Food and Agriculture Organization
of the United Nations

STUDY ON

SMALL-SCALE FAMILY FARMING IN THE NEAR EAST AND NORTH AFRICA REGION

FOCUS COUNTRY

Sudan

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PREFACE

The 2014 International Year of Family Farming (IYFF) focused global attention on the important role of family farming in providing food and nutrition security and enabling sustainable development. The celebration of the IYFF also significantly raised the profile of family farming, which was included in the Second International Conference on Nutrition (ICN2) in 2014, and in the United Nations Post-2015 Development Agenda, adopted inSeptember 2015. In the new Agenda, small holders and family farmers were placed at the centre of many of the 17 Sustainable Development Goals and 169 targets (notably, the goals of No poverty [SDG1]; Zero hunger [SDG2]; Gender equality [SDG5]; Decent work andeconomic growth [SDG8]; Responsible consumption and production [SDG12]; Climate action [SDG13] and Peace, justice and strong institutions [SDG16]), thus recognising the central role of small holders and family farmers in combining economic, social and environmental sustainability and food security.

Small-scale family farming (SSFF) is considered one of the most important factors in agricultural and rural development in Sudan. This is especially so because of the growing phenomenon of land fragmentation and its negative impact on agricultural production, efficiency in the use of natural resources and food security, as well as on the living conditions of small farmers and their families .

In this context, FAO in collaboration with the Mamoun Beheiry Centre for Economic and Social Studies and Research in Africa (MBC) from Sudan and under the FAO's Regional Initiative on Small-Scale Family Farming (SSFF), have conducted an in-depth national study in Sudan. The overall objective of the study is to undertake a review of small-scale family farming in order to generate a medium term action plan to catalyse the sustainable and inclusive development of SSFF in the region.

The study relies on national data and accessible documents, including academic and non-academic literature and documents from development projects. Additionally, interviews were conducted with key stakeholders to identify and analyse their experience with regard to the current and past state of affairs of public policies in support of SSFF. The final report draws conclusions and makes recommendations for future plans for sustainable development of SSFF in Sudan.

We hope that this publication will significantly help FAO and its partners in Sudan to more directly respond to the needs of small-scale farmers, better target policies, identify research priorities, propose more fitting strategies and activities and suggest ways of bolstering and supporting farmer's associations and other stakeholders, with the ultimate goal of contributing more effectively to reducing rural poverty through the sustainable and inclusive development ofthe whole NENA region.

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This publication is the national study on small-scale family farming in Sudan, produced by the FAO Regional Office for Near East and North Africa (FAO-RNE) in collaboration with the Mamoun Beheiry Centre for Economic and Social Studies and Research in Africa (MBC) in Sudan. The study was carried out in 2015 -2016 with the aim of producing a comprehensive assessment of the situation of small-scale family farming (characterisation, context in which it operates, support it receives), as the essential starting point to more effectively guide FAO's activities and improve the support given to government by the various stakeholders.

Several individuals contributed to the finalization of this study. We particularly acknowledge major inputs provided by the team of experts comprising Ali Abdel Aziz Salih, Amel Mustafa Mubarak, Elnour Abdalla Elsiddig, Elrashied Elimam ElKhidir, Salwa Abdelrahman Hassan, Hassan Mohamed Nur, Salah Mohamed Elawad, Elfatih Shaaeldin and Mohamed Fawz. The overall supervision of the study was by Alfredo Impiglia, FAO Delivery Manager for the Small-Scale Family Farming (SSFF) Initiative, Regional office for the Near East and North Africa of FAO.

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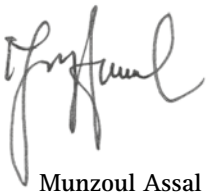
Abdi Jama
FAO Representative Sudan



Munzoul Assal
Executive Director
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ACRONYMS

ACRD-DS	Administrative Committee for Route Delineation – Darfur States
ADCs	Agricultural Development Centres
AFF	Agriculture, Forestry and Fisheries
AI	Artificial Insemination
ARC	Agricultural Research Corporation
ARP	Agricultural Revival Plan
ARSCO	Animal Resources Services Company
CAADP	Comprehensive Africa Agriculture Development Program
CAHW	Community Animal Health Worker
CBOs	Community Based Organizations
CBPP	Contagious Bovine Pleuropneumonia
CCPP	Contagious Caprine Pleuropneumonia
CNSs	Comprehensive National Strategies
COSOP	Country Strategic Opportunities Paper
CPA	Comprehensive Peace Agreement
CPF	Country Programming Framework
DPA	Darfur Peace Agreement
DRM	Disaster Risk Management
FEWSNET	Famine Early Warning Systems Network
FFS	Farmers Field School
FNC	Forests National Corporation
GAPA	Gum Arabic Producers Association
GGWI	Great Green Wall Initiative
GHG	Green House Gases
GM	Genetically Modified
GMP	Green Mobilization Plan
IASSTD	International Assessment of Agricultural Knowledge, Science and Technology for Development
IDPs	Internally Displaced Persons
ILPM	Improving Livestock Production and Marketing
ITK	Indigenous Technical Knowledge
LMMC	Livestock and Meat Marketing Corporation

