



Seed Security Assessment in Sudan



FINAL REPORT

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The SSA in Sudan was sponsored by FAO/Sudan and implemented by FSTS/MoAF. The SSA took place in Northern, North Kordofan, South Darfur, Khartoum, Gezira and Gedarif states of Sudan representing the various farming system.

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THE ASSESSMENT TEAM

This seed security assessment was conducted by a team lead by Mahmoud Hussein Numan, Seed Security Consultant with participation and support from FAO/ HQ and FAO Sudan, FSTS / Ministry of Agriculture and Forestry (MoAF), NSA/ MoAF and State Ministry of Production and Economic Resources in Northern, North Kordofan, South Darfur, Khartoum, Gezira and Gedarif states of the Sudan.

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- *CT: Core Team Member*
- *TL: Team Leader*
- *IT: Information Technology*
- *C: Consultant*

ABBREVIATIONS AND ACRONYMS

AFISF	African International Seed Federation
AFSTA	African Seed Trade Association
ARC	Agricultural Research Corporation
ARS	Agricultural Research Station
ASSCO	Arab Sudanese Seed Company Limited
CBO	Community-based organization
CIAT	International Centre for Tropical Agriculture
CFSAM	Crop and Food Supply Assessment Mission
COMESA	Common Market for Eastern and Southern Africa
CRS	Catholic Relief Services
DUS	Distinct, Uniform and Stable
FAO	Food and Agriculture Organization of the United Nations
KSC	Kenana Sugar Company
ICRC	International Committee of the Red Cross
IDP	Internally displaced person
ISTA	International Seed Testing Association
MoAF	Ministry of Agriculture and Forestry
NGO	Non-governmental Organization
NK	North Kordofan State
NS	Northern State
NSA	National Seed Administration
OECD	Organization of Economic Cooperation and Development
PGRP	Plant Genetic Resources Programme
SD	South Darfur State
MOPER	Ministry of Production and Economic Resources
SSA	Seed Security Assessment
TL	Team Leader
UN	United Nations
USAID	United States Agency for International Development
UPOV	International Union for the Protection of New Varieties of Plants
VCU	Value for Cultivation and Use
WFP	World Food Programme
WVI	World Vision International

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EXECUTIVE SUMMARY

Sudan is a vast country with several ecological zones ranging from desert in the north to savannah in the south with pocket of Mediterranean climate in Jebel Mara in the west and Arkawait in Red Sea state. The total area of Sudan is about 185 million hectares while the arable land for agriculture is estimated about 68,186,000 hectares¹

The main staple food crop in Sudan is sorghum followed by millet and wheat. The main cash crops are cotton, groundnut, sesame, faba beans, vegetables and sunflower. The average area cultivated in season 2018/19 to crops was about 24 million hectares and more than 40% of this area was devoted for sorghum².

The formal and informal seed sectors are the main sources for seeds in Sudan. The informal sector is the main producer of seed in the country and produces about 86% of the seed requirements while the formal seed sector produces about 14% of seeds requirements in Sudan before the SSA. This situation is attributed to the meagre facilities of the formal seed sector in production of quality seed, few hybrids and the preference of farmers to their own seed varieties.³

The quality seed is an important pillar in increasing the productivity of the unit area and seeds are considered the cheapest input compared to costs of other inputs such as fertilizers and pesticides/herbicides required for boosting the production and productivity.

The SSA took place in six states representing the farming zones of Sudan. The six states are South Darfur, North Kordofan, Northern Sudan, Khartoum, Gezira and Gedaref. The farming zones included traditional rain-fed agriculture in sandy and clay soils, semi-mechanized agriculture in South Darfur, North Kordofan and Gedaref while the irrigated zones included Gezira Scheme, pump irrigation schemes in Khartoum and basin irrigated in Northern states.

Farming families are seed secure when they have access to seed and other planting materials of adequate quantity, acceptable quality in time for planting in good and bad seasons. Helping farmers to obtain seeds and the planting materials enables them to produce their own food for consumption and improving their income. Achieving seed security is quite different from attaining food security, despite their obvious links. The concept of seed security embodies several fundamental aspects that include seed availability, access, varietal suitability and seed quality. Differentiating among these is crucial for promoting those features that foster seed security as well as for anticipating the ways in which such security might be threatened.

The rationale for conducting seed security assessment in Sudan focused on understanding the seed production systems, channels of distribution, effect of continuous seed distribution to small farmers as well as the difficulties facing seed security of farmers in the country.

The objectives of conducting SSA are:

- a) to create better understanding of the seed systems, both formal and informal, for programming in the short and medium terms through knowledge of how are farmers procuring seed for their key food and income-generating crops and what are priority activities for improving seed security, across the whole seed system, and how best to ensure farmers have access to quality seed of a

¹ FAO 2016

² Statistics department, Ministry of Agric. and Forestry 2019

³ Seed Administration, Ministry of Agric. and Forestry 2012

range of crops, new variety diversity and to innovations. In addition, the SSA aim at understanding the constraints and opportunities for seed security, and identify practical and actionable recommendations.

- b) UN/ INGOs and Ministry of Agriculture and Forestry have been repeatedly distributed seeds and hand tools to small farmers in war affected and drought prone areas without targeting specifically to specific seed security needs. Therefore the impacts on smallholders' seed security, or on the seed systems more widely, is unknown

The SSA preparation and conducting took time more than anticipated due to situation of unrest in Khartoum and other states. Core Team and Technical Committee were formed to support in training and the implementation of the SSA. The training of Team Leaders took place from 11-16 December 2021 while the training of data collectors and collection of data in the selected states commenced in the third week of December 2021 and accomplished in the first week of February 2022. FAO is the sponsor of the SSA in partnership with FSTS/MoAF as the implementer of the SAA supported by NSA and SMoPER in the targeted states.

The tools deployed in SSA included secondary data and tools developed by CIAT, USAID, CRS and FAO. The tools deployed included Individual Household Questionnaires, Focus Group Discussion (Men and Women), and interviews with seed producers, , agro-dealers, agro-processors, traders in local markets, seed companies and local officials and NGOs experts, The tools were adapted from standard internationally-used tools to suit the context of seed multiplication and distribution channels in Sudan then translated into Arabic. Special questionnaires was designed for installation in Smart phones (Tabs) using Kobo software for collection of data pertaining to seed systems and seed security from HHs.

Experts from NSA and ARC contributed in providing background information on formal seed propagation and plant breeding in Sudan. Plant breeding in Sudan started in 1910 for cotton which was the main crop for export. ARC is the main research institute in the country with about 18 ARS and 11 specialized research centers spread to cover research on crops in the various ecological zones in Sudan. KSC and ASSCO as private companies also contribute to breeding and introducing improved varieties of sugar cane and food crops. The role of universities in breeding is relatively limited.

The average household size is 6-7. The female headed household is the highest in three villages in North Kordofan (43.8%) and zero in Elselaim Administration Unit in Northern state. In total, about 62% of households have cultivated an area between 1-10 feddan and 38% cultivated more than 50 feddan, with the largest holdings found in mechanized farming in Gedaref and Blue Nile, Sennar and South Kordofan states state, and the smallest in irrigated farming systems in Northern and Gezira States

More than 403 varieties were released between 1913-2021, including 63 sorghum varieties, 47 cotton and 36 varieties of bread wheat. Breeding methods are include conventional crossing, as well as mutation and biotechnological methods, though the main source of improved food crop, sugarcane and fruit tree varieties in Sudan remains introductions from international research centers . Cotton is an exception as all varieties released have been locally bred.

The adoption rate of new varieties is low especially in sorghum compared to the number of varieties released and farmers depend on their local varieties for cultivation. There is need for research and development of early maturing varieties of sorghum for the drought prone areas. There is international interest in development of millet because of its high nutritive value and tolerance to stress.

In the formal seed multiplication sector, the Seed Unit separated from the ARC in 1968 to form Plant Propagation Improvement and Development (PPID) then in 1982 became National Seed Administration then finally in 1995 is called Seed Administration which is responsible of the enforcement of the seed law and certification. The Seed Council is mandated with setting general policies for organizing and encouraging seed production, circulation and use of varieties and seeds as well as setting the rules/regulations for organizing the production of varieties and certification of seeds. The Variety Release Committee is responsible for release of new varieties in the country.

Seed companies and seed production units in the major irrigated schemes and some MoPER in rain-fed areas are the main supplier of certified seeds. It is worth noting some crops such as cotton the certified seed cover more than 90% of the requirement of the country as the seeds are mainly GMO and produced by seed companies.

The informal /traditional seed systems are based on farmers 'own production from their harvests, on seed exchanged or bartered among friends, neighbours, and relatives, and on grains traded in local markets. Varieties in the informal system may be landrace developed over time through farmer selection or may be variants of improved varieties originally sourced from the formal system such as Arfa Gadamak which turned into population of Arfa Gadamak crossed with other sorghum varieties and Sudan grass weed (Adar).

The informal seed sector is the major source of seeds for farmers however it is neglected and there is no plans to develop this sector or to improve the seed production except some efforts carried out by NGOs to introduce certified seeds of crops, establish seed banks and to train the community in production of good seeds. The role of the agricultural extension in production of quality seed is absent as there is no efforts exerted in increasing the awareness of farmers in production of quality seeds through use of certified seeds, field inspection and certification of their crops. It is imperative to increase the awareness of traders on quality seed parameters and where they can carry out germination tests.

SSA Findings

The SSA was conducted in six states in Sudan from 29th December 2021 to 4th of February 2022. The following are the main findings of SSA:

1. Seed Sources/Availability

- The dominant crops cultivated included sorghum, millet, sesame and groundnut in the rain-fed areas of Gedaref, NK and SD while the crops cultivated in the irrigated areas in Gezira, Khartoum and Northern states are wheat, faba beans, potato, onion, groundnut, sorghum and chickpea and spices. The main women crops in SD and Gedaref included okra, cowpea, watermelon seeds and maize.
- The main sources of certified seeds indicated in the HHs survey in 2021 were seed companies/agro-dealers, seed growers, partnership between seed companies and community, distribution by NGOs and MoPER while the main sources of informal seeds were farmers' saved seeds, traders/ local market, local seed producers, exchange between farmers and gifts.
- In the last five years, MoPER in SD, NK and Gedaref distributed on subsidized basis sorghum, millet, sesame and groundnut plus vegetables represented 5-7% of the seed requirement of the small farmers while FAO as coordinator of the Food Security and Livelihood Sector is considered the major seed distributor for free seeds for displaced and destitute HHs represented about 10% of the requirement of seed for small farmers. FAO

in 2021 distributed 1,241 tons of sorghum, millet, groundnut, sesame, cowpea, pigeon pea (cajanus) and chick pea in Darfur, Gedaref, Kassala, Sinnar, Blue Nile and Red Sea states. MoPER in SD distributed about 153 MT of Wad Ahmed and Arfa Gadamak to farmers. This amount distributed represented about 4% of the state requirements for seeds. Farmers in Khartoum obtained seeds on loan basis from Development Fund / Government while North Kordofan farmers benefit from the government and NGO distribution of seed and partnership with ARS where new varieties were introduced

- The HHs survey also indicated that farmer's plan for obtaining seeds for the next season has not changed very much as they will continue tapping the same sources used in the previous season e.g. farmer' saved seeds and selling/buying from local market- for cultivation. The change in the plan is usually in millet and sorghum every season depending on the prices of crops in the season and pests. Many farmers decreased their areas of millet because of birds and diseases that affect millet
- The traders at village level and state level represent the major source of grain/ potential seeds for farmers. The seed produced by some farmers are better than grains and have a demand by neighbouring farmers. It is cleaner and have higher in prices than grains.

2. Access to seeds

- Seed companies have small shops for direct selling or through agro-dealers and big traders to increase accessibility by farmers at planting time however the prices of seeds are not affordable to farmers that encouraged FAO, NGOs to distribute free seeds. MoPER use subsidized distribution of seed.
- Agro-dealers are found in the main towns and rarely in rural areas. Most of the agro-dealers are owners of the business and agents for seed companies and they have stores and show places. Cash payment, ATM and other banking applications are the most acceptable for payment for seed and inputs cost that contribute to access of seeds in the town. Some agro-dealers offer credits for certain farmers and they are dealing with men only.
- The farmers obtain local varieties by borrowing from other farmers or lending from local market and local merchants compared to high prices of certified seeds, difficulty in obtaining certified. The farmers in many cases use their saved seeds for cultivation in next season.
- Some NGOs used seed vouchers and seed fair to enable farmers to choose the seed they would like to grow.

3. Quality of seeds

- The quality of seeds used in cultivation of crops in 2021 as perceived by farmers are generally of good quality compared to certified seeds which are genetically pure and meeting the seed quality parameters
- Grains/ potential seeds available with farmers and in the local markets are a mixture of improved seeds crossed with land races
- The reputable traders keep the seeds well in the store to keep the quality of the seeds. Farmers are keen about quality and they look for fresh stocks, specific vendors, and graded stocks.
- The key features the farmers used for purchasing potential seeds include clean stocks, stocks of known origin, pure seeds not mixed with other seed and specific crop variety by name compared to certified seeds which are genetically pure and meeting the seed quality parameters.

4. Adoption of new varieties

- The rate of adoption level for new varieties is relatively slow as the promotion for new varieties is weak, in addition to difficulties in accessing certified seeds for farmers in remote areas as the agro-dealers concentrate in the towns.
- The new varieties adopted by farmers in the last five years were Imam Wheat in Northern, Gebaish groundnut in NK and Arfa Gadamak sorghum in Gedaref. From the variety released list we found that AG8 sorghum, Imam Wheat and Gebaish groundnut were released in 2009, 2000 and 1997 respectively. In addition Tabat and Wad Ahmed -released in 1992 and 1996 respectively- are the most popular varieties in SD and Gezira
- In SD the most popular varieties of sorghum are Wad Ahmed and Tabat. Farmers use certified seeds when the land is infested with Sudan grass weeds (Adar).
- Farmers buy certified seeds of watermelon and tomato every season as the seeds saved by farmers from these crops are inferior in quality and germination.
- Farmers' associations, community seed production and seed banks are very few in South Darfur, Khartoum, Gezira and Northern states..

5. Utilization of crops and Inputs

- The agro-processing business were established to make use of crops produced by farmer where decortication of groundnut is concentrated in SD; oil extracting from groundnut and sesame into oil and cakes are in SD, Gedaref and Gezira; grinding of dried hibiscus tomato and spices in all states and drying of lemon and onion is special business for export emerged late in Khartoum. The HHs survey on utilization of inputs indicated that:
 - The utilization of fertilizers in irrigated areas is indespicable for crops while in rain-fed areas the application of fertilizers is in a limited scale.
 - The farmers in the irrigated areas use herbicides for the crop establishment in Northern, Gezira and Khartoum due to awareness of farmers about the importance of using the technical package for crops and availability of herbicides while farmers in rain-fed areas are not familiar with use of herbicides for crops due to poor extension, difficulty to obtain and high prices of herbicides.
 - The utilization of organic fertilizers is mainly for vegetable crop and fruits in Northern state and Khartoum and some experimental plots in North Kordofan in collaboration with Elobeid ARS.
 - Farmers are familiar with use of storage chemicals especially in Northern state while the least utilization take place in SD. The seed/grain losses during storage is high in SD, Northern and North Kordofan states as grains are kept in traditional stores near their living places subjecting them to animal and poultry and store pests.

6. Marketing

The main problems encountered are marketing of groundnut and faba beans when there is high production as traders were reluctant to buy the crops because the capacity of marketing is limited.

- Packing in small packs of 20 Kg or less can improve the marketing for faba beans and this was noticed when some traders imported faba beans from Egypt in small packages.
- The agro-processing business were established to make use of crops produced by farmers were:
 - Milling of sorghum and wheat are found in all states
 - Decortication of groundnut concentrated in SD
 - Oil extracting and cakes from groundnut and sesame in SD, Gedaref and Gezira;
 - Grinding of groundnut, dried hibiscus tomato and spices in all states.

- Decorticated GN in SD have a good market in Khartoum for oil extraction and the peak of extracting oil from groundnut is from November to June in local markets in SD.
 - The by-products of decortication have a good market for brick making in SD
 - Drying of onion and lemon is a business for export emerged late in Khartoum.
- Challenges encountered by agro-processors are access to funds to buy crops at time of harvest for continuation of business all over the year.

7. Gender

- In SD, women-headed households is 70 percent due to fighting context since 2003. In Gedaref women-headed households is about 40 percent and almost zero in Elselaim basin/ Northern state.
- The most vulnerable households in the community are widows, ill and elderly people.
- The main women's crops include okra, cowpea, watermelon seeds, millet, groundnut, sorghum and maize.
- Women keep their seeds for next season; 100 percent for groundnut and millet in SD; 70 percent for sorghum and 30 percent for sesame in Gedaref. Bartering of grains for seeds is practiced among women or sometimes they obtain seeds free as a gift.
- Women sell their products and have the freedom in spending the money in SD. Marketing of crops is a male activity and the control of money belonging to women is the husband in Gedaref. Decision on what to grow is taken by men and women together.

8. MoPER and NGOs:

- MoPER and NGOs use to distribute seeds annually to displaced and vulnerable HHs.
- MoPER conducted training sessions in seeds production in coordination with NGOs in rural areas and facilitated the process of seed inspection to encourage local producers to produce quality seeds.
- Most of the training conducted delivered to staff especially in seed production and establishment of seed banks is part of the NGOs intervention in agriculture
- The principal priority activities of MoPER in the states in the coming 10 years include:
 - Training of staff and farmers on seed production
 - Facilitate provision of farm machinery and seeds for association
 - Seed production in SD and Gedaref states
 - Increase access agricultural land through use of solar energy in irrigation and connect the agricultural project with electricity in NS.
- The major challenges/ bottlenecks to be solved over the coming 5-10 years are:
 - Utilization of solar energy in irrigation in NS.
 - Seed production for most of the important crops in the states.
 - There is need to establish a seed unit in MoA specialized in seed extension to increase the awareness of farmers on quality of seed and promote for the new varieties released and their merits compared to local varieties and seeds.
 - Increase involvement in agro-processing activities.

