

# ERF Policy Brief

## Sudan's Challenges and Opportunities: A Renaissance Project for Sudan

From Poor Agriculture to Agro-Industrial  
Growth and Sustainable Development

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### In a nutshell

- Key interventions to catalyse the transformation of Sudanese agriculture from a subsistence-oriented, low-output sector to a high-performing sector well integrated into the national economy.
- Increasing budgetary allocations on agriculture and agro-industries and ending the legacy of excessive direct and indirect taxation of agriculture.
- Fostering a favorable policy environment and strengthening the role of the private sector in agricultural transformation (PPPs).
- Improving farmers' access to financial resources, inputs, and services.
- Enhancing irrigation water infrastructure, mechanization, and the power sectors.
- Establishing agricultural commodity development councils, including producers' councils.
- Building the capacities of the industrial sector to manufacture agricultural inputs and link the production-processing marketing chain.
- Utilizing agro-industrial growth corridors to promote the efficient use of resources.
- Resolving conflicts through the capacity building of local governance and the demarcation of migratory routes.
- Building the capacities of producers through their institutions.
- Introducing a grant institutions system to improve NARS' effectiveness.
- Introducing digital and technical innovations to increase their productivity, efficiency, and competitiveness.

This Policy Brief is based on an ERF policy research report titled "Sudan's Challenges and Opportunities: A Renaissance Project for Sudan: From Poor Agriculture to Agro-Industrial Growth and Sustainable Development" authored by Ibrahim Elbadawi, Abdelrazig Elbashir, Abdelrahman Osman, Amir Hamid Elobaid, Elfatih Eltahir, Alzaki Alhelo, and Kabbashi M. Suliman.

### *Main challenges and reasons for the weak performance of the agricultural sector:*

- *Low spending and allocation of resources to agriculture-related developments resulted in poor agricultural support infrastructure (such as feeder roads, storage, energy, irrigation systems, livestock routes, processing facilities, and marketing).*
- *Weakness or absence of a consistent and long-term agricultural policy and an environment conducive to investment in the agricultural sector.*
- *Low and declined agricultural productivity.*
- *Lacking/limited value addition activities due to the lack of a fully developed agro-industry resulting in the export of raw materials.*
- *Low level of mechanization and access to services (research, extension, protection finance, credit, and market) and inputs (improved seeds and agrochemicals).*
- *Limited use of improved agricultural practices and technology (machinery and improved crop, soil, and water management practices).*
- *Limited spread of effective CBOs and cooperatives.*
- *Climate change, degradation of related natural resources, and recurrent droughts, floods, conflict, and social unrest.*

### *Opportunities for agricultural development:*

- *Rich natural resource base (million hectares of potentially cultivable land and heads of animals, vast natural range and forest, and underground and surface water supplies).*
- *Large yield potential to increase agricultural production.*
- *High technical potential for renewable energy resources (hydro, solar, and wind).*

## **1. Introduction and background**

Agriculture is the backbone of Sudan's economy and crucial for the country's food security.

Between 1960 and 2020, agriculture ranked second to services in terms of contribution to real gross domestic product (GDP), each adding 35.2 percent and 48.7 percent, respectively.

It is the main source of livelihood for around two-thirds of the population and the main employer of skilled labor. In addition, it is characterized by diversity in crop and livestock production systems, agro-climatic conditions, soil types, and socio-economic conditions.

Despite these diversities and the huge natural resource base, Sudanese agriculture has failed to become the "breadbasket of the world." Some important indicators of this failure are:

- Low value addition by the sector and weak linkages to agro-industry.
- Rural migration and rush to urban centers, gold mining, and other countries.
- Decline of productivity of land and labor.
- Deterioration of social services, namely health and education.
- Deterioration of infrastructure.

The main reasons behind the depressed performance are:

- Weak allocation of resources to agriculture.
- Low spending on basic production inputs.
- Weak linkages to modern agro-industry.
- High poverty rates among farming communities and poor access to basic services.

The main reason behind the dismal performance of the agricultural sector is agriculture's decades-long low priority in the allocation of resources.

Recognizing the neglect of agriculture in their countries as the main reason behind the prevalence of poverty and food insecurity, the African heads of state issued the Maputo Declaration in 2008, in which each country committed to allocating at least 10 percent of its public expenditure to agriculture.

According to the Ministry of Finance and National Planning, public investment in agriculture and related sectors accounted for one percent of the GDP during 2012-14.

*Table 1. Livestock production systems and distribution*

<b>Production System</b>	<b>Description and share (%) in national herd (116 heads)</b>
Nomadic system (pastoralists)	2
Transhumant system-Agropastoral	6
Sedentary system	17

**Sudanese agriculture failed to achieve the long-awaited dream of becoming a major "breadbasket of the world" despite the huge resource potential and the country's strategic location.**



Table 2. Average share of the different farming sectors in national cultivated areas and food grain production

Production System	Area (Million Hectares)	Share of Cultivated Land (%)	Contribution to Main Food Crops			Overall Contribution on Main Food Crops
			Wheat	Sorghum	Millet	
Irrigated	2	12	23	1	Desert	25
Mechanized Rain-fed	6	35	38	5	Semi-desert	20
Traditional Rain-fed	9	53	39	94	Arid	55
Total	17	100	100	100	100	100

Table 3. Agro-climatic zones of Sudan: General characteristics and land area occupied

Agro-ecological zone	Annual rainfall (mm)	Humid months (#)	Growing season length (days)	Area (%)	Agro-ecological zone
Desert	<100	≤1	≤30	34	Desert
Semi-desert	100 - 250	1 - 2	30 - 60	21	Semi-desert
Arid	250 - 350	2 - 3	60 - 75	10	Arid
Semi-arid					Semi-arid
Semi-arid (a)	350 - 450	3 - 4	75 - 90	13	Semi-arid (a)
Semi-arid (a)	450 - 750	3 - 4	90 - 120	14	Semi-arid (a)
Sub-humid	≤750	4 - 5	≤120	8	Sub-humid

**Part I - Agricultural productivity in Sudan and other comparator countries**

*2. Value-added in Sudanese agriculture*

Between 1960 and 2020, the patterns of value-added shares by major sectors in the GDP suggest that Sudan appears to have been caught in a premature deindustrialization process, where the share of services (48.7) dominated that of agriculture (35.2) and industry (16.1). The latter sector comprises larger-scale agro-based manufacturing (as well as medium and small-scale edible oil, construction, leather tanning plants, and cottage industries). As seen in the figure below, this process becomes prominent after the rise of petroleum in the economy during 2000-11.

Despite the poor performance of agriculture in terms of contribution to real value addition and economic growth, it generated the bulk of exports (mainly cotton, livestock, and oilseeds).

**This evidence clearly indicates that the prevailing patterns of land use, particularly in the rainfed subsector, are inconsistent with the long-run goal of sustainable growth in the country’s food production.**

Figure 1. Value-added shares by major sectors (percent of GDP)

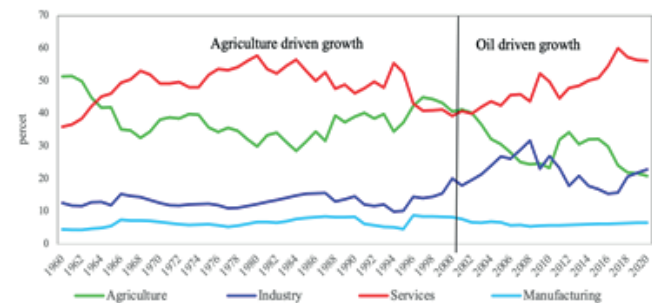
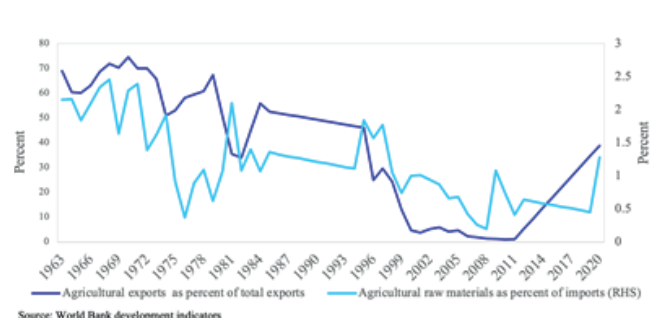


Figure 2. Agricultural exports and the share of imported agricultural inputs in total imports



Source: World Bank development indicators



### Agricultural policies

Since 1956, Sudan opted for bimodal peasant export agriculture instead of peasant export-oriented agriculture in African countries, where the state generates rents from taxing farmers and marketing boards.

The Gezira Ordinance of 1925 is based on a partnership with farmers, including the promotion of dry agriculture to stabilize food production and ensure cheap rural labor supply.

The Dar system was introduced under the supervision of the Sheikh-Omda-Nazir hierarchy to regulate land usage for shifting cultivation, multi-plots, and nomadic pastoralism.

The Unregistered Lands Act of 1970 favored big private businesses over the informal institution of the Dar system, leading to farmer-herder conflicts that erupted in the mid-1980s.

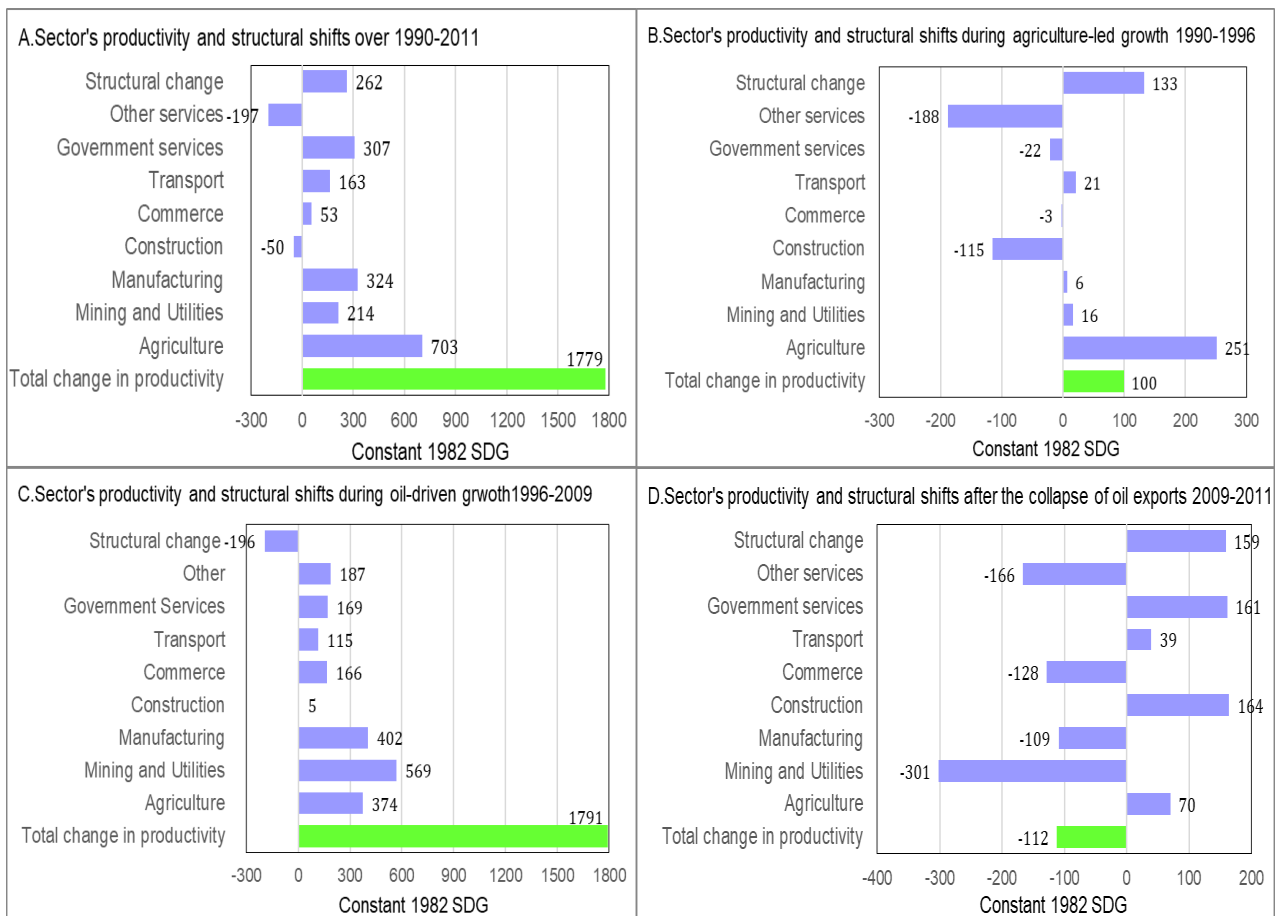
The Gezira Ordinance was then repealed by the 2005 Gezira Act, which signified a complete change in the institutions, thereby underpinning the inherited peasant export agriculture, the earners of foreign exchange, and the growth driver of the economy.

