

Republic of the Sudan



National Rice Development Strategy (NRDS)

Member of the
Coalition for African Rice Development
(CARD)

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Acronyms

ABS	Agricultural Bank of Sudan
AGRA	Alliance for Green Revolution in Africa
AR	Africa Rice
ARC	Agricultural Research Corporation
ARI	African Rice Initiative
CAADP	Comprehensive Africa Agriculture Development Program
CARD	Coalition for Africa Rice Development
EPAR	Executive Program for Agricultural Revival
FAO	Food and Agriculture Organization
FCB	Farmers Commercial Bank
GDP	Gross Domestic Product
IRRI	International Rice Research Institute
JICA	Japan International Cooperation Agency
M & E	Monitoring and Evaluation
NRP	National Rice Project
NEPAD	New Partnership for African Development
NERICA	New Rice for Africa
NRDS	National Rice Development Strategy
SDG	Sudanese Pound
SSA	Sub-Saharan Africa
TICAD	Tokyo International Conference on Africa Development
TCP	Technical Cooperation Program

Executive Summary

In order to strengthen the role of the agricultural sector in achieving the development objectives such as food security, poverty alleviation, export promotion, the government of the Republic of Sudan has adopted diversification of enterprises as strategic approach and rice has been considered as one of the most important food and cash crop, even though it is a secondary cereal crop that ranks fourth after sorghum, wheat and millet yet it is strategic crop behind wheat in their agricultural policy. During the last ten years rice consumption has outpaced production therefore Sudan imported most of its rice needs from Egypt (80~90%) in order to close the demand –supply gap. Consumption continue to increase due to population increase, urbanization and more importantly due to the fact that a large number of Sudanese have migrated to the Gulf countries since 1960s where the staple food is rice, migrated Sudanese were affected by that food culture which they transferred to the Sudan upon return. In order to accelerate the production of rice to close the demand-supply gap a National Rice project (NRP) unit was created in the Federal Ministry of Agriculture, the project focuses on operations of rice cultivation and investment promotion, furthermore, Sudan has applied to become a member of the Coalition for African Rice Development (CARD). The Coalition for Africa Rice Development (CARD) is an initiative for doubling rice production in sub-Saharan Africa within the next ten years (2019-2030). CARD was launched at the fourth Tokyo International Conference on Africa Development (TICAD IV) in May 2008, and has already covered the first phase (2008-2018). CARD was jointly formed by the Alliance for a Green Revolution in Africa (AGRA), Japan International Cooperation Agency (JICA) and New Partnership for Africa Development (NEPAD). This initiative is being implemented in full respect of African ownership and leadership embodied in the Comprehensive Africa Agriculture Development Program (CAADP), and with strong links to existing structures, programs, networks and initiatives such as African Rice Initiative (ARI).

Under the CARD initiative the government of Sudan is provided technical support to develop a National Rice Development Strategy (NRDS). The vision of NRDS is to produce rice to meet domestic demand, thus contribute to food security and poverty alleviation in Sudan and further aimed to export rice to other rice importing countries such as Saudi Arabia, UAE etc. The goal is to contribute to the development of a sustainable agricultural sector through establishment of a competitive and sustainable rice production and marketing system.

The seven (7) strategic component areas to be pursued in order to realize the objectives of increasing rice production and attaining self-sufficiency as envisaged under the strategy

include i) production techniques ii) research and extension iii) rehabilitation of irrigation facilities iv) post-harvest techniques and marketing v) supporting services vi) capacity building and vii) private sector investment. Greater attention will be paid to financial mechanism in order to promote the implementation of projects that will be developed therefore; availability and accessibility of credit is a critical factor. Lending conditions should be sufficiently broad and flexible to allow for the kind of investments associated with on-farm development works and annual seasonal working capital. Major investment promotion policies that encourage rice production and marketing will need to be put in place. Overall monitoring and evaluation framework which hitherto was absent will also need to be put in place to monitor achievements made.

The projection made under this strategy is that rice production in Sudan will increase from about 13,611 MT in 2019 to 433,610 MT in 2030 while rice demand which stood at 86,000 MT in 2019 will increase to 239,000 MT in 2030 this shows that while production will increase by well over 3000%, domestic demand will only increase by 178% this will therefore result in closing the demand-supply gap and thus attaining self-sufficiency in rice production and a huge surplus for export.

The strategy will be implemented using different approaches and technologies, each technology tailoring to the needs of each of the identified selected rice ecosystems. Emphasis will be put on expansion of areas in upland (aerobic) and low land (submerge) ecosystems and increasing productivity of the traditional (swamp) rice ecosystem

In order to attain self-sufficiency as envisaged under this strategy, integrated approach in rice sub-sector development will be promoted this include agro-ecology, value chain and private sector led approach, this is to ensure that all actors along the chain will get the benefits from rice development strategy. Under the agro-ecology approach the top priority is proposed to be given to aerobic rice ecosystem followed by the submerged ecosystem. The private sector farmers' organizations (cooperatives, unions and associations) will be supported with the enabling environment for investment.

The need to increase rice production in Sudan cannot be overemphasized with the increase in per capita consumption which was estimated at 2.0 kg in 2009, while the current projection under this strategy is put at 4.5kg, therefore all efforts from the public and private sector to increase production will need to be harnessed.

In order to accelerate rice production the government of Sudan has established a unit of

National Rice Project (NRP) in the Federal Ministry of Agriculture with the objective of coordinating rice production and investment. Overall there are perceived limiting factors which need to be overcome in order to achieve the objective of this strategy some of which include i) the need for availability of sufficient land resources especially irrigation schemes with good water management ii) paucity of labor for irrigation farming activity iii) lack of appropriate herbicide for rice iv) poor quality of seeds v) limited access to finance vi) insufficient extension services vii) insufficient irrigation facilities and lack of appropriate irrigation techniques viii) lack of rice specific machineries and ix) low level of knowledge and techniques of rice production

1.0 Introduction

Rice is considered as an important food crop as it is the main staple food crop for 54% of world population and provides 21% of total human caloric requirements. In the Sudan, it is a new crop, and modern rice cultivation began in the seventies of the last century; consumption was limited and imported. The rice industry in the Sudan is in its early stages.

Rice and its stalks are considered as most important source of forage for livestock and poultry. Also, rice could be used in starch and glucose industries in addition to oil that could be extracted from its seed.

1.1 Global Rice Sector

For centuries, rice has been one of the world's most important food crops. The total area under rice cultivation is estimated to be 150 million ha with annual production averaging 465 million metric tons (milled rice) in 2010, two percent above the 2009 harvest (FAOSTAT 2010). Rice is a tropical crop that have been cultivated in moderate regions and achieved high productivity that reached 8 tons per hectare in Australia, 6 tons per hectare in China and Japan. Rice world trade in 2010 stands at 31.0 million tons, 6 percent above the previous year. FAO forecast of global rice trade in 2011 points to two percent contraction to 30.5 million tons (milled basis). However, rice world stocks may rise by five percent to 136.2 million tons, the highest since 2002.

1.2 Africa Rice Sector

Rice paddy production in Africa is projected in 2010 at 24.6 million tons, one percent more than 2009. Consumption of rice in Africa is within the range of 16.0 million metric tons while production is at 14.0 million metric tons, creating a deficit of 2.0 million metric tons.

Rice is a staple food for a rapidly growing population in Sub-Saharan Africa (SSA). It is the fourth most important cereal crop in SSA in terms of production after sorghum, maize and millet. Rice occupies 10 % of total land under cereal production and produces 155% of total cereal production in SSA. Approximately 20 million farmers in SSA grow rice and about 100 million people depend on it for their livelihood. In SSA between 1960 and 2003 consumption increased annually by 4.4 %. Among major cereals cultivated in SSA, rice is the most rapidly growing food source and the annual increase in production is about 4%. New Rice for Africa (NERICA) is popular among farmers and has the potential for high impact on their livelihood. The increasing dissemination of imported rice in SSA does not only result from constraints that hampered the development of local production, it also reflects imported rice distribution channels advantages in terms of product handling and packaging. But as rice is becoming a core component of the diet in many countries, consumers will be more sensitive to quality and taste attributes which might benefit local rice industry if handling is upgraded.

1.3 Sudan Rice Sector

Historical Evolution of Rice Production:

In order to strengthen the role of the agricultural sector in achieving the development objectives such as food security, poverty alleviation, export promotion, the government has adopted diversification of enterprises as strategic approach.

In Sudan rice is a secondary cereal crop that ranks fourth after sorghum, wheat and millet. Its cultivation is limited between Latitudes 4 and 13.5 North, where the climatic conditions are suitable for its growth. Historically, flooded rice is first planted in Aweil, BahrAlgalzal in 1905(now part of South Sudan), and then it is introduced to the Gezira scheme in 1976/1977 season with total planted area of 4200 hectares and achieved high productivity about 6 tons per hectare under irrigated low land cultivation.

Studies that have been conducted by Japan International Cooperation Agency (JICA) during 1973-78 periods proved the feasibility of growing rice in White Nile State as the average productivity for the experiments reached 9.9 tons per hectare under irrigated low land cultivation.

Flooded rice is being cultivated traditionally (local varieties) at Kosti area on White Nile banks under 5000-8000 hectares with average productivity of 3.5 tons per hectare (Table 1).

In spite of rice production fluctuations during the 1990's, its cultivated area has increased three times and its productivity reached about 3.5 in recent years.

2.0 Review of the National Rice Sector

2.1 Status of Rice in National Agricultural Policies

The Republic of Sudan formulated “Executive Program for Agricultural Revival” (EPAR) as a national strategy in April 2008. This program targets export development of agricultural products, poverty reduction, and food security as overall goals. The program aims to improve agriculture productivity and competitiveness of agricultural products.

Agricultural policies call that the agricultural sector is the engine of growth of the Sudanese economy. These policies endorse the private sector to perform all agricultural production, services, inputs and marketing activities. It calls to reduce taxes on agriculture, support extension services, avail finance and promote export of agricultural commodities.

The Republic of the Sudan positions rice as one of the strategic crops in the agricultural policy. Although monitoring and evaluation of policies are insufficient, it is said that rice self-sufficiency was estimated at around 21% in 2007

The Republic of Sudan established a unit of “National Rice Project” (NRP) in the Federal Ministry of Agriculture under the Government of National Unity. The project focuses on operation of the pilot farms for rice cultivation and investment promotion, and currently NERICA4 is cultivated on several pilot farms in the White Nile state, the Gezira state and other states.

Rice specific development policies at national level have not yet been officially formulated. Though rice target stipulated in EPAR is considered only as official target figures, EPAR does not specifically mention particular rice development policy (it deals with wider crops). Under one of the activities in the FAO/TCP project which gave technical assistance to Sudan about aerobic rice from April 2007 to March 2009, a medium term program of rice for five year was developed.