Recommendations

1. Accessibility

To increase farmer's access to seeds, the consultant recommends supporting vulnerable farmers with Income Generating Activities (IGA) and cash assistance to improve the income of the family to enhance vulnerable farmers' access to seeds and other inputs. Conduct of seed fairs and use of voucher assistance

is another way to improve access of vulnerable farmers in selection of crops and varieties that required for planting. Encourage seed companies to go for small packets for seed varieties for crops and vegetables required by small scale farmers.

2. *Availability*

The Immediate solution for seed availability is to continue distribution of seeds by FAO, MoPER and NGOs for displaced and destitute HHs especially in areas where there is fighting and instability.

The Intermediate action to increase availability at community level are to encourage agro-dealers to establish agricultural services at the village level and provision of seeds, chemicals and fertilizers beside farm machinery for seed growers. Decentralization of seed certification and building strong seed units in the states to carry out field inspection on time and seed testing at the state level to make quality seeds available at state level at time of planting.

3. *Quality of seeds*

The seed industry in Sudan is progressing very slowly due to the political instability in the country, high investment costs in seed production and low revenue for seed companies. The seeds produced by seed companies are of good quality while those produced under informal sector need special attention on the production steps and to improve the quality of seeds. The following are the recommendations to improve the quality of seeds produced by the informal sector:

- Immediate solution for improving the quality is introduction of germination test for grains in merchants' stores that can be used as seed to ensure compliance with seed standards before selling to farmers.
- Intermediate solutions for improving the quality are:
 - a. Establishment of seed extension unit in MoA specialized in seed extension to train farmers on production of Quality Declared Seed, to increase the awareness on seed quality and promote for new varieties.
 - b. Training of farmers, middlemen and traders on aspects of seed quality to select the best lots of grains available at village level. Premium for the best quality produced by farmers is an important factor to encourage farmers to improve the cultural practices to produce better grains that can be used as potential seed in case of emergency.

4. *Varietal Suitability*

- The immediate action is to encourage the participatory breeding so that breeders and farmers are together in all steps of selection of new lines in the field to focus on the most appropriate elite lines that meet farmers' preferences and consumer tastes before the process of variety releasing. This will also help in adoption of new varieties by farmers.
- Intermediate and long run action includes:
 - Support to ARC by training of staff and equipment that facilitate breeding of varieties suitable and accepted by farmers.
 - The climate is changing and there is a need to direct research to focus on crops suitable for marginal and harsh environments.

5. *Adoption of new crops and varieties*

- Participatory breeding is one of the solution that can improve adoption of new varieties by farmers.

- Awareness sessions among farmers on the merits of the new varieties, where they can obtain seeds and how much they can gain from cultivation of new varieties.

6. *Acute and Chronic*

- Quality seeds of sorghum and millet are available with difficulty at time of planting in big towns in that can be solved by encouraging companies/Agrodealers to open more small shops in rural areas.
- Introduction of seed varieties that suit harsh environment and training farmers in seed production can contribute in solving the chronic seeds availability is remote and harsh environment.

1. INTRODUCTION

1.1 Background

Sudan is a vast country with several ecological zones ranging from desert in the north to savannah in the south with pocket of Mediterranean climate in Jebel Mara in the west and Arkawait in Red Sea state. Sudan comprises of 18 states and each state is further divided into localities. The total area of Sudan is about 185 million hectares while the arable land for agriculture is estimated about 68,186,000 hectares⁴

The main staple crop in Sudan is sorghum followed by millet and wheat. The main cash crops are cotton, groundnut, sesame, faba beans, vegetables and sunflower. The average area cultivated in season 2018/19 to crops was about 24 million hectares and more than 40% of this area was devoted for sorghum⁵.

The formal and informal seed sectors are the main sources for seed production of crops in Sudan. The informal sector is the main producer of seed in the country and produces about 86% of the seed requirements while the formal seed sector produces about 14% of seeds requirements in Sudan. This situation is attributed to the meagre facilities of the formal seed sector in production of quality seed, few hybrids and the preference of farmers to their own seed varieties.⁶

Quality seed is an important pillar in increasing the productivity of the unit area and seeds are considered the cheapest input compared to costs of other inputs such as fertilizers and pesticides/ herbicides required for boosting the production and productivity.

1.2 Farming Systems in Sudan

The farming systems in Sudan reflects the various agro-ecological zones. The farming systems in Sudan composed of the following:

- ***Traditional Farming System*** where farmers practice agriculture in small holdings using hand tools, intermediate technology and rarely have access to machinery. These are grouped into:
 - *Sandy Soils Farming System* where groundnut, sesame, millet and early maturing varieties of sorghum are grown as the main staple and cash crops. In addition, small areas are cultivated by karkade and okra.
 - *Clay Soils Farming System* where sorghum, millet, sesame and ground nut are grown as the main staple and cash crops. In addition to small areas (jubraka) cultivated by karkade and okra and other vegetables.
- ***Semi-Mechanized Farming System*** where farmers have big area and have access to agro-services, credit and agricultural machinery. The main crops are sorghum, sesame, millet,

⁴ FAO 2016

⁵ Statistics department, Ministry of Agric. and Forestry 2019

⁶ Seed Administration, Ministry of Agric. and Forestry 2012

groundnut, cotton and sunflower. New crops are introduced such as soybean and watermelon for seeds.

- **National Irrigated Schemes** in Gezira, Rahad, New Halfa and Suki schemes. The main crops are cotton, groundnut, sorghum, wheat and sunflower. New crops are introduced in the rotation such as cajanus (adsia).
- **Irrigated Pump Farming System** along the White Nile, Blue Nile and the main Nile. The main crops are wheat, potato, onion, fodders and vegetables.
- **Spate Irrigated Farming System** in Gash and Toker deltas where farmers grow cotton in the past and currently sorghum, millet and some vegetables are the main crops.

Table (1) shows the characteristics of the farming systems, farmer's holdings, states and the main and minor crops cultivated in Sudan.

Table (1): Characteristics of Farming systems, farmer's holdings, states and crops

Farming System	Size of holding	States	Crops
Traditional farming Sandy soils	2-10 hectares	North Darfur, North and West Kordofan	Food Crops: Millet, Sorghum, Cash crops: Sesame, Groundnut. Minor crops: Karkade, Cowpea, Watermelon seeds and vegetables
Traditional farming Savannah/clays	2-20 hectares	Gedaref, Blue Nile, South Kordofan, South Darfur	Food Crops: Sorghum, Millet Cash crops: Sesame, Groundnut Minor crops: Cowpea, Roselle (Karkade), and vegetables
Semi-mechanized farming	200 hectares and above	Gedaref, Blue Nile, South Kordofan and White Nile	Main crops: Sorghum, Millet, Sesame, Sunflower. New crops: cotton, Guar/ Soybeans and Watermelon seeds
Irrigated Farming/Clays	4-10 hectares	Gezira, Rahad, Halfa and Suki National schemes	Main crops: Cotton, sorghum, wheat, groundnut, sunflower and vegetables New crops: <i>Cajanus cajan</i> (Adasia)
Irrigated Farming/pumps	Less than 4 hectares	Northern, Nahr Elneel, Khartoum, White Nile and Red Sea states	Main crops: Wheat, Faba beans (broad beans), Potato, Onion, Fodders and Vegetables New crops: sesame, groundnut, Watermelon seeds
Spate/flood Irrigation	Less than 8 hectares	Kassala (Gash), Red Sea (Toker)	Main crops: Sorghum, Cotton, Vegetables, Millet

Source: Developed by Mahmoud Nouman from MOAF data, 2021

2. INTRODUCTION TO THE SSA

2.1 The concept of seed security

Farming families are seed secure when they have access to seed (and other planting materials) of adequate quantity, acceptable quality and in time for planting in bad and good seasons. Achieving seed security is quite different from attaining food security, despite their obvious links. A farmer can have enough seed to sow a plot but lack sufficient food to eat, for example, during the “hungry season” prior to harvest. Conversely, a household can have adequate food but lack access to appropriate seeds for planting.

2.2 The Dimensions of Seed Security

The concept of seed security embodies several fundamental aspects. Differentiating among these is crucial for promoting those features that foster seed security as well as for anticipating the ways in which such security might be threatened. Table (2) outlines the key dimensions of seed security

Table (2): Seed Security Key dimensions

<i>Dimension</i>	<i>Focus</i>
<i>Availability</i>	Supply of seed, <u>from any source</u> , in reasonable proximity and in time for planting.
<i>Access</i>	<u>People are able to buy /borrow/barter for seed.</u>
<i>Varietal suitability</i>	Variety is <u>adapted to growing environments</u> , and has <u>traits that farmers want</u>
<i>Seed quality</i>	Seed is able to germinate, is free of pests/diseases, and free of any physical contaminants
<i>Resilience of system</i>	Ability of system to resist, adapt to , and recover from shocks and stresses

Availability is defined narrowly as whether a sufficient quantity of seed of target crops is present within reasonable proximity (spatial availability) and in time for critical sowing periods (temporal availability). It is essentially a geographically based parameter, and so is independent of the socioeconomic status of farmers.

Seed access is a parameter specific to farmers or communities. It largely depends upon the assets of the farmer or household in question: whether they have the cash (financial capital) or social networks (social capital) to purchase or barter for seed.

Seed quality Seed quality consists of physical, physiological and sanitary attributes (such as germination rate and the absence or presence of disease, stones, sand, broken seed or weeds).

Varietal quality refers to genetic attributes, such as plant type, duration of growth cycle, seed colour and shape, and palatability.

Resilience of system is the ability of the system to resist, adapt to and recover from shocks and stresses. In situations of stress, it is rare to have constraints in all three seed security features at the same time. The challenge is to identify the real problem and then to target actions that alleviate well-defined problem.

2.3 Acute and chronic seed insecurity

Analysis of seed security requires consideration of the duration of the stress: whether it is “acute” or “chronic” (recognizing that the divisions are not absolute).

Acute seed insecurity is brought on by distinct, short-lived events that often affect a broad range of the population. It may be spurred by failure to plant, loss of a harvest, or high pest infestation of seed in storage. While in normal times households may have various degrees of seed security, all may be affected by an acute event such as a flood.

Chronic seed insecurity is independent of an acute stress or disaster. It may be found among groups who have been marginalized in different ways: economically (i.e. due to poor, inadequate land or insufficient labour); ecologically (i.e. in areas of repeated drought and degraded land); or politically (in insecure areas, or on land with uncertain tenure arrangements). Chronically seed-insecure populations may have ongoing difficulties in acquiring off-farm seed due to lack of funds or they may routinely use low-quality seed and unwanted varieties. The result is households with built-in vulnerabilities.

Acute and chronic seed insecurity often coexist in emergency contexts. In cases where emergencies persist – in drought-prone areas, for example – acute problems are nearly always superimposed on chronic problems rooted in poverty.

2.4 Rationale for conducting SSA in Sudan

The rationale for conducting the SSA in Sudan can be summarized in the followings:

- a. Sudan is big country with various agro-ecological zones where farmers obtain suitable seeds from various sources to produce food for the family and for marketing.
- b. The understanding of the seed production systems, channels of distribution, effect of continuous seed distribution to small farmers as well as the difficulties facing seed security of farmers in the country is the main objective behind the conducting of the SSA across the country.
- c. The small farmers in the rain-fed agro-ecological zones are the most important sector in terms of areas cultivated, aggregated production, contribution to food security and livelihoods of poor rural and employment opportunities.
- d. Over the past years, UN/ INGOs and Ministry of Agriculture and Forestry have been repeatedly distributed seeds and hand tools to small farmers in war affected and drought prone areas without clear understanding of the impact of such crises on the elements of seed security and its dimension (availability, access, quality, varietal suitability and the resilience of the system).

2.5 Objectives of Conducting SSA in Sudan:

The main objectives of conducting SSA are to create better understanding of the seed systems, both formal and informal, for programming in the short and medium terms. FAO and its partners in Sudan main objectives through conducting this SSA is to address the difficulties facing the farmers.

2.6 Selection of SSA areas

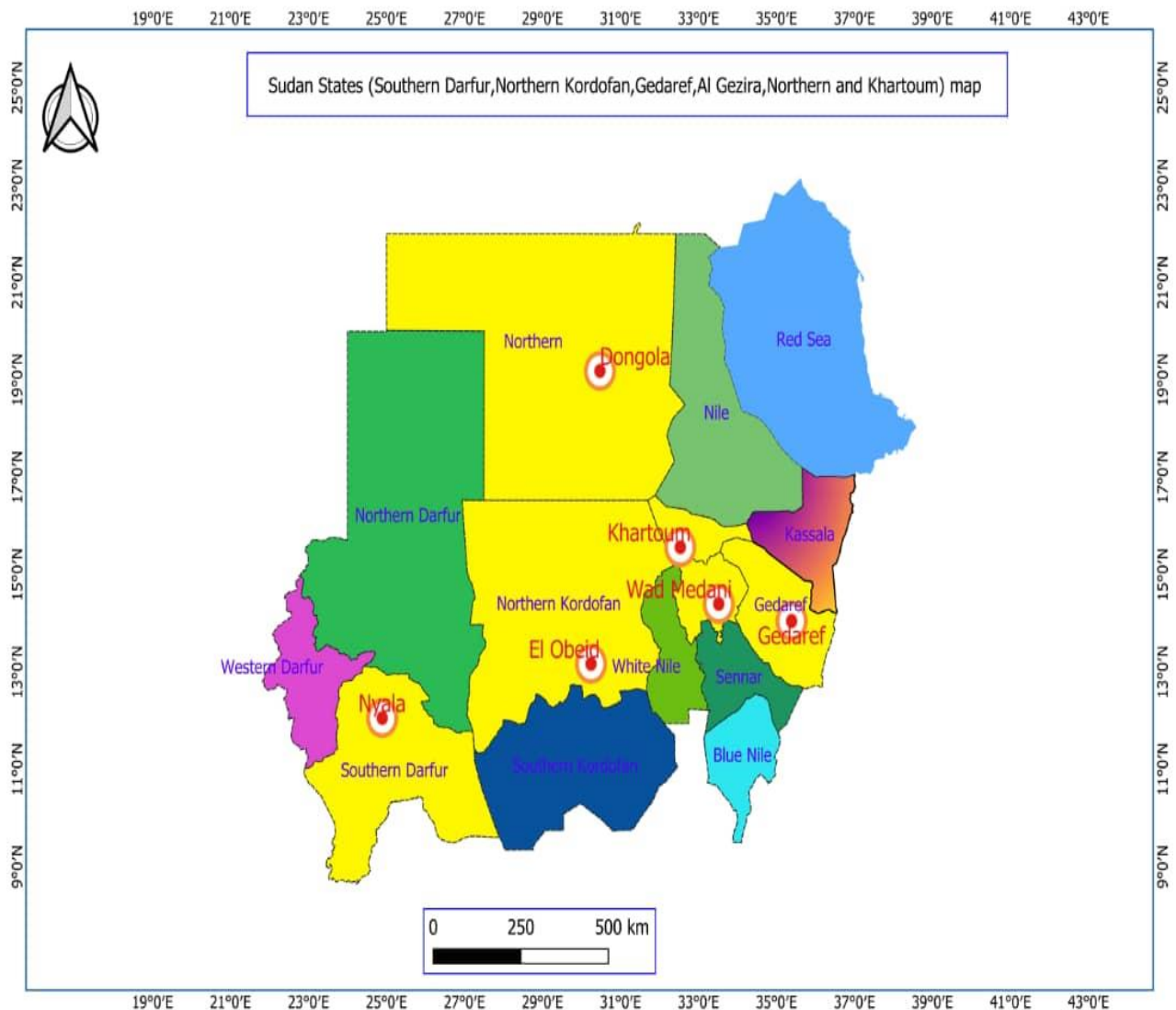
The criteria for selecting sites for conducting SSA are to simulate a fair representation of the farming zones in Sudan. Locations of assessment were selected to highlight different types of possible seed security scenarios tied to the following factors: a) agro-ecology/livelihood zones; b) intensity of crop production; c) security risks (Genaina is excluded); d) environmental risks; f) cropping systems and d) accessibility, e) locations where seeds multiplication by local farmers is introduced (Table 1) above.

The selection of sites for conducting SSA in Sudan is discussed with FAO in coordination with FSTS and Seed Administration. The meetings reviewed the farming zones in Sudan and the similarities between them, then agreed on six farming zones. Fig (1) shows the states and Table (3) shows the final farming zones selected for conducting the SSA in Sudan.

Table (3) Final Farming Zones, State and Main Towns

Farming Zone	State	Towns for SSA
Traditional Farming –Sandy Soils	North Kordofan	EIObeid
Savannah/clays Traditional Farming	South Darfur	Nyala
Semi-mechanized farming	Gedaref	Gedaref
Irrigated Schemes/Central Clays	Gezira	Wad Medani
Irrigated Farming/pumps	Khartoum	Khartoum
Irrigated Farming/Riverine pumps	Northern	Elselaim, Dongola

Fig (1): Map of Sudan showing in yellow SSA sites and states



3. MATERIALS AND METHODS

Sudan is a big country and sites for SSA in the states are far from each other and need time to conduct the SSA. The consultant agreed with FAO to form a Core Team to be trained on SSA to lead the SSA in the states.

3.1 Formation of the Core Team

The Core Team composed of NSA and FSTS to support the Seed Security Consultant in training of Team Leaders from the states and to lead the SSA in the states. The documents pertained to SSA training and questionnaires were translated and shared with the members of the Core Team for reading and fine tuning the Arabic translation. Each of the Core Team is assigned to support two states in conducting the SSA in coordination with the Team Leaders and the MoPER authorities

3.2 Formation of a Technical Committee

A technical Committee from Seed Administration, Planning General Administration, Technology Transfer and Extension Department, FSTS/MOAF and ARC in addition to donors working in livelihood

and seed distribution including USAID, DFID and ECHO and some INGOs was also formed to support SSA technically and to participate in the field activities. Due to COVID-19, the SSA is conducted by FSTS and NSA and the teams in the selected states.