### The oil boom

During the oil boom, the agricultural sector suffered from the combined impacts of exchange rate overvaluation due to Dutch Disease associated with the substantial inflows of oil revenues and political elites' lack of commitment to developing the sector.

The share of imported agricultural inputs (excluding fuel, which is subsidized) as a percentage of total imports dropped by 0.8 percentage points down to 0.7 percent, confirming the complete loss of interest by the Ingaz elite in the bimodal export-oriented agricultural model.

Figure 3. Decomposition of output per worker (productivity) into own-sector changes in productivity and structural changes



The harvested area for irrigated cotton shrank by 34 percent compared to the average before oil. However, its yield increased by 29 percent, reflecting investments in genetically modified cotton.

The harvested area for sorghum, which is the key crop in the rainfed subsector, increased by 53 percent, while yield dropped by 30 percent on average compared to the agricultural-driven growth. Similar patterns were shown for cereals and oil crops.

*A “national industrial policy” intervention is required to enhance agricultural inputs (fertilizers and improved seeds), including the augmentation of the capital base of agricultural supply to increase value addition and the contribution of the sector to the GDP. Institutional reform is required to redress the land tenure system, land usufruct rights, and the demarcation of communal lands. In addition, contractual agriculture should be institutionalized to provide a durable integrated solution to finance and link-up with high value chain markets.*

### 3. Conditional convergence in agriculture

During 2009 and 2014/15, the poverty rate almost doubled, rising to 83.2 percent. This was mainly driven by inflation, with the rate increasing with the distance from the core region.

Poverty predominates in the regions of Darfur, Kordofan, and the East, which are inhabited by farmers, herders, and nomad communities largely engaging in traditional rainfed agriculture and animal husbandry.

While Sudan’s agricultural productivity exceeds the median of low-income countries, it is still lower than that of middle-income countries.

**Successful agricultural transformation has been largely confined to Asian developing countries, which avoided overvalued real exchange rates and indirect taxation and combined modest direct taxation with investment in agricultural supply.**

Convergence in industry tends to be much stronger than in agriculture, which might be explained by the different nature of the technology in the two sectors.

As a growth fundamental, real exchange rate is a key ingredient for any successful export-oriented development strategy for low-income countries. The quantity and quality of infrastructure are expected to positively affect the growth rate in agriculture productivity.

Higher levels of human capital are expected to positively impact productivity in the agricultural sector.

If Sudan were to increase its infrastructure index by 1.6 units to reach that of Egypt (4.5), this could contribute to an increase in the growth rate of agricultural productivity by around 0.7 percentage points.

Special emphasis is needed on energy and financial development, where Sudan particularly lags.

Information and communication technology (ICT) improvements would also greatly benefit productivity.

Increasing fertilizer consumption could also play an important role in boosting Sudan’s agricultural productivity.

Building human capital requires a major reallocation of public spending on education and health.

Farmers’ robust organization in the form of cooperatives could be an effective institutional and societal instrument for enhancing the efficiency of service delivery in the areas of health, education, seeds, fertilizers, and the marketing of produce. It would also facilitate the formation of new business models in agriculture.

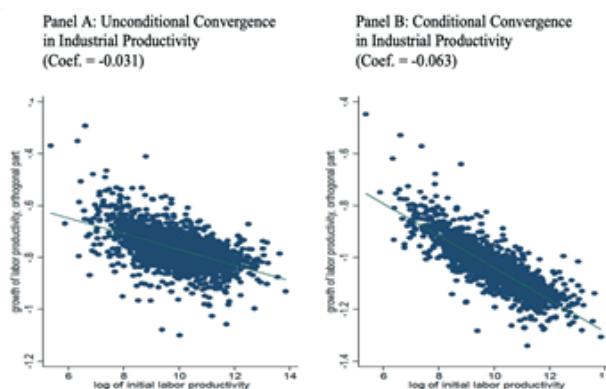
Agriculture in developing countries has been subjected to two types of taxes.

First, agricultural prices are generally suppressed through marketing boards, forced procurement, export taxation...etc. This is a direct form of taxation, which creates a wedge between farmgate and border prices. The second is indirect but no less impactful. This impinges through overvalued real exchange rates and is associated with unsustainable macroeconomic policies in general, especially excessive deficit financing.

*The main lesson is to design a macroeconomic policy from an agricultural transformation perspective to maintain a stable macroeconomic environment and competitive real exchange rates while modestly taxing agriculture at the sectoral level to finance investment in agricultural supply (research and extensions, infrastructure, provision of finance and fertilizers... etc.) similar to the Asian states.*



*Figure 4. Unconditional and conditional convergence in industrial labor productivity*



*Table 4. Taxation of Sudanese agriculture (percent)*

Year	NPRI	NPRD	NPRT
1970	1.54	20.94	22.48
1971	6.15	21.03	27.18
1972	1.53	28.39	29.92
1973	20.72	16.95	37.67
1974	34.17	15.85	50.02
1975	42.24	13.14	55.39
1976	45.17	11.32	56.49
1977	57.91	8.99	66.90
1978	55.49	8.95	64.43
1979	56.51	8.58	65.09
1980	54.17	10.08	64.25
1981	43.55	11.92	55.47
1982	40.22	12.07	52.29
1983	50.37	9.22	59.59
1984	52.51	9.67	62.18
1985	53.83	8.68	62.51
1986	52.87	5.51	58.38
1987	56.86	3.37	60.23
1988	68.37	3.76	72.12

#### 4. The traditional rainfed sector

- There are predominant production systems in 12 of the country's 18 states.
- This sector accounts for nearly 55 percent of the cultivated area and contributes around 85, 90, 52, 90,

and 60 percent, respectively, of millet, groundnut, sesame, gum arabic, and livestock national production.

- It is based on inter-related cropping and animal husbandry systems.
- It is highly affected by climate change, and farming is performed under risky environmental conditions.
- It features small holding size and entirely manual farming operations with little or no external inputs.
- Farmers have limited resources and poor access to market, credit, and improved production technologies.
- It is characterized by weak agro-industrial development and low agricultural output.

The table below shows the gap in agricultural productivity in Sudan on the one hand and in Egypt and South Africa on the other hand. The gap has been widening over the years.

#### *Challenges and constraints:*

- Ecological: Climatic change and variability, low soil fertility, and limited access to water.
- Biotic: Poor genetic stock, use of traditional livestock and crop husbandry practices, nutritional deficiencies, high cost of animal feeds, diseases, and pest infestation.
- Socio-economic: Poor infrastructure marketing, unavailability of inputs, conflicts among groups, and absence of producers' cooperatives.
- Institutional: Research, advisory, credit livestock and crops marketing, and veterinary services.
- Policies: Credit, subsidies, pricing incentive, marketing, value chain, processing of feeds, export of by-products, and insufficiency of funds allocated.

*Table 5. Loss in livestock productivity under traditional systems (%)*

Parameter	Desert Sheep	Nubian Goats
Breeding age	30.00%	30.00%
Offspring per lifetime	50.00%	28.60%
Calving/lambing/kidding rate (%)	36.00%	31.00%
Pre-weaning mortality rate (%)	43.00%	9.00%
Adult mortality rate (%)	15.00%	12.00%
Milk yield (liter)	-	72.00%
Milking period	-	50.00%



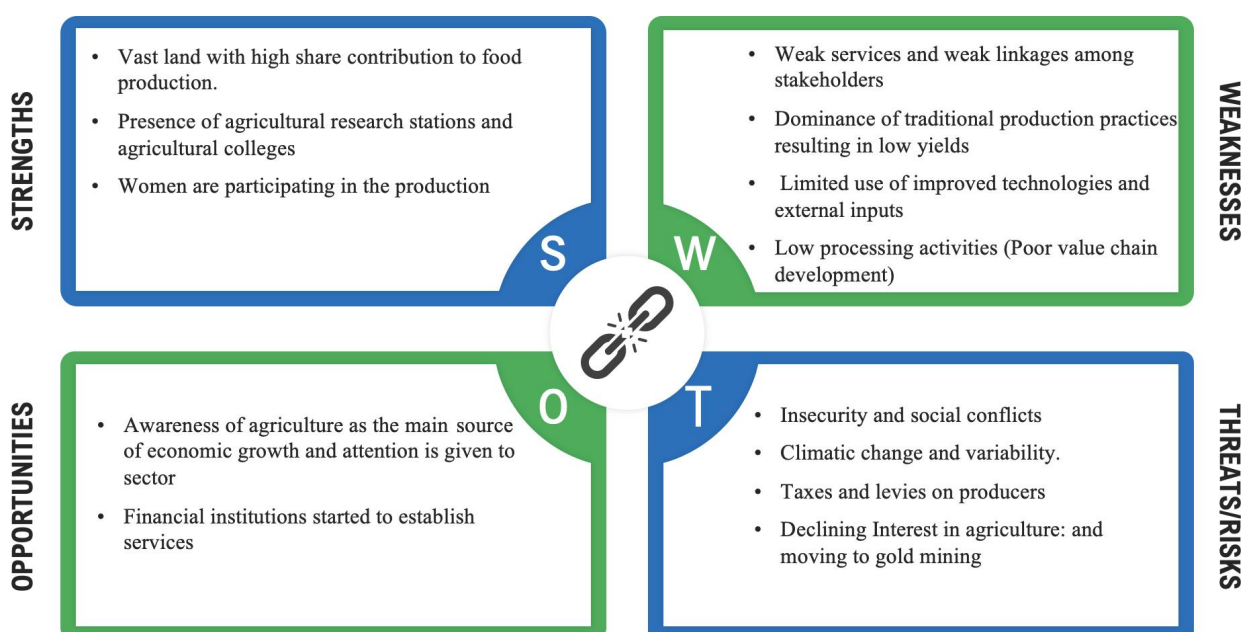
*Table 5. Average yields of the main food and cash crops by sector compared to some regional, international, and national research standards*

Country/Location	Sorghum (ton/ha)	Wheat (ton/ha)	Millet (ton/ha)	Groundnut (ton/ha)	Sesame (ton/ha)
World	1.57	2.6	0.79	2.60	0.52
Africa	0.87	0.85	0.67	0.96	0.42
USA	3.31	2.7	-	4.59	-
India	0.97	2.6	0.96	1.34	0.41
Sudan (National)	0.65	2.36	0.47	0.90	0.28
Sudan (Traditional)	0.59	-	0.37	0.95	0.27
Sudan (Mechanized)	0.41	-	0.47	-	0.30
Sudan (Irrigated)	2.16	2.40	0.81	2.82	-
Research yield (traditional)	1.29	-	0.83	1.42	0.43
Research (Mechanized - Blue Nile)	1.40	-	-	-	0.88
Research yield (irrigated)	3.57	2.6	-	4.14	-
Some global recorded high yields	6.0	3.30	1.26	6.39	0.96

*Key recommendations:*

- Support access to financial services.
- Establish private input supply at the village level.
- Enable access to high-yielding disease- and drought-tolerant varieties and climate-smart practices.
- Open traditional migratory routes all year with water points.
- Develop rural services (education, health, and vaccinations).
- Develop seed programs, seed supply, and regulations.
- Establish producers' and agro-dealers' organizations.
- Conduct training, capacity building, and knowledge dissemination.
- Enforce strict input market regulation.
- Provide farmers with crop insurance.