2.2 National Rice Production Trends

Except the traditional rice cultivation along the White Nile River, rice is a new crop in Sudan thus consolidation of surrounding system for rice cultivation is essential requirement for

introduction of rice cultivation to farmers. Total rice area, productivity and production have shown significant increase in the last two decades (Table 1).

Table 1: Domestic Rice Area, Productivity and Production, 1995-2018

Year	Area (Ha)	Productivity (Ton/Ha)	Production (Tons)
1995	1630	0.74	1200
1996	2940	0.68	2000
1997	2940	0.68	2000
1998	3780	0.52	2000
1999	2940	1.19	11000
2000	5460	1.16	8000
2001	6061	1.78	11000
2002	4762	3.03	15748
2003	4800	3.12	15000
2004	5880	3.40	14500
2005	7560	3.44	14700
2006	7560	3.04	14690
2007	6250	3.7	23000
2008	6722	4.5	30000
2009	6303	3.6	22500
2010	4847	3.6	17449
2011	6333	3.6	22798
2012	11760	3.6	42336
2013	3631	3.6	13072
2014	6508	3.6	23429
2015	4932	3.6	17755
2016	9981	3.6	35932
2017	5760	3.6	20736
2018	6217	3.6	22381

Source: FAOSTAT 2010 & National Rice Program – Reports 2018

2.3 Rice Import and Self Sufficiency

In the mid-70's, rice self-sufficiency reached to almost 100%, but it has been low at less than 30% during the period of 80's and below 5% during the period of 90's. Amount of rice as food has shown an upward trend since 1961, and accordingly import of rice has also increased. As of 2007, amount of rice consumed as food was about seventy thousand tons of milled rice while domestic production of milled rice was estimated at about fifteen thousand metric tons which gave a deficit of fifty five thousand metric tons of milled rice which was imported; this shows a self-sufficiency of just 21%.

In similar vein per capita consumption of rice has shown the tendency of gradual increase starting from 1999 and it was 1.98 kg/capita/year in 2007, since then there has not been any significant increase, in that per capita consumption in 2019 was only 2.00kg, however, it is projected that per capita consumption will increase by 125% to 4.5kg by 2030 (Table 2). This

is due to the fact that a large number of Sudanese have migrated to the Gulf countries since 1960s where the staple food is rice; migrated Sudanese were affected by that food culture which they have transferred to the Sudan upon return. For the last three years, Sudan imported most of rice from Egypt (80~90%). Rice from Egypt is considered short grain rice, therefore most of the consumed rice in Sudan except for traditional cultivated area is assumed to be short grain type. Following Egypt, Thailand came with the share of 13.6% in 2008 though shares of imported rice from Thailand in 2006 and 2007 were very small. India and Pakistan had constant shares for the three years, totaling to six to seven percent. Some of rice from India and Pakistan are considered Basmati which is aromatic rice with higher price.

2.4 Rice Marketing and Consumers' Preference

Rice is imported to Sudan by traders, it is distributed via wholesalers or packaging companies to retailers in the whole country. Traders import only milled rice, and milled rice is traded for all distribution channels. On the other hand, traditional rice produced in the swamp area in the White Nile state is consumed in the surrounding areas. In most of these areas the farmers consume all the rice they produce, with non for the market, therefore this supply channels ends within the production area. In those areas, although local rice is preferred by local consumers, imported rice is also sold in the local shops.

Elements of consumers' preference of rice can be divided into variety and quality. There could be three different groups based on varieties for imported rice. One is Basmati group. Basmati is normally imported from Pakistan and India and preferred by high income consumers with high price. The other two groups, namely other long grain group and short grain group, are for the general consumers. In the markets, other long grain seems to be imported from Thailand and Vietnam, and Egypt is a big exporter of short grain to Sudan. As for quality, important traits are color and shape of grain of rice. For all three groups of imported rice, common traits are white and head rice (without broken).The quality of Sudanese rice can meet these standards if the new released varieties and the proper production and processing technologies are adopted.

2.5 Rice Demand Projection

Demand for rice in Sudan is projected as shown in Table 2. Assumptions adopted for this projection are that i) rice demand per capita is assumed to increase from the current level andii) population growth is assumed as linear using the past data (1993 to 2007 from

FAOSTAT& National Rice Program- reports 2018) Target year is tentatively set as 2030 for this projection.

Table 2: Rice Domestic Demand Projection

	2019	2024	2030
Per capita consumption (kg/year)	2.00	3.13	4.50
Population (Million)	43	48	53
Domestic Rice Demand(MT)	86,000	150,240	239,000

Source: Agricultural Statistics Department MOAF 2018.

As a result, in around 10 years (from 2019 to 2030), the domestic demand of rice would reach to 239,000 MT and this is around 178% increase.

2.6 Typology and number of rice farmers, processors and traders

In Sudan rice is mainly produced by small-scale farmers in banks of White Nile River. About ten thousand farmers provide labor and also earn their livelihood out of crop production. There are only two traditional rice mills with limited processing capacity. Few whole sale traders are involved in importing rice but there are numerous small traders who sell rice in the local markets.

There is integrated rice mill in White Nile state established by JICA now owned by Crown Company, a joint venture between Sudan Government and the private sector. Setting up new mills is possible if the production increased especially that the policies encourage that.

2.7 Gender dimensions of rice production, processing and trading

Rice is produced mostly in rural areas in the traditional sector in White Nile state. Women and youth play a major role in rice production, processing and trading in the country. In order to create jobs for the youth, enabling environment for their participation in rice farming needs to be created through mechanization and digitalization of the rice value chain where their participation will be enhanced and sustained. In most of sub-Saharan Africa countries just like in Sudan, the farming population is aging and to guarantee food security replacement with the teeming youths is necessary. Also it is observed that only two traditional rice mills are available in Sudan with limited processing capacity, while only one integrated rice mill is

available in the White Nile state currently operated by Crown company (mill was provided through JICA project). This gloomy picture entails that for competitiveness of the local rice, small scale rice processors need to be encouraged through improvement in processing, the processing aspect will create jobs for the teeming women and thus improvement in the social status of their households

2.8 Comparative Advantage of Domestic Rice Production

In Sudan rice is considered a new crop, modern rice cultivation began in the seventies of the last century, consumption was limited and imported. The rice industry is in its early stage and rice growing is still under several challenges which include i) poor policies on agro-inputs ii) lack of specialized knowledge in rice farming iii) limited staff in development of the rice sector iv) low funding to rice research and limited facilitation of state extension staff v) farmers of rice are not organized yet with insignificant role in decision making. However, rice has become an increasingly important cash crop in rice producing areas mainly due to the increase in its domestic demand and increasing consumer preference in addition to its high profitability in comparison to other cereal crops. The comparative advantages of domestic rice production are in the following:

- Existence of suitable production potentials (land, water resources and climate for growing different types of rice as the country is endowed with different ecologies and climates).
- Existence of considerable demand for rice
- Competitiveness of the crop because of high yield and profitability compared to other cereals
- Rice production cost can be reduced by development and introduction of cost effective production technologies and installation of milling facilities close to the producing areas.

Gross margin analysis of unit area (feddan) of an aerobic rice, groundnut and sorghum production in White Nile state revealed that comparatively rice has secured highest gross margin and profitability among the three crops as shown Table 3.

Table 3 Gross Margin of Rice, Groundnut and Sorghum Production in White Nile State 2010(Unit: SDG/ Feddan)

Item	Rice	Groundnut	Sorghum
Disk plough	250	250	250
Disk harrow	200	200	200
Leveling	100	100	100
Ridging (2 times)	--	100	100
Canal and terrace	70	70	70
Herbicides	330	660	440
Seed	180	90	80
Sewing	150	170	170
Irrigation	200	200	200
Fertilizer	1135	--	565
Weeding	450 (3 times)	450 (3 times)	220 (2 times)
Thinning	--	--	70
Green ridging	--	80	--
Harvesting	150	600	375
Others	225	208	199
Total cost	3440	3178	3039
Productivity	15 sacks	25 sacks	10 sacks
Total returns	15750	12500	5000
Gross margin	12310	9322	1961

Source: Ministry of Agriculture 2011. Gezira State & Agricultural Statistics Department MOAF 2018

3.0 Strength, Weaknesses, Opportunities and Threats

Analysis of the existing situation in the rice production is made using SWOT analysis model, this model identify the Weaknesses and Strengths in the performance of rice crop sector, Opportunities for development and the Threats involved.

3.1 Strengths

Potential agriculture land in Sudan is reported as 84 million ha, even though the regularly cultivated land out of it is estimated at less than 10 million ha (below 12%). Agriculture sector in Sudan is categorized into three sectors: irrigated sector, semi-mechanized rain-fed sector, and traditional rain-fed sector.

Large proportion of the cultivated land is occupied by traditional rain-fed sector as around 60%, followed by semi-mechanized rain-fed sector (30~35%), and rest (less than 10%) is irrigated sector. Furthermore the listed item below create very strong advantage to rice farming in Sudan

- Vast agricultural land suitable for rice cultivation.
- Deferent climate zones suitable for rice cultivation.

- Water resources from rainfall, rivers, and underground to meet the crop requirements.
- Strategic geographical location, which facilitates the marketing of crop.
- Commitment and a political will supporting the cultivation and promotion of rice crop.
- The existence of the National Rice Project NRP
- The existence of rice promoting units in some states.
- The existence of JICA rice project working in the rice sector.
- The existence of trained manpower capable of leading the cultivation of rice crop.
- Some successful rice farming experience in the traditional sector (White Nile).
- Improvement of infrastructure such as roads, communications, soil etc.

3.2 Weaknesses

Some prevalent factors that could inhibit the development of the rice sector are listed below

- Producers are trapped in traditional system of production resulting in underdevelopment and weak technical, managerial and financial capacity of the producers.
- Weak research and extension services and lack of improved seed.
- Lack of application of recommendations of research findings
- Lack of coordination of policies between the various resources users.
- Lack of adoption of new technology for rice production
- Lack of knowledge and experience of Farmers in good agronomic practices in rice production.
- Shortage of finance and absence of marketing policies.
- Lack of effective method on weed control(ineffectiveness of the herbicide provided)

3.3 Opportunities:

There are prevalent opportunities that could result in increased production of rice and enable Sudan to attain rice self-sufficiency within the period of this strategy, listed below though not exhaustive are such opportunities.

- Rice is main food in the world, so the decline in rice production in Asian with increasing in the population create big rice gap in the world.
- Egypt is big producer and consumer of rice, due to water shortage, Egypt reduced rice area, which led to food gap in rice production.
- The existence of rice marketing in Gulf countries is very promising.

- The realization of rice as strategic food and cash crop will encourage big companies in private sector to be involved in rice production.
- The change in Sudanese food culture toward rice instead of wheat, give opportunity to increase rice production.