3.3 Tools deployed

FAO provided the consultant with documents and websites on seed security systems and SSA reports from various countries where SSA was conducted. There is also good literature about agriculture, livelihood and soils in Sudan that enable the consultant to formulate sound back ground on farming systems and agro-ecological zones of Sudan. In addition, two consultants were assigned to enrich the SSA with background on formal seed multiplication and plant breeding and structures in Sudan

The SSA tools were developed by CIAT⁷, CRS⁸, USAID⁹ and FAO were used in the last ten years in conducting SSA in Mali, Kenya, Ethiopia, Darfur and other African countries. The SSA involves qualitative and quantitative data collection. The tools were adapted to suit the context of seed multiplication and distribution channels in Sudan then translated into Arabic. Special questionnaire was designed for installation in Tabs using Kobo application for collection of data pertained to seed systems and seed security from HHs in the targeted sites. The tools deployed for this assessment included:

- Individual Household Questionnaire
- Seed Producers group/individuals
- Focus Group men farmers
- Focus Group women farmers
- Agro-dealers
- Agro-processors
- Traders in local markets
- Seed companies
- Key informants (e.g. local officials and NGOs),

3.4 Selection and Training of Team Leaders

The criteria for selection of team leaders focused on senior staff with university degree in Agriculture, good background on seed production/extension and experience in assessment and surveys in the last five years and have experience with Tab operation. A Team Leader was selected from each state to attend ToT on SSA.

The Arabic language was the main language for instruction in SSA training with some terminology in English as most of the participants have low level of understanding English very well. The training material were translated into Arabic then compiled in a guide and distributed for the TL trainee during the training. The team leader from the states were trained as ToT on SSA at Wad Medani for five days. The training was conducted by the consultant and the Core Team. Various training tools such as participatory approach, flip charts, and slides/charts and video sessions were deployed to maximize the understanding of the topics delivered. The training material included the Seed Systems Conceptual Framework and Introduction to Seed System Assessment and the tools required for conducting the SSA in the field (Annex 1).

3.5 Selection and Training of Data Collectors

Selection of data collectors is very important for the success of the assessment and collection of the required data. The main criteria for selection of data collectors were university graduate, good background on seed production/Agric. Extension and experience in surveys and assessments

⁷ CIAT: International Center for Agriculture Development

⁸ CRS: Catholic Relief Services

⁹ USAID: United States Agency for International Development

The team leader from each state and a consultant/core team conducted similar training on the basics of SSA and tools for collection of data for the data collectors in the state for three days.

3.6 Team Composition and Collection of Data

Each SSA team is composed of 8 persons and a team leader and member from the Core Team for each state. Usually the team for any survey is divided into data collectors to fill in the HH questionnaires and those who have skill in communication /experience handle the focus group discussion to deal with community FGD, women groups and other tools. Accordingly, the team assigned four persons to fill in the 60 HH questionnaires using Tab; two persons to handle the community and women focus group, seed producers, agro-dealers and agro-processors in each location. The other two persons were assigned to collecting information from traders at local and town markets, seed companies and key informants at state level. The Team leaders and the Core Team members also helped in supervising/participating in the field work and data collection from community groups, traders and key informants in the states

The team leaders were well briefed on their responsibilities while in the location to ensure every member of the team is doing well and have no problems with the respondents. Informal discussions were held with the team members at the end of each day or in the morning before going to the field to give feedback on their perception on the response of the HHs and community on the questions and their recommendations to improve the collection of data on seed security assessment. This will assist the team leader to develop the daily report and respond to difficulties encountered.

4. SEED SYSTEMS IN SUDAN

Seed systems in Sudan comprise both the formal and informal sectors. The formal sector includes plant breeding, for testing and development of new crop varieties, variety release, in coordination with ARC and Seed Council, and organized seed production including quality assurance. The informal seed sector produces, stores, markets and disseminates seeds, of local varieties and materials that originated from improved varieties, among farmers and through local markets.

4.1 Plant Breeding

Plant breeding is done by people who have actively studied the underlying biological mechanisms involved in plant improvement. The art and science of plant breeding bring together the application and educational and research aspects of this important activity (Lamkey, 2003).

4.1.1 Plant Breeding Methods:

Variety introduction remains the main method of crop improvement in Sudan, especially in respect of non-indigenous crops. Cotton is an exception in that as all released varieties have been locally bred. In

contrast, all varieties of sugarcane, fruit trees, cowpea, chickpea, pigeon pea, potato, and rice were introductions.

The methods applied in plant breeding consist of:

- a. **Conventional and Introduction methods:** The conventional methods of breeding include selection, hybridization, crossing of inbred lines without male sterility and polyploidy. Introduction of varieties from international centres such as ICRISAT and adapting them to Sudan's environments is another method for varietal development.
- b. **Biotechnical Methods:** Biotechnical methods applied to plant breeding include in-vitro cultivation of plant cells, regeneration of plant cultured cells callas certain isolate cells, in-vitro selection and the use of soma clonal variation and somatic hybrid plants,
- c. **Genetic Engineering:** Genetic engineering methods applied to plant breeding include restriction fragment length polymorphism (RFLP), transgene expression, selection and plant regeneration and genetic transfer. The latter develops the genetically modified organisms (GMOs). GMOs are not used in Sudan except in Bt-cotton only for African boll worm resistance.
- d. **Mutation:** Induced mutation, via chemicals or radiation, increasing the variability in uncultivated gene pools or from other cultivars. Mutation has resulted in release of Tafra Groundnut.

4.1.2 Plant Breeding in the Past:

Plant breeding in Sudan has started since the early 1910s on cotton breeding at the Gezira Research Station. Tothill (1948) and ODA (1954) recorded considerable achievements in germplasm collection, introductions and crop improvement. Yambio Research Station was established in 1948 for cotton research to support production of cotton in Nzara/south Sudan. Other crops including maize, groundnuts and upland rice were tested in that station, but the records of the trials were lost.

The plant breeding activities carried out from 1970 onwards focused on staple crops such as sorghum, pearl millet, wheat, sesame, groundnut and sunflower with little work on maize. Some of the research activities were supported by International Agricultural Research Centre that culminated with release of notable varieties of crops including Tabat and Wad Ahmed sorghum varieties, Sodari and Gebaish groundnut varieties, Promo sesame variety and Ashana millet variety. Lack of special seed production farms is one of the limitation that hindered the breeding efforts and spread of new varieties released by ARC (Annex 2).

4.1.3 Present Plant-breeding:

Currently, plant-breeding programmes are conducted within the Agricultural Research Corporation (ARC), universities, and the private sector.

a) ARC:

ARC is the largest public research institution in Sudan. The Gezira Research Station (GRS) was established in 1918. ARC now comprises 18 research stations covering most of the agro-ecological zones in the country (Annex 3).

Breeding programmes in ARC cover almost all important field crops, horticultural crops, fodder crops, fruits and forest trees. ARC established many Agricultural Research Stations to cover most of the agricultural zones. ARC also developed 11centers/ programmes for coordination of research. These Centres are:

- *Cereal Research Centre* covers wheat, sorghum, pearl millet, rice, and maize.
- *Oilseed Research Centre* coordinates research on groundnut, sesame, sunflower and soybean.
- *Pasture and Forage Programme:* Breeding work in this programme covers irrigated forage crops with an emphasis on the development of sorghum varieties and hybrids using local materials.

- *Food Legumes Research Programme*: In this programme, breeding work covers three winter legumes: faba beans, chickpea, and common beans. The focal point for this programme is the Hudeiba Research Station in River Nile state. Other tropical grain legumes covers cowpea, pigeon pea, and Bambara groundnut are handled by El Obeid Research Station in North Kordofan state.
- *Cotton Research Programme*: Cotton breeding is organized into 11 projects including breeding for disease and insect resistance, biotechnology, mutation breeding, etc.
- *Horticultural Crops Research Programme*: Tomato breeding occupies a prominent position in this programme with emphasis on breeding for disease resistance or tolerance, specifically tomato yellow leaf curl virus. Breeding activities also cover all important vegetable crops in the Sudan watermelon (Galia) is previously released at Gezira University horticultural exports center as well as okra (Khartoumia). Kerkade, an important cash crop in western Sudan, is included in the vegetable crops programme.
- *Fruit Tree Programme*: covers grapefruit, mango, banana, date palm and guava.
- *Plant Genetic Resources Programme (PGRP)*: deals with the collection, conservation, evaluation and documentation of local genetic resources in the various agricultural crops in the Sudan. The PGRP is run by a unit located at Genetic Resources Programme (GRS) with sub units at El Obeid and Kassala. Banana breeding is well developed connected with tissue cultures labs in ARC, Gezira University and Shambat. A field gene bank has been established in Kassala ARS in eastern Sudan and a new regional seed bank was established in El Obeid ARS for conservation of an active collection from Kordofan and Darfur. PGRP provides critical support to all breeding programmes. Over 9,000 entries are maintained by the unit.
- *Forest Trees Seeds Multiplication Centre* in Soba with sub units Gedarif, El Obeid and Damazine dealing with seeds collection treating, testing and registration of forest trees. Soba Centre includes a mutation breeding unit.
- *Arid and Semi-arid Research Center* is dealing with water harvesting and breeding of drought tolerant varieties. New crops were introduced in Savannah clays such as water melon for seed (Tasali haab Elbatekh) under climate change fund. ARC has a Varietal Maintenance Center for foundation seed production.

b) Universities:

Research and breeding activities established in University of Khartoum and University of Gezira contributed to the development of new varieties such as sunflower hybrids, soybean, tomato varieties, muskmelon Galia, Okra, and sorghum varieties.

c) Private sector: The major private sector companies involved in plant breeding and agricultural research are Kenana Sugar Company (KSC), ASSCO and other seed companies. Kenana Sugar Company (KSC) established strong sugarcane breeding programme was in collaboration with Guneid Sugarcane Research Station. Bilateral contracts were made with the West Indies Central Sugarcane Breeding Station at Barbados and hundreds of varieties were introduced. Screening for disease and yield resulted in the selection of the varieties released in 1998 and 2003. ASSCO was established in 1997 in accordance with the 1925 corporate law. ASSCO replaced the Plant Propagation Administration (PPA) and assets of PPA including land, processing plants and irrigation facilities formed the share of the Ministry of Finance in the new company while the Arab Authority for Agricultural Investment and Development was the second largest shareholder. ASSCO established a research and development unit in 1998. The main breeding agenda undertaken by ASSCO are to introduce and test hybrids of sorghum, pearl millet, maize and sunflower. In addition, a sorghum breeding project to develop hybrids that meet the local taste was initiated. Some selected hybrids are currently in the advanced stage of evaluation. As indicated earlier, ASSCO released a sunflower hybrid, maize and a forage sorghum hybrid (Annex I).

4.1.4 Progress of Plant Breeding of the Major Crops:

The breeding activities efforts are concluded with release of many varieties in various crops that can be summarized in the following:

Cotton: Cotton breeding started early last century when breeding efforts were directed toward the development of long staple cotton varieties resistant to leaf curl and black arm diseases. The most recently released varieties are ‘Hamid,’ ‘Burhan’ and ‘Abdeen’ were mainly bred for resistance to black arm including new strains of the bacterium. Improved lint yield and fiber quality have also been continuous objectives in cotton breeding programs. Cotton breeders were able to open new markets for Sudanese cottons by developing varieties for different needs. New GMOs improved Bt-cotton varieties resistant to African boll worm for rain-fed cotton production resulted in release of Senni-1&Senni-2 cotton varieties (Annex 1)

Cereals: sorghum improvement started at Tozi then Abu Na’ama Research Station, resulted in the development of high-yielding varieties such as Tozi Um Benein’ (TUB) varieties: ‘TUB-7’, ‘TUB-11’, and ‘TUB-22’ then ‘Gadam Elhamam,’ ‘Dabar 1’ ‘Kerktib’).

Sorghum and pearl millet breeding, benefitted greatly from cooperative programme with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) established in 1977 and the International Sorghum and Millet Collaborative Research Support Programme in 1980. The ICRISAT programme resulted in the release of the first sorghum hybrid in Sudan, ‘Hageen Dura-1’. In 1990 the UNDP Regional Arab Bureau launched a regional project for the improvement and development of sorghum and millet.

During the 1990s and as a result of financial support to ARC from the different projects, another hybrid, ‘Rabih,’ was released for irrigated areas plus three open-pollinated varieties; ‘Wad Ahmed’, Arfa Gadamak and ‘Tabat’ are considered the most popular sorghum varieties among the rain-fed and irrigated farmers in Sudan.

Pearl millet: Over 95 percent of pearl millet is grown in the western states of Kordofan and Darfur. Local varieties still predominate in that region. Pearl millet was included in all the major projects with sorghum, but not much was achieved regarding variety development. The ICRISAT-Sudan cooperative programme resulted in the release of Serere Composite II (SCII) under the name ‘Ugandi’. The variety did not perform well and has not been maintained. Subsequent evaluation of ICRISAT pearl millet varieties in western Sudan ARS by plant pathologists led to the release of ‘Ashana’ in Sudan. A project to improve ‘Ugandi’ to convert its grey seed color to yellow through backcrossing started in 1990 in cooperation with ICRISAT. Backcrossing was performed at ICRISAT and selection was practiced at El Obeid Research Station. Although in 1999 it was claimed that breeder seed of the new converted variety was being produced, actually nothing materialized.

Wheat: A primary objective of wheat breeding was to push production further south, especially into the Gezira Scheme. Research at Hudeiba Station started with evaluating of local land races. The FAO Near East Wheat and Barley Project in the early 1960s provided large numbers of germplasm and nurseries that resulted in release ‘Falchetto I.B.O.’. With the establishment of the International Maize and Wheat Improvement Centre (CIMMYT) and the International Centre for Agricultural Research in Dry Areas (ICARDA), the supply of germplasm for evaluation increased tremendously and included pure lines and segregating generations.

The Nile Valley Project with backstopping from ICARDA and financial support from the Netherlands, OPEC and others, resulted in the release of many improved varieties such as Dibaira, Condor, Nileen and Buhein that suit wheat production in White Nile State. Experimentation of wheat production in rain-fed are going on at demonstration level in Nyala and Gedarif.

Biotechnological breeding methods are a recent development in Sudan and have resulted in the production of two doubled haploid wheat varieties – ‘Khalifa’ and ‘Tiqana,’ which are now under cultivation.

Maize: The important contribution made by that programme was the collection of maize germplasm from almost all maize-growing regions in the country. The programme recommended three varieties namely 'Alaf,' 'Bafrew,' and 'Stock 113.' Only the latter is now available. A new programme for evaluating hybrids and open-pollinated varieties started at the Gezira Research Station and at Hudeiba Station in 1996 which culminated with the release of two open pollinated varieties designated 'Hudeiba-1' and 'Hudeiba-2,' in 1998.

More research work at the Gezira Research Station was directed towards evaluating hybrids from Pannar, (South Africa) and Advanta, (India). High quality protein maize and striga-resistant material from the regional programme of CIMMYT in Nairobi were also introduced. Several hybrids and open pollinated varieties were released from this programme such as Hageen Dura 1 (Sorghum hybrid), Mogawim boda1, and Mogawim boda 2 (Striga resistant sorghum)

Rice: The crop breeding in rice began later and one variety was release under Umcheer which widely spread in water pond in White Nile State.

Oil crops: Oil crops include groundnuts, sesame, sunflower and safflower:

Groundnut: Groundnut improvement efforts in Sudan began in the 1930s. The cultivar 'Barberton' was identified as a suitable variety for rain-fed in western Sudan. Because of its earliness. The spread of 'Barberton' was quick and it almost replaced the late-maturing runner type that was cultivated at that time in the drier parts of the region.

The groundnut collection assembled by A.H. Bunting and the agronomic classification he developed facilitated screening the collection to select varieties adapted to irrigated central clay soils and others suitable for rain-fed production. 'MH 383,' an alternately-branched late-maturing introduction from Nigeria, was released in 1970 for irrigated areas.

In 1980, a new programme of variety introduction accompanied by an intensive crossing effort was initiated at the Gezira Research Station at Wad Medani. Cooperation with Jebel Marra Development Project, Western Savannah Development Corporation, and Mechanized Farming Corporation resulted in the release of 'Sodari' for rain-fed western Sudan. 'Sodari' is now replacing 'Barberton'. 'Kiriz' was released for the irrigated clays and River Nile State for confectionary and table groundnut. From the hybridization programme, four cultivars namely 'Medani,' 'Ahmadi,' 'Tozi' and 'Bunting' were released for the irrigated clays while 'Gubaish' released for rain-fed soils in western Sudan.

Sesame: Sesame breeding began in Sudan with selection from American population introduced in 1951, as well as screening among local land races based on seed color. These breeding programme resulted in release of Ziraa-1, Ziraa-3 and Ziraa-7 highly pure, white seeds. Sesame improvement started at Tozi in early 1950s with collecting, characterizing and evaluating the yield potential of local cultivars. Selected varieties were distributed to farmers. However, farmers grew different varieties on the same farm and the subsequent outcrossing caused the varieties to deteriorate rapidly. Attempts to combine yield components did not result in the development of varieties higher in yield than the improved local selections. Efforts to develop non-shattering varieties for mechanical harvest also did not succeed.

In 1975 a cooperative programme between the University of California, Riverside and the Agricultural Research Corporation, funded by UNDP, was launched. In that project crosses were made at Riverside and selection undertaken at Kenana Research Station (Abu Na'ama). The project was successful and two selections were released: 'Kenana-1' (UCR770011-32) and 'Khider' (UCR 770192). Later, Kenana-2 and Promo were released. Promo is a variety selected from introduced materials of temperate origin (Greece) characterized by high branching, medium duration, even maturity and delayed shattering. Promo is considered the most popular improved variety among farmers.