*Figure 5. SWOT analysis of traditional rainfed farming*



### 5. Sudan's gum arabic sector

Sudan is the world's largest producer of gum arabic, providing around 80 percent of international gum production and exporting an average of 25 thousand tons annually.

The gum arabic belt extends over four main regions, and producers involved in gum arabic activities are estimated at around six million.

The share of Kordofan, Darfur, and the Eastern and Central regions in national gum production is 50, 18, 16, and 16 percent, respectively.

The gum arabic belt features widespread traditional farming, extended areas of mechanized and irrigated agriculture, the bulk of national livestock herd, and vast grazing lands.

#### Key recommendations:

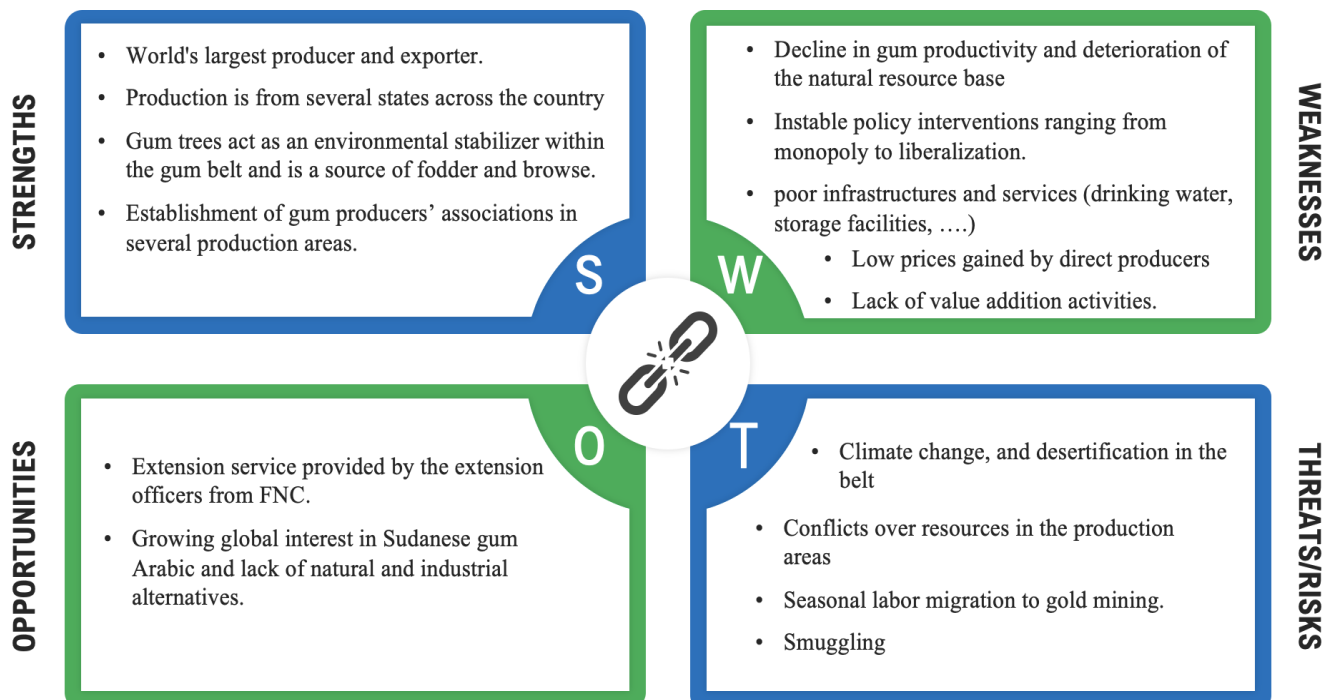
- Improve infrastructure and services.
- Improve the availability of clean drinking water.
- Encourage the development of intermediate technologies to design suitable tools for gum arabic production.

Figure 6



- Rehabilitate the Hashab forests.
- Provide suitable extension services (i.e., improved technology transfer and reforestation).
- Promote gum research and support relevant research institutions.
- Support climate change adaptation and resilience.
- Resolve conflicts on land tenure systems and resource users between different stakeholders.
- Enable and encourage local gum processing and manufacturing.
- Set and execute prompt marketing strategies.

Figure 7. SWOT analysis of gum arabic sector in Sudan





## 6. Semi-mechanized rainfed farming (SMRF)

- Covers an area of around 10 million hectares and extends across six states.
- Rainfall is between 400 and 800 mm in heavy clay soils.
- Farms are large to medium (about 200-400 hectares).
- Use of machinery in land preparation and threshing and dependence on seasonal labor.
- Accounts for around 65 percent and 53 percent of the sorghum and sesame national production, respectively.

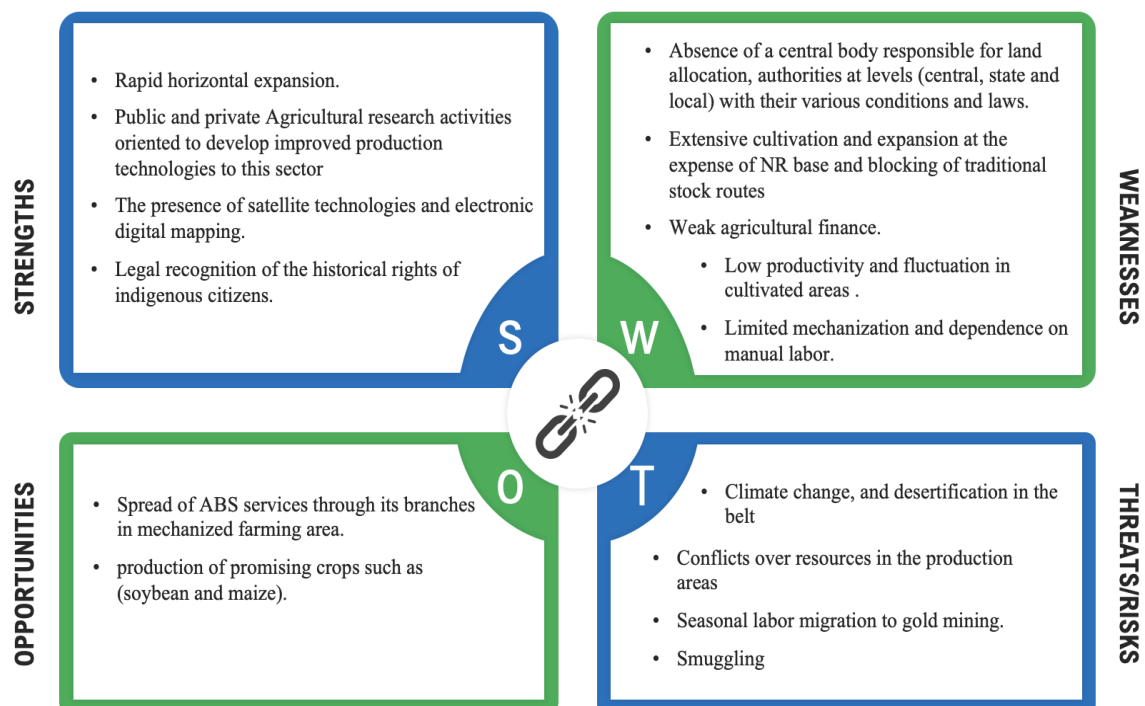
### Current status:

- Sudan does not currently have a law on land use planning for guiding land allocations.
- Extremely low yields due to diseconomies of scale (rising cost of production per ton of product due to the increasing management and supervision costs of large farms and the lack of good roads).
- Loss of traditional grazing lands and livestock movement routes, loss of water supplies, poor productivity, and reduction of herd sizes due to a shortage of good quality pasture.
- Large areas of forest and rangeland have been destroyed through the encroachment and expansion of mechanized farming.

Table 6. Perceptions of the community about the different benefits achieved by the association (%)

Reasonable Prices	Protection of Farmers	Water & Other Services	Collective Marketing	Access to Credit	Extension Services	Production of Seedlings	Village
Um Gzera	5.8	3.8	1.9	3.8	1.9	5.8	3.8
Merhbiba	17.3	17.3	23.1	9.6	15.4	11.5	19.2
Um Siriha	25	23.1	32.7	19.2	26.9	28.8	30.8
Um Elshik	15.4	17.3	21.2	13.7	11.5	11.5	17.3
Suntshrg	1.9	3.8	1.9	-	3.8	1.9	3.8
SuntGrb	1.9	3.8	1.9	1.9	1.9	-	3.8
Total	67.3	69.2	82.7	48.1	61.5	59.6	78.8

Figure 8. SWOT analysis of mechanized farming



**Immediate actions:**

1. Institute arrangement for reform.
2. Establish a technology transfer system.
3. Introduction of modern machinery and technology for sustainable impact adoption of innovative “Zero tillage” farming. Different rotations would be applied for different agro-ecological zones.
4. Fodder production encouraged where appropriate to the farming system.
5. Gum Arabic on 10% of the area would be a feature in suitable areas for the crop.
6. Development of viable inter-relationship between rainfed farmers and livestock producers would be a priority for extension.
7. Immediate reform of the methodology for collecting zakat. VAT should be abolished on provision of agricultural services. A study should be carried out to outline a framework for successful marketing.
8. A study should be carried out to recommend necessary reforms.
9. A study was recommended to come up with detailed recommendations.
10. A rationalization strategy needs to be made to revitalize the public sector mechanized enterprises.

**Medium- and long-term actions:**

1. Agricultural financing with strict lending criteria using technology and financial planning methods.
2. Recapitalization matching grants.
3. Revitalization of research by establishing three research stations would be established one in each major agro-ecological zone.
4. Import requirements of agricultural chemicals, seeds and machinery should be rationalized by federal government.
5. Gum Arabic marketing should be liberalized.
6. Contract farming should be encouraged.
7. Prioritize investment in infrastructure.

