESTEL لتقييم نقاط القوة والضعف الداخلية، والفرص والتهديدات الخارجية. وأظهرت النتائج أن إجمالي الطاقة المتاحة لا يزال منخفضاً إلى متوسط (0.41 حصان/هكتار)، وبلغت كثافة الجرارات جرار واحد لكل 200 هكتار. كشفت النتائج عن تباينات كبيرة في مستويات الميكنة للمحاصيل، حيث سجل القمح أعلى مستوى (96.7%)، بينما سجل الفول السوداني أدنى مستوى (20.4%). شكلت الميكنة 26.3% من تكاليف إنتاج القمح، حيث يعد الحصاد أعلى عملية ميكنة (29.7%). على الرغم من التحديات مثل ارتفاع تكاليف الآلات ونقص الوقود ومحدودية الوصول إلى المعدات المتخصصة. تؤكد الدراسة على الحاجة إلى تحسين كفاءة الآلات والمعدات وتعزيز الزراعة الحافظة للموارد. لعبت الميكنة دوراً حاسماً في تحسين المحصول، خاصة بالنسبة للقمح. ومع ذلك، لا يزال اعتمادها محدوداً بالنسبة لمحاصيل مثل الفول السوداني والقطن. تحتوي الورقة على بيانات متنوعة لتوليد معرفة قابلة للتطبيق ولتحسين الميكنة. تختتم الدراسة بتوصيات تقنية ومؤسسية لتعزيز استدامة وشمولية الميكنة في مشروع الجزيرة.

الكلمات المفتاحية: الميكنة الزراعية؛ الإستدامة؛ SWOT؛ PESTEL؛ مشروع الجزيرة والسودان

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