3.4 Threats:

Several threats could also inhibit the development of the rice sector thus delaying the achievement of the set out objectives; some of the identified threats are listed below

- Trade barriers established by developed countries to protect their producers, limit access to their market.
- Climatic change resulting in fluctuations of production and productivity of rice.
- Current economic instability, reflected in high inflation rate, and exchange rate instability provide unfavorable climate for investment in agricultural sector in general, especially rice crop.
- Insufficient irrigation facilities and lack of appropriate irrigation technique.
- Insufficient extension services, Low level of knowledge and techniques on rice production

3.5 Analysis of the Political, Economic, Social and Technology (PEST):

To complement the SWOT analysis, here the PEST analysis is also carried out:

- Political and security instability and a lot of pressure on the political system and the security services create an environment that is not conducive to the sustainable development of the agricultural sector.
- Economic instability resulting in creating an unsustainable environment for sustainable development especially in agricultural sector.
- The favorable geographical location of Sudan in Africa, the Arab world, and its membership in the African, Arab and international organizations qualify it for an important role in regional food security.
- The development of the agricultural sector ensure general peace, food security and settlement of people in the rural areas, and is the easiest and most effective means for poverty reduction.
- The international demand on organic food products accompanied by the emergence of groupings and economic partnership offers investment opportunities, which secure finance, and contributes to technology transfer and marketing.

4.0 Vision and Scope

4.1 Vision, Goal and Objective

A vision statement is needed to guide the strategic re-orientation of the rice sector. The vision of the NRDS is to produce rice to meet domestic demand and contribute to food security and poverty alleviation in Sudan.

The goal is to contribute to the development of a sustainable agricultural sector through establishment of a competitive and sustainable rice production and marketing system

The general objective is to increase rice production to attain self-sufficiency in rice production in Sudan by the year 2030 while the specific objectives are:

- To increase rice productivity per unit area depending on ecosystem through intervention in input delivery and empowerment of rice stakeholders through capacity building on rice cultivation techniques;
- Support private investors in rice production in up-land and low-land irrigated ecosystems and establishment of rice processing facilities;
- Provide suitable irrigation facilities through the rehabilitation of irrigated schemes;
- Improve production, multiplication and dissemination of purified rice seed;
- Enhance mechanization of the rice cultivation and harvest;
- Minimize post-harvest losses through improved post-harvest handling and processing technologies;
- Improve research, technology dissemination and capacity building on rice cultivation

4.2 Targets

Generally to increase rice production in the Sudan two elements have to be considered, one is to expand area and the second is to increase unit yield. The Sudan NRDS aim to increase rice production to attain self-sufficiency during the period of the NRDS, Table 4 outline that by 2030 a total of 722,683 MT of paddy will be produced made of 546,215 MT of upland irrigated, 126,048MT of lowland irrigated and 50,420MT of swampy rice.

Table 4: Estimated Production of rice ecosystems (tons) 2019-2030

Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Upland rice, irrigated	3780	6300	20790	34650	56700	95550	147000	226800	303563	378153	469010	546215
Low land rice, irrigated	5250	8400	11550	13860	18900	28700	36 750	50400	66177	84035	103994	126048
Swampy rice	13655	15755	18900	23108	23108	25210	25210	25210	30043	35294	42544	50420
Total production	22685	30455	51240	71618	98708	149460	208960	302410	399783	497482	615548	722683

Source: National Rice Program – Reports 2018

5.0 Priority Areas and Approach

5.1 Strategic Approach

In order to achieve the set out objective the NRDS will employ the following strategic approaches:

5.1.1 Agro-ecology-based Approach

In Sudan, there are four potential ecosystems for rice as shown below:

i. Rain-fed upland rice

More than 500 ~ 700 mm/year of rainfall is considered to be required for this ecosystem. It could be enjoyed in the southern part of Sudan. At present, there are no reports of rice cultivation in this ecosystem.

ii. Aerobic rice (irrigated upland)

This is one of the rice ecosystems under irrigated condition with less water than submerged rice. Like other upland crops, rice is cultivated without submerged water. Irrigation is normally made for six to nine times until harvest. NERICA4 is a famous variety for this ecosystem.

iii. Submerged rice (irrigated lowland)

This is the same ecosystem normally observed in Asian countries. Rice is cultivated with water throughout its growing period. It consumes a lot of water, but most of the high value rice is grown under this ecosystem such as Basmati.

iv. Swamp rice

Under this ecosystem, rice is cultivated along the White Nile River in the White Nile State by cultivating flooded areas. Farming operation of this rice is traditional and conventional. Normally farmers do not use any inputs such as fertilizers. Seeds are used out of previous years' self- production, therefore yield is low around two tons/ha, this ecosystem is sometimes called flooded sector.

For all four ecosystems, it is reported that the land suitable for rice production is assumed as more than 100,000 ha in the White Nile state alone. If all irrigated areas in major irrigated schemes are added up to the total area it becomes huge areas (see Table 5). Potential lands for rice cultivation can be regarded as abundant

5.1.2 Value Chain Approach

Integrated approach in rice sub-sector development efforts following value chain approach will be promoted to make sure that all actors along the chain will get the benefits from rice development strategy. The engagement of private sector and farmers' organizations (cooperatives, unions and associations) will be promoted along the chain.

5.1.3 Promotion of Private Sector Approach

The withdrawal of the government from direct production, commodity marketing and services within the framework of the privatization policies transferred the burden to the private sector. Enabling policy environments for private sector investment in rice production and marketing through consultations and meetings with worker union chambers will be promoted under this strategy, also development of strategic partnership between national and foreign investors for joint agribusiness projects. Organize investment forums for collaboration with public and private sector partners regarding monitoring and follow-up of implementation of rice investment projects, Coordination between the federal ministries and states for developing and maintaining rice investment database and information system. The government will collaborate with the private sector in order to build capacity in the area of marketing, while the government will endeavor to provide a conducive environment for the private sector to operate. Such enabling environment will include the following areas:

- Providing infrastructures including roads, electricity, water and health services support;
- Encouraging and providing incentives for the private sector to invest in the areas of storage, and transport ;

- Implementation of specifications and criteria of quality control in markets and ports of export;
- Reforming special laws relating to trade deals, and implementation of contracts and resolving conflicts;
- Establishment of rice commodity board whose membership should include the producers, exporters, processors, researchers, financiers and representatives of the related ministries. The board will study supply and demand in the local and international markets and formulate strategies to raise the share of Sudan in the markets of the commodity at lower cost resulting from the use of improved technologies, good infrastructure and effective institutions. The roles of government will gradually diminish in favor of the private sector;
- Increased attention for organic farming in view of the new directions for production and marketing of rice.
- Making use of the membership of Sudan in the regional economic groups to increase the exports and follow-up of the negotiations for access to W.T.O.

5.2 Priority Areas

Following value chain, agro-ecology and the promotion of private sector approach, top priority will be given to aerobic rice ecosystem. Since this production technique can be applied in the current irrigated upland area, it is considered that farmers can easily adopt this system. Next prioritized ecosystem will be submerged, because the private sector operators cultivate Basmati rice in this ecosystem, the private investors are expected to manage irrigation lowland areas properly. For the traditional swamp ecosystem, the strategy can focus only on improvement of current practice through research. Prioritizing of the rain-fed system might be low because promotion seems difficult geographically and practically. The above prioritization will take into cognizance the below very important requirements

- That area/state has experiences of rice cultivation in the past.
- That irrigation facilities with good conditions/management and suitable lands for rice cultivation are available in area/state.
- State/area is not far from the potential consumer point.
- Commitment of the state government to rice promotion is assured.

In consideration of the above requirements, the White Nile state and the Gezira state are proposed to be the priority states. Both states have experiences in rice cultivation (traditional swamp rice cultivation, JICA Abugasba study, and FAO/TCP in the White Nile state, and

Chinese assistance in the Gezira Scheme) and irrigation facilities are equipped. Distance from Khartoum to both states is not far for transporting of rice, and there are cities (Wad Medani and Kosti) as consumers' areas in both states. Both state ministries of agriculture have strong wills for rice promotion. However, priority states are not limited to just these two states, but to any states which can meet the above requirements.

6.0 Detailed Strategies for the Rice Sector

The Sudan NRDS shall focus on seven (strategic) components to develop the rice sector towards attaining self-sufficiency in rice production by 2030, the components and detailed pathways to achieving the objectives are provided in this section, however certain bottlenecks need to be overcome in order to promote the rice businesses, these include:

- i. Shortages in improved seeds
- ii. Deficiency in innovative technology generation and transfer methods and in supply of market-related services
- iii. Absence of integrated approach to rice management from land preparation to harvest and post-harvest interventions, rather than a single component approach
- iv. Lack of long term policy consideration along the rice value chain

6.1 Strategic Component 1: Production Techniques

There are several limiting factors to expand area and production of rice these include:

- Land resources especially irrigation schemes with good management (in terms of size of area), which can be utilized for rice cultivation for each ecosystem is one of the basic limiting factors for rice cultivation. For swamp rice ecosystem, swamp area is estimated as maximum 6,300 ha which is not stable due to available water in the White Nile River Table 5. For submerged rice ecosystem, potential land is estimated at 100,000 feddans (42,000 ha) according to the state ministry in the White Nile State. However, it should be noted that the actual area which private investors can handle and continue to cultivate in a sustainable way could be far less than this maximum area, depending upon the capacities of private investors.

Table 5: Target Area in Rice Development Plan

		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Upland Rice Irrigated	Feddan	3600	6000	18000	30000	45000	65000	100000	135000	170000	200000	235000	260000
	Ha	1512	2520	7560	12600	18900	27300	42000	56700	71429	84034	98739	109243
Lowland Rice Irrigated	Feddan	5000	8000	10000	12000	15000	20000	25000	30000	35000	40000	45000	50000
	Ha	2100	3360	4200	5040	6300	8200	10500	12600	14706	16807	18908	21008
Rice Swampy	Feddan	13000	15000	18000	20000	20000	20000	20000	20000	22000	24000	27000	30000
	Ha	5462	6302	7561	8403	8403	8403	8403	8403	9244	10084	11345	12605
Total	Feddan	21600	29000	46000	62000	80000	105000	145000	185000	227000	264000	307000	340000
	Ha	9027	12180	19320	26040	33600	44100	60900	77700	95379	110925	128992	142856

Source: White Nile State (MOAS 2010) & National Rice Program Reports (2018)

➤ Availability of agricultural labor (in terms of size of area)

Generally, one of the limiting factors is availability of agricultural labor for farmers who manage their farms by using labors. Although good irrigated land is available, farmers cannot cultivate if they cannot use required numbers of labors, resulting in no expansion of rice area. For swamp rice ecosystem, it seems that it is not an issue because currently they cultivate rice. For aerobic rice ecosystem, it seems also not a big problem because rice is intended to be introduced as one of rotation crops and currently farmers cultivate other crops by using agricultural labors. For submerged rice ecosystem, labor arrangement is basically handled by private investors. In case an investor manages whole land without any farmers, the investor may suffer difficulty to find labors to work in the water. The corporate farming houses and the individual farmers are adopting the smart agriculture tools and equipment in order to fulfill the lack of labors. Full mechanization/using herbicide for weeding are one of the keys to reduce labor requirement.