**7. Semi-mechanized rainfed farming (SMRF)**

Based on the irrigation water source, method and holding size can be divided into the below, mainly along the Nile and its tributaries:

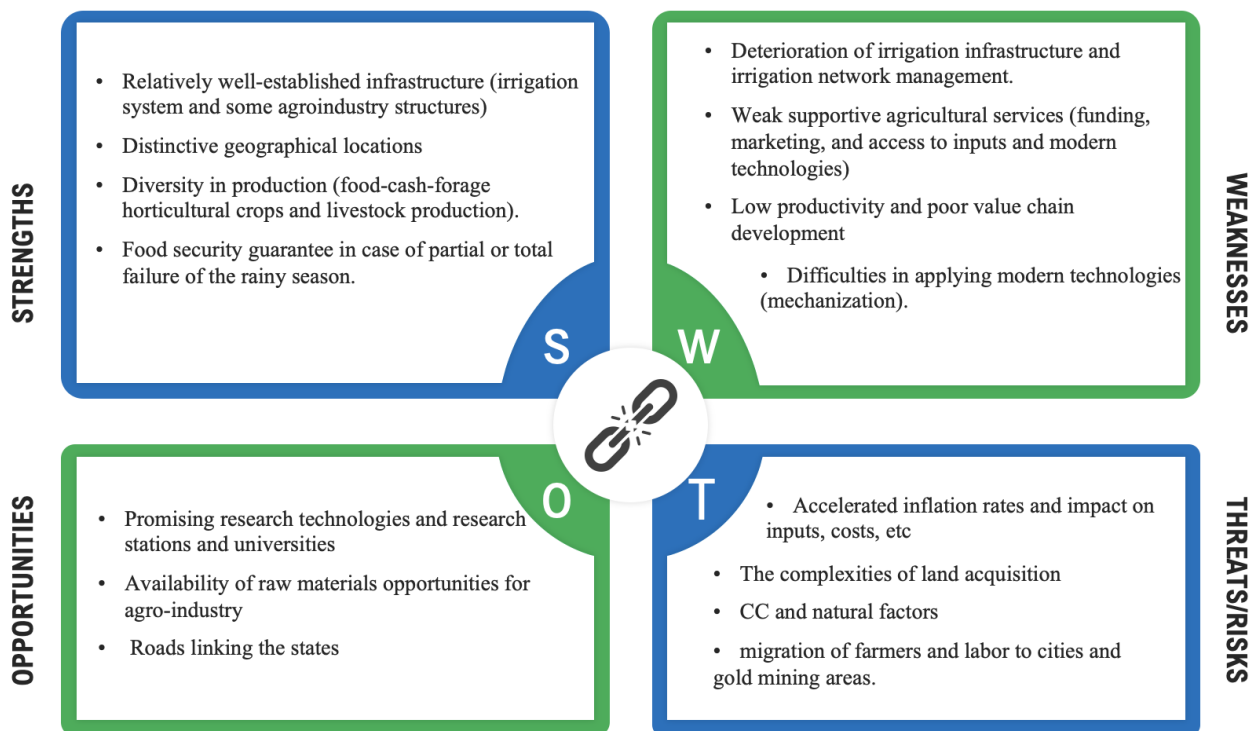
- Public production schemes using gravity irrigation (Gezira, Rahad, Halfa, and Suki).
- Pump schemes: Private and public as well as large and small (scattered in the White Nile and the Blue Nile).
- Flood irrigated schemes: the Abu-Habil, Tokar, and Gash deltas rely on seasonal streams.
- Small-scale along the riverain lands of the Northern and Nile States (horticulturally based).
- Large-scale investment farming extends to the Northern states, using pivot irrigation mostly from Nubian aquifer. Land deals and acquisitions are characterized by purchases and/or long-term leasing by local or foreign private investors.

**Current status and constraints:**

- Deteriorating operation and management (O&M) conditions due to underfunding of O&M activities and loss of technical and institutional capacity.
- Minor canals are heavily silted and in need of cleaning to enable effective and efficient water distribution.
- System operation suffers from insufficient staff, inadequate and inaccurate measurement, and poor communications.
- Loss of irrigated lands due to degraded infrastructure and change in farming systems.
- Extremely low extension staff to farmers ratio.
- The wide-level disc used in land preparation changed the farms or tenancies into bowl-shaped fields with deep centers suffering from excessive watering and shallow peripheries suffering from water stress.
- High sedimentation loads leading to rising maintenance costs and the increasing siltation of canals.
- Aging farming population and growing dependence on sharecropping arrangements.
- Current land tenure arrangements are not conducive to the aggregation of farms for contract farming.
- Holdings are generally too small to provide income for the family, so there are many part-time farmers with outside jobs.
- Farmers’ unions are ineffective and are now in transition to commodity-based producer associations.



Figure 9. SWOT analysis of the irrigated sector

**Key points for modernization:**

1. GIS data to be developed.
2. Status quo assessment through a rapid appraisal procedure.
3. Irrigation scheme hydraulic simulation.
4. Land tenure.
5. Institutional and management structure.
6. Technical aspects for canal modelling.
7. Cropping pattern and future production model.

**Modernization of Gezira:**

1. Limited to one fourth of scheme in the first phase and then later replicated. This consists of 200000ha.
2. Off-farm costs US \$400 million.
3. On-farm costs US\$100 million.
4. Central pivot development US\$600 million.
5. Gum Arabic on 10% of the area would be a feature in suitable areas for the crop.
6. O&M 5% of investment costs plus 1% for desilting
7. EIRR 32% estimated.

**Modernization of Rahad and New Halfa:**

1. For the Rahad Project the modernization area is 126000 ha. Preliminary on and off farm costs are US\$250 million plus US\$380 million for pivot development. EIRR is 32%.
2. For New Halfa the modernization area is 126000 ha. The preliminary on and off farm costs are US\$328million plus US\$380million for pivot development. EIRR is 37%.

### Part III - Transforming Sudanese agriculture: Institutions and empowerment

#### 8. Establishment of agricultural commodity development councils

Proposed commodity councils include cotton, livestock, skins and hides, milk, fish, wildlife, wheat, cereals, sugar cane, oilseed, gum arabic, fruits and vegetables, local manufacturing of inputs, and women and youth. Some of the advantages of this approach include:

- Provides a forum for all stakeholders in the commodity supply chain and supports the process of reaching a common understanding of strategies and requirements for development.
- Ensures the sustainable production of the commodity because it strengthens all the components of the commodity chain (research, production, processing, marketing, and export).
- Provides a quick and easy way to monitor the process of achieving the objectives of development.
- Helps maintain quality standards and upgrade the technical and business skills of producers by focusing on the commodity.

Proposed TOR of the councils:

- Analyzing the present situation of each commodity with respect to production, consumption, and domestic and export trade.
- Identifying strengths, weaknesses, opportunities, and challenges.
- Exploring opportunities for growth to meet domestic and international demand.
- Recommending a package of incentives and policy reforms to support commodity development

programmers to fulfill the following objectives:

- Increase productive efficiency.
- Emphasize the rational use of resources.
- Promote fair competition and eliminate monopolistic practices.
- Strengthening agricultural support services, including applied research, credit for producers, and the adoption of a quality control system.
- Increasing the share of Sudan in the markets of the traditional trading partners and accessing new markets.
- Prioritizing commodities that promote interdependence between the different parts of the country.
- The development of some commodities induces socio-economic development in a wide geographical area.
- Creating a forum for all stakeholders in the commodity supply chain improves cooperation and helps reach a common understanding of strategies and requirements for development.
- This approach ensures the sustainable production of the commodity because it strengthens all the components of the commodity chain (research, production, processing, marketing, and export). The focus on the commodity helps maintain quality standards and upgrade the technical and business skills of the producers.

**The Ministry of Finance and Planning and the relevant ministries should initiate the establishment of these councils in consultation with stakeholders. The government has a key role at the start-up stage in terms of financial and technical assistance.**

Table 7. General guidelines for operating the councils

Commodity	Topic/ Intervention Area	Commodity	Topic/ Intervention Area	Commodity	Topic/ Intervention Area
Cotton	Promoting Cotton Textile Industry	Milk	Milk and Milk Products	Wheat	Wheat
Livestock	livestock and Red Meat	Fish	Fish and aquatic species	Cereals	Sorghum, Millet; Maize, Rice
Skins and Hides	Processing of skins and hides	Wildlife	Wildlife and natural habitat	Sugar cane	Sugar cane
Oilseed crops	Vegetable Oils Sesame, Groundnuts, Sunflower, Cotton Seed, Soya Bean	Local Manufacturing of inputs	Local manufacturing of agricultural input	Fruits and Vegetables	Fruits and vegetables
Gum Arabic	Gum Arabic and Forestry products	Women and Youth	Women and Youth	Strengthening producer Organizations	Strengthening producer Organizations



### 9. Overview of Sudan’s National Agricultural Research System (NARS)

Sudan’s National Agricultural Research System (NARS) structure includes several research institutions. The Agricultural Research Corporation (ARC) and the Animal Resource Research Corporation (ARRC) are the main agricultural research agencies, representing the bulk of the country’s total agricultural research spending and staff numbers.

Other NARS institutions include the faculties of agriculture and natural resources, forestry, veterinary medicine, and animal production, as well as Kenana Sugarcane Company (KSC) and the Hydrology Research Station.

The analysis of the current situation and the comprehensive recommendations for improvements are summarized below:

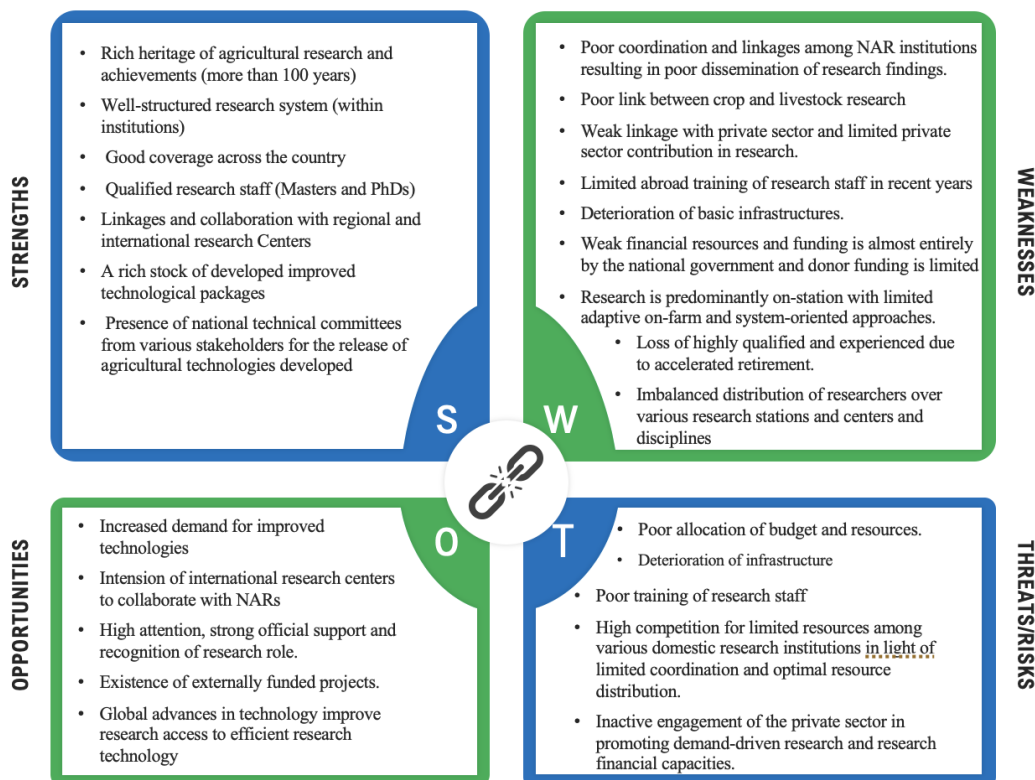
- The system involves the use of both agricultural machinery and labor.
- The central government, the State’s ministries of agriculture, and traditional local authorities are all engaged in the allocation and management of land.
- The sector suffers from extremely low yields. Smaller farmers get slightly better yields than larger farmers and the largest farms appear to be the least efficient.
- The effects on pastoralists have been harmful.

Table 8.