In 2003, Um Shagara and Gedarif-1, were released. Gedarif-1 is a variety selected from segregating materials of crosses between temperate and tropical cultivars. It is characterized with non-branching habit, medium -late duration to flowering and good vigorous habit of growth. Um Shagara is selected from segregated materials of crosses between introduced and local cultivars. In 2012, a new sesame variety was released named Elgizouli. It is selected from segregated materials of crosses between introduced and local cultivars, characterized by high branching, long capsule, white seed and even maturity.

Local landraces of sesame are grown widely in the traditional sector. In Kordofan the farmers grow early maturing Hirahiry, medium maturing Gabarouk and late maturing Gabaly while in eastern Sudan they are called Khafif for early maturing and Tageel for late maturing landraces. The low productivity of local landraces limited their direct utilization as commercial level varieties in large scale production as new early maturing varieties are available. Recently a black sesame seeds is requested for exportation for medicinal purposes and there is one variety under process to be released.

Sunflower: Research on sunflower started at Abu Na'ama Station in the 1980s resulted in the release of two open pollinated varieties given the names 'Damazin-1' and 'Damazin-2'. The private sector pioneered the commercial production of the crop by planting imported unreleased hybrids. Introduced hybrids were evaluated by ARC and ASSCO resulted in release of several hybrids ('Hysun-33' from Pacific Seed Company of Australia, 'Juwalamukhi' from Proagro of India; and 'PAN-7392,' 'PAN-7355,' 'PAN7351,' and 'PAN-7371' from Pannar Seed Company of South Africa). The Faculty of Agriculture, University of Khartoum was the first to develop local hybrids; 'Shambat' and 'Salih'. Subsequently ARC developed three hybrids: 'Buhuth-1,' 'Buhuth-2,' and 'Buhuth-3'. (Annex I)

Soybean: There are two varieties of soybean released namely Sudan-1 and Sudan-2.

4.1.5 Variety Release Process

The Seed Council issued the National System for Testing and Releasing Varieties in Sudan on steps to be followed on submitting a new variety for release¹⁰. The breeder has to review the environmental conditions that contribute to the success of the variety they intend to produce, as well as farmer-preferred characteristics such as yield, marketability, palatability, water requirements, input requirements and socio-economic aspects before submission for release.

The process of variety release involves:

- a) Reporting from other research stations' testing on the DUS and VCU aspects of the bred variety,
- b) Producing a full description of the morphological characteristics of the variety,
- c) Compiling all reports on the variety by the breeders and submit to the Variety Release Committee for review and decision. The Variety Release Committee meets when requested by the NSA and ARC.
- d) Suggesting a name for the new variety

4.1.5.1 Varieties Released between 1913-2020

The earliest breeding work in cotton started in 1913 and bread wheat started in 1940 where many wheat varieties were released. The first variety of sorghum was released in 1957 followed by release of many varieties of crops in successive years. Table (4) shows crop varieties released from 1913-2020, where 63 sorghum varieties were released in Sudan, representing more than 20 percent of the 306 field crop varieties released. Sorghum is followed by cotton and bread wheat varieties. Table (4) also shows that additionally 95 horticultural and 2 forest crops varieties were released in this period, or 403 varieties in total

¹⁰ Seed Council (17 Dec 2013): National System for Testing and Releasing varieties in Sudan

Breeding of horticultural crops began later in 1970s with faba beans and onion. The varieties released in vegetables and fruits are also shown in Table (4). The breeding on fruits is limited to grapefruit, sweet orange, mango, citrus yousifi and banana.

Table (4): Summary of Crop varieties released between 1913 and 2020

Horticulture crop & forest species	Number of varieties released	Field Crop species	Number of varieties released
Garlic	1	Pigeon pea	1
Melon	1	Roselle	2
Banana	2	Soybean	4
Forestry	2	Rice	4
Mango	2	Cowpea	4
Squash	2	Durum Wheat	5
Sweet Potato	2	Common bean	5
Grapefruit	3	Pea	5
Citrus Yousifi	3	Millet	7
Lentil	3	Chickpea	8
Okra	3	Sesame	13
Sugar Beet	4	Groundnut	13
Onion	5	Sugarcane	14
Sweet orange	6	Faba bean	16
Watermelon	9	Maize	26
Potato	23	Bread Wheat	33
Tomato	26	Sunflower	36
Forest crops	2	Cotton	47
		Sorghum	63
<i>16 horticultural crops + 2 forest</i>	97	<i>19 field crops</i>	306
TOTAL %	24%		76%

The varieties released for the farming zones that are currently used by the farmers where SSA was conducted are shown in Table (5).

Table (5): Varieties Released Suitable and Available to Farmers (Complete the table)

Farming Zone	Crop	Variety Released
<i>Traditional Farming–Sandy Soils</i>	Sorghum	<i>Arfa Gadamak</i>
	Millet	<i>Ashana</i>
	Groundnut	<i>Sodari, Gebaish</i>
	Sesame	<i>Promo</i>
<i>Savannah/clays Traditional Farming</i>	Sorghum	<i>Wad Ahmed, Tabat</i>
	Millet	<i>Ashana, Wadelbasheir, Faris, Dimbi</i>

	Groundnut Sesame Cowpea	<i>Gebaish, Sudari, Barberton Promo Ain El gazal, Baladi cultivars</i>
<i>Semi-mechanized farming</i>	Sorghum Groundnut Sesame Cotton Sunflower	<i>Wad Ahmed, Arfa Gadamak & Tabat Gebaish Promo, Kenana 2, Um Shagara, Algozuli, Gadarif-1, Seeni 1, Seeni2, RR Hysun 33, Bohooth1, Bohoot2, Bohooth3, Jwalmukhi, Karam Aguara 4, Sirena,</i>
<i>Irrigated Schemes/ Central Clays</i>	Sorghum Groundnut Wheat Cotton	<i>Tabat & Wad Ahmed Medani, Nileen, ELTagana Bt-cotton Seeni 1, Seeni2</i>
<i>Irrigated Farming /pumps</i>	Fodders Wheat Onion Tomato Potato	<i>Abu Sabeen & Alfalfa Condor, Debiera, EL Neileen Baftaim, Strain-B, Introduction Elmundo</i>
<i>Irrigated Farming/ Riverine pumps</i>	Wheat Broad beans Onion Potato Tomato	<i>Emam, Eltagana Bohein& Jawahir Suliam , Improved Suliam Aldonglawy (balady), Zafira Draga, Belleni, Burren, Safari Jelly, Introductions</i>
<i>Spate Irrigation</i>	Tomato Sorghum Millet	<i>Local varieties, St B Aklamoi (local landrace), Tabat, Wad Ahmed Tokarawy (Local)</i>

Source: Developed by Hanan Abdelmutalib and Mahmoud Nouman 2022

4.1.5.2 Evidence of farmer's preference on crops varieties

The reasons that landraces are preferred by farmers to improved varieties can be summarized in the following:

- Seeds are selected and saved by farmers and available at village or local markets, or from other farmers.
- Compatible to the environment, though landraces may have variable responses to different environments.
- Informal seeds are lower in price compared to certified seed, and is available in local markets.

4.2 Formal Seed Multiplication

The establishment of the formal seed sector goes back to 1902. It started with the introduction and trials of new cotton germplasm for adaptation in the country. It was a new economically important crop for the colonial authorities. Later, in 1918, the Gezira Research Station was established to serve the intended Gezira Scheme with a more developed breeding and other research activities. In 1967 the research authority was changed to the Agricultural Research Corporation (ARC) of which the Plant Propagation and Improvement Department (PPID) was a part of the discipline. In 1968 the PPID separated from the ARC to be an independent specialized body to develop the seed system in the country.

With the increase of seed demand and the new policy of the government in 1992 to withdraw from production and leave it to private sector, the Seed Administration of the Ministry of Agriculture became the regulatory seed authority supervising the seed production by the private sector and other public or parastatal seed units in the country. The infrastructure and production assets of the Seed Administration became the share of the government to form the Arab Sudanese Seed Company (ASSCO). ASSCO is a parastatal company working according to market-oriented policies.

4.2.1 The current situation:

This SSA found that the informal sector produces about 86 percent of the seed planted by farmers, with the formal seed sector providing about 14 percent of seeds in Sudan. The reasons for this is the inadequate facilities of the formal seed sector for producing quality seed and high costs of certified seeds. The seeds produced by the informal sector are accessible at any time, affordable and preferred by farmers. Using quality seed is important for increasing productivity, and is considered the cheapest input compared to other inputs costs such as fertilizers and pesticides/ herbicides.

4.2.2 Formal seed sector:

The formal seed production is led by private seed companies and public units. The public units for seed production in Gezaira, Rahad and New Halfa Schemes have some contribution in provision of certified seeds for the farmers in the irrigated sector especially seeds of cotton, sorghum and groundnuts. The challenge for the formal seed sector is to expand and attract more farmers to adopt and use certified seeds varieties.

The Seed By-laws specify clearly the production of seeds starting from land history, seed category, percentage of off-types and diseased plants, inspection of fields, harvest and lots then processing of seeds, seed testing and seed tags/labels. Sample taking from Agro-dealers and seed companies' stores for testing quality to insure compliance of seed labels on containers and quality of stored seeds.

Table (6) show the components of the main seed system activities and the main actor responsible of production of seed categories, inspection, quality control, marketing and promotion along the seed value chain.

Table (6): Activities and Actors along the Seed Value chain

Activity	Main Actors
Plant Breeding and Introduction of New Improved Varieties	<ul style="list-style-type: none"> • ARC • Universities and research centers • Private seed companies • Local agents for seed companies
Early Seed Generations and Parental Lines Producers and Suppliers	<ul style="list-style-type: none"> • ARC seed unit • ARAB Sudanese seed Co. (ASSCO) • Other private seed companies • Companies' agents (introduced varieties from foreign companies)
Certified Seed Production	<ul style="list-style-type: none"> • ASSCO and other private Co. • ARC seed unit • Seed units in Agricultural corporations and states • NGO's programs • Individual registered seed producers
Marketing and Distribution	<ul style="list-style-type: none"> • Seed companies (direct selling points / Agrodealers and agents) • State ministries of Agriculture • Agricultural corporations and schemes • Agrodealers (local markets and village level)
Variety Release and Registration	<ul style="list-style-type: none"> • Variety Release Committee and National Seed Council
Quality Control	<ul style="list-style-type: none"> • General Seed Administration • ARC • Plant Protection Administration • Sudanese Standards and Metrology • Biosafety Authority
Extension /Promotion / Awareness Creation	<ul style="list-style-type: none"> • Extension services, Agricultural Corporations, companies, Service providers and agro-dealers
End Product Users supporters Initiatives	<ul style="list-style-type: none"> • Millers, Vegetable Oil, Textile Industry and Product Exporters
Training and Capacity Building of Staff and Infrastructures	<ul style="list-style-type: none"> • The State Organization, National and International centers, Companies, NGOs and UN agencies(FAO, IFAD...etc.
Agricultural Financing Services	<ul style="list-style-type: none"> • Agricultural Bank of Sudan • Commercial Banks • Micro-finance Institutions

Source: Mubarak Mutasim, Seed Administration 2022

4.2.2.1 Seed Laboratories

The working seed laboratories for seed testing in Sudan are shown in Table (7) below:

Table (7): Seed Administration Seed Testing Laboratories in Sudan*

Location of Seed Laboratory	State
Khartoum Central Laboratory	Khartoum State
Sennar Laboratory	Sennar state
Port Sudan Laboratory	Red Sea State
Gedarif Laboratory	Gedarif State
Hudieba Laboratory	River Nile State
Nyala Laboratory	South Darfur State
ElObeid Laboratory	North Kordofan State

**Data compiled by Mubarak Elmutasim, Seed Administration 2022*

The annual seed tests conducted are around 1635 samples and the main tests carried were seed purity and germination tests mainly for crops grown by the seed companies and inspected by the Seed Administration

4.2.3 Development and acquiring new improved plant varieties:

The breeding activities in Sudan are carried out by ARC and universities while the seed companies lead the breeding activities in the private sector.

ARC: Most of the breeding activities in the country are carried by ARC researchers. Other varieties introduced by private companies or from other breeding activities outside ARC are introduced in collaboration with ARC scientists for trials and release by the Variety Release Committee (VRC).

Private Sector: In a later development, varieties introduced or bred by scientists from private companies and universities are accepted by the VRC and some of these are recognized and now on the National Variety List. The following are the main companies involved in plant breeding in the country:

- Arab Sudanese seed company (ASSCO)
- Kenana Sugar Company (Cane plantation)
- Green Lakes Company (vegetables, mainly tomatoes)
- Nectar group (Sorghum, Maize, Vegetables)
- Nile Sun (sorghum, sunflower, vegetables)

4.2.4 Seed Importation and Exportation Requirements:

The Seed Administration is responsible for the importation and exportation of seeds in the country. The following are the requirements for seed importation by seed companies or enterprises:

1. Registration with Seed Administration
2. Proforma invoice stating origin – quantity – variety-port of entry.
3. Application supported with the above information.
4. Provisional approval from undersecretary of the ministry of Agriculture to get the importation permit.

5. Certificate of origin of seeds.
6. Phytosanitary certificate from the origin.
7. Seed testing certificate from a recognized organization e.g. ISTA.
8. Non Genetically Modified (NGM) crop variety certificate.
9. Local quality control organizations acceptance S.A., Sudanese standards and metrology organization (SSMO) and National Plant Protection Directorate (NPPD).

On the other hand the requirements for seed exportation by seed companies or enterprises are:

1. An application on headed paper and the stamp of the exporter showing the crop, the variety, the quantity, and port of departure.
2. The application should be accompanied with the following documents:
 - Selling contract approved by the Ministry of Trade.
 - Seed analysis certificate.
 - Phytosanitary certificate.
 - Seed should be labelled.
 - For forestry materials, no objection letter from National Forestry Corporation.

4.2.5 Trends of Change on Seed Industry

The seeds industry in Sudan is progressing very slowly due to the political instability in the country, high investment requirements for establishing seed enterprises, and low farmer income. Most released varieties are open pollinated and can be propagated by farmers for several years, most of the seeds are sold to MoAF on credit basis, and there is low acceptability of new varieties by farmers. The following are the main challenges facing the development of the formal seeds sector in Sudan:

- *Seed Law*: The first Seed Law was issued in the year 1990 followed by the Seed Regulations 1992. It reflected the seed supply system which was dominated by the public sector and lead by the Seed Administration and the Seed Units in the Agricultural Schemes and Corporations. The government policies in 1992 adopted privatisation of production including seed production. The new policy was reflected in National Seed Conference of 1995 which suggested the gradual withdrawal of the public sector and encouraging the private sector to take the lead.

After the Comprehensive Peace Agreement (CPA) in 2005 and the new constitution of the same year which adopted federalism and self-governance for South Sudan the Seed Law, among others, needed to be revised to comply with the new constitution. Hence the current Seed Law was issued in the year 2010 followed by the Seed Regulations in the year 2012.

With the efforts of the country to join the WTO and to encourage foreign investment in the sector, the government required to adopt a law that complies with Plant Variety Rights Protection (PVRP). Based on that it was suggested to issue two separate laws. Accordingly the two Seed Law drafts were completed in 2016 and 2017; one for seed production and other for the protection of new varieties and were submitted to the Ministry of Justice. The new Plant Varieties Protection draft of 2016 is based on the International Protection Regulations (IPR) while the Seed Law draft of 2016 focused on regulation to boost seed production. The new seed laws suggested aim to encourage foreign seed companies to invest in the seed sector in Sudan under the offered protection for their germplasm and genetic materials.

- *Private Plant Breeding:* In the field of plant breeding more private seed companies started to have their own breeding programmes. Progress in seed industry for some crops is linked with production of hybrids to ensure more regular purchases by farmers.
- *Storage Capacity for seeds:* Processing capacity and storage facilities are of acceptable capacity in volume but not well distributed in the country to cover differed agro-ecological zones that can be reached with difficulty due to weak transportation means and paved roads. New facilities need to be constructed in areas lacking them for availing quality seeds near to farmers. Good store are important to keep the quality of seeds for marketing places.
- *Quality of Products:* Some of the end users of the products like oil mills and food companies started lead programmes for involvement in certified seed production to produce seeds of certain quality for contractors to meet the specification required for export.

4.2.6 Constraints Facing the Seed Industry:

- Most of seeds varieties released are open pollinated varieties, and there is no strong protection for plant breeders' rights that limit farmers to produce and use the seeds for many generations.
- The size of the seed market is comparatively small; this SSA estimates that 14 percent of total requirements come via the formal sector.
- Weak government institutions involved in seed certification (SA) and extension services.
- Credit terms are not encouraging for investment in seed industry.

The most important areas that require strong immediate efforts to make real progress:

- Formation of an independent, efficient, and fair variety testing system for DUS and VCU.
- ISTA accreditation of seed laboratories or at least have recognition to improving the acceptance of the seed testing laboratories.
- Securing plant variety protection and breeder's rights in accordance with UPOV requirements or another means.
- Facilitate seed trade within the region to expand the seed market for growing of the seed industry.

Currently, the Seed Administration is a member of many international organization such CBD, AFSTA, AFISF and looking for membership in OECD, ISTA and UPOV.

4.3 Informal Seed System

The informal seed system is sometimes referred to as local, farmer, or traditional seed systems and based on farmer-saved seed. These systems are dominated by farmer-saved seed where farmers themselves produce, disseminate, and access seed directly from their own harvest, through exchange and barter among friends, neighbours, and relatives. It was observed that some seed traders are also involved in seed production and grow big areas with the most popular varieties for marketing. Varieties/local landraces in the informal system may be variants of improved varieties originally sourced from the formal system or they may be landrace varieties developed over time through farmer selection. Seed is produced and often sorted as an integral part of the farmers' grain production, rather than as a discrete seed production business.

Local technical knowledge is the main factor in informal seed system performance, including the requirement of local markets. Some of the released varieties are used in production of informal seed by farmers for many generations, such as Arfa Gadamak which is turned into populations of Arfa Gadamak crossed with other sorghum varieties and Sudan grass weed (Adar).