➤ Seed multiplication and milling capacity (in terms of volume of production)

For swamp rice ecosystem, they are not a problem because seeds and rural millers are both available. For submerged ecosystem, private investors buy seeds and milling machines, therefore they may not be a big issue. However, there will be limiting factors especially for aerobic rice ecosystem since promotion strategy is to disseminate aerobic rice to local farmers who do not have experience in rice cultivation. Since aerobic rice is a

new ecosystem, seeds for expansion are required and milling machines are necessary, because the markets buy only milled rice. However, milling machines are very few at this moment for this ecosystem. Difficulty on availability of milling machines for rice in this country should be eased in the coming years.

The most important challenges and constraints that faced production of aerobic (upland) rice and deep water rice (or flooded rice) in White Nile state, and aerobic rice in Gezira scheme during the last decades are:

- Availability of poor quality seeds (Sudan in general have a seed law for all crops; therefore is no special law for rice seeds, however, there are regulations controlling rice seed production)
- Insufficient land preparation (e.g. land leveling);
- Poor access to credit facilities and delays of finance (e.g. Agricultural Bank of Sudan(ABS));
- Lack of effective method on weed control(ineffectiveness of the herbicide provided);
- Insufficient irrigation facilities and lack of appropriate irrigation technique;
- Insufficient extension service;
- Low level of knowledge and technique on rice production

6.1.1 Land preparation

Land preparation for many crops is mechanized in Sudan. However, regarding rice cultivation careful attention is required so as to handle rice growth smoothly, in particular, for upland rice. Plowing machinery is being used for the preparation of upland rice cultivation and uneven land leveling. The unevenly prepared lands do result in uneven water distribution in the field which does inhibit seedling emergence and establishment, lack of proper land leveling also affect herbicide distribution such that the applied herbicides is collected in the lower portions of the unevenly prepared land (means higher dosage than necessary) resulting in the withering or death of the rice plants in the field. To avoid this problem, application of herbicide (pre-emergence) must be finished well before the start of rainfall. Furthermore it is very important to establish efficient method of “even land leveling for upland rice cultivation”. It seems recommendable to introduce the method of using motor grader to be equipped with auto-leveler as one measure. By using this method, the efficient technique should be developed by testing several combinations of motor grader and auto-

leveler. From the view point of farmers, the practical, efficient and more economical technique on land leveling should be developed for cultivating rice.

6.1.2 Seed Development

When rice production is intended to be promoted to local farmers, seed multiplication is one of the limiting factors. Availability of good quality seeds is one of the main challenges impeding the development of the rice sector in Sudan. In case of aerobic rice, the required varieties have to be multiplied to meet intended expansion. Firstly, the government (either the NRP or ARC) must have a role to produce seed and distribute them to farmers. Seed production is still carried out by the public sector and in very limited areas although rice is considered as one of the crops that requires high seed rate (30-40 kg/fed). There are many registered seed companies, so the government should promote rice seed production and encourage for adoption of rice as strategic food security and export crop. Selection of some seed companies particularly those who have assets and activities in rice producing states may represent a good starting point for establishing rice seed industry and marketing system.

Intensive research for developing new varieties is required to cover the different cropping systems, particularly the hybrid varieties that characterized by high yield. Care should be paid for improving farmer's traditional varieties by intensive cleaning (rouging) and sorting out seeds of good physical purity. Currently seed distribution channel is limited only to the traditional swamp rice ecosystem. Seeds normally used for this ecosystem are local and traditional ones, mixing short and long grains which result in poor quality of milled rice. Traditional farmers recycle seeds by keeping some amounts of paddy out of their previous year production as seeds for next season. The current channel is closed within traditional swamp farmers. Seeds for aerobic rice, which is intended to be promoted, are produced by the demonstration farms of the NRP and ARC. Varieties considered are summarized in the Table 6. Although these 4 varieties were released in 2010 their seeds are still not available in sufficient amounts to cover the suggested cultivated areas. NERICA 4 is an aerobic (upland) variety developed by Africa Rice (AR) and is well known by farmers and more disseminated than the other 4 varieties, but it is not released yet. It is currently under testing and it may take 2 years to be approved. To save pure seeds for this variety there is a possibility for importing sufficient amount of certified seeds from the country of origin after the acceptance of the national seed council until it will be released in the Sudan. Furthermore, there should be a seed multiplication system which need to be carried out in parallel with variety testing procedures, so that we can end up with a reliable amount of pure seeds that will contribute in

expansion in areas of production. After the release of the variety, it will be introduced in varietal certification system through field inspection, seed processing and laboratory testing.

Table 6: Aerobic Rice Varieties in Sudan

Varieties	Origin	Main Institutions Intending To Disseminate	Yield (ton/ha)	Remark
NREICA4	AfricaRice	NRP & JICA	2.8	Not yet released
KOSTI 1	AfricaRice	NRP , JICA&ARC	3.6	Released (genotype: WAB981SG33)
KOSTI2	AfricaRice	NRP &ARC	3.5	Released (genotype: WAB891SG14)
WAKRA	CHINA	NRP , JICA&ARC	3.5	Released (genotype: Yunlu No.30)
UMGER	INDONESIA	NRP &ARC	3.4	Released (genotype: Situppatenggang, aromatic)

Source: Mustafa, et al, (2010). A Proposal for the release of four aerobic rice varieties

6.1.3 Water Management

Rice cultivation is currently being conducted mainly by using rainfall (represented by Aweil, Bahr El Gazer) and flooding (submerged, method represented by White Nile State) except some introductory irrigated upland rice cultivation in White Nile State and GeziraState. Irrigation water is the most critical input factor in rice cultivation as well as other crops. In the Sudan rice sowing date is mainly associated with rainfall and flooding time. Main constraints facing irrigation on upland rice cultivation could be listed as follows:

- Insufficient cleaning of irrigation channels from weeds and sediments
- lack and inefficient irrigation pumps
- Insufficient funds for operation and maintenance of irrigation pumps
- Improper irrigation distribution structures which facilitate availability of irrigation water based on actual water-crop demand.
- Lack of appropriate and efficient irrigation technique

As for upland rice cultivation, it can be managed by using 40%of water compare to that of irrigated rice cultivation. Thus upland rice cultivation can save water requirement by 60 %. The water requirement level for upland rice is similar to wheat cultivation, although the total

requirement of water is relatively small, water deficiency especially at some specific growth could cause serious damage to the production of upland rice. Government is embarking on undertaking rehabilitation of the existing agriculture schemes in order to ease current situation. It is also important to tackle the rehabilitation and modernization of infrastructure of the existing schemes and traditional farming areas as well in order to promote rice cultivation. One option for increasing rice productivity is to improve water distribution and management and to ensure that water is efficiently distributed.

6.1.4 Pests and Disease Control

One of the major challenges to rice production is the issue of pests and diseases, the farmers will need to be educated on the effective use of chemicals and its environmental impacts. There is the need for coordination on handling of agro-chemicals to control pests and diseases. Furthermore the need for the public sector to facilitate access to credit facilities for agro-chemical trade and other inputs.

6.1.5 Weed Control

Weed is one of the major constraints and challenges in upland rice cultivation in the country; weed control is an important and essential operation in cultivating rice for any kind of rice variety or any area in the country. In comparison of upland rice to low land rice, weed control of upland rice is more important and critical in terms of its impact on yield, meanwhile weed percent in field of seed production for any crop is an important element for quality evaluation, since it should be free of noxious weeds. The standard for weed percentage in field of rice seeds should be only about 0.01-0.02%, therefore intensive rouging should be done for seed certification. In the case of paddy field, keeping water could prevent some kind of weeds from growing to a certain degree, whereas upland rice growth could be retarded by the growth of various weeds unless otherwise properly controlled. However, the proper method or efficient ways to control weed in upland rice field needs to be established. In addition, particular herbicides for rice are not available in Sudan, so herbicide for other crops must be used for rice cultivation for the time-being. Insufficient weed control or failure to control weed results in low yield. Therefore effective weed control method should be developed for the expansion of upland rice cultivation. With regard to herbicide, proper method for using available herbicide must be introduced (or developed). New herbicides should be examined in a small test trial base. The relation between water (including land leveling, irrigation and rainfall) and herbicide application need to be studied further so as to

find out effective way, amount and proper timing of herbicide application. Mechanical plowing coupled with certain amount of irrigation and germination of weeds before sowing rice seeds should be studied more as cultivation control method. Drying field after germination of weeds also is one of them. Hand weeding is effective at early stage of weeds, but it is suitable for small area considering high labor cost.

6.1.6 Fertilizer and Soil Management

It is generally recognized that soil in Sudan is rich in nutrient where rice is cultivated, however, soil fertility differ from one place to another depending on the nature of the soil. Soil analysis has not been carried out for the soil of upland rice cultivation. In general, soil of the field in White Nile State and GeziraState is very heavy clay soil and it is suitable for upland rice cultivation from the view point of nutrient content. It seems that Sudan has a lot of alkaline soil as agricultural land, so it is recommended to adjust pH for cultivating upland rice by applying ammonium sulfate.

In order to obtain higher yield of rice it is necessary to analyze the nature of the soil so as to apply the appropriate amount of fertilizer in the right quantity and manner. Some other constraints are difficulties in procurement of some kind of fertilizers and farmers are unable to purchase fertilizers due to the relatively high cost of fertilizer to the subsistent farmers.

At this stage the National Rice Program at the Ministry of Agriculture provides fertilizers to farmers' demonstration field. There is no problem in providing them as the Agricultural Bank makes them commercially available to farmers in the market.

6.1.7 Agricultural Mechanization

Normally, machineries and implements are not owned by the local farmers in irrigated areas. Farmers usually rent them from the owners who are big time farmers or rural entrepreneurs. Since rice is a new crop, no machineries and implements specifically designed for rice, however, some machinery and implements such as plough, seeding machine, and combine harvester designed for wheat and sorghum can be utilized for rice with some minor adjustments, even though the efficiency is not high. There are workshops to make such adjustment in Wad Medani and Khartoum. Thus, when rice farming is disseminated to the local farmers, it is recommended that they utilize currently available machineries with some adjustment for easy entry. But in order to expand rice cultivation area with appropriate cultivation techniques, rice specific machines, such as seeding machine, combine harvester is necessary in the long run, however, husking/milling machine, specifically designed for rice is

needed. In the villages closer to the producing area of swamp rice, there are private millers with husk/milling machines though these milling machines are old, and output quality is poor, for introduction of aerobic rice, it is important to foster private millers in the area nearby the production area. Once specifications of husk/milling machines are clarified, dealers/agents can import them by giving the specifications. The private sector companies provide agricultural machinery and equipment.