Research executing institutions	Main features
Agricultural Research Corporation (ARC)	(ARC) is the principal research organization in the Sudan, responsible of conducting most of the applied research in the different fields of agriculture. It has a network of 27 research stations, 14 specialized institutes and centers distributed throughout the 18 states in the country
Animal Resources Research Corporation (ARRC)	(ARRC) consists of the Central Veterinary Research Laboratory, the Animal Production Research Centre, the Fisheries Research Centre, the Wildlife Research Centre, and a network of 22 regional veterinary laboratories and animal production research stations.
National Food Research Centre (NFRC)	(NFRC)consists of nine research departments: Animal Products, Canning technology, Food chemistry and nutrition, Food safety and biotechnology, Cereal technology, Oilseed’s technology, Post-harvest Physiology, Food dehydration technology and economics and marketing.
National Centre for Research (NCR)	NRC consists of nine institutes. Three of them related to Agricultural Research i.e.: Medicinal, Aromatic Plants & Traditional Medicine Research Institute, Environment, Natural Resources and Desertification Research Institute and Commission for biotechnology& Genetic Engineering.

- There are large areas of forest and rangeland that have been destroyed through encroachment and the expansion of mechanized farming.

Figure 10. NARS SWOT analysis



**In summary, the SMRF farming sector is in serious disarray, with major associated public and private costs and negative implications for all stakeholders.**

The main contributing factors to the current situation include:

- The government's policies did not support increases in productivity per unit of cultivated land.
- The laws that have been present since colonial periods have reduced the rights of traditional users of the land.
- There has been poor sectoral management over a long period.
- Farmers have extremely low levels of investments.
- Limited financing by the Agricultural Bank of Sudan and other commercial banks.
- Poor marketing and a lack liquidity and absorptive capacity in the markets.
- Poor rural roads with no all-weather access.
- The imposition of various levies and charges.

The Strategy for Land Use should be built on a combination of technology promotion, applied research, targeted financing, and institutional reform.

*Table 9. Recommendations for action: Immediate actions*

Domain	Recommended Action
Institution Arrangement for Reform	A Transitional Facilitation Commission for Rain-fed Farming Reform (TFC-RFR) should be formed.
Institution Arrangement for Reform	The National Land Commission (NLC) proposed as part of the Comprehensive Peace Agreement (CPA) should be made fully operational without delay.
Establish a Technology Transfer System	Resolving A Technology Transfer System would be established as soon as possible. 30 demonstration farms would be established on existing operating semi-mechanized farms. Rainfed Farming Extension Department Team (RFEDT) would be provided by a contractor to support implementation.
Technology	The central feature would be moisture management.
Zakat Reform	Introduction of modern machinery and technology for sustainable impact.
Taxation	There should be an immediate reform of the methodology for collecting zakat.
Marketing	VAT should be abolished on provision of agricultural services.
Agricultural Finance	A study should be carried out to outline a framework for successful marketing.
Investment in Infrastructure	A study should be carried out to recommend necessary reforms.
Large Farms	A study was recommended to come up with detailed recommendations.
	A rationalization strategy needs to be made to revitalize the public sector mechanized enterprises.

*Recommendations for action: Medium- and long-term actions*

- Agricultural financing (loan finance).
- Recapitalization of matching grants.
- Revitalization of research.
- Improvement of marketing.
- Investment in infrastructure.

## 10. Seed industry in Sudan

The seed systems in Sudan can be divided into informal and formal systems. The main stakeholders involved in the seed industry are the Ministry of Agriculture, the National Seed Council, the Agricultural Research Corporation, the Variety Release Committee, the Seed Administration (SA), private seed producers, and farming communities.

In the informal system, the seed production-distribution chain is community-based without any regulations, while the formal system is guided by a regulatory framework.

*Table 10.*

Characteristic	Informal System	Formal System
General Description	<ul style="list-style-type: none"> <li>• Also known as farmer, local, traditional</li> <li>• Community based</li> <li>• Farmers save from their own harvest, donation from friends, neighbors and relatives, or buying from local grain markets or traders.</li> </ul>	<ul style="list-style-type: none"> <li>• Introduced or developed by plant breeding,</li> <li>• Release of varieties and the subsequent multiplication and dissemination of the released varieties</li> </ul>
Type of Varieties and Crops	<ul style="list-style-type: none"> <li>• Local landraces or mixed populations</li> <li>• Food and subsistence crops</li> </ul>	<ul style="list-style-type: none"> <li>• Improved varieties, released through research</li> <li>• Imported and hybrid Varieties</li> <li>• Major food and cash crops</li> </ul>
Seed Quality	<ul style="list-style-type: none"> <li>• Variable quality (variation in purity, physical and physiological quality).</li> </ul>	<ul style="list-style-type: none"> <li>• Standard / quality declared governed by regulations intended to maintain varietal identity and purity.</li> </ul>
Seed Production-Distribution	<ul style="list-style-type: none"> <li>• The seed production-distribution chain is community based, short and simple, without any regulations.</li> </ul>	<ul style="list-style-type: none"> <li>• Guided by a regulatory framework,</li> <li>• Improved seed produced in organized chain of institutions of seed production, quality control; and</li> <li>• Marketed through officially recognized outlets</li> </ul>



The formal sector supplies certified improved and imported hybrid varieties. The average estimated national coverage of certified seeds is only around 12 percent. The formal seed system in Sudan is led by the private sector following government policy changes toward the privatization of seed production activities.

**Constraints facing the SA include:**

- Lack of transport facilities necessary for field inspection; inspectors rely on companies and common transport.
- Inability to allocate enough resources for the SA to fulfill its mandate of quality assurance and control.
- Shortage of well-trained staff; most of the staff and members are new graduates with inadequate experience and training.
- The role of private investment in the seed industry is very small due to several factors:
- The production of improved high-quality seeds is faced with higher production risks and needs compared to normal commercial crop production.
- The rate of returns from investment in seed production is generally lower than the rate of returns from other industries. Therefore, the seed industry receives fewer investment funds.
- Seed production involves a set of technical steps that are tightly linked together. The failure of any of these steps would lead to total crop failure and/or rejection of the produced seeds. Hence, there is more risk and loss of investment money.

The table below outlines the fundamental elements of seed security: seed must be available; farmers must have the means to access it, and the seed quality must be sufficient to promote good production (FAO, 2012).

**Key steps to accelerate the use and demand for improved varieties:**

1. Educational awareness campaigns and increased promotional activities by community seed producers to stimulate the demand for improved varieties.

*Figure 11. SWOT analysis of the seed sector*

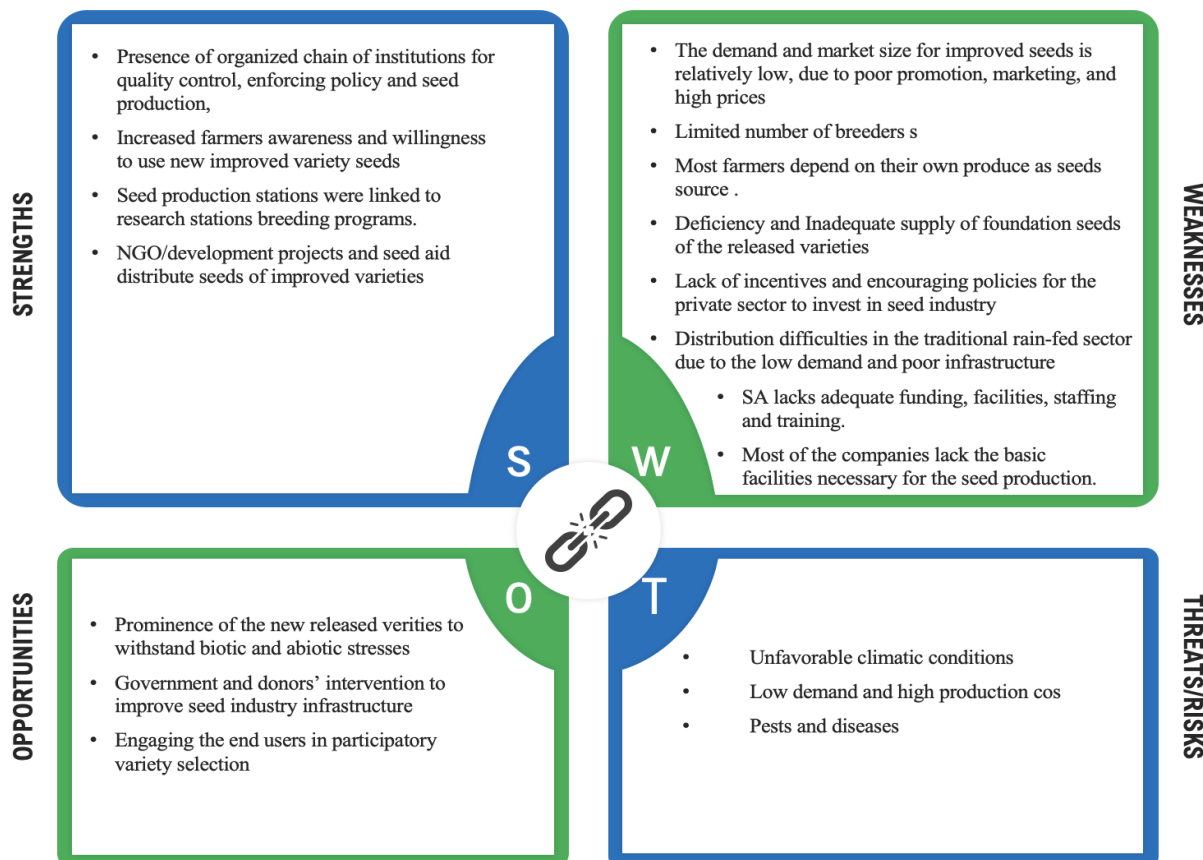


Table 11.

Fundamental Element of seed Security	Seed Security	Key Intervention to Promote
Availability	Sufficient quantity of seed of appropriate crops is available within reasonable proximity and in time for planting.	<ul style="list-style-type: none"> <li>• Support establishment of seed supply at village level.</li> <li>• Linkages with the (Research -Federal Seed Administration- Financial Institutions and extension).</li> <li>• Develop formal community-based seed multiplication.</li> <li>• Improved varieties pilot demonstration plots (innovation platforms) in farmers' fields.</li> </ul>
Access	People have adequate income or other resources to purchase or barter for seed	<ul style="list-style-type: none"> <li>• Local seed procurement</li> <li>• Demand in bulk through farmers organization groups/ association- collective action to secure seed supply</li> <li>• Support access to financial services through organizing farmers in groups/associations and expansion of microfinance services</li> </ul>
Quality	Seed is of acceptable quality: 'healthy' (physiological, analytical, and sanitary) adapted and farmer-acceptable varieties.	<ul style="list-style-type: none"> <li>• Efficient extension services/ awareness campaigns</li> <li>• Seed quality control and compliance with seed certification regulation</li> </ul>

2. Access to credit is vital to the development of seed enterprises for the purchase of inputs.
3. Development of partnerships and linkages with other service providers.
4. Development and promotion of the seed production market for smallholders.
5. Supporting the development of seed regulations, laws, guidelines, and protocols for quality seed production.
6. Foundation seed multiplication and processing.

### 11. Strengthening farmers' cooperatives and producers' organizations

The traditional rainfed production system, which is scattered throughout the country, is characterized by disorganization and the absence of collective actions. In fact, no communities were organized into community-based organizations (CBOs), community development committees (CDCs), or societies to meet agricultural development demand and challenges, except for those associated with some developmental projects devoted by international interest to form CBOs/CDCs.