The informal system provides most of the popular seeds the farmers use because of its ability to meet local needs and preferences. Farmers normally obtain their seed from both formal and informal channels for different kind of crops. It is also not unusual for a household to meet its needs for a single crop from different seed channels. Table (8) shows some essential differences between formal and informal seed system.

Table (8): Some Differences between the Formal and Informal Seed System

<i>Criterion</i>	<i>Formal Seed System</i>	<i>Informal Seed System</i>
Seed selection	Researchers and companies selection	Farmers select and save
Supply	Private companies, government and/or researchers multiply and sell seed	Farmers exchange, borrow and/or buy seed from family, neighbours and local markets
Seeds packaging	Quantities in standard weight unit (kg per pack)	Local volume measurement used (Kella and / or Mullwa)
Seed Quality	Seed is certified and quality is assured	Quality not assured through any organised process
Traits of varieties offered	Often high-yielding and disease resistant varieties of some major crops; sometimes short-duration (depends on traits that have been bred)	Mainly local varieties of a range of locally important crops or modern varieties have been cycled within local system. Good adaptation and cooking qualities
Variety Genetic base	Narrow uniform genome (variety)	Broad genepool (landraces)

Source: Hanan Abdelmutalib /GARS 2022

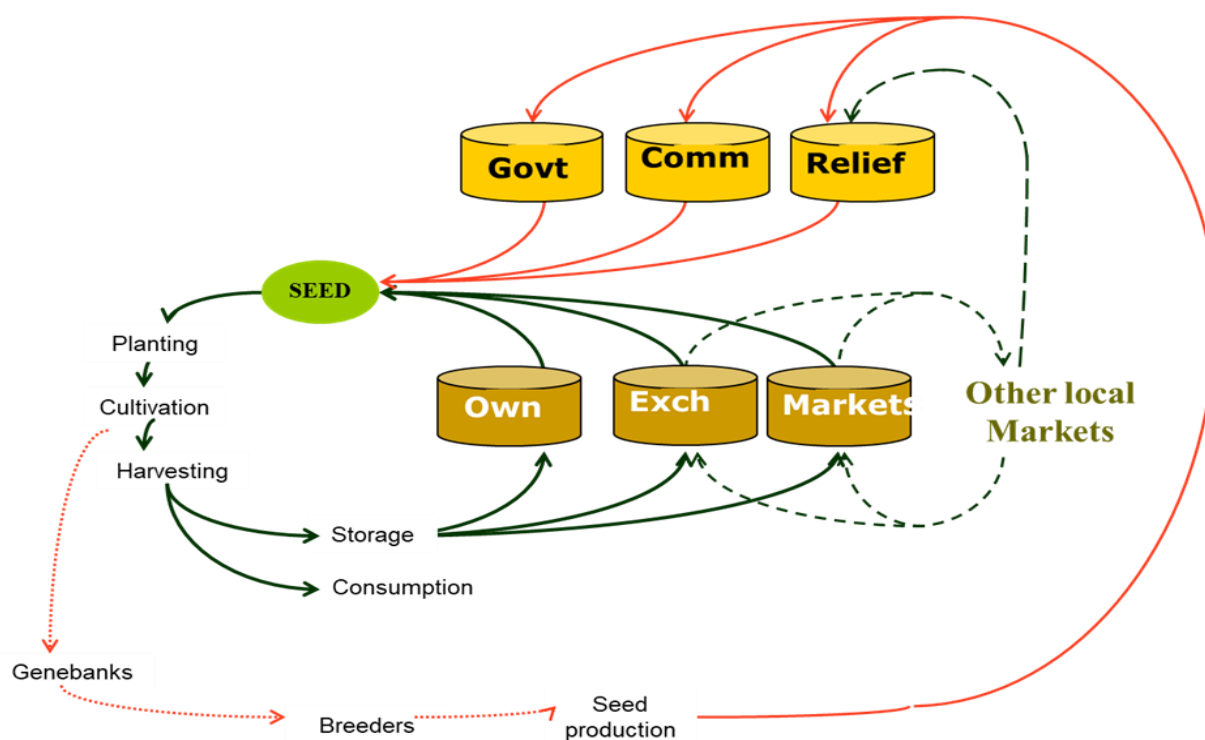
The informal seed is the major source of seeds, however it is neglected and there is no plans to develop this sector or improve the seed production except some efforts carried out by NGOs to establish seed banks and train the community in production of good seeds. The role of the extension in production of quality seed is absent as there is efforts exerted in increasing the awareness of farmers in production of quality seeds through used of certified seeds, field inspection and certification of their crops.

4.4 Seed Supply

4.4.1 Seed Sources

Various sources contribute to seed supply and availability in the market including formal and informal systems (Fig 1). The RED lines broadly describe the formal sector and in this case, seed companies and agro-dealers.

Fig (1): Source of seeds to farmers



Source: Modified from Almekinders and Louwaars 1999

The Dark Green lines reflect the farmer-managed or what some people call the informal seed system. This typically provides about 86% of what farmers' plant in Sudan, depending on the crop. Around the world, farmers are in multiple seed systems are few, if any, farmers are entirely in the formal system for all their crops. Outside of the most industrialised countries, we typically see a real mix of different seed systems used by farmers.

4.4.1.1 Formal Sector Contribution:

Seed production under certification scheme includes mainly field crops and to a lesser extend some vegetables, legumes, and others that contribute to improve productivity of the crop in the country (Table 9).

Table (9): Quantities of Certified Seed Produced (MT) between 2012 and 2019

Year	2012	2013	2014	2015	2016	2017	2018	2019
Sorghum	19740.6	18768.3	22799	22862.6	26258.1	21202.4	18445.1	18776.8
Groundnut	2629.3	3629.8	910.5	1414.9	1431.3	3191.3	1509	1278.2
Sesame	639.3	673.4	614.9	490.5	1256.8	1558.2	947	1011.1
Maize	81.2	138.4	606.5	2.3	4.25	15.7	1.3	0.9
Millet	1142.2	316.1	606.5	413.4	65.7	84.1	244.3	409.1

Cowpea	13	254.3	0	14.74	47.9	118	72.4	27.6
Okra	20.7	56.3	90.5	102.9	77.3	141.1	50.1	31.9
Cotton	4302.9	3872	765.8	292.3	8640.6	11807.5	10201	4389.2
Sunflower	254.6	96.3	207.2	71.4	69.3	0	7.2	0
Soybeans	0	0	0	46	275.4	135	401.1	271.9
Watermelon	0	0	0	0.6	1.9	24.9	80	0
Forage crops	0	0	0	0	0	0	0	15.8
Rosette	0	0	0	0	0	0	0	1.4
Rice	0	0	0	0	0	0.7	0.5	0.3
Wheat	12604.4	12579	-	24214.9	15096.7	1520	50232.1	55309.2
Total	41428.1	40383.9	26600.9	49926.6	53225.1	39798.2	82190.4	81522.7

**Source: Seed Administration, MoAF 2019*

The comparison between the total seed requirement of the main crops in Sudan and the total seed produced shows a big gap between what is required and available. Table (10) indicates that the cotton seeds annual seed requirement are 100 percent satisfied because cotton is considered a strategic and economic crop for exportation and its seed is produced directly by ARC. The estimated coverage of wheat, sorghum, millet, sesame and groundnut are 65, 29, 3.3, 6.5 and 1 percent, respectively (Table 10). The areas of wheat is less than 400,000 hectares and there is focus from the government to avail farmers of these seeds. The seed production units in the big irrigated schemes and companies are engaged in seed production of wheat as one of the strategic food crops in Sudan.

Table (10): Annual Seed Requirement, Production and Coverage of Certified Seeds

Crop	Annual Seeds Requirements (MT)	Average Annual Seeds Production (MT)	Estimated coverage of certified seeds (%)
Sorghum	71,673	21,106.6	29%
Groundnut	188,375	1,999.2	1.06%
Sesame	13,824	898.8	6.5%

Maize	757.5	106.3	14%
Millet	12,379.6	410.2	3.3%
Cowpea	9,740	78.3	0.8%
Okra	-	71.3	-
Cotton	4,000	5,533.9	100%
Sunflower	950.4	117.7	12.4%
Soybeans	-	225.9	-
Watermelon	-	26.9	-
Forage Crops	-	15.75	-
Rosette	-	1.4	-
Rice	-	0.47	-
Wheat	37,400	24,508.1	65%

* Source: Adapted by Mubarak Mutasim, Seed Administration, 2019

The cotton and sugarcane are the two main crops having special arrangements for seed production. Cotton seed is looked after by Sudan Cotton Company and other private companies in collaboration with Cotton Department in ARC. Sugarcane breeding programme is designed by ARC for public seed plantation and by Kenana Research Unit for Kenana Sugar Company (KSC) cane plantation to produce planting material for KSC sugar cane factory.

4.4.1.2 Informal Seed Sector Contribution:

Most of the seed used in agricultural sector comes from farmers retained seeds, community farms or local markets. In Sudan, statistics show that about 86% of the seed used in crop production are from farmers' retained seeds. These seeds come from local varieties and land races kept by farmers or from improved varieties that not inspected officially by Seed Administration. The local seeds are mixture of improved seeds and land races or mixture of local seeds. Table (11) shows some popular landraces for sorghum, millet, sesame and groundnut crops in the Sudan.

Table (11): Some Popular Landraces for selected crops in the Sudan.

Region	Landraces
<i>Sorghum</i>	
El Butana (Low Rains)	Feterita Geshaish
South Kordofan	Kulum, Karamaka, , Najjad, Ghalla, Korgi
Kordofan	Zinnary, Abu Digin Wad El Gusair
Darfur	Berberi, Haja Banat

Northern (Gezira, Gedaref and Northern states)	Hemaisi, Dibaikri, Mugud. Safra, Mugud, Himaisi, El Aab Jaro, Wad Baku, Korakolo, Arfa Gadamak
Gash & Tokar	Aklamoi, Hagartie, Baham, Hijairi Tokarawy.
Millet	
Kordofan	Dembi, Aish Bernu, Hammir, Sharoba
Darfur	Bauda
Tokar Delta	Tokarawi
S. Kordofan	Mana
Sesame	
All over Sudan	Tageel (late maturing)
	Khafeef (early Maturing)
	Hiraihri (Early Maturing in N. Kordofan)
	Jabaroak (Medium maturity)
Groundnut	
Abu Heibeilat	North Kordofan

Source: Adapted by Mahmoud Nouman from Hassan Khalifa: Proceedings of a Workshop on Seed Needs for Small-Scale Farmers Affected by Disaster, 2022

5. SSA FINDINGS

The SSA took place in six admin Units/localities in six states Table (12) from 27th December 2021 to 3rd February 2022 due to instability in Khartoum and security clearance to some areas. The collection of data went well due to good organization in the targeted states and experience of data collectors (Annex 4)

5.1 Sites of SSA

The SSA conducted in six states and in each state one locality is selected for taking data on the various aspects of SSA. The sites are shown in Table (12) below.

Table (12): Sites of SSA

State	Locations of SSA samples
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North Kordofan	Shikan Locality (Faris , Forry and Um Abu Saadain)
South Darfur	Belail Admin. Unit (Belail Village)
Gedaref	Gedaref Locality (Gadambalia and Abuelnaga)
Gezira Scheme	Wad Medani Locality (Hamadnalla Block)
Khartoum	Khartoum Locality (Elfaki Hashim Village)
Northern	Elselaim Admin. Unit (Elselaim)

5.2 Samples Collected

The total samples collected from the targeted sites for the SSA questionnaires are shown in Table (13). It is worth noting that HHs data were collected using Kobo software in tablets (smart phones). HHs data were analysed using SPSS.

Table (13): Samples Collected from the Locations of SSA

<i>Tool</i>	<i>SD</i>	<i>NS</i>	<i>NK</i>	<i>Ged S</i>	<i>GS</i>	<i>Kh. S</i>	<i>TOTAL</i>
Individual HH Questionnaire	60	60	64	64	60	60	368
Seed Producers group/individuals	2	2	2	4	0	2	12
Focus Group men farmers	1	2	3	3	1	1	11
Focus Group women farmers	1	0	3	2	1	1	8
Agro-dealers	2	2	2	1	2	2	11
Agro-processors	2	2	2	3	2	2	13
Traders	2	2	4	5	2	2	17
Seed Companies	2	1	1	2	2	2	10
Key informants- Officials	2	2	2	1	2	2	11
Key informants- NGOs	3	0	2	2	0	0	6

The general observation on the data collected are:

- Seed production in the states is handled by seeds companies and farmers while in Gezira Scheme the Seed Unit handles the production of seeds.
- Farmers' women are not active in agriculture in Northern state however the migrated women from other parts of Sudan are the main labour force in agriculture and the market.
- NGOs dealing with agricultural activities and seeds improvements have no presence in Northern, Khartoum and Gezira states.
- Agro-dealers are active in the main towns and selling agricultural inputs beside crop seeds and vegetables seeds.
- Agro-processors are found in villages and towns for processing wheat, dura, groundnut, sesame and dried spices.
- Potential seeds for sorghum, groundnut, and faba beans are available with seed producers, and traders.

- The total households interviewed was 368. The average household size is 6-7 persons. The female head of household is the highest in North Kordofan (43.8%) and zero in of Northern state (Table 14) indicating that the site of SSA (Elselaim) is stable and has not been subject to natural or man made disasters (drought or war). It was expected that the number of headed household in Darfur is higher due to unceasing instability in the region and fighting.
- In total, about 62% of households have cultivated an area between 1-10 feddan and 38% cultivated more than 50 feddan. It is worth noting that the holding of some HHs include the farmer's tenancy and wife/relatives especially where men are working outside Sudan. In Gezira there are some farmers are also responsible of the land owned by their relative who is working outside the state.

Table (14): Household Size and Per cent of female and male headed HH

State	Average HHs size	% Female Headed HH	% Male Headed HH
Gedaref	7	36.6%	63.4%
North Kordofan	7	43.8%	56.3%
Gezira	7	12.5%	87.5%
South Darfur	7	20.0%	80.0%
Northern	6	0.0%	100.0%
Khartoum	7	3.3%	96.7%

- The main food crops cultivated in the SSA assessed are wheat, sorghum, millet and some faba beans, groundnut while the major cash crops are faba beans, wheat and fennel in Northern state; onion, eggplant and vegetables in Khartoum state; and wheat, groundnut, cajanus and cotton in Gezira; sorghum, groundnut and sesame in SD and NK.
- New crops introduced are sesame, watermelon and watermelon for seeds in Northern state, cajanus is replacing cotton in some parts of Gezira Scheme; and sunflower, guar, rain-fed cotton, soybeans and watermelon for seeds in Gedaref state.

5.3 Sources of Seeds

The main seed sources in Sudan are from formal and informal sector. The formal sector consist of seed companies and public seed units in the major irrigated schemes and in some units in rain-fed agriculture such as Gedaref and South Darfur. The informal sources included farmer' saved seeds, seeds from local market, bartering between farmers and seeds from neighbours as a gift or lending. The seeds from formal sector are certified seeds obtained by farmers from agro-dealers, small shops of seed companies, distribution from MoPER and NGOs and seeds offered by the seed units in the major irrigated schemes.

5.3.1 Sources of Seeds in 2021

- The farmer' saved seeds and seeds from local market composed about 87.2% of the seed sources for farmers in 2021 representing the contribution of the informal seed sector that can be accessed by the farmer, while the certified seeds from Agro-dealers, government and NGOs distribution is about 12.8%. This indicated clearly that farmers have easy access to informal seeds and can be obtained at time for planting.

Table (15): Source of Seeds for Farmers in 2021

Source of Seeds in 2021				
Farmer's saved seeds	Local market	FAO/NGOs	Government	Agro-Dealers
35.7%	51.5%	7.4%	1.4%	4.0%

- The high contribution of informal seed production is attributed to preference of local varieties, easy access of local seeds through borrowing from farmers or lending from local market and local merchants and availability at time of planting compared to high prices of certified seeds, difficulty in obtaining certified seeds at time of planting. The farmers in many cases use their saved seeds for cultivation in next season.
- FAO and NGOs were active in distribution of seed and tools in 2021
 - FAO in 2021 distributed 1,241 MT of sorghum, millet, groundnut, sesame, cowpea, pigeon pea (cajanus) and chick pea in Darfur, Gedaref, Kassala, Sinnar, Blue Nile and Red Sea states that represent about 10% of the requirement of seed for small farmers.
 - WVI distributed seeds (GN, sorghum, millet and vegetable) using seed vouchers, seed shows and free distribution in 14 localities. WV established seed banks and seed production in four localities.
 - NUHA distributed free seed of Millet, sorghum, GN, vegetable and maize), goat restocking, and capacity building in two localities. In addition, conduct capacity building of farmers in technical packages, provision of seeds suitable for each area and extension services in coordination with the partners
 - ZOA in Gedaref have seeds interventions and technology transfer to support small farmers in the state and some intervention in soil management and drought.
- MoPER used to distribute subsidized seeds of sorghum, millet and groundnut very year to farmers. In 2021 MoPER in SD distributed about 153 MT of Wad Ahmed and Arfa Gadamak to farmers. The amount distributed represented about 4% of the state requirements for seeds.
- The sources of sorghum seeds indicated that farmers tends to use certified seeds (5.4%) from agro-dealers and contracts plus 7.2% from distribution by MoPER and NGOs (Table 16) which is more or less the same finding of the sources of seeds for farmers in 2021 (12.8%). It was observed during the FGD that farmers used the certified seeds in the first season and keep seed for planting in the coming seasons leading to mixing of varieties. Replacement of local seeds with certified seeds usually take place when the land is infested with Sudan grass weeds (Adar).

Table (16): Source of Sorghum Seeds for Farmers in 2021

Source of Sorghum Seed for Farmers in 2021				
Farmer's saved seeds	Local market	Government/NGOs	Agro-D	Contracts
46.1%	41.2%	7.2%	4.2%	1.2%

- The farmer's plan for obtaining seeds for cultivation in the next season 2022 has not changed very much as they will tap the same sources used in the previous season. (Table 17) showed that farmer's saved seeds and selling/buying from local market are the main sources in the next

season. The distribution of seeds by government and NGOs is less compared to 2021 as the seeds were delivered late in 2021.