6.1.8 Target Yield of Rice Ecosystem

Increase yield is a prerequisite to increasing rice production to attaining self-sufficiency by 2030 as proposed under this strategy, while increasing the area under rice cultivation, intensification needs to be pursued vigorously. For aerobic rice ecosystem, target yield could be 5 tons/ha assuming varieties of NERICA4 and other four released varieties because ARC test results show around 3 ton/ha. Target varieties in NRDS should not just focus on one variety but on all available ones. Target yield of submerged ecosystem can be 6 tons/ha. Yield of submerged rice is generally high when farming operation is properly managed. Target variety in submerged ecosystem could be any type of varieties if available, but Basmati is the promising one because this ecosystem will be promoted primarily by private investors, and Basmati is the highest value rice in the Sudan market. Yield of swamp rice system is assumed to be improved to reach 4 tons per hectare due to the efforts of Agricultural Research Corporation and the government of the White Nile state. Target varieties in this ecosystem are current local varieties plus improved varieties Table 7.

Table 7: Tentative Target Yield of rice ecosystems

Ecosystem	Current yield	2030 estimated yield
Aerobic Target Variety: Nerica 4 , four released varieties by ARC& others	- 1-2 ton/ha	5 tons/ha (refer to the result of ARC’s test result and demonstration farm)
Submerged Target Variety: Basmati& others	- 2-3 ton/ha	6 ton/ha (if properly managed by investors)
Swamp Target Variety: Local varieties, ARC , hybrids expected& others	1-2 ton/ha	4 ton/ha (increase due to ARC and the state government effort)

Source: JICA Economist Expert Report (2012) & National Rice Program Reports (2018)

6.2 Strategic Component 2: Research and Extension

Rice research is conducted by the Agricultural Research Corporation (ARC) under the supervision of the Federal Ministry of Agriculture and Forestry. In ARC, the National Rice Research Program is running since 2001 and is led by the National Rice Research Coordinator. ARC has 27 research stations, 14 research centers and 3 research units.

6.2.1 Research

The current research effort focuses on three major areas namely:

- Evaluation of new rice varieties (aerobic and anaerobic)
- Agronomic practices- seed rate, sowing date, fertilizer application and water requirements /management.
- Control of pests and diseases

Recently ARC released four aerobic varieties, namely Kosti 1 (WAB981SG33 genotype), Kosti 2 (WAB891SG14 genotype), Umger (YunluNo.30) and Wakra (Situppatenggang genotype) which is aromatic and the program intends to multiply these newly released varieties Table 6.

For traditional swamp rice, ARC is evaluating hundreds of genotypes introduced from the International Rice Research Institute (IRRI), China, Korea and many other institutes working with rice. When rice production is intended to be promoted to local farmers, seed multiplication is one of the limiting factors. In case of aerobic rice, the above varieties have to be multiplied to meet the intended expansion. Firstly, the government (either the National Rice Project or ARC) must have a role to produce seed and distribute them to farmers but gradually, it would be recommended that such a role is played by the private sector.

Production of high categories of seed is the responsibility of ARC (pre-basic and basic seeds) then it will be provided to seed companies to produce to multiply the required amount of certified seeds for farmers. Seed companies can produce seeds through direct production or in contract production system. The first system can be hindered due to limited areas of production and competitiveness of other crops. Contract farming enables expansion of production areas in farmer's fields. The companies provide farmers with certified seeds and committed with the role of technical supervision. The farmer adheres to all the cultural practices until the approval of the production for the company by the seed authority. Then the company will buy the quantity of certified seeds from farmers with an excess price not less than 15% of market price. The advantage of this system is enhancing the capabilities and

awareness of farmers by involving them in seed production procedures; in contrast lack of good supervision and coordination may result in an inferior seed quality and rejection of seeds by the seed certification unit.

6.2.2 Extension

The federal ministry and state ministries of agriculture have a role to play to ensure adequate of extension services. The mandate of the federal ministry of agriculture include i) training and strengthening of extension workers, ii) coordination, iii) technical backup, policy formulation, and iv) international relations. Implementation of actual extension services is delegated to the state ministries, though the federal ministry has seven technology transfer and extension centers in the Gezira, Sinner, Kassala, White Nile, Northern, Southern Darfur, Northern Kordofan state. Numbers of extension workers are 199 for the federal level and 774 for the northern part of Sudan at state level, meaning that average around 50 extension workers in each state in the northern part.

6.3 Strategic Component 3: Rehabilitation of Irrigation Facilities

The Federal and state institutions need to rehabilitate irrigation infrastructures at targeted states for rice development plan. Financial institutions have to provide credit facilities for availing irrigation pumps and equipment needed for rice area expansion. Also irrigation canals need to be regularly maintained in order to reduce wastage of irrigation water. Completion of the institutional reform in the agriculture corporations to grant the farmers the right to land ownership title and the establishment of the water user associations and cooperatives so that they undertake the management of all the cultural practices and the sustainability of the irrigation facilities over time.

6.4 Strategic Component 4: Post Harvest Technique and Marketing

In order to strengthen rice price competitiveness post-harvest techniques must be improved. Post-harvest techniques, as well as packaging processes should be improved to reduce the cost of production and to improve the quality. However, the consumers in the Sudan are more attracted by the rice quality traits. For submerged sector, private investors can create new marketing channels.

6.4.1 Post Harvest Technique

It is important to introduce machinery to cope with the newly introduced upland rice cultivation. Large areas are expected to be cultivated under upland rice, partly due to

substitution of traditional crops such as cotton, sorghum, millet, sesame and groundnuts. It is recommended to use mechanical harvesting and milling machines. It is also very important to make smooth linkages between harvest and storage, and between harvest and milling. This is important to achieve smooth handling of the afore-mentioned processes. There should be a systematic approach of setting up of milling machinery and rice storage facilities. As for harvest, renting system of machinery such as, combined-harvester or reaper should be developed and made available to farmers. With regard to milling, there are some constraints which need to be surmounted although a great deal of effort has been put in place to improve the current situation. Milling machine of high caliber (milling capacity: 30 tons/ hour, whereby hulling and milling are done with the same machine in one passage) are being provided for the rice produced in White Nile State. Regarding threshing, this can be done using available cereal threshing machines. However, extra machines are required for rice such as milling and cleaning machines. The private sector can easily provide such in their areas of operation, large rice producers and service companies can also utilize these machines. Strategies for improving storage and warehouse facilities should look at increasing the size of storage facilities and improving quality assurance. It is very important to make smooth linkages between the upper and downstream of the value chain.

6.4.2 Rice Marketing

The radical changes in the strategy of the agricultural sector from the one that emphasize a traditional crop to the strategy that adopt food security and export expansion objective has rendered marketing of crops to play a major role in achieving the new strategic objectives.

In Sudan private sector is responsible for the bulk of grain marketing, although a significant share of farmer consumption is met by retentions from own production, a major share of urban needs of cereals, are provided by surpluses produced on farms and marketed by private sector merchants. These merchants performed several marketing functions such as transportation, storage and trade. However, poor market connections preclude markets from clearing because of high market transaction costs. The marketing strategy for Sudan agricultural exports will hinge on joint marketing, promotion of commodities being sold in niche marketseg basmati rice (see appendix 2), monitoring the need for change in operating strategy as commodities enter into mainstream markets and the building of strategic alliances with market participants (producer/exporter/ importeralliances). In order to be more competitive, marketing services with strong private sector participation should be knowledgeable of the markets, set standards, provide information and co-ordinate decisions

on transportation, packaging, training, quality, etc. Existing Cereal Marketing Boards could be seen as the agencies best placed to provide market intelligence and information; export facilitation, and develop farmer organizations (farmer's cooperatives) in addition to private traders and exporters. As rice is a newly introduced crop in the farming system, and due to lack of marketing information it needs to be marketed through groups (farmer's cooperative marketing). However, in order to compete with imported rice and due to sensitivity of consumers to rice quality and taste attributes, marketing cooperatives should take care of post-harvest operations and be aware of standards and quality measures. Furthermore one of the biggest challenges is how to create new marketing channel of rice because there is no marketing channel at this moment except swamp rice ecosystem. Consumers of swamp rice are farmers producing swamp rice and their neighbors, if surplus is obtained; it has to be linked to the local market. In order to do so, post-harvest technique must be improved. For submerged sector, private investors can create new marketing channel to domestic market or even to international market by export to Arabic countries. For sustainable and spontaneous dissemination of rice, the most important ecosystem for marketing is aerobic (upland) rice system. Strategy of rice technology dissemination in this ecosystem is to introduce rice as one of the rotation crops. In this sense, creation of new marketing channel is indispensable. It could happen that the government continues to purchase whole increased paddy in order to stabilize the market in years of surplus. Thus, it is recommended that increased domestic rice production should get into private marketing flow.

Based on the current imported distribution channel of rice, the proposed strategy is to create new channel under the aerobic system. Producing milled rice with good quality is what is required to convince key stakeholders such as wholesalers, packaging company, and local shops. Once they are aware of availability of good domestic rice with reasonable price, they start to patronize the market gradually. Therefore the government needs to create new marketing channels in the early years (at least in the first one to two years of NRDS). The proposed activities by the government should be i) Conduct a campaign of domestic rice for consumers and wholesalers, ii) Conduct some workshops with rural entrepreneurs to foster rural millers and iii) Facilitate export of surplus rice production to neighboring countries.

Some challenges that need to be ameliorated include i) lack of producers' associations for rice farmers ii) lack of specialized agricultural machinery and equipment for rice post-harvest handling and iii) lack of knowledge of the private sector rice marketing system

The following are proposed pillars for establishing proper rice marketing strategy:

- i. Production according to market needs and establishment of good linkages between farm and the market.
- ii. Marketing policies that encourage establishment of marketing system and provision of adequate marketing services.
- iii. Establishment of effective market information system that provides dealers with the required information (in a proper time and easy form) about market demand, market standards and market structures.
- iv. Development of marketing infrastructures such as roads, bridges, stores, processing and agricultural industries.

6.5 Strategic Component 5: Supporting Services

Supporting services is cross cutting element that serves both the upper and downstream of the rice value chain these include:

6.5.1 Inputs and Machineries Provision

There are many elements that have to be considered when procuring production inputs for rice production: quality determinants; time considerations; cost determinants; and organization (procurement system, institutional organizations etc).

In order to further commercialize agricultural operations there is a need to change negative attitude to credit and a need for the credit institutions to devise financing schemes for small/medium commercial operators and agricultural cooperatives to develop rice production and marketing.