Moreover, Bushara (2012) notes that lacking CBOs in the rainfed sector placed the following challenges and implications on the path of rural development:

- Communities, individuals, and poor families have no voices or power as long as they are unorganized in making decisions in their favor throughout the production cycle.
- The creation and existence of middlemen affect the market prices, which reduces farmers' benefits.
- Limited or no access to external inputs, market,

credit, financial resources, and improved production technologies.

Unbalanced gender roles are always associated with unorganized communities, as there are no opportunities for organized meetings, contacts, training, and decision-making. Organizations offer opportunities for women's participation and create women leaders. Adding to this, gender balance is ensured and confirmed in the existence of gender policies, especially when supported by the external donors' fund.

Hence, interventions to organize communities become crucial in facing all the above challenges (Bushara, 2012).

#### Roles of the revitalized cooperatives and CBOs:

- Finding potentially useful ways of providing bundles of services to farmers, thereby connecting them with input and output markets.
- Creating economies of scale; farmers can aggregate crops and sell in bulk to an exporter or a processor and demand a higher price. They also give farmers credit to allow them to purchase farm inputs.
- Farmers could also collectively hire trucks to collect their produce at harvest time, rent a warehouse, and pay for extension services, information, and technology services to determine prices and demand elsewhere...etc.

A case study of groundnut farmers in the Enahud district, West Kordofan, showed that cooperative members had higher incomes than non-members, strongly supporting the use of cooperatives as a means for agricultural development.





The good performance of CBOs in seed production and their ability to disseminate improved seeds to the farming communities qualified them for further support and upscaling. The success of upscaling depends on the following prerequisites:

- Creating an enabling environment for the private sector, including CBOs, to ensure the sustainability of the production of improved seeds.
- Improving the regulatory framework through the enforcement of the Seed Act and capacitating and empowering the National Seed Administration to carry out its seed quality regulatory functions effectively.
- Increasing the supply of good quality and appropriate varieties of seeds of all classes of crops and ensuring their timely delivery to end users.
- Developing a sustained marketing outlet by enhancing the effective demand for certified seed by farmers using microcredit facilities.
- Building the capacities of agricultural research workers to produce new high-yielding varieties and motivating the extension departments in the localities to deliver the required training and ensure that farmers carry out the full production package.

The ingredients of success for these cooperatives were:

- The selection of beneficiary cooperatives was based on their track record.
- The producers' cooperatives improved the bargaining power of producers in negotiating with the MOFNE to reduce taxes and levies.
- The cooperatives provided collateral for each member borrowing from the project fund.
- The grant provided by the project enabled cooperatives to keep their produce in stores until prices improved later in the season.
- The grant was to be used by the cooperatives as a revolving fund for financing members in subsequent seasons.

**Prescription for strengthening and upscaling farmers' cooperatives:**

- Ensure the organization of every cooperative according to the classic principles of cooperatives.
- Inject new skills by training cooperative committee leaders.
- Provide technical training for leaders and members of the cooperative.
- Improve the availability and accessibility of microfinance.
- Provide effective guidance by the concerned government departments to ensure cooperatives' good performance.

## **Part V - Transforming Sudanese agriculture: Investing in agricultural supply**

### *12. Promoting fertilizer use to increase productivity, stimulate pro-poor growth, and enhance environmental sustainability*

Measured by the average consumption per hectare, Sudan's use of fertilizer falls much lower than that of other countries in the region. For example, the World Bank Development Indicators show that the average annual use of fertilizer of all types in kilograms per hectare during 2007-10 was 18.6 in Ethiopia, 33 in Kenya, and 161 in India, compared to 6.7 in Sudan.

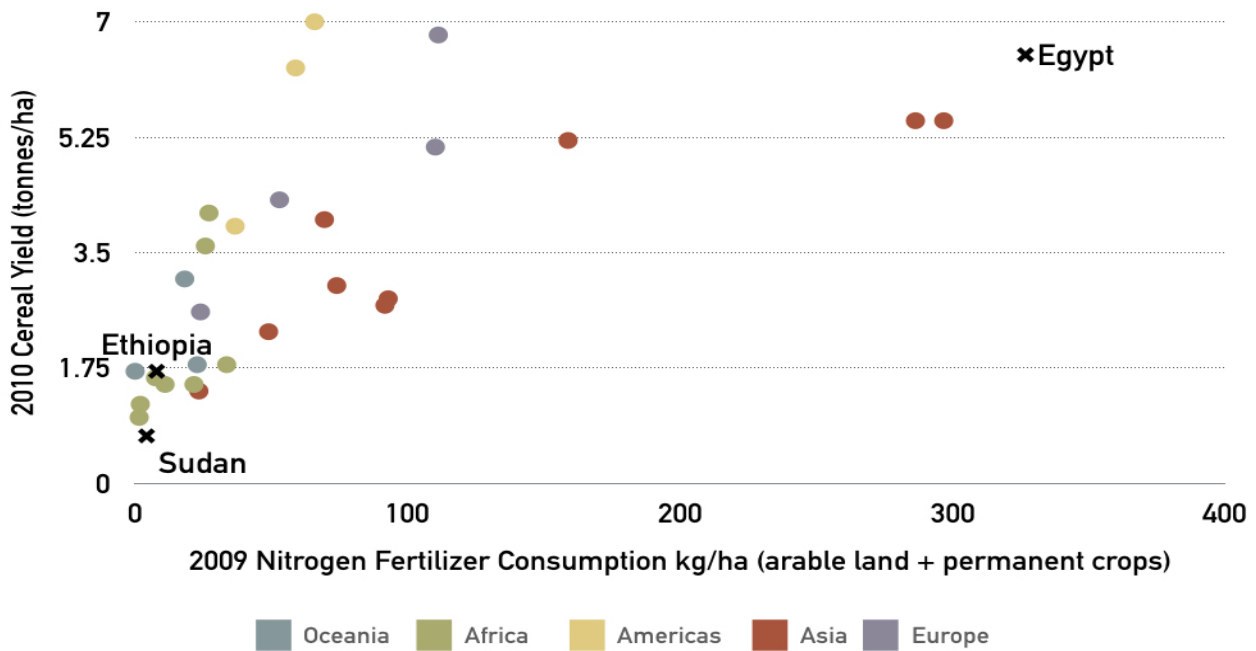
The low use of fertilizer is due to demand as well as supply factors. Demand for fertilizer is often weak in Sudan because incentives to use fertilizer are undermined by the low level and high variability of crop yields on the one hand and the high fertilizer prices relative to crop prices on the other hand. The demand-depressing effects of unfavorable price incentives are aggravated by many other factors, including the general lack of market information about the availability and cost of fertilizer, the inability of many farmers to raise the resources needed to purchase fertilizer, and the lack of knowledge on the part of many farmers about fertilizer use efficiency. These constraints on the demand side are accompanied by factors that reduce the timely availability of affordable fertilizer in the market on the supply side.

Sudan's fertilizer consumption was at the level of 8.6 kilograms per hectare in 2018, down from 8.7 kilograms per hectare in 2017, registering a change of 1.05 percent. Increasing input use, such as the rate of fertilizer and pesticide use, can increase farm productivity and thereby increase economic growth.

**Reasons for the low use of fertilizer are due to demand as well as supply factors. Demand for fertilizer is often weak in Sudan because incentives to use fertilizer are undermined by the low level and high variability of crop yields on the one hand and the high fertilizer prices relative to crop prices on the other hand.**



Figure 12. Rates of fertilizer application and agricultural productivity



Some interventions that can be used to strengthen the supply of fertilizer include:

- Reducing fertilizer sourcing costs (ex. by lowering trade barriers, adopting common quality standards, and harmonizing approval processes to increase the size of national and regional markets, which would allow fertilizer importers and eventually manufacturers to capture economies of size and scope).
- Reducing fertilizer distribution costs (ex. improving road infrastructure to reduce high transport costs).
- Procuring fertilizer in bulk (aggregating the needs of most farmers) to entertain economies of scale and get the lowest price possible.
- Prices of fertilizer in the international market are characterized by seasonal variations based on supply and demand. It is recommended to enter the market for procurement when prices are at their lowest

In short, to establish a competitive fertilizer industry, Sudan must meet two criteria:

- A large enough local market
- Abundance of natural gas with very low opportunity cost.

Table 12: Quantities and value of imported fertilizer

Year	Quantity in tons	Value in \$US
2016	289,414	87034.000
2017	234,093	108393000
2018	299,408	98572000
2019	424,157	11867300



### 13. Irrigation systems and renewable energy

Sudan meets approximately 87 percent of its energy needs with biomass, while oil supplies 12 percent. The remaining one percent is produced from hydro and thermal power. The heavy dependence on biomass threatens the health and future of domestic forests, and the large quantities of oil purchased abroad cause Sudan to suffer from serious trade imbalances. A shift to renewable energy would therefore help solve some of these problems while also providing the population with higher-quality energy, which will, in turn, improve living standards and help reduce poverty.

The current and future mix of energy sources in Sudan include network/national grid (poor infrastructure and frequent power outages), solar (high potential for solar energy use), wind (considerable resources), biomass (organic, non-fossil material of biological origins), geothermal (potential geothermal fields identified), and hydropower (annual production of 24,132 GWh). Challenges facing the utilization of renewable energy in Sudan include planning location sites, finance, technology, and integration of renewable power into the main grid.

Solar energy applications can be divided into two main categories: solar thermal applications and photovoltaic technologies (PV). Sudan's average temperature ranges from 28 to 39°C. The average solar insolation in the country is roughly 6.1 kWh/m<sup>2</sup>/day, indicating a high potential for solar energy use. Total potentials over the course of a year have been estimated at 10.1 GJ/m<sup>2</sup>.

Wind energy has considerable resources in Sudan, where the annual average wind speeds exceed five m/s in most parts of the north (latitude 12°N) and along the Nile valley.

Biomass includes solid biomass, biogas, liquid biofuels, and municipal waste.

**The emergence of renewable energy sources, especially solar energy, offers Sudan a great opportunity for modernizing its irrigation systems. Solar-powered pumps present an attractive economically efficient and environmentally-friendly solution.**

Mitigation of key challenges:

- The renewable power plants should be located close to load centers in Khartoum and areas out of national electricity network.
- The government must encourage the private sector to invest in the installation of renewable power.
- Efficient electricity-demand and grid management mechanisms should be established to reduce peak loads and improve grid flexibility, responsiveness, and security of supply to deal with increased systemic variability.
- Technologies and procedures for ensuring proper grid operation stability and control should be introduced (ex. frequency, voltage, power balance) in the presence of a significant share of variable renewables.

### 14. Disruptive technology in agriculture

Disruptive technologies in agriculture consist of digital and technical innovations that enable farmers and agribusiness entrepreneurs to leapfrog current methods to increase their productivity, efficiency, and competitiveness, thereby facilitating access to markets, improving nutritional outcomes, and enhancing resilience to climate change. Agri-tech solutions range from mobile phone apps to solar applications, portable agriculture devices, and bio-fortified foods. Disruptive agricultural technologies differ from other agri-technology solutions in that they empower farmers by accelerating agri-food outcomes threefold to fivefold or by circumventing the conventions of the value chain to achieve the same or better results, but with a more efficient agri-food outcome.

Based on the weakness identified, technology intervention measures to strengthen the agriculture sector in Sudan include: (a) building a national agriculture digital framework and applications to facilitate communication and access to information; (b) introducing the use of improved production practices and advanced technologies; (c) connecting production sites by a wireless network; and (d) establishing a monitoring center to disseminate knowledge and training.