- The easy access to local seed and flexibility of traders in offering credit for farmers are the major factors for farmers to continue using local seed. The Shail system is used by traders in borrowing seeds and food where the traders offer seeds and food for the farmer during the planting season and at harvest the farmer paid the amount borrowed from the trader in kind.

5.3.2 Sources of Seeds from 2016- 2021

- The seed sources used by farmers in the last five years (2016 -2020) are ranging from 60%-100% from farmers' saved seed in Northern state, South Darfur, Khartoum, Gedaref and southern parts of North Kordofan state while in the northern parts of NK seeds from market/traders are the main source of seeds as mentioned in the Focus Group discussions. Cotton seed in Gezira is provide by contracting seed companies and the Seed Unit of Gezira Scheme.
- In the last five years, MoPER in SD, NK and Gedaref distributed annually sorghum, millet, sesame and groundnut plus vegetables for 5-7% of the seed requirement of the small farmers on subsidized basis. FAO is the major seed distributor as the head of Food Security and Livelihood sector they sell seeds and distributed them for various states according to their projects. The per cent of farmers who received seeds in the last five years is about 10-15. In Khartoum seeds is obtained on loan basis from Agricultural Development Fund / Government.
- The Agrodealers and seed distributed by MoPER and NGOs represent the certified seed source for farmers
- FGD indicated that the expected traders contribution in provision of seeds for next season (2022) for faba beans is (25%) in NS, and 80% to 90% of sorghum, millet and sesame in NK. The certified seed expected for next season that will be availed by Agro-dealers' and NGOs and government distribution is (50%, -80%) for Sorghum, groundnut and sesame in SD, vegetables (20%) in Khartoum, 70% of groundnut in northern NK and 20% for crops grown in Gedaref (Table 17). It is observed that there is no big changes in the sources of seeds regards the farmers saved seeds in the last five years (2016-2021 and for 2021 and 2022

Table (17): Seed Sources for Small Farmers in the Last Five Years and 2021 &2022

State	Crop	Source of Seeds				
		Farmers saved% in 2016-2020	Farmers saved in % 2021	Farmers saved % for next year	Traders next year (2022)	Agrodealers /NGOs- MoPER (2022)
Northern State (NS)	<i>Wheat</i>	100%	100%	100%	0%	0%
	<i>Faba beans</i>	75%	75%	75%	25%	0%
	<i>Fennel</i>	100%	100%	100%	0%	0%
South Darfur (SD)	<i>Sorghum</i>	100%	60%	20%	0%	80%
	<i>Millet</i>	100%	90%	100%	10%	0%

	<i>Groundnut</i>	100%	80%	50%	0%	50%
	<i>Sesame</i>	100%	100%	50%	0%	50%
<i>Khartoum</i>	<i>Faba bean</i>	60%	60%	60%	20%	20%
	<i>Onion</i>	60%	60%	60%	20%	20%
	<i>Eggplant</i>	60%	60%	60%	20%	20%
<i>north/ North Kordofan (NK)*</i>	<i>Sorghum</i>	10%	10%	10%	80%	10%
	<i>Millet</i>	10%	10%	10%	90%	0%
	<i>Sesame</i>	10%	10%	10%	90%	0%
	<i>Groundnut</i>	10%	10%	10%	20%	70%
<i>South/ North Kordofan (NK)*</i>	<i>Sorghum</i>	90%	90%	90%	10%	10%
	<i>Millet</i>	90%	90%	90%	10%	0%
	<i>Sesame</i>	90%	90%	90%	10%	0%
	<i>Groundnut</i>	10%	10%	10%	80%	10%
<i>Gezira</i>	<i>Wheat</i>	60%	60%	60%	20%	20%
	<i>Sorghum</i>	25%	25%	25%	40%	35%
	<i>Groundnut</i>	68%	68%	68%	18%	14%
	<i>Cotton</i>	0%	0%	0%	0%	100%
<i>Gedaref</i>	<i>Sorghum</i>	80%	80%	80%	0%	20%
	<i>Millet</i>	80%	80%	80%	0%	20%
	<i>Groundnut</i>	80%	80%	80%	0%	20%

*North of North Kordofan where the rainfall are less than 300 mm/annum while in the south of the state is between 300-450 mm / annum

- Table (17) shows data from the HHs survey for the expected sources seeds in 2022 where farmers will obtain about 89.6 per cent from informal sources while the share of the formal sources is about 10.4 per cent

Table (17): Expected Source of Seeds for Farmers in 2022

Expected Sources of Seeds for Farmers in Season 2022				
Farmer's saved seeds	Local market	Government/NGOs	Agro-Dealers	Contracts
48.3%	41.3%	4.9%	4.7%	0.8%

5.4 Accessibility

- Most of the agro-dealers are owners of the business and agents for seed companies and they have stores and show places. They sell pesticides and fertilizers besides seeds.
- Agro-dealers are found in the main towns. Most of them sell seeds of tomato, watermelon and onion imported by seed companies beside certified seeds of sorghum and sesame.
- Cash payment, ATM and other banking applications are the most acceptable for payment for seed and inputs cost
- The highest prices for tomato is August, for watermelon is February and March and for onion is January and September. These prices coincide with the start of preparation of land for cultivation of these crops.
- Tomato, watermelon and sunflower seeds are imported one while the sources of onion are seed companies and local market. Onion and watermelon have higher demand compared to tomato.
- Certified seeds of sorghum, sesame are available with seed companies but there is problems in access as their prices are high. Some agro-dealers offer credit for certain farmers, and they are dealing with men only.

5.5 Seed Production

5.5.1 Formal seed Production

- There is a growing business in seed production in the states and there are many small companies entering the business such as Abu Amar for Agriculture and Veterinary Services in SD. The main crops handled by the seed companies are sorghum, sesame, wheat and groundnut.
- The **Sudanese Arab Seed Company, CTC, Nile Sun** seed companies are among the best seed producers in the country and they have presence in the SSA locations. **CTC** in addition to provision of seeds, they also offer services of machinery, fertilizers and pesticides for their customers.
- The contractual system for seed production with farmers/ seed growers and small companies are the main system used by the companies for production of certified seeds outside their land.
- Seed companies have small shops in communities for direct selling or through agro-dealers and big traders.

5.5.2 Informal seed Production

- There are seeds producers groups in Gedaref and individuals in SD and northern states. They produce seeds of local popular varieties according to the producers' accumulated knowledge and selection. The local seeds produced are cleaner and sell for about 10% higher prices in the market compared to grains.
- Farmers associations, community seed production and seed banks are very few in South Darfur, Khartoum, Gezira and Northern states. It is important to establish community seed production and seed banks in villages to produce quality seeds at community level in collaboration with NGOs and Ministry of Agriculture to handle extension on seed production and certification.
- Seed producers had not received any training in seed production or other related capacity building sessions and farmers who have local experience in seed production produce seeds of better quality compared to grains and have a high demand in the market.
- Seed production Gezira is handled by the Seed Unit of the Gezira Scheme for cotton and sorghum.
- The major challenges in production are lack of farm machinery and fuel, lack of labour and insecurity. Other problems affecting the season in 2021 are the irrigation difficulties due to increase in electricity fees in Northern state which is reflected in low production of faba beans and wheat.

- The plan for next season is to increase the area of seeds in case of availability of security and a demand for certified popular varieties.
- The main concerns tied to production are availability of credit, animal intrusion and fuel at time of land preparation in SD and Gedaref states while increased electricity prices is the main constraint in Northern state.

5.6 Quality of seeds

- The quality of seeds used in cultivation of crops in 2021 as perceived by farmers are generally of good quality (Fig 1) showing that the local seeds are acceptable to farmers for cultivation. Potential seeds available with traders are clean and well stored. This high acceptability of local seeds coupled with low price compared to certified seeds is another indicator that farmers will continue cultivation of local seeds.
- Fig (1):Quality of seeds cultivatd in 2021 as perceived by farmers**

Quality Category	Percentage
V Good	13.8%
Good	81.0%
Poor	3.5%
- FGD in Northern state revealed that there is no varieties released for fennel which explains why the farmers keep their seeds. The famers lost their old stocks of garlic seeds as they use to sell all production after harvest due to unsuitable storage at home and the seed rate is high (450 pounds per feddan). The Chinese variety adopted is productive in the first season and deteriorates in the second season
 - Awareness on quality of seeds is important by agricultural extension is needed and promotion and field days on new varieties is essential to show to farmers the merits of the new released varieties so that farmers can adopt and cultivate in their farm
 - The key signs that farmers are looking for when purchasing potential seeds include:
 - Pure seeds not mixed with other seed crops.
 - Stocks that are clean (no debris).
 - Specific variety by name.
 - Ask about the origin (place) where the stocks are from?
 - Packed in bags of 25 kg weight for sorghum and millet and for 2 kg for onion
 - Traders at village level use trier sticks to inspect the content of bags to ensure quality before offering price to the farmers. Traders are keen about grains quality especially those that can be used as potential seeds and they buy sorghum and millet seeds from farmers directly. Cleaning of seed take place at tme of selling.
 - No germination testing is carried out potential seeds and the prices of the potential seeds are higher for wheat, sorghum, millet and faba beans are 10-15% higher than grains.
 - The Potential Seed Stocks are:
 - Grains collected are used as potential seeds for faba beans, sorghum, millet, groundnut and fennel.

- The main sources of grains/ potential seeds are from self-production, farmers directly, collectors, other small traders, and from other whole-sale traders in 2020 and 2021.
 - Potential seeds for millet were more in 2021 and the peak stock availability period was in June while for sorghum and groundnut are less/same due to high costs of transportation and bad roads.
 - Potential seeds of faba beans and fennel are more in 2021 and the peak stock availability period were in March and April due to availability from the sources.
- Most farmers expected to cultivate almost the same amount of seeds in next season (77.1% and 64.2 for sorghum and sesame) while 5.2% and 14.2% of the farmers shall use less seeds in 2022 (Table 18). Sorghum is the main food crop while sesame is the main cash crop in the clay soils. The amount of seeds determine the area that will be cultivated. For sesame the increase or decrease in area is depending on the demand and prices each year. Area in the rain-fed sector is available through renting or opening new areas.

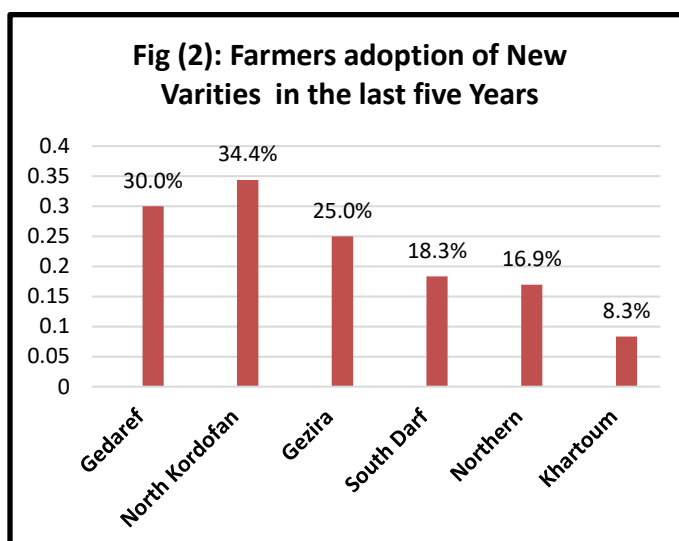
Table (18): Amount of Seeds Expected for growing Sorghum and Sesame in 2022 compared to 2021

Crop	Quantity/ Kg in 2021	Quantity expected for growing in 2022 compared to 2021		
		Same	More	Less
Sorghum	123	77.1%	17.9%	5.2%
Sesame	8	64.2%	21.6%	14.2%

5.6 Adoption of new varieties

- Adoption of new varieties by farmers is low (Fig 2). The new varieties adopted by farmers in the last five years are Imam Wheat in Northern, Gebaish groundnut in NK and Arfa Gadamak sorghum in Gedaref. From the variety released list we found that AG8 sorghum, Imam Wheat and Gebaish groundnut were released in 2009, 2000 and 1997 respectively.
- The farmers use them continuously without field inspection and certification. Farmers change their stocks of seeds with certified varieties of sorghum when their fields are infested with Sudan grass.
- In North Kordofan the adoption rate is high as Elobeid Agricultural Research Station have experimental farm in Faris and ASSCO in Abum Saadain for groundnut seed production. Farmers obtained new varieties from selling, distribution by NGOs or on loan basis.

- The low adoption rate of new varieties is attributed mainly to the selection of breeders of new varieties without involvement of the farmers from the beginning in addition to poor promotion for the new varieties released by seeds companies and ARC.
- Participatory breeding between breeders of ARC and farmers is important to know the preference of farmers to certain characteristics of the developed variety as it happen between Elobeid ARS and farmers in NK which resulted in release of new variety.



5.7 Varietal Suitability

- In SD there is high demand on Butana and Tabat sorghum seeds by farmers while in Gedaref there is a demand for local varieties such as Wad Bako sorghum as they are resistant to striga.
- The most popular varieties of sorghum in Gezira, Gedaref and SD are Wad Ahmed and Tabat which were released in the 1992 and 1996 respectively.
- Farmers also believed that their landraces, especially millet, are more reliable than improved varieties.
- The food security in SD is affected by land deterioration and low productivity. In response to stress, the strategy of women is to grow local early maturing varieties (Haja Banat) and leaving certified seeds (Tabat) while some crops such as cowpea are no longer grown.

5.8 Marketing

- The main problems encountered are marketing of groundnut and faba beans when there is high production as traders were reluctant to buy the crops because the capacity of marketing is limited. Packing in small packs of 20 Kg or less can improve the marketing for faba beans and this was noticed when some traders imported faba beans from Egypt in small packages.
- The main constraints that faced agricultural production in the last five years are control of pests and diseases and availability and high costs of inputs; intruding of animals in the farms, availability of farm machinery and labour in SD.
- The main concerned tied to storage are store pests and availability of good stores in all states.
- The most marketable crop seeds in Northern state are faba beans and garlic.
- The prices of 2020/2021 were higher than 2019/2020 for fennel, millet and dates because of good season and high demand. The prices of fennel sharply increased in October 2021 as there is demand for sowing and the harvest was not very good while date price increased in March 2021 because all quantities stored are in the hands of merchants and they control the prices of crops..
- The peak stocks for faba beans were in April-June while the peak stocks for fennel and dates were in October. Stocks in 2021 are less than 2020 for faba beans and fennel because of good season

and while the stocks of dates are more in 2021 for the good season and due to availability in the market.

- The quantities of sorghum, millet and groundnut available in 2020 were more than 2021 in SD and Gedaref due to good harvest in 2021.
- The peak stocks of millet were in July while the peak stocks for sorghum and groundnut were in March in Gedaref and in June in SD.
- The main challenges in the trade are the fluctuation of prices, insecurity, and transportation, availability of stores and storage pests and importation of crops.
- Agro-processing is open for big quantities from traders and small ones from individuals. Decorticated GN have a good market in Khartoum for oil extraction. The peak of extracting oil from groundnut is from November to June in local markets in SD. The by-products of decortication have a good market for brick making in SD.
- Drying of lemon and onion is a business for export in Khartoum.
- Challenges encountered by agro-processors are access to funds to buy crops at time of harvest for continuation of business all over the year. Government and NGOs supported community and individuals with milling machines as a source of income.

5.9 Gender

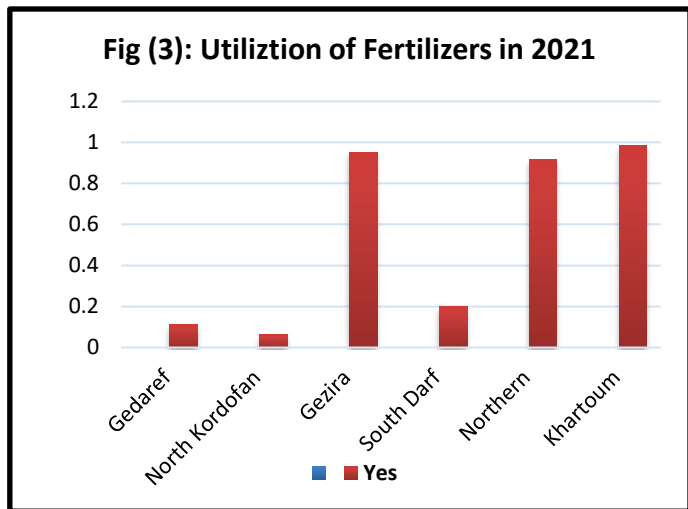
- The average family size is ranging between 6-7 persons. In South Darfur, women-headed households is 70 percent due to fighting context since 2003. In Gedaref women-headed households is about 40 percent and almost zero in Elselaim basin/ Northern state
- Women in all other states practice agriculture. The most vulnerable households in the community are widows, ill and elderly people
- The main women's crops in SD and Gedaref include okra, cowpea, watermelon seeds and maize. Women keep their seeds for next season; 100 percent for groundnut and millet in SD; 70 percent for sorghum and 30 percent for sesame in Gedaref. Bartering of grains for seeds is practiced among women or sometimes they obtain seeds free as a gift.
- Marketing of crops is a male activity and the control of money belonging to women is the husband in Gedaref. Women sell their products and have the freedom in spending the money she got from work in SD. Decision on what to grow is taken by men and women together.
- In SD off-farm work for women includes the selling of vegetables and other items in the market and working as labours in brick making.
- All NGOs have concern about gender and empowerment of women in their programmes.

5.10 Utilization of Inputs

The following data on the utilization of different agricultural inputs are extracted from the analysis of data collected from the households survey:

5.10.1 Fertilizers

- The utilization of fertilizers in irrigated areas is widespread while in rain-fed areas the farmers use in a limited scale (Fig 3). The farmers in irrigated areas use more than one fertilizer type, according to the recommendation from ARC.
- Use of the technical package was successful in areas with rainfall more than 450 mm and small farmers benefitted from that. Farmers in these areas need support from NGOs or access to credit from banks to apply the technical package.