6.5.2 Financing Mechanism

The broadening of access to agriculture should be enhanced by adequate agricultural policy instruments, and supported by means of the provision of appropriate services. Financial systems should focus on the resource-poor and beginner farmers, enabling them to purchase agricultural inputs. Farmers must be assured of equitable access to efficient financial services

In spite of the high contribution of the agricultural sector to GDP, the ratio of the formal agricultural credit and finance to the GDP in Sudan is very meager compared with other developing countries. Availability and accessibility of credit will be critical to achieving diversification and intensification of non-traditional commodities. Lending conditions should be sufficiently broad and flexible to allow for the kind of investments associated with on-farm development works and annual seasonal working capital. To promote rice production,

the current loan systems of Agricultural Bank of Sudan (ABS) and other banks can be leveraged. However, an important thing is to convince ABS to permit disbursement of loan for rice production. To realize this, it is necessary to show the fact that rice can be sold to the local market. Once rice is sold to the market, farmers start to grow more rice, and demand for loan for rice production will increase. Then, ABS with government support can commence to provide loan to rice production and marketing. Loan provision in kind can be done except rice seed, however, repayment in kind by paddy or rice seems difficult at the initial stage. So repayment has to be made by cash at the beginning, and in-kind repayment is gradually accepted as transactions of rice in the markets are increased, and rice is confirmed as a salable crop. In 2009, more than 95% of total ABS finance went to the agriculture sector. The size of finance to the agriculture sector was 737 million SDG, more than two times of that of 2006, and this occupied 44% of total finances disbursed to the agriculture sector by 38 banks. This shows the significant importance of ABS in financing to the agriculture sector.

In the ABS finance, Murabaha mode of finance is 76.1% for both short and medium/long term loan and 15.5% is by Salam mode. This composition is different from that of overall finance in Sudan, namely 47% Murabaha and 2% for Salam in 2008. Murabaha mode is dominant in agriculture sector and Salam is also more common than that for overall sectors. Out of seasonal loan for agriculture, irrigated sector had 86% share, semi-mechanized rain-fed sector occupied 13%. Even though finance to irrigated sector is large, repayment rate in the sector is the lowest. Out of total finance provided during 2009 by Farmers Commercial Bank (FCB), finance to agriculture sector has 49%. Systems of finance such as seasonal, mid-term, acceptance of cash and in kind, profit margin, mode of Islamic finance, borrowers, and collateral are more or less similar to ABS.

6.5.3 Farmers Organization

Farmers' organizations which seem to have a certain relationship with rice promotion are:

i) Farmers' Union

Farmers' Union is an organization of farmers to make policy recommendations for policy makers for the sake of farmers. One Farmers' Union is formed basically for each state covering irrigated, semi mechanized rain-fed, and traditional rain-fed sector. Headquarter is in Khartoum, and there is a general assembly consisting of representative of all states. Executive body of Farmers' Union at national level has 26 members. Anyone who is a

farmer can participate in Farmers' Union. To become a member, farmers have to be registered.

ii) Cooperative Societies.

Cooperative societies are organizations for the promotion of the economic and social interests of member farmers. According to the officers at the state ministries related to agriculture in the Gezira and the White Nile state, there are few cooperatives in irrigated sector for major crops. In the White Nile state, 90 cooperative societies are formed in the agriculture sector; however 88 are in the traditional rain-fed sector and mainly for sorghum.

Cooperative formation enable farmers to organize the economic and social services they need, thus relieving the burden of the states and contributing to the success of structural reforms which make them more aware of their freedom and responsibility to determine and control their own resources and enterprises. Furthermore they strengthen popular participation and decentralized decision-making so as to put national agricultural development on a broader base. However, cooperatives need a conducive environment before they play their beneficial role.

Agricultural cooperatives for marketing and input supply provide member farmers with required production inputs and sell their crop to local whole-sellers and exporters. Also, they facilitate provision of credit, processing, and other additional services such as education, extension, training and adoption of new technologies.

iii) Organizations Related to Irrigation Management

To envisage efficient irrigation management, the White Nile State government plans to regroup the 159 irrigation schemes into 18 groups. The state government is thinking that private investors invest initial capital for physical construction for regrouping the schemes, and operate and manage new schemes under the long term lease contract. For trial, a project for the Malaha scheme is on-going by the federal government budget, regrouping 11 schemes into one. Main canals and a link canal have been completed with pump station. However, a management body or a company has not yet been decided even now for the integrated large scheme of 11 schemes, either the government or private investors, proper management is expected to be established for improvement of the performance of irrigation schemes.

6.6 Strategic Component 6: Capacity building

Rice development strategy require building domestic capacity for production, processing and marketing of good quality rice that could compete in domestic and export markets. Provision

of adequate training programs on rice research on appropriate pre-harvest and post-harvest technologies, extension and dissemination of technologies and marketing of rice are considered necessity. For a proper technical capacity building and upgrading of farmers skills training should continue to deliver more knowledge and information regarding aerobic rice production and other ecosystems. Some specific areas for capacity building proposed by Seed Administration include seed technology, rice seed production, field inspection, variety testing, variety characterization, seed processing, and laboratory seed testing (physical purity, germination, seed vigor, seed viability and seed diseases).

The training program has to include breeders, agronomists, entomologists, pathologists, plant nutrition, and extension workers as shown in Tables 8 and 9.

Table 8: Capacity Building Program for (2019-2030)

Activity	Purpose	Objective	Beneficiaries	Duration	Location
TOT	Capacity building	Yield enhancing technologies	500 Agric. Extension	2019 – 2030	6 states
Exchange visit	Capacity building	Sharing experience	200 Agric. extension	2019 – 2030	Uganda – Japan- Egypt - other
Scientists Training	Capacity building	To quality for high degree	30 Agric. Extension	2019 – 2030	Local universities and outside
Field Farmers School	Capacity building	-Disseminate technologies	700 Farmers	2019 – 2030	6 states
Training courses	Capacity building	Different field	500 Agric. Extension	2019 – 2030	Uganda – Japan- Egypt - other
Workshop to Evaluate cultivate stage			Senior staff	2019 – 2030	6 states
Workshop to Establishment stage			Senior staff	2019 – 2030	6 states
Workshop Evaluate to harvest stage and all season			Senior staff	2019 – 2030	6 states

Table 9: Capacity Building Program proposed by Agricultural Research Corporation (ARC) for the period 2019-22030

Activity	Year 1	Year 2	Year 3	Year 4	Year 5
Breeding(PhD)abroad&local	1	2	1	1	1
(M.Sc.) abroad& local	1	2	2	1	1
Agronomy(PhD) abroad& local	1	2	1	1	1
(M.Sc.) abroad& local	1	2	2	1	1
Protection Entomology(PhD) abroad & local		1	1	1	
(M.Sc.) abroad& local	1	1	1	1	
Protection Pathology (PhD) abroad& local		1	1	1	
(M.Sc.) abroad& local	1	1	1	1	
Protection Weed control (PhD) abroad& local	1	1	2	1	1
(M.Sc.) abroad& local	1	1	1	1	1
Plant nutrition	1	1	1	1	

(PhD) abroad& local					
(M.Sc.) abroad& local	1	1	1	1	1
Seed production (PhD) abroad& local	1	1	1	1	1
Seed production (M.Sc.) abroad& local	1	1	1	1	1
Technicians	14	13	10	9	6

6.7 Strategic Component 7: Private Sector Investment

The Government of Sudan wants to promote private participation in the rice sector, to this end three companies are interested in submerged rice production probably because yield of submerged rice is higher than aerobic rice, and there is a high value variety, Basmati, for submerged rice. According to the information of Crown Company, the area harvested will be much less than 1,000 feddan. Lesson learned from the first years' experience is that of scarcity of labor. The company maintained that rice cultivation is labor intensive, and the usual laborers do not want to work in the water. Their plan is to aim domestic market for the first two years and then target to Arabic market by export after that. Seeds (ERIK6, Basmati variety) were provided by the Pakistan seed company. The company purchased milling machine (capacity of 30 tons/day) and processing plant which enable them to process and package (the company has already designed their package).

Steps for private investments

- Determinethe ecological zone(s) to be involve
- Establish yield goals
- Carry out soil sampling and data interpretation
- Monitor and establish yield maps
- Make decisions regarding management of land preparation, varieties, fertilizers and other nutrients to achieve yield goals.

7.0 Implementation Structure

7.1 Institutions

1) *Federal Ministry of Agriculture*

At the national level, the Ministry of Agriculture in particular has a critical role to play in creating the environment for and facilitating the production of the non-traditional crops like rice, which fall under the diversification plan. The ministry is responsible for:

- Providing support for the production of non-traditional crops like rice to meet market demand
- Mobilizing the resources to ensure success in production;
- Advising farmers on crop production technologies;
- Educating farmers to undertake farming as a business;
- Providing technical services in support of farm production operations;
- Ensure the availability of inputs such as seeds, fertilizers and pesticides and facilitation of the regulations for financing of these inputs and their import and distribution together with the commitment for quality and use;
- Increase of the mechanized agricultural operations while considering the economic, social and environmental aspects and upgrading the farmers operational and maintenance capacities in dealing with the agricultural implements.
- Completion of the institutional reform in the agriculture corporations to grant the farmers the right to land ownership, title, and the establishment of the water user associations and cooperatives so that they undertake the management of all the cultural practices

2) National Rice Project

National Rice Project was established in 2005 to implement the presidential order and the ministerial decree of rice development. Major activities were i) test trials of NERICA4 under aerobic condition under the FAO/TCP project from April 2007 to March 2009, and ii) establishment of demonstration farms of 400 feddan for NERICA4 at the irrigated field of the sugarcane company in the 2010.