The following is a proposed conceptual framework for a technology roadmap introduction and evolution in the agriculture sector, which must be integrated into a national digital and infrastructure development strategy.



Figure 13. Disruptive technology ecosystem

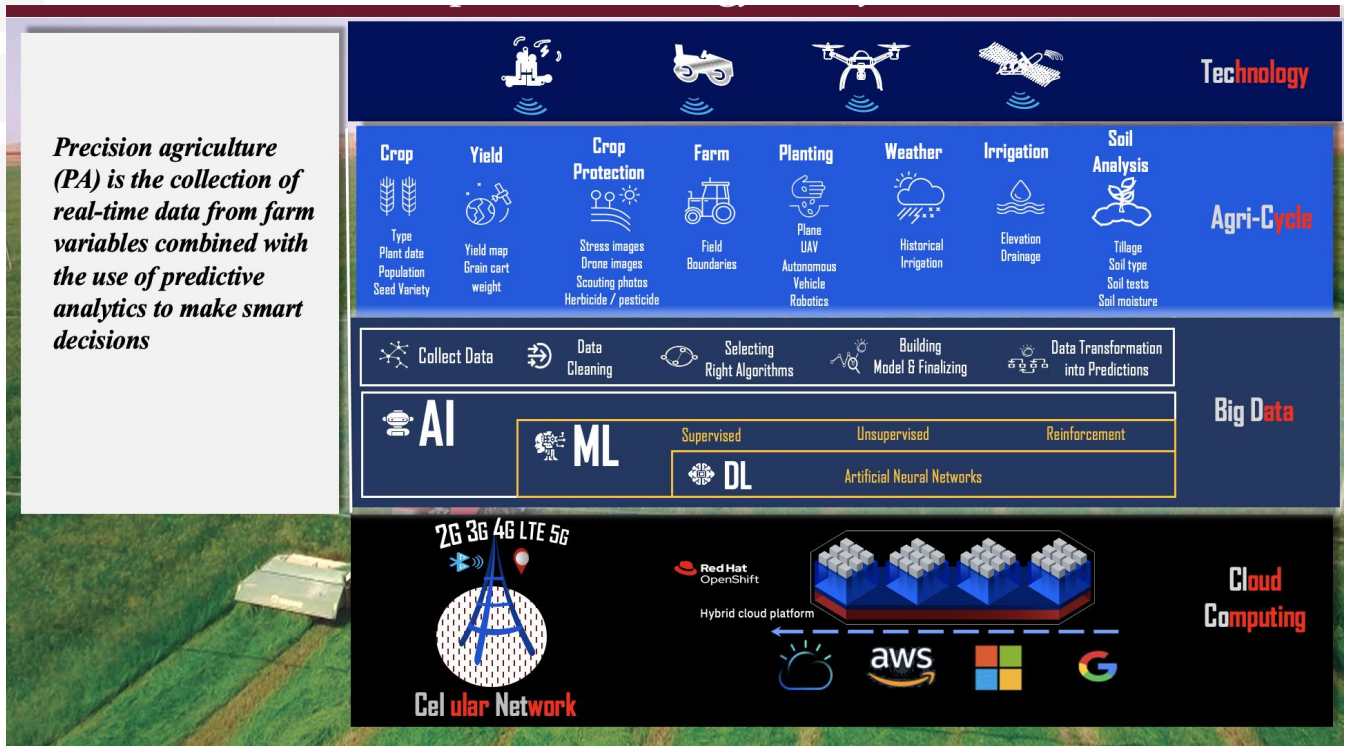
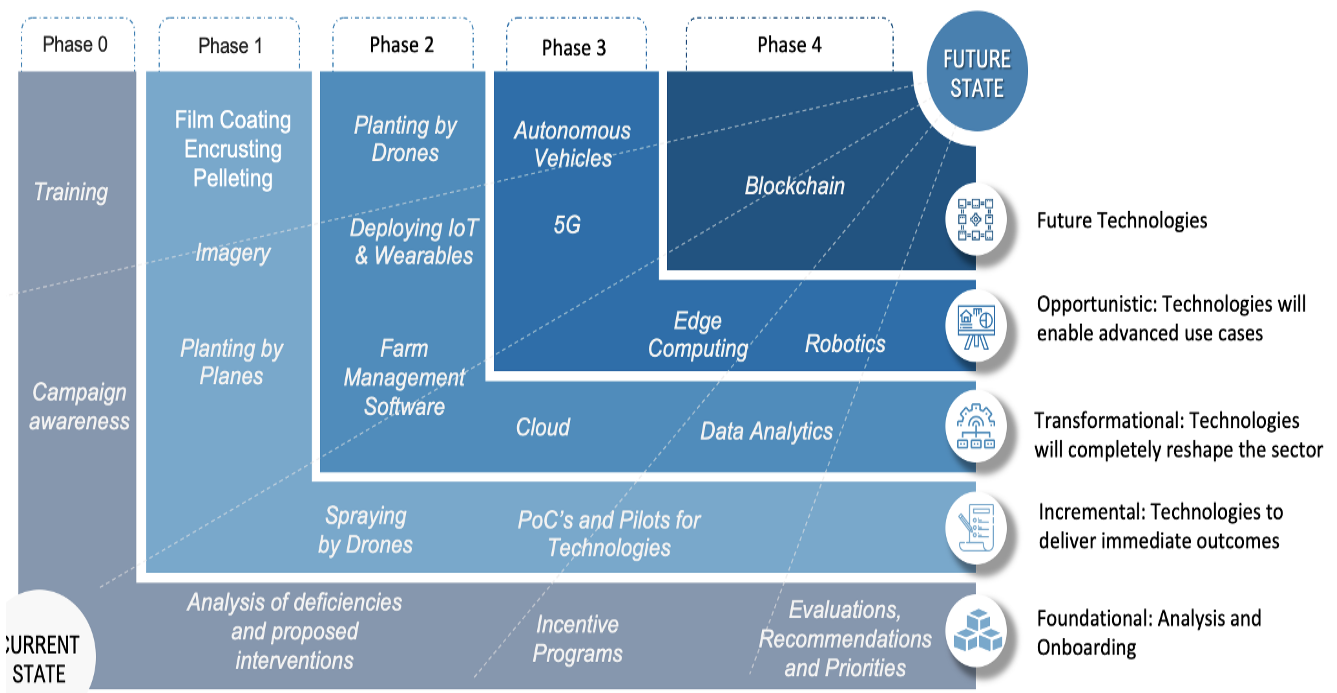


Figure 14



Seed coating is the process of applying materials onto the surface of seeds to ease the planting process and/or apply active compounds that improve seed quality and protect the seed from biotic and abiotic stress.

Hyperspectral imaging can be used to identify soil type, which is crucial for determining the type of crop to be cultivated.

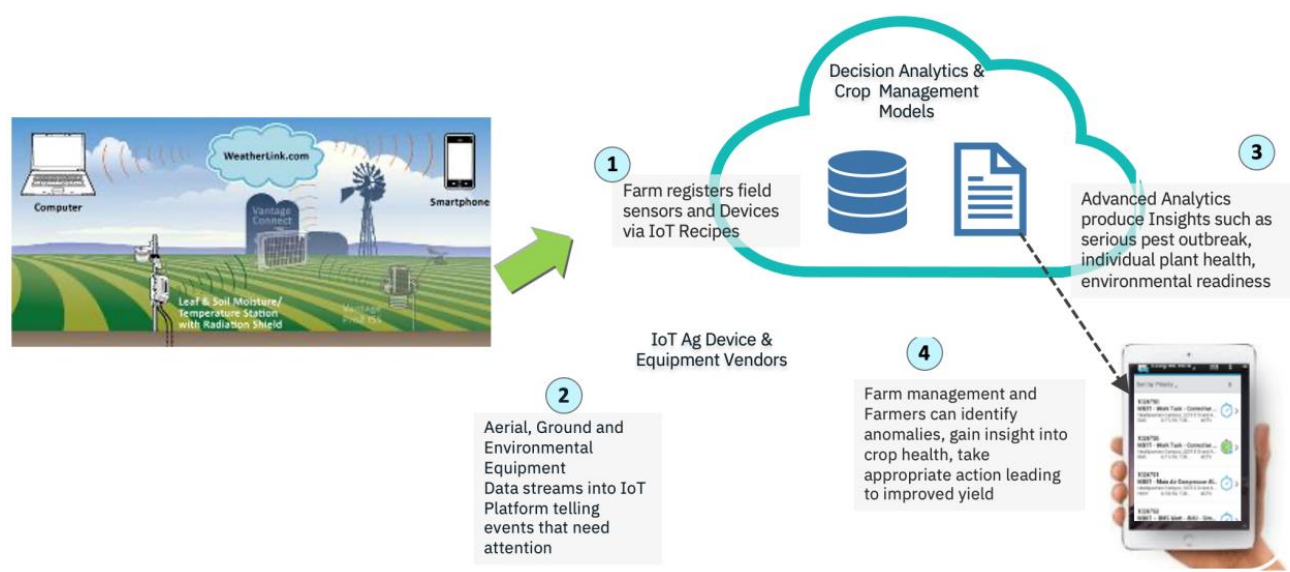
The mobile application enables the user to take images of the plant (live mode) or choose existing images from the gallery (offline mode) and upload them to the cloud backend for analysis.

IoT sensors are another way to collect soil variables and then transmit data to a data hub for analysis and predictions. The sensors can be classified into temperature sensors, humidity sensors, and nano biosensors.

Drones or Unmanned Aerial Vehicles (UAV) are revolutionizing agriculture because of their precision and speed. Drones are widely used for surveying and monitoring soil and crops. Recently, drones were introduced in the deforestation to plant trees and, most recently, in the planting of rice.

**Develop an e-agriculture strategy to be integrated into the overall agriculture sector development strategy. Develop data policies that clarify data privacy, ownership, and sharing rules. Enable telecommunication infrastructure and payment systems in rural and remote areas.**

Figure 15



## Part V - Transforming Sudanese agriculture: Toward a new business model

### 15. Agricultural and agro-industrial growth corridors

The agro-industrial sector in Sudan shares more than two-thirds of the overall industrial output. Principal crops that have been considered promising products for agro-industrial development include cotton, groundnuts, sesame, gum arabic, sorghum, and sugarcane, as well as some horticultural crops such as banana, mango, okra, and grapefruit.

Agro-industrialization constitutes an added value for agricultural products, maximizes the return from agriculture, provides employment opportunities, modernizes life, and strengthens the links between industry and agriculture. Few parts of Sudan offer the infrastructure necessary to support large-scale manufacturing. Small firms can be found everywhere, but larger firms are located primarily in Khartoum. The main agro-based industries include food, oil, sugar, and textile industries.