- The Food Security for Small Holders Project proved that application of the technical package (Technical package compose of improved seeds + land preparation + herbicides + fertilizers) in rain-fed areas in small holders in in Gedaref increases the productivity of sorghum. The main problems that hindered utilization of fertilizers are its availability and high prices. The issue of utilization requires extension and provision of inputs. Seed companies can support seed producers in rural areas with rainfall more than 450 mm with fertilizers and herbicides then deduct the cost at harvest.
- The quantities of fertilizers and pesticides sold in 2021 are more than those in 2020 as farmers know the importance of fertilizers and control of pests and diseases to increase production.
- In 2020-2021 season, the availability of inputs such as fertilizers in the right time for farmers affected their business.

5.10.2 Herbicides

- Application of herbicides on crops was high in the irrigated areas in Northern, Gezira and Khartoum for the crop establishment due to awareness about the importance of using the technical package for crop and crop intensification. The farmers in low rainfall areas are less familiar with use of herbicides in crop establishment due to poor extension, high prices and low availability.

5.10.3 Organic Fertilizers

- The utilization of organic fertilizers is mainly for vegetable crops and fruits in Sudan. The study showed that utilization is highest in in North Kordofan (village Fury and Faris/Sheikan Locality) where there are contracts between the community association and Elobeid Agricultural Research Station. Farmers in Northern state and Khartoum use organic fertilizers in vegetables.

5.10.4 Store chemicals and Grain Losses During Storage

- Farmers are familiar with use of storage chemicals especially in Northern state while the least utilization take place in SD. In Khartoum as they sell fresh vegetables or sell the produce to merchants who have cold stores for potato and onion. The highest utilization of chemical for storage took place in 2020 as the input prices were lower than 2021.
- The grain losses during storage is varied between states and very high in oil crops where the losses exceed 50% and there is need the agricultural extension to focus on post harvest handling

(Table 19). Zero losses in some states means that these crops are not grown in these states or in small quantities for home consumption. Sesame in in Gedarif is the second crop after sorghum while in South Darfur, groundnut is the second crop after sorghum/millet and grown in big areas.

- In Khartoum where they grow vegetable and sell it fresh in the market and storage of potato and onion take place in cold stores run by big merchants.

Table (19) : Grain losses during storage at Farmer stores in 2020

State	Sorghum	Millet	Wheat	Faba beans	Groundnut	Sesame
Gedaref	15.0%	25.0%	0.0%	0.0%	50.0%	50.0%
North Kordofan	13.3%	13.3%	0.0%	0.0%	26.7%	13.3%
Gezira	12.5%	0.0%	25.0%	0.0%	0.0%	12.5%
South Darfur	4.5%	13.6%	0.0%	0.0%	59.1%	0.0%
Northern	0.0%	0.0%	20.0%	13.3%	0.0%	0.0%
Khartoum	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

5.11 Dimensions of Seed Security

The dimensions of seed security includes availability, access, varietal suitability, seed quality. Appropriate responses depend on whether the constraints are acute, or reflect chronic, longer-term stresses. Table (20) highlights the situation in the states and suggests action for each dimension.

Table (20): Dimensions of Seed Security

Dimension	ACUTE	CHRONIC
Seed is unavailable	<p>Situation: Quality seeds of Sorghum seeds and millet in South Darfur are not available at time of planting.</p> <p>Action:</p> <ul style="list-style-type: none"> • Distribution of seeds by Government and NGOs to enable farmers to grow crops 	<p>Situation: The environmental condition northern North Kordofan is harsh and the low capacity of seed production.</p> <p>Action:</p> <ul style="list-style-type: none"> • Introduction of seed varieties that suit the environment • Training farmers in seed production and

		establishment seed banks
Farmers do not have <u>access</u> to seed	<p>Most of farmers have no access to quality seeds</p> <p>Action:</p> <ul style="list-style-type: none"> • NGOs developed seeds Fairs using w/ vouchers or cash to enable farmers to access good seeds. • Extension on seed production is crucial for farmers in NK, SD and Gedaref states to establishment of seed production activities in coordination with MoA and seed companies 	<p>Action:</p> <ul style="list-style-type: none"> • Income-generation activities are best suited in NK and SD • Value-chain development is required in Northern states for better marketing of faba beans and fennel to reap more money
Varieties are <u>unsuitable</u>	<p>Situation:</p> <p>Limited introduction of new varieties took place in Northern state for wheat, broad beans and fennel and Khartoum state for local vegetable seeds</p> <p>Action:</p> <ul style="list-style-type: none"> • Promotion for suitable varieties and demonstration plots • Breeding for more suitable varieties • Participatory breeding is the best solution for introduction and adoption of new seed varieties in the rain-fed and irrigated sectors. 	<p>Action</p> <p>There is a lot of sorghum varieties that need to be adopted by the farmers to increase production and required intensive extension to convince farmers using demonstration plots and farmer field schools (FFS).</p> <p>Participatory breeding is the best solution for introduction and adoption of new seed varieties in the rain-fed and irrigated sectors.</p>
Seed is of <u>poor quality</u>	<p>Action</p> <ul style="list-style-type: none"> • Ensure that seeds for distribution are tested. • Improve the management and quality assurance among local traders 	<p>Action</p> <ul style="list-style-type: none"> • Distribution of good quality seeds. • Demonstration plots with farmers as in NK with ARC Elobeid. • Partnership for production of quality seeds as in Gedaref.

		<ul style="list-style-type: none"> • Training farmers in seed production and establishment seed banks • Introduce proper cleaning and germination test for potential seeds before distribution.
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6. RECOMMENDATIONS

6.1 Accessibility

To increase farmer's access to seeds, the consultant recommend the following:

- Seed fairs and use of voucher assistance are approaches that are targeted specifically at access constraints. Where possible, these modes of assistance should be to support vulnerable farmers to select the crops and varieties that they required for planting.
- Encourage seed companies to market their seed in smaller packet sizes for the crops and vegetables required by small scale farmers, to encourage greater uptake.
- Encourage agro-dealers to establish agricultural services at the village level and provision of seeds, chemicals and fertilizers beside farm machinery for farmers.
- Over the longer term, the best intervention for improving vulnerable farmers' ability to afford quality seeds is to support them with Income Generating Activities (IGA) and cash assistance, to improve family income and enhance access to seeds and other inputs

6.2 Availability

- Seed availability may continue to be a constraint for crops with high seeding rates and for displaced and destitute HHs, especially in areas where there is fighting and instability. In these situations, the most effective immediate response may be to continue distribution of seeds by FAO, MoPER and NGOs.
- As a medium-term recommendation (next two to five seasons), the promotion of decentralised seed production can increase the availability of good quality seed for communities. Models to explore include contracting the village committee/elite farmers with Agrodealers for the production of popular varieties, in coordination with the MoA for field inspection and seed certification services. For this production to be sustainable, it must be linked to seed marketing and to strategies for building, and serving, local demand.
- Following the above recommendation, enhancing the capacity of seed units and seed certification services in the states to carry out field inspection and seed testing in a timely manner can help support the emergence of more decentralized seed production, from a diversity of producers. This would also increase the timely availability of quality seeds at state level.
- Other, longer term, areas to explore include the establishment of a seed extension unit in the MoA to train farmers on quality seed production, and the recognition of Quality Declared Seeds within the national seed laws, in order to support the emergence of a more diverse seed production sector.

6.3 Seed Quality

The seed industry in Sudan is progressing slowly due to the political instability in the country, high investment costs for production and low revenue for seed companies. The seeds produced by seed companies are of good quality, while those produced under informal sector need special attention on the production steps and to improve the quality of seeds. The following are the recommendations to improve the quality of seeds produced by the informal sector:

- Working with the most seed-orientated informal traders to identify practices to improve the quality of the 'potential seed' they sell to farmers. This may include fostering links to quality seed producers, improved storage and handling practices, or encouragement of testing of germination or physical purity, among other areas for support.
- Support to household-level seed storage, including assisting farmers to access hermetic storage bags, provide appropriate training, and foster the growth of the market for improved storage technologies.
- Medium-term recommendations for improving the quality are to provide training to farmers, traders and other actors in the informal seed system on key seed quality aspects that can be managed, from seed selection to storage and management.

6.4 Varietal Suitability

- Demonstration plots should be used in as many locations as possible to expose farmers to released crop varieties, and allow them to observe these varieties' performance under local conditions and management through an entire cropping season. These plots could be targeted towards crops facing priority challenges or where there are released varieties that have been under-promoted (for example, pulses or forage crops). Demonstration plots can be used for marketing and to promote adoption, and to develop a better sense of local farmer demand for different crop varieties, and as such can be a valuable tool to assist all types of seed enterprises - including decentralised seed production groups.
- Improve messaging to farmers to raise their appreciation of the merits of specific new varieties, improved agricultural practices, and of where they can obtain seeds. This may include conventional extension approaches such as via demonstration farmers and field days, farmer field schools, local media, or via other means.
- Participatory crop breeding should be encouraged, so that breeders and farmers work together to select or identify new lines in the field that are most appropriate to meet farmers' preferences and consumer tastes before the process of variety releasing. This will also help in adoption of new varieties by farmers.
- Medium-term activities include:
 - Support to ARC capacities, by training of staff and equipment that facilitate breeding of varieties that are suitable for the growing conditions of the country and are accepted by farmers.
 - The climate is changing and there is a need to direct research to focus on crops suitable for marginal and harsh environments.

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ANNEXES

**Annex (1): Time Table for ToT training on Seed Security Assessment
Wad Medani/ Sudan (12 -16/12/2022)**

First Day		
8:30 - 9:00	Welcome and Registration	Mahmoud Nouman (MN)
9:00 – 9:20	Opening session	FAO
9:20 – 10:00	Seed Security Conceptual Framework and Introduction on SSA	MN / Shawn

10:00 – 10:30	Formal and Informal Seed Production in Sudan	Anas Elzain
10:30- 11:00	Break Fast	
11:00- 12:00	Overview on SSA Training Programme	MN
12:00: – 12:30	Locations selected and Objectives of SSA	MN
12:30 -13:00	Prayer and Tea Break	
13:00 -13:30	Terminology and measures used and useful definitions	MN
13:30 – 14:00	Evaluation of markets and trade and seed flow and seed mapping	MN
14:00 -14:30	Tools and division of labour	MN
14:30 -15:00	Overview of Organization of SSA and Sampling	Hamza Siror
15:00 -16:00	Discussion And Evaluation of The Day and Preparation For The Next Day	Anas Elzain
Second Day		
8:30 -9:00	Recap of the previous day	Anas Elzain
9:00 – 10:30	HHs Questionnaire	MN
10:30 – 11:00	Break Fast	
11:00 -11:30	Codes for HHs Questionnaire	MN
11:30 – 12:30	Discussion and Practicing on HHs Questionnaire including local measures	MN/ Anas Elzain
12:30 – 13:00	Prayer and Tea Break	
13:30 – 14:30	Focus Group Discussion Questions/Men	MN
14:30 – 15:00	Discussion and Practicing FG /Men	MN/Hamza
15:30 -16:30	Discussion And Evaluation of The Day and Preparation For The Next Day	Hamza
Third day		
8:30 -9:00	Recap of the previous day	Hamza
9:00 – 10:30	Focus Group Discussion for Women and Training	MN/Anas
10:30 – 11:00	Break Fast	
11:00 – 12:00	Individual /Community Seed Growers Questionnaire	MN
12:00 – 12:30	Discussion and training on Individual /Community Seed Growers Questionnaire	MN/Hamza
12:30 – 13:00	Prayer and Tea Break	
13:00 - 14:30	Agro-dealers Questionnaire + Discussion and Training	MN/Anas

14:30 – 15:30	Processors Questionnaire + Discussion and Training	MN/Hamza
15:30 – 16:30	Discussion And Evaluation of The Day and Preparation For The Next Day	MN/Hamza
Fourth Day		
8:30 - 9:00	Recap of the previous day	Anas Elzain
9:00 – 10:30	Local Markets and Traders questionnaire + Discussion and Training	MH/Hamza
10:30 – 11:00	Break Fast	
11:00 – 12:30	Seed Companies Questionnaire + Discussion and Training	MN/Anas
12:30 – 13:00	Prayer and Tea Break	
13:00 - 14:00	Humanitarian Organization Questionnaire Discussion and Training+	MN/Hamza
14:00 – 15:00	Government Authorities Questionnaire + Discussion and Training	MN/Anas
16:00 – 16:45	Format For Current View on Seed Security Situation in the States	MN
16:45 – 17:15	Selection Criteria for Enumerators in the States and SSA Organization	MN
15:00 – 16:00	Discussion And Evaluation of The Day and Preparation For The Next Day	Hamza
Fifth Day		
8:30 - 9:00	Recap of the previous day	Hamza
9:00 – 11:00	Application of SSA in a village	MN/Hamza/Anas
11:00 – 11:30	Break Fast in the field	
11:30 - 12:30	Discussion on Pros and cons of Application of SSA in that village	Hamza/MN
12:30 – 13:00	Prayer and Tea Break	
13:0 – 13:30	Daily reporting on SSA in the site	MN
13:30 – 14:00	Closing Session and Distribution of Certificates	FAO and the Team

Annex (2): List of Released Varieties

**General Seed Administration
Varieties Registration Department
List of Released Varieties from 1913 - 2020**

Species	Variety	Breeder/ Maintainer	Year of Release
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<i>Banana</i>	Grand Nain	ARC	2001
	Albeely	ARC	2003
<i>Bread Wheat</i>	Giza 144	ARC	1940
	Falsheto	ARC	1970
	Giza 148	ARC	1972
	Giza 155	ARC	1972
	Mexipak	ARC	1976
	Mexcani	ARC	1977
	Mukhtar	ARC	1978
	Chiniab-70	ARC	1978
	Condor	ARC	1979
	Debiera	ARC	1979
	Wadi EL-Neil	ARC	1987
	Giza 157	ARC	1980
	Sasariab	ARC	1992
	EL Neileen	ARC	1992
	Argeen	ARC	1996
	Nasr	ARC	1996
	Emam	ARC	2000
	ELTagana	ARC	2004
	Khalifa	ARC	2004
	Gezira	ARC	2006
	Bohein	ARC	2006
	Nebta	ARC	2007
	Goumria	ARC	2013
	Zakia	ARC	2013
	Jawahir	ARC	2018
	Okasha	ARC	2018
	Al-Shibaik	ARC	2018
	Khidaiwi	ARC	2018
	Ageeb	ARC	2018
	Amel	ARC	2018
	Salah	ARC	2018
	Ashri	Mahgoub Sons+ARC	2018
	<i>Durum Wheat</i>	Sham-1	ARC
Argu		ARC	2018
Dahab		ARC	2018
Wadelbur		ARC	2018
Basatna		ARC	2018
<i>Sugarcane</i>	Co 6806	KSC	
	Co 527	KSC	
	Co 997	KSC	
	B 63349	KSC	1998
	B 70531	KSC	1998
	BJ 7938	KSC	1998
	BT 74209	KSC	1998
	Coc 671	KSC	1998

	Kn H 80412	KSC	1998
	Co 775	KSC	2001
	TUC 75-3	KSC	2003
	BJ 8532	KSC	2003
	R-579	KSC	2010
	BR81116(B74254 x polycross)	GSC	2017
<i>Citrus Yousifi</i>	Kinnow	ARC	1997
	Karra	ARC	1997
	Honey	ARC	1997
<i>Chickpea</i>	NEC 2491(Shendi)	ARC	1987
	Gebel marra	ARC	1995
	Atmor	ARC	1996
	Salawa	ARC	
	Wad Hamid	ARC	1996
	El Matama	ARC	1998
	Sheikh Mohamed	ARC	2016
	Meroe	ARC	2016
<i>Cotton</i>	Sakil	ARC	1913
	X1530	ARC	1935
	Domain sakil	ARC	1938
	X1730A	ARC	1940
	AKALA4-42	ARC	1954
	BARXLI	ARC	1956
	BAR14/25	ARC	1956
	BAR 7/1,8	ARC	1957
	ALBAR 7/11	ARC	1957
	ALBAR(57)12	ARC	1967
	Brakat	ARC	1969
	ALMAK(69)29	ARC	1969
	VSI/VSA	ARC	1971
	Huda	ARC	1975
	Marioud	ARC	1975
	BA-1303/1308	ARC	1976
	Shambat (B,C,X)	ARC	1976
	ALMAK (80)15	ARC	1980
	Huda 82	ARC	1982
	Marioud 82	ARC	1982
	Brakat 82	ARC	1982
	VS 82	ARC	1982
	AKALA	ARC	1983
	Sudak-k	ARC	1984
	Shambat-B	ARC	1993
	Barac (67)B	ARC	1993
	Barac (69)2	ARC	1993
	Brakat S	ARC	1998
	Dr. Knight	ARC	2004

	Hadi	ARC	2004
	Hamid	ARC	2004
	Khairalla	ARC	2004
	Sidig	ARC	2004
	Khalefa	ARC	2006
	Borhan	ARC	2006
	Abdeen	ARC	2006
	Wagar	ARC	2006
	Seeni 1	ARC + Shandong Gold Agric. Development Co.	2012
	Seeni2	ARC + Shandong Gold Agric. Development Co.	2015
	Hindi1	ARC + Aleena Agricultural Service	2015
	Hindi 2	ARC + Aleena Agricultural Service	2015
	Almuntij1	Zagros	2019
	Almuntij2	Zagros	2019
	BA440	Zadna	2019
	CRISMA	Zadna	2019
	SD/LG145	ARC	2019
	SDLG149	ARC	2019
<i>Cowpea</i>	Ain El gazal	ARC	2000
	Dhab El goz	ARC	2000
	Gamardourin	ARC	2000
	Hidob	ARC	2000
<i>Common bean</i>	Basabeer	ARC	1998
	Giza 3	ARC	1998
	Sirage	ARC	1998
	Motwaki	ARC	2003
	Ibariea	ARC	2003
<i>Faba bean</i>	BF 2/2	ARC	1971
	Hudeiba 72	ARC	1972
	Sulaim	ARC	1985
	Improved Sulaim	ARC	1987
	Shambat 75	ARC	1991
	Shambat 104	ARC	1991
	Basabeer	ARC	1993
	Hudeiba 93	ARC	1993
	Shambat 616	ARC	1993
	Damar	ARC	2006
	Salih Hussein	ARC	2009
	Merowe	ARC	2013
	Shendi	ARC	2013
	Turkey	ARC	2017