7.2 Institutional Arrangement

In order to fully implement NRDS a steering committee was established with a lot of related institutions. It was also decided that the National Rice Project become the secretariat of the committee. It is recommended that the NRDS steering committee should be the main body of formulation, monitoring, and evaluation of NRDS. Important arrangement is to share important information such as production technique, market, and progress of NRDS among all related institutions; so that each institution can work more efficiently to achieve their respective goals and synergistic effect as expected. The NRDS steering committee and the National Rice Project are expected to be a center of coordination among them (though there is the rice council, which is another candidate for a center, its activities are not visible). Figure 1 indicates proposed institutional arrangement for NRDS implementation

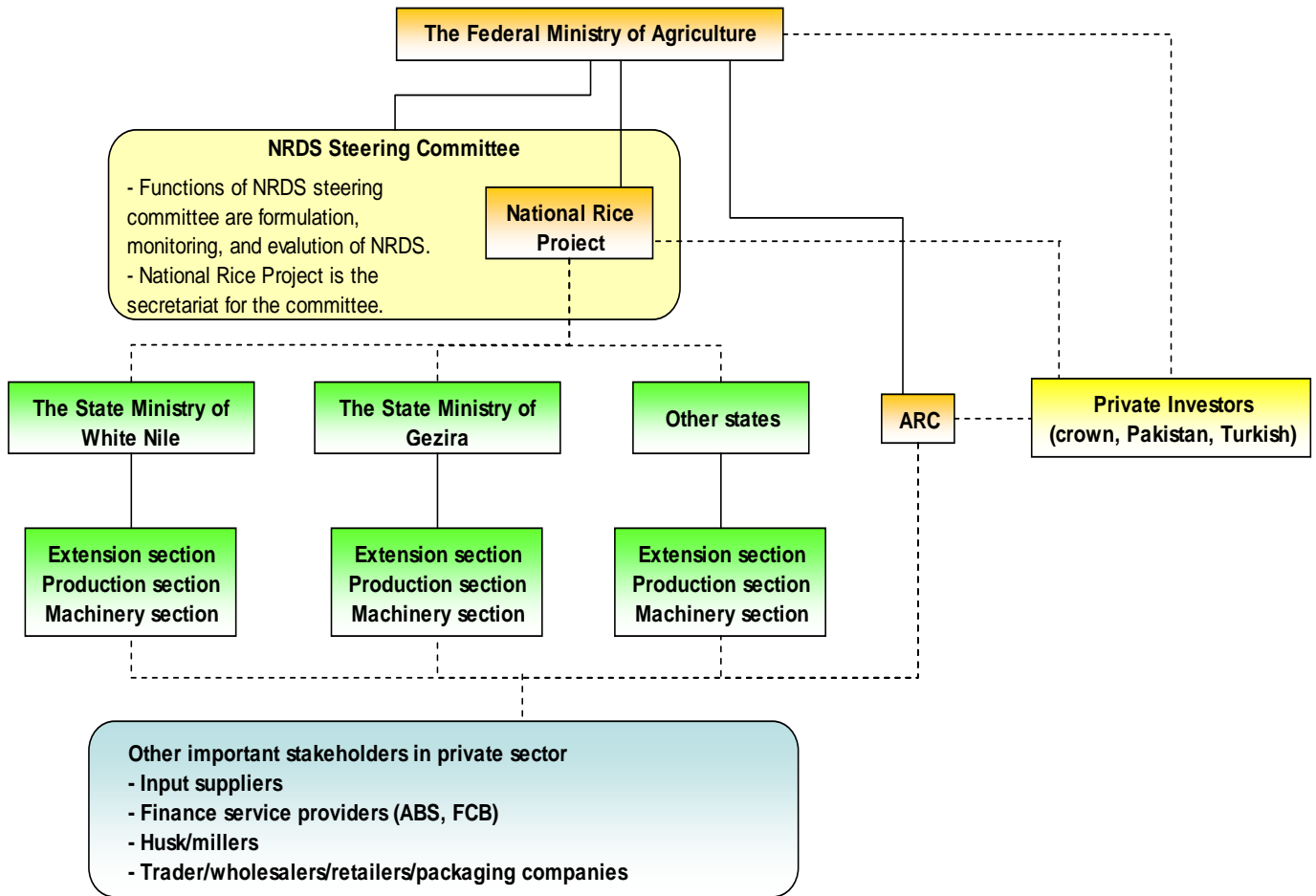


Figure 1: Institutional Organization of Rice Development.

7.3 Monitoring and Evaluation

After the formulation of NRDS, monitoring and evaluation is important. So far, monitoring and evaluation of past policies of rice are weak. The National Rice Project is expected to collect and keep statistical data from each ecosystem (especially submerged sector by private investors), and prepare periodical reports (at least annual report). These reports are proposed to be submitted to the committee and shared among stakeholders. If it is found that progress is not as planned for a particular ecosystem, some countermeasures could be proposed and implemented. At the end of the period of NRDS, it should be evaluated in order to formulate a next plan, so that focal points in a next plan are easily specified and policies become efficient. This cycle is called “PDCA cycle” (plan, do, check, and action) and is recommended to be adopted.

8.0 Policy Development

Currently policies of the Government is geared towards production, National Rice Project is expanding its size of demonstration farms. National Rice Research has been focusing on rice production technique and varietal selection, and has succeeded in releasing four varieties. The government is also promoting private investment in the rice sector.

The major aspects of investment promoting policies that encourage rice production and marketing are the following:-

- Macroeconomic indicators which reflect the stability of the economic performance (economic growth rates, exchange rate, inflation rate etc).
- Agribusiness environment: The agribusiness environment plays a major role in improving Sudan competitiveness of and attraction of foreign direct investment. The agribusiness environment elements are:
 - Government systems and procedures
 - States of infrastructures (roads, power etc)
 - Available technologies and their utilization
 - Labor market and management
 - Investment laws, by-laws and legal rules
 - Capital market and finance
 - Types and degree of business risks
- Investment Pulling Factors:

An attractive investment environment has a major role in successful investment. The major pulling factors are:

- Policy framework, economic and legal procedures
- Agribusiness encouraging procedures
- Investment marketing promotion, basic services, technical and logistical support, pre- and post-investment services and helping investors to solve their obstacles
- Economic factor: natural and human resources, domestic product and labor market, technologies, accumulated knowledge in agribusiness sector.
- Regular consultations with private sector as stakeholders of investment program and their feedback on current government policies, rules and regulations are considered important factor to shape and re-shape policies.

APPENDICES

Appendix1. Types of Land holding in Sudan

The federal, state and local governments need to work together, in consultation with the civil society, for a land policy that provides long-term rights to land, and put in place the institutions for enforcement of the land rights and conflicts arising from land use and disputes.

Land issues are generally sensitive in most countries and so are they in Sudan. By Unregistered Land Act of 1970, land was formally owned by the government except the land registered before 1970 under a 1929 land ordinance. Under the current system, all lands other than freehold land can generally be classified into three types.

Type I: Registered leases on Government land which have been surveyed.

This land is usually under cultivation in large-scale semi-mechanized schemes, or in traditional irrigated farming. These types of tenure can be small and large farms. Lease rights are for specified periods of time; for example, the large semi-mechanized farm leases are typically 25 years. They carry cultivation rights and also certain lease conditions, such as protection of the environment, sub-leasing, and transgression of easements in the semi-mechanized farming areas. It is usually unlawful to sell land leases and hence the leases are of no use as collateral for formal credit. In aggregate this type covers a vast area in Sudan.

Type II: Registered land with usufruct rights on Government land which has been surveyed and is usually cultivated.

Cultivation rights are held in perpetuity, but leases are held for specific periods of time. The extent of this type of tenure is limited but the exact areas involved are apparently not known.

Type III: Unregistered land with traditional usufruct rights but not surveyed, yet deemed to be Government land.

The use of these lands (often referred to as "un-demarcated land") has usually been established through its unlawful settlement and unlawful clearing and cultivation by individuals or groups. Eventual registration of this land merely formalizes an unauthorized occupation. This type of land, like Type I, also covers vast areas - typically on the margins of the registered areas in semi-mechanized and traditional rain-fed areas. Within these three types, there are many variants depending on location and type of land. The main variants are related to the extent of local jurisdiction over land rights and land use. Some examples are listed below:

- Communal land, though owned by the Government, is under the control of the community or village leader (the sheikh) and is usually allocated to households from the village or the ethnic group for their exclusive use. The land would normally be inherited, but it is not possible to use it as collateral; this limits access to formal credit for holders, who are sometimes small farmers.
- Leaseholds are allocated by the government to private farmers with water license to draw from the Nile for 15 years, recently up to 25 years. This constitutes most of the irrigated land along the major rivers. Leases on land for foreign investors usually in rain-fed areas have been granted for 25 to 99 years.
- Land rented by Government by decree, or owned within the command area of an irrigation scheme, such as the Gezira Irrigation Scheme, and leased to tenants. Neither the owner nor the tenant has the right to sell the land or the tenancy rights, even though a number of informal transactions do take place. Obviously under these circumstances the land cannot be used as collateral for formal credit.

For domestic rice promotion, the priority area/land is proposed for each rice ecosystem. Main idea to increase rice production is to utilize current irrigated upland areas where sorghum and wheat are grown by substituting rice for other traditional crops, not to develop new area for rice. Normally in irrigated area, land is clearly demarcated. Farmers in irrigated sector can access to banks for getting loans. Thus, land issues seem not to be as serious as new development for domestic rice promotion in terms of current assumed strategy for NRDS.

Appendix 2: Comparison of rice types and prices at different locations

Comparing the various types of rice at different locations in Sudan will show that basmati type rice has the highest value, and retail price of basmati is 50 and 55 SDG/kg. Basmati rice is considered to form independent market segment. For other types of imported rice, other long grain rice is cheaper than short grain rice at any points of distribution channel. Currently, the total amount of this type of rice is less compared with short grain paddy imported from Egypt, but could be a very strong potential competitor in terms of price. Short grain, though prices are higher than other long grain rice, is considered the most popular rice in Sudan (in terms of total amount of import), and its prices change from 25 of wholesale price to 40 and 50 of retail price.

For domestic swamp rice, price of milled rice from farmers to retailers is very low in villages nearby producing areas at the range between 25 and 30 SDG/kg. If farmers sell paddy instead of milled rice, price is lower than milled rice as 20 ~ 25 SDG/kg.

Table 10: Price of Rice in Different Points of Distribution Channel in 2018

Unit: SDG/kg of Milled Rice

Stakeholder		Import			Domestic Swamp Rice
		Basmati	Other long grain	Short grain	Local variety
Wholesaler at Omdurman market	Price for purchase	45	40	30	not available
	Price for sell	50	45	35	not available
Retailer at Omdurman market	Price for purchase	50	40	35	not available
	Price for sell	55	45	40	not available
Retailer (supermarket) at Khartoum	Price for purchase	60	45	40	not available
	Price for sell	65	50	45	not available
Retailer at Kosti (village of swamp rice farmers)	Price for purchase	-	50	-	30
	Price for sell	-	55	-	35

Source: JICA Economist Expert based on the information collected from each stakeholder (Nov.2010) & national rice program – reports 2018

Appendix 3: Action Plan:

The Action Plan is the next step following the endorsement of NRDS. In preparation of the Rice Action Plan, some elaborations were made on priority areas of the NRDS. These are included in the NRDS appendices.