The proposed growth corridors promote the efficient use of resources by concentrating capital on the area of greatest agricultural potential, eliciting a quick supply response that can generate central loops. This large-scale approach has many advantages, such as:

- Attracting the participation of many investors because risks are pooled.
- Concentration of agri-business allows for economies

Table 13

Merawi-Dongla-Halfa	Khartoum-Shendi-EIDammer	Gezira- Managil	Sennar- Elsuki-Eldinder-Eldamazin	Gedarif-Rahad	New Half-Kassla
Wheat mills	Milling of wheat, millet and sorghum	Textile industries	Sorghum mills	Sorghum milling	Sugar industry
Slaughterhouses	Meat (beef, sheep, poultry, fish)	Wheat and sorghum mills	Ginning and textile factories	vegetable oil (sesame) industry	Wheat milling
Fruit processing	Milk	Vegetable oil mills	Vegetable oil mills	Animal feeds	Vegetable oil processing
Animal feeds industry	Vegetable oils	Fruits and vegetable factories	Animal feeds industries	Ginning and textile factories	Animal feeds factories
Fishery industry development (Lake Nuba).	Agricultural input procuring and or manufacturing	Feeds factories	Feedlots for animal fattening	Feedlots for livestock fattening	Textile industry
	Processing of fruits and vegetables	Feedlots for livestock fattening	Sugar factories		Fruit processing
	Leather industries	Manufacturing of agricultural inputs	-Development and Promotion of tourism in Dinder Reserve		Feedlots for livestock fattening
		Dairy Industry			
		Aquaculture			

Kosti-Eduiem	Enahud-Gobiesh	Elobeid-Umrawaba-Bara-Sodari	Dilling-Kadugli_Elabssya	Nyala-Edien-Zalingi
Textile	Slaughterhouses for export of sheep meet	Production of vegetable oils	Textile industry which is labor intensive and could contribute to poverty reduction	Meat industry
Sugar	Groundnut oil production	Processing of Gum Arabic	Potential for using contract farming models	Leather industry
Feeds factories	Animal feeds	Slaughterhouses for livestock	Vegetable oil processing	Vegetable oil industry
Meat and milk factories	Leather industry			Fruit processing industry
	Gum Arabic processing			Production of honey
				Cereal milling
				Sugar industry

of scale and lowers the cost per unit of production.

- Diffusion of technology takes place more easily.
- Various supportive markets form to serve the area.

We propose 12 corridors' industries scattered across the country based on the strengths of each, bearing in mind the necessity of stimulating growth, poverty reduction, and food security in the different regions of the country.

The main constraints facing growth corridors and the industrial sector development include: A large enough local market

- The high dependency on agricultural inputs and the lack of coordination between the industrial and agricultural sectors at all stages of production.
- The seasonality of the supply of agricultural raw materials.
- Coordination problems between the various public and private actors in the corridor.
- The low levels of technological improvements, obsolete machinery, and shortage of skilled labor force, raw materials, investments, foreign currency, and spare parts availability.
- The high production cost due to power and energy prices.
- The lack of approved technical specifications and quality standards and poor user confidence in the local product.
- Poor training programs targeting producers in the manufacturing field.

- Poor infrastructure and absence of proper economic policies (technology, storage, electricity, financing, duties, taxes, and VAT).
- The sector's activities are limited and concentrated in big towns and certain states.

## 16. Private sector and contractual agriculture

Typically, contractual agriculture is an agreement between a private company and a group of farmers whereby the former are provided with capital inputs, including improved seed varieties, fertilizers, agrochemicals, machinery, and finance. In return, farmers carry out the agricultural operations and pay the company the total cost of production in-kind at an agreed-upon price at the time of signing the contract. Company contractual relations also include link-up to the high value-added markets. Some domestic and foreign private companies (ex. Dal Group, Mahgoub Sons, Chinese) launched contract farming.

Despite the successes that have been achieved from contract farming in production and productivity, this type of farming has faced several problems that require State intervention through legislation and arrangements. The most important problems are:

- Wide variation in contract models between partners (investors and farmers), especially in the prices of



- inputs and produce at the beginning of harvest.
- Lack of enforceability of contracting agreements can result in the breakage of contracts by either party.
- Entry of intermediaries (Warraga/brokers) by offering higher produce prices (ex. for the export of cotton) for the benefit of some foreigners for the purpose of smuggling hard currency.

## Part VI - Toward a strategy for transforming Sudanese agriculture

### 17. Summary and key messages

*Does the unconditional convergence property also extend to the agricultural sector?*

Recent evidence suggests that productivity in manufacturing tends to converge unconditionally regardless of the prevailing institutions or policy environment (Rodrik, 2013).

Against this backdrop, this paper first asks a fundamental question as to what went wrong with the Sudanese agricultural development model. It then probes into the issue of how agriculture could be developed as an industry within a national development plan.

In order to address these two questions, we conduct a preliminary descriptive analysis of the aggregate and sectoral value-addition in the Sudanese economy. We then assess the determinants of conditional convergence of agricultural value-added by estimating an empirical agricultural growth model using global data covering more than 120 countries.

#### *Key findings*

1. Over the last six decades, Sudanese agriculture ranked second to services in terms of contribution to total value addition and then grew by 2.8 percent, which is half the average growth of services. However, it remains home to more than 60 percent of the population, the source of almost all non-oil and mineral exports, and contributed more than half of paid and unpaid family work and more than two-thirds of own-account businesses' work in the sector. The sector is also beset with low productivity and weak linkages to the modern agro-industry.
2. The Sudanese agricultural development model has been lopsided, with virtually all capital stock, agricultural technology, and extension concentrated in the irrigated sub-sector, leaving the vast rainfed agriculture at a near subsistence level of productivity.
3. Agriculture has been subjected to heavy taxation both at the sectoral and macroeconomic policy levels. The sector became the tax base of choice for the predatory practices of cash-poor states that were created under the new federal system in the early 1990s. Perhaps even more damaging to the sector were the macroeconomic policies that produced long episodes of hyperinflation during the early 1990s and, more recently, since the last two years of the former regime, thereby undermining the competitiveness of highly tradable agriculture.
4. Agriculture suffered from the combined impacts of exchange rate overvaluation due to Dutch Disease associated with the oil boom and the lack of commitment by political elites to develop the sector, especially the rainfed subsector. While the irrigated sector remained resilient in terms of crop productivity, harvested areas, and access to high-value markets, the rainfed subsector continued to face significant challenges relating to the decline of crop productivity despite the huge growth of harvested areas and the absence of key inputs and outputs markets. This evidence clearly indicates that the prevailing patterns of land use, particularly in the rainfed subsector, are inconsistent with the long-run goal of sustainable growth in food production in the country and thereby call for deep-seated land reforms.
5. The total factor productivity growth recently turned negative, and the contribution of structural change to the path of catching up through manufacturing has been limited. Moreover, the bulk of employment growth occurred in low-productivity sectors, mainly agriculture and informal services.
6. Evidence confirmed that the agricultural growth process is divergent; however, like other countries, it tends to converge conditionally on the key three stalwarts of productivity: i) policy variables (measured by REER under/overvaluation); ii) infrastructure and input variables (measured by the overall infrastructure index, ICT, transport, and finance); and iii) human capital variables (measured by the Human Development Index and educational attainment).



Table 15: Key messages and recommendations of the SWOT analysis

Domain	Recommendations
Gum Arabic	<ul style="list-style-type: none"> <li>Improving inputs and services delivery centers model and strengthening the capabilities of technology transfer centers</li> <li>Development of technologies to design suitable tools for gum Arabic tapping collection and primary processing</li> <li>Provide extension services: improved technology transfer and reforestation; training on seedling nurseries establishment.</li> <li>Promote gum research and support relevant research institutions.</li> <li>Enable and encourage local processing and manufacturing of gum, to maximize add value to exports.</li> <li>Build the capacity of gum producers on gum drying cleaning, sorting and packing</li> </ul>
Rain-Fed and Irrigated Sectors	<ul style="list-style-type: none"> <li>Transitional Facilitation Commission for Rain-fed Farming Reform (SMRF)</li> <li>Establishment of standardized system of leaseholds for rain-fed farming for investment security.</li> <li>Modernization of the irrigated sector through GIS data to be developed, irrigation scheme hydraulic simulation, land tenure, institutional and management structure, technical aspects for canal modelling, and cropping pattern</li> <li>Establishment of Agricultural Commodities Development Councils Grant Institution System to improve NARS effectiveness</li> <li>Increasing financial resources and sources of funds to agricultural research to carry out its research activities.</li> <li>Research institutions strengthening linkages with national, regional and international organizations.</li> <li>Backing farming system research/extension approach in the traditional rain-fed sector to assure community involvement</li> </ul>
Fertilizers	<ul style="list-style-type: none"> <li>Improving the agricultural resource base so that use of fertilizer can be more profitable</li> <li>Reducing fertilizer sourcing costs, distribution costs, procuring fertilizer in bulk and enter the market at low prices</li> <li>Strengthening business finance and risk management instruments</li> <li>Improving supply chain coordination mechanisms</li> <li>Establishment of a competitive fertilizer industry in the country</li> </ul>
Renewable Energy	<ul style="list-style-type: none"> <li>Introduction and expanding the use of renewable energies, especially solar energy. at a vast scale for modernization of its irrigation systems.</li> </ul>
Technology	<ul style="list-style-type: none"> <li>Building a national agriculture digital framework and applications to facilitate communication and access to information</li> <li>Introduction of spraying, planting and monitoring by tractors and drones</li> <li>Importing of seed coating machines and use of organic materials and nutrients to improve seed germination</li> <li>Increased coverage of mobile network will facilitate communication and access to market information</li> <li>Adoption of smart agriculture technology for planting and harvesting will minimize labor intensive activities</li> </ul>
Growth Corridors	<ul style="list-style-type: none"> <li>Develop agricultural and Agro-Industrial Growth Corridors to promote efficient use of resources by concentrating capital on the area of greatest agricultural potential, eliciting a quick supply response that can generate central loops</li> </ul>
Laws & Infrastructure	<ul style="list-style-type: none"> <li>Creating the appropriate environment (laws, infrastructure):</li> <li>Encouraging investment in the agricultural industries.</li> <li>Develop policies to develop the agricultural value chain with a focus to encourage small industries</li> </ul>
Private Sector	<ul style="list-style-type: none"> <li>Building on the positive private-sector experience in improving productivity, promoting the use of fertilizers and contract farming</li> </ul>

## 18. Policy recommendations

Based on the findings of this paper, a set of interventions are proposed to catalyze the transformation of Sudanese agriculture from a subsistence-oriented, low-output sector to a high-performing sector well integrated into the national economy through:

- Increasing budgetary allocations on agriculture and agro-industries substantially and ending the legacy of excessive direct and indirect taxation of agriculture.
- Fostering a favorable policy environment that addresses all the agricultural transformation interventions and strengthens the role of the private sector in agricultural transformation (PPPs).
- Improving farmers' access to financial resources, inputs, and services (research, extension, credit, and market insurance services, weather forecasts, and climate information).
- Conducting commercial orientation of smallholder agriculture and market development.
- Improving gum arabic infrastructure and services and developing intermediate technologies for tapping, collection, and primary processing.
- Reviving institutions for rainfed agriculture at the State level (related to land tenure, rural infrastructure investment, taxation, marketing, and agricultural finance).
- Rehabilitating and modernizing the irrigation water infrastructure and enhancing the power sectors (renewable energy) as an important vehicle for developing the agricultural sector.
- Mechanizing agricultural operations from planting to harvesting and post-harvest operations.
- Establishing agricultural commodity development councils and ensuring the participation of all the stakeholders, including the producers.
- Establishing a competitive fertilizer industry.
- Building the capacities of the industrial sector to manufacture agricultural inputs (ex. competitive fertilizer industry), satisfying agro-industry with their





requirements of raw materials (industrial crops), and linking the production-processing marketing chain.

- Promoting the efficient use of resources by concentrating capital on the area of greatest agricultural industry potential (agro-industrial growth corridors).
- Resolving conflicts on land and resource users through the support and capacity building of local governance and the demarcation and maintenance of traditional migratory routes provided with services.
- Building the capacities of producers through their institutions, thereby increasing their productive and managerial capacities.
- Introducing a grant institutions system to improve NARS' effectiveness in replacing the fragmented research organizations in the State with a multidisciplinary approach.
- Introducing digital and technical innovations that enable farmers and agri-business entrepreneurs to leapfrog current methods to increase their productivity, efficiency, and competitiveness.



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