	Gizal	ARC	2017
	Spain	ARC	2017
<i>Forestry</i>	Altragma	ARC	1998
	Kaly	ARC	1998
<i>Grapefruit</i>	Frost Marsh	ARC	1995
	Red Blush	ARC	1995
	Miami	ARC	1995
<i>Garlic</i>	Chinese Garlic	ARC	1995
<i>Groundnut</i>	Ashford	ARC	1960
	Barberton	ARC	1960
	MH-383	ARC	1970
	Natal	ARC	1970
	Espanco	ARC	1984
	Sodari	ARC	1986
	Kiriz	ARC	1987
	Medani	ARC	1993
	Gebaish	ARC	1997
	Tozie	ARC	2000
	El Ahmadi	ARC	2000
	Bunting	ARC	2007
	Tefra 1	ARC	2021
<i>Lentil</i>	Gebel mara	ARC	1993
	Robatab	ARC	1993
	Ndea	ARC	1998
<i>Maize</i>	Stock 113 (Fodder)	ARC	1975
	Mexican June	ARC	1978
	Bafwear	ARC	1978
	Hudeiba 1	ARC	1998
	Hudeiba 2	ARC	1998
	PAN 6480	ARC	1998
	PAN 6578	ARC	1998
	PAN-6966	ARC	2009
	PAN-6026	ARC	2009
	PAN-6568	ARC	2009
	Yai1	ARC	2010
	Yai2	ARC	2010
	Konsur	ARC	2012
	Turky1	ASSCO	2012
	Turky2	ASSCO	2012
	Hytech 2055	ARC + Alam Eldin Agric. Enterprises	2013
	Galaxy (white)	ARC	2013
	Golden – 1 (Hageen)	ARC	2013
HYTECH 2066	ARC+ Alam Eldin Agric. Enterprises	2015	
HYTECH 1100	ARC+ Alam Eldin Agric. Enterprises	2015	

	Simon	ARC + Tila	2016
	PL71	ARC + Tila	2016
	PL712	ARC + Tila	2016
	PL508	ARC + Tila	2016
	PAN12 (forage hybrid - Yellow)	ARC + Pannar Co. South Africa	2018
	Hytech 2031(forage hybrid -white)	ARC+ Alam Eldin Agric. Enterprises	2018
<i>Mango</i>	Abu- Samaka	ARC	2015
	Wad- Sirare	ARC	2015
<i>Millet</i>	Biuda 1	ARC	1970
	Sereira Composite 2(Ugandi)	ARC	1981
	Ashana	ARC	2000
	Shaikan	ARC	2012
	Wadelbasheir	ARC	2012
	Ombadir	ARC	2018
	Faris	ARC	2018
<i>Onion</i>	Elhelo	ARC	1987
	Kamleen	ARC	1987
	Sagai mohasen	ARC	1987
	Aldonglawy (balady)	ARC	1993
	Baftaim	ARC	2007
<i>Okra</i>	Higairat	ARC	1987
	Raeba	ARC	1987
	Sennar	ARC	1987
<i>Pea</i>	Karima	ARC	1989
	Shambat	ARC	2003
	Salih Husein	ARC	2009
	Salim Pejow Round	ARC	2011
	Faroug DMR	ARC	2011
<i>Pigeon pea</i>	Tiba	ARC	2000
<i>Potato</i>	Desiree	ARC	2004
	Diamant	ARC	2004
	Draga	ARC	2004
	Frisia	ARC	2004
	Spunta	ARC	2004
	Belleni	ARC	2011
	Arnova	ARC	2011
	Mondial	ARC	2011
	Almera	ARC	2011
	Armada	ARC	2011
	Zafira	ARC	2011
	Burren	ARC	2013
	Alaska	ARC	2013
	Everst	ARC	2013
	Safari	ARC	2013

	Banba	ARC	2013
	Triplo	ARC	2017
	Markeis	ARC	2017
	Santana	ARC	2017
	Jelly	ARC	2018
	Arizona	ARC	2018
	Barcelona	ARC	2018
	Elmundo	ARC	2018
<i>Rice</i>	Kosti1	ARC	2010
	Kosti 2	ARC	2010
	Umgar	ARC	2010
	Wakra	ARC	2010
<i>Roselle</i>	Rahad 1	ARC	2012
	Abied	ARC	2012
<i>Sesame</i>	Ziraa 1	ARC	1964
	Ziraa 7	ARC	1964
	Al Ziraa 3	ARC	1964
	Ziraa 9	ARC	1985
	Huria 49	ARC	1985
	Huria 31	ARC	1985
	Kenana 1	ARC	1985
	Kenana 2	ARC	1991
	Khider	ARC	1998
	Promo	ARC	1998
	Um Shagara	ARC	2003
	Gadarif	ARC	2003
	Algozuli	ARC	2012
	<i>Snap bean</i>	Venda	ARC
Star 2052		ARC	2016
<i>Sorghum</i>	Zanab Alshah	ARC	1957
	Karkateib	ARC	1957
	Dwarf White Milo	ARC	1957
	Maatug	ARC	1967
	Wad Akar	ARC	1967
	TUB 11	ARC	1971
	TUB 22	ARC	1971
	UB 7	ARC	1971
	Dabar/1/1/1/1	ARC	1978
	Gadam El Hamam-47	ARC	1978
	Hageen Dura 1	ARC/ICRISAT	1983
	Mogawim boda 1	ARC/ICRISAT	1991
	Mogawim boda	ARC/ICRISAT	1991
	Pioneer 988 (Fodder)	ARC+ Pioneer	1991
	Pioneer 877 (Fodder)	ARC+ Pioneer	1992
	Ingaz	ARC	1992
	Shaikhan	ARC	1992

<i>Sorghum</i>	Wad Ahmed	ARC	1992
	Rabih- Hageen	ARC	1996
	Tabat	ARC	1996
	Hageen Y,SW64	ARC	1996
	PAN - 888(Fodder)	Pioneer	1998
	PAN- 606(Hybrid)	ARC	1998
	Aros El Remal	ARC	2000
	Yarwasha	ARC	2003
	Safed Moti (Fodder)	ASSCO	2003
	Kambal (Fodder)	ARC	2004
	Bashayir	ARC	2008
	Butana	ARC	2008
	Sudani 1(Fodder)	ARC	2009
	AG 8	ARC	2009
	Hageen garawia (fodder)	ARC	2010
	Hageen dura 2(HD.2)	ARC	2011
	DIA-07666(Hybrid)	ARC	2011
	PAC-501(Hybrid)	ARC + CTC	2011
	Alfa-2(Hybrid)	U.G	2011
	ASARECA1-W	ARC	2012
	ASARECA2-T	ARC	2012
	ASARECA3-AG1	ARC	2012
	ASARECA4-AG2	ARC	2012
	Mabrouk –Hageen (Fodder)	ARC +Alam Eldin Agric. Enterprises	2013
	Alwafir	ASSCO	2013
	NS-5511	ARC + Mahgoub Sons Co.	2016
	Hageen Gazeira	ARC	2016
	Hageen Gedarif	ARC	2016
	Horous (hybrid)	ARC+ Alam Eldin Agric. Enterprises	2016
	Hageen Soki	ARC	2016
	Ageeb	Agronectar Group-Sudan	2018
	Dindir	Agronectar Group-Sudan	2018
JKSH-433(hybrid)	ARC+ Aleenah Company	2018	
JKSH-221(hybrid)	ARC + Aleenah Company	2018	
Pradhan(hybrid)	ARC+ Syngenta Company	2018	
MLSH-151(hybrid)	ARC + Syngenta Company	2018	

	SPX-17413(hybrid)	ARC + Agrimatco Company	2018
	PAN8816(hybrid)	ARC + Somarin Oriental Seed Company	2018
	Nile Sun 316(hybrid)	Nile Sun Seed Co.	2018
	Nile Sun 308(hybrid)	Nile Sun Seed Co.	2018
	RANGER	Tila company	2019
	CLASS	Tila company	2019
	OCEAN	Tila company	2019
	Mena	ARC	2019
	ALFA 1	Alfa Trading Enterprises	2019
	Maroa	ARC	2019
<i>Soybean</i>	Sudan1	ARC	2012
	Sudan2	ARC	2012
	Soya3	ARC	2017
	Soya4	ARC	2017
	Damazin 1	ARC	1991
	Damazin 2	ARC	1991
	PAN – 7392	ARC+ASSCO	2003
	PAN – 7355	ARC	2003
	Hysun 33	ARC	2003
	Jwalmukhi	ASSCO	2003
	Salih	U. K	2004
	Shambat	U. K	2004
	PAN – 7351	ARC	2006
	PAN – 7371	ARC	2006
	Bohooth1	ARC	2009
	Bohooth2	ARC	2009
	Bohooth3	ARC	2009
	Aguara 4	ARC	2011
	Pan 7049	ARC	2011
	Pan 7033	ARC	2011
	Sirena	Harvest Investment Co. + ARC	2012
<i>Sunflower</i>	Opera	ARC	2012
	Nugold Dowana	ARC	2013
	Nugold Darya	ARC	2013
	Pac334	ARC	2015
	Pac361	ARC	2015
	Pan-7057	ARC	2015
	SY-4045	ARC	2015
	NK Kondi	ARC	2015

	Reyflo	Mahgoub Suns Co.+ ARC	2015
	Clara	Mahgoub Suns Co+ ARC	2015
	Agsun-5264	Nile Sun+ ARC	2016
	Agsun-5284	Nile Sun+ ARC	2016
	ChinaSun-1	Chinese Training and Demonstration Center- Sudan	2016
	ChinaSun-2	Chinese Training and Demonstration Center- Sudan	2016
	Karam	Harvest Investment Co.+ ARC	2017
	Numantia	Unifert	2019
	Hispalis	Unifert	2019
	Italicais	Unifert	2019
	SV – 66	Mahgoub Sons	2019
<i>Sugar Beet</i>	SUD – 03 - 08	ARC	2011
	SUD - 02 – 08	ARC	2011
	Dorotea	ARC	2016
	Valentina	GSSC	2016
<i>Squash</i>	Gezira 1	UG	2009
	Gezira 2	UG	2009
<i>Sweet orange</i>	Butler	ARC	1995
	Hamlin	ARC	1995
	Campbell	ARC	1995
	Olinda	ARC	1995
	Frost	ARC	1995
	Local Selection	ARC	1995
<i>Sweet Potato</i>	Salih Hussein	ARC	2009
	Abusabi	ARC	2009
<i>Tomato</i>	Higairat	ARC	1987
	Raiba	ARC	1987
	Siraira	ARC	1987
	Sennar 1	ARC	1993
	Sennar 2	ARC	1993
	Gezira	U.G	2000
	Abdalla	U.G	2000
	Elsalama1	Mohammed Taha	2009
	Elsalama2	Mohammed Taha	2009
	Sennar 4	ARC	2011
	Sennar 8	ARC	2011
	Darmali BLO3	ASSCO	2011
	Zahrat Elneel	ASSCO	2011
	Wisam	Wisam Seed Company	2018
	Biely	Wisam Seed Company	2018

	Summer set	Wisam Seed Company	2018
	Mabroka	Wisam Seed Company	2018
	T. Glory	ARC	2018
	Athyla	ARC	2018
	Baraka	ARC	2018
	Prof. Abdalla Improved	Wisam Seed Company	2018
	Renad	Wisam Seed Company	2018
	Solarset	Wisam Seed Company	2018
	Nubian Delta	Wisam Seed Company	2018
	Shahd	Wisam Seed Company	2018
<i>Watermelon</i>	Cachier	ARC	2009
	Kordofan 1	ARC	2009
	Nectar baby	Agronectar Group-Sudan	2016
	Nectar sweet	Agronectar Group-Sudan	2016
	Vikie baby	Agronectar Group-Sudan	2016
	Vikie tassali	Agronectar Group-Sudan	2017
	Omara	ARC	2018
	Wadah	ARC	2018
	Wisam	ARC	2018

Annex (3): People Met

1. Selection Committee for sites (27/07/2021 and 02/08/2021)

- Anas Elzain/ Seed Administration, MoAF
- Hamza Siror/FSTS, MoAF
- Elwathig Mukhtar, Asst., Representative, FAO Khartoum
- Aisha Osheikh, Agric. Coordinator, FAO Kassala (Through Team Meeting)
- Mahmoud Dafaalla, Agric. Coordinator, FAO Khartoum
- Abdalla , Agric. Coordinator, FAO Khartoum
- Mahmoud Hussein Nouman. SSSA Consultant
- Shawn McGuire, Agricultural Officer (Seed Security), FAO, Rome

2. Technical Committee Meeting (23/11/2021)

- Mahmoud Dafalla, FAO
- Abdalla Ismail Adam, FAO
- Salma Rashid, USAID

- Hassan Abdelrahman Hussein, FAO
- Isam Habish, WFP
- Dr. Huda Ahmed Abdelmageed, MoH
- Anas Elzain Abdelgader, NSA
- Eiman Abass Bakheit, NSA
- Samia Musa Betake, Standards, MoA
- Azhari Mahgoub, Planning, MoA
- Mubarak Elmutasim Elsheikh, NSA
- Khalda Abdelrahman, SSMO
- Abdelmoniem Abdelsalam Mohamed Ahmed, UFS
- Hamza Abdalla Siror, FSTS
- Ali Ibrahim Elkhalil, FSTS
- Nagwa Mohamed Hassan Ali, FSTS, Analysis unit
- Wogdam Mohamed Ali, FSTS, Policies Unit
- Mahasin Elhag Osman, FSTS
- Amira Abdelrahim Ali, FSTS
- Thoeiba Ali Mekki, FSTS
- Suhair Khalafalla, FSTS
- Hisham Mohamed Osman, FSTS, Planning

4 TOT Training , Wad Medani (12-16/12/2021)

- Abuelgasim Ahmed Eldoma Ibrahim, North Kordofan State
- Nagimeldin Salih Adam Ahmed, South Darfur State
- Abubaker Eltayeb Ali Elamin, Khartoum State
- Elfadul Gabosh Kumi Abdon, Gezira Scheme
- Abdelrahim Hussein Osman Ahmed, Northern State
- Abdelgalil Adam Ali, Gedarif State
- Thewaiba Ali Mekki, FSTS Khartoum
- Eiman Abbass Bakheit, NSA Khartoum
- Munzer Abdelwahid Mohamed, FSTS (IT) Khartoum
- Suhair Khalafalla, FSTS (Admin) Khartoum
- Hamza Siror Ali, Core Team/ FSTS Khartoum
- Anas Elzain Abdelgadir, Core Team NSA Khartoum

5 Data Collection

5.1 Khartoum

(CT: Hamza Siror, TL: Abubaker Eltayeb Ali Elamin and IT: Munzer Abdelwahid Mohamed)

- Samia Abdalla Musa Mohamed
- Tamadur Mahgoub Ahmed Mohamed
- Galaleldin Khalil Mohamed Adam
- Omer Elamin Awadelkareem
- Ismat Abdelkarim Saber Ali
- Nageeb Fitrain Mohamed Daheia
- Mohamed Salih Adam Saleem
- Elmugdad Abdelazim Gadelrab

5.2 North Kordofan

(CT: Anas Elzain and TL: Abuelgasim Ahmed Eldoma Ibrahim)

- Fatima Mohamed Ismail
- Muna Ahmed Eldoma
- Eatizaz Mohamed Khair Adam
- Hassan Mustafa Hassan
- Wigdan Abdalla Taha
- Khaliefa Ahmed Ganim A/Rahim
- Musa Adam Mohamed Abaker
- Hassan Musa Adam Kudy

5.3 South Darfur

(CT: Mahmoud Hussein Numan and TL: Nagimeldin Hassan)

- Mohamed Abdalla Mohamed Neel
- Suad Abdelhameed Abdalla
- Mashaer Abdelwahab Ahmed
- Saadia Suliman Bakheit
- Gameela Gamal Khogali
- Ehsan Dafalla Elobeid
- Tigani Abdelrahman Ahmed
- Hayder Hassan Ali

5.4 Gezira Scheme

(CT: Hamza Siror, TL: Elfadul Gabush Kumi and IT: Munzer Abdelwahid Mohamed)

- Asaad Elsir Mohamed
- Galal Saifeldin Kamel Elnour
- Abdulkarim Osman Breima
- Hala Abdelsadig Adam Mohamed
- Samia Elderdeiri Mustafa Mohamed
- Raga Atta Bahloul
- Khalda Yousif Ahmed Abdalla
- Mohamed Abdalla Ahmed Mohamed

5.5 Gedarif

(CT: Anas Elzain and TL: Abdelgalil Adam Ali)

- Hafez Ibrahim Ahmed Eltigani
- Mohamed Adam Gorashi
- Thuraia Mohamed Osman
- Hana Abdelhameed Hamad
- Samah Izzeldin Osman
- Yousif Alawad Ibrahim
- Abubaker Mohamed Deen Yousif
- Abdelatif Awad Eldaw

5.6 Northern State

(CT: Mahmoud Hussein Numan, TL: Abdelrahim Hussein Osman and IT: Musaab Mustafa

Saeed

- Idris Khairy Fagiry
- Islah Ahmed Omer
- Eiman Elfarid Ahmed
- Ibrahim Ali Mohamed Hassan
- Intisar Saied Elamin
- Salma Abdelatif Ibrahim
- Hussein Ahmed Mohamed Hassan
- Elnazeer Abdalla Zaid
- Abdelrahim Hussein Osman, Team Leader/MoPER, Dongola
- Musaab Mustafa Saeed, GIS, MoPER, Dongola

Dr. Abdelrahim Elsayed, DG /MoPER, Dongola