In order to achieve the objective of increasing rice production and attaining self-sufficiency by 2030, four component areas were singled out for immediate attention, thus elaboration was carried out in order to find out the current situation, make long and short term projections, identify challenges/bottlenecks that would impede the achievement of the set out objectives, mitigating measures are also proposed in order to obtain the desired output. Appendix 3 though not exhaustive itemize the priority areas

Appendix 3.1. Production Techniques

Appendix 3.2. Research and Extension

Appendix 3.3. Post-harvest and Capacity building

Appendix 3.4. Implementation (policies- marketing –price – laws & institutional setup)

Appendix 3.1: Production Techniques

Priority areas	Current situation	Projections ST: 1 -4 ye LT: > 5 ye	Challenges Bottle neck (SWOT analysis)	Measures to mitigate challenges	Results of Mitigation	Resp Min
1, Land preparation	-Availability of mechanical land preparation -Poor land leveling -Poor water distribution -Poor herbicide distribution	-Establishment of a method of even land leveling -Use of motor grader equipped with auto-leveler	-Lack of efficient technique for testing several combination of graders	-Develop practical, efficient and more economic techniques on land leveling	-Efficient land leveling system	-Ministry of Agriculture (ARC and other research institutes) -Private sectors.
2., Seed development	-Availability of poor quality seed -Insufficient seed in the system -Public sector responsible for seed production -Limited area for seed production	-Establishment of rice seed industry and marketing system in the short term -Intensive research for the development of new varieties in the long term	-Limited seed distribution channels -Mixing of short and long grains -Prevalence of seed recycling -Poor quality milled rice	-Establishment of demonstration farms by NRP and NRC -Establishment of seed multiplication system	-Availability of reliable amount of good quality seeds -Expansion of production area	Ministry of Agriculture (ARC and other research institutes) -NRP&NRC
4, Weed control	-No rice specific herbicide -Use of herbicides of other crops for rice	-Development of effective weed control method in the short term -New herbicide testing for rice to be carried out	-Unknown timing for herbicide application	-Need to effective way, amount and proper timing for herbicide application	- Reduced weed infestation -Increase productivity	Ministry of Agriculture (ARC and other research institutes) -NRP&NRC
5, Fertilizer & soil management	-Soil in Sudan is rich nutrient	-Carry out soil analysis in the short	-Soil high in alkaline content	-Adjustment of soil PH -Subsidies on fertilizers	-Increased productivity	Ministry of Agriculture

	<ul style="list-style-type: none"> - Soil mainly alkaline in nature -Fertilizer provided by government for demo farms 	term	<ul style="list-style-type: none"> -Difficult in procurement of certain types of fertilizers -High cost of fertilizers 		-	<ul style="list-style-type: none"> (ARC and other research institutes) -Private sector
6, Agricultural Mechanization	<ul style="list-style-type: none"> -Available machines are owned by entrepreneurs -No rice specific machines 	<ul style="list-style-type: none"> -Provide rice specific machines in the short run -Establish more workshops for adjustment of currently available machines 	<ul style="list-style-type: none"> -Fewer fabricators -Fewer processing machines - 	<ul style="list-style-type: none"> -Increase machineries in the system -Provision of processing machines -Increase private millers 	<ul style="list-style-type: none"> -Increase production and productivity -High quality of milled rice 	<ul style="list-style-type: none"> -Ministry of agriculture -Private sector -DPs

Appendix 3. 2: Research and Extension

Priority Areas	Current Situation	Projections ST: 1 -4 year LT: > 5 year	Challenges Bottle neck (SWOT Analysis)	Measures to mitigate challenges	Results of Mitigation	RESP MIN
RESAERCH						
1. Evaluation of the released genotypes in new ecological zones	-Released of four aerobic rice varieties	-Maintenance and multiplication of the released varieties. -Distribution of multiplied seeds to farmers -Private seed companies to take over seed distribution in the long term - Seed companies to produce seeds through contract system	-Limited area for seed production -Competitiveness from other traditional crops -Low research capacity -Shortage of laboratory equipment -Poor funding for research	-Encourage contract farming system for seed multiplication -Seed companies to provide farmers with technical capacity to multiply seeds -Seed companies to buy seed from farmers at 15% more than market price - Upgrading the research stations. - Enhancing the collection process of local germplasm.	-Creating capacity and awareness in seed production procedure -Elimination of inferior seed -promotion of research activities.	-Ministry of Agriculture (ARC and other research institutes) -Private sectors. -Seed companies -farmers
2. Genetic enhancement of promising germplasm in irrigated and rain-fed sectors including local rice materials (eg Darfur, state)	-Low availability of local germplasm	- More varieties to be released in the short and long term	Low research capacity -Shortage of laboratory equipment -Poor funding for research	Upgrading the research stations. - Enhancing the collection process of local germplasm. -private sector support and funding from in	-promotion of research activities.	-Ministry of Agriculture (ARC and other research institutes)

3. Development and recommendation of improved crop husbandry practices for different eco-logical zones.	-Absence of good agronomic	- Released of some good agronomic practices such as water requirementetc	-Lack of capacity building on good agronomic practices	-Training on GAP - Technology transfer and extension services	-Availability of quality seeds in the system	-Ministry of Agriculture (ARC and other research institutes) -Private sectors. -Seed companies -farmers
4. Establishment of national rice Res. Centre	-No rice research center	Establishment of 1 rice research center in the short term	Low research capacity -Shortage of laboratory equipment -Poor funding for research	-Training of researchers	Availability of well equipped research personnel	-Ministry of agriculture -Universities -Development partners support e.g. KAFACI, IRRI, Africa Rice and JICA
5. Coordination between ARC and other Res. Institutes	-Lack of proper coordination	-Establishment of good coordination mechanism		-Coordination result in proper planning system	-Better planning for seed availability in the system	Ministry of Agriculture (ARC and other research institutes)
EXTENSION						
1. Strength relation between ARC\TTEA	-Weakness of coordination	-Proper definition of the role of extension agent and researcher -availability of appropriate toolseg. demonstration field	-Lack of extension tools -Lack of funding	-Availability of extension tools -Establishment of proper funding mechanism -Promotion of the extension activities.	- Availability of more extension agents Availability of funding to carry out extension functions.	-Ministry of Agriculture.(ARC and other research institutes)

2. Capacity building	-Lack of training for extension agent and contact farmers	-Training of 250 extension agent and contact farmers in the short term -Double the number trained in the long term	-Lack of funding for training	-Availability of funding for training	-Availability of sufficient extension agents in the country.	-Ministry of Agriculture. - Private sectors .- Other organizations
3 Management of technical package	-Lack of knowledge about rice production -weak coordination -Lack of technical manuals	-Production of technical manuals in the short term -Capacity building in GAP in the long term	-Lack of technical personnel -Poor funding -Lack of production manuals	-Availability of funding for training -production of technical manuals	-Availability of technical manuals - Availability of well trainedpersonnels	Ministry of Agriculture. -Research institutes - Private sectors .- Other organizations

Appendix 3.3: Post-harvest and Capacity building

Priority areas	Current Situation	Projections Short term: 1 -4 ye long term: > 5 ye	Challenges Bottle neck (SWOT analysis)	Measures to mitigate challenges	Results of Mitigation	Responsible Ministry
1.Capacity Building	-Low level of extension agents and other actors along the RVC	-Upgrade the skills of extension agents in the short term -Training and re-training of actors along the RVC	-Low training level for farmers and operators -Poor field management & machinery operation	-Upper level training for extension staff - capacity building program required - Rice mechanization 20 participants per year - machinery repair and maintenance 120 participants per year - Farmers exchange visits 10 participants per year - post harvest technology 20 participants per year	- Improvement of post-harvest technology system - Adoption of rice cultivation technology - High degree level of mechanization system - Efficient application of mechanization system - Sustainability of rice production	MoANR & TTEA
2 Rice Machinery	-Lack of new technology for rice mechanization system - Performance indicator for rice mechanization system very low	-Short term: capacity building and piloting stage for rice development - long term: expansion of rice cultivation areas,	-Inadequate provision of rice machinery package	-provision of rice machinery through the technical cooperation program - Provision of model farm machinery	-High degree level of mechanization system -Expansion of rice cultivated area -Increase productivity & production - Enhance opportunity to mechanization of rice cultivation - Rice machinery package for upland rice are available	MoANR & AEA
3. Post-Harvest Technology	- Lack of know how application & experience - low execution	-Short term:availability of equipment - long term: increase rice processing capacity	- Lack of Post- harvest equipment & storage facilities -Unavailability of lab test equipment for post- harvest technology - lack of experience	-Avail equipment through technical cooperation program -offer specialized training for post-harvest technology	- Quality assurance of processed rice - Existence of qualified profession - Improved post-harvest technical - Minimize post-harvest losses	MoANR & AEA

Appendix 3.4: Implementation(Policies-marketing-price laws and institutional set up)

Priority areas	Current Situation	Projections Short term: 1 -4 ye long term: > 5 ye	Challenges Bottle neck (SWOT analysis)	Measures to mitigate challenges	Results of Mitigation	Responsible Ministry
1. financing policies	-Lack of clear policies to encourage rice cultivation	-Encouraging the provision and financing of production inputs for rice cultivation	-Lack of defined policy for rice development financing	-Allocating a specific percentage of the financing portfolio to the Agricultural Bank to finance rice cultivation - Encourage increased financial flows from donors and the investor	- A well developed rice sector	-Ministry Of Agriculture, -Ministry of Finance, -Agricultural Bank of Sudan -Bank of Sudan
2. policies on Infrastructural development	-Weak government infrastructure for rice production - A power gap	- Create the climate to encourage infrastructure investment - Motivating the private sector to invest in energy	-Poor private sector participation in infrastructural development	- Increasing the size of microfinance to provide funding for infrastructures eg rural roads, storage facilities etc	-Better marketing of local rice	-Ministry of Irrigation & -Ministry of Finance and -Economic Planning
3. Institutional and legal policies	-Poor coordination between the different bodies	-Full coordination between the various parties				Federal Ministry Of Agriculture & state Ministries
4. Marketing policies	- Poor promotion of rice marketing -lack of encouraging prices	-Establishing legal incentives to cultivate and invest in rice and protect and protect local producers -Promoting the cultivation and consumption of rice and its products locally	- Lack of scientific research on the rice crop marketing	-Adopting the private sector initiative and research in the field of developing the rice industry - Encouraging investment in the value added chain -Announcing encouraging focus prices	-More patronage of local rice	-Ministry of Justice and Parliament -Ministry Of Agriculture - Ministry of Finance -Bank of Sudan -Agricultural Bank -private sector
5. Policies to modernize rice cultivation	-Failure to provide approved seeds -Unavailability of approved pesticides -Lack of processingfactorie	-Providing options for approved solutions in pest and seed management -Encouraging the application of agricultural technologies -Encouraging investment in rice processing	-Low private sector participation	-Provide conducive environment for private sector investment -Encouraging small farmers to produce rice through microfinance	Competitive ness of local processed rice	Ministry Of Agriculture The Ministry of Finance and Economic Planning, the Ministry of Industry, the Agricultural Research Corporation and the private sector

	s					
6, Capacity building and research policies	The weakness of the human cadre and scientific research in the field of rice	-Increased support for scientific research in the short term -Establish training and scientific research centers to support knowledge and skills in rice production and marketing in the long term	-Lack of scientific research in rice sector development	-Create avenue for increase research in rice value chain	-More robust rice industry	Ministry of Finance, Ministry of Agriculture, and Ministry of Infrastructure