MARF	Ministry of Animal Resources and Fisheries
MDGs	Millennium Development Goals
MLFR	Ministry of Livestock, Fisheries and Rangelands
MOI	Ministry of Irrigation
NA	Native Administration
NAPA	National Adaptation Program of Action
NDC	Nomads Development Council
NED	Non-Essential Disease
NSA	National Seed Administration
NWFP	Non-Wood Forest Product
PAS	Pastoralism Association Sudan
PPR	Peste des Petits Ruminants
PRSP	Poverty Reduction Strategy Paper
QCS	Quarter Centennial Strategy
REDD	Reducing Emission from Deforestation & Forests Degradation
RVF	Rift Valley Fever
SDG	Sudanese Pound
SFF	Small Family Farm
SGB	Sudan Gezira Board
SPS	Sanitary and Phytosanitary Measures
SSF	Small-scale Farming
SUCA	Sudan Camel Association
TBT	Technical Barriers to Trade
TLU	Tropical Livestock Unit
UNDAF	United Nations Development Assistance Framework

EXECUTIVE SUMMARY

BACKGROUND

About the study: This study on small-scale family farming (SSFF) in Sudan was sponsored by the Ministry of Agriculture and Forests and supported by FAO. The study was based on secondary data as well as on information provided by relevant government and non-government agricultural units at the federal and states levels. It is intended to provide an analytical basis for recommending policy actions towards revitalizing the small-scale family farming subsector in an inclusive and sustainable manner.

Definition of small-scale farming (SSF): The term small-scale farmers is defined for the purpose of the study as "those who, while fully or partially engaged in agricultural activities, have limited endowments of productive assets though they are in full control of their own production, managerial and marketing choices". This includes, but is not restricted to, those involved in traditional family-based farming. However, it is to be noted that family members are usually engaged in more than one agricultural occupation and often sell their labour for off farm-activities in rural and/or urban areas. The agricultural activities the study dealt with comprised crop production, animal production, forestry and fisheries. Though traditional farmers represent the largest segment of the category of small-scale farmers, the definition adopted here includes non-traditional small-scale farmers as well. It excludes, however, the group of the tenants in large agricultural schemes and the class of seasonal labourers who do not carry out farming activities on their own.

Just as there is no definition of small-scale farmers in Sudan, there is no census or official estimate of the number of farmers and households engaged in small-scale family farming in Sudan. A starting point for such an estimation is the size of the population of the country, projected to have been about 40 235 million in 2015.[1] Since the 2009 Household Budget Survey estimated the average household size at 5.7, the number of households should be about 7 059 million.[2] As the rural population constitutes 66.8 percent of the total population, the rural population was approximately 26 861 million, with about 4.708 million households. The rural population is estimated to be 57.83 percent sedentary and 8.93 percent nomadic. Hence, the number of sedentary households is 4.080 million and that of nomadic households is 0.628 million. Assuming that 95 percent of the rural sedentary population is small-scale farmers, the entire nomadic population is small-scale farmers, and 10 percent of the urban population work in small-scale agricultural production. Thus, the total number of households relying on small-scale farming can be estimated at 4 738 million.

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[1] United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects (2015).

[2] Source: Central Bureau of Statistics. 2009 National Baseline Household Survey. Khartoum.

Why is it important to promote SSF? Promoting small-scale family farming helps in addressing poverty reduction, the underdevelopment of rural economies, regional inequalities, the internal conflicts in which the country is mired, the risks of food insecurity, rural to urban migration, ecological imbalances and the deterioration of the natural resources base. Well-managed small-scale family farming can reverse the trend of soil erosion and the breakdown of agro-ecological functions, which have resulted in poor crop yields, deforestation and ever increasing movement of rural farmers into marginal land. Also, given that the country is experiencing a youth bulge with no urban jobs available to the youth, a revitalized subsector can arrest the migration of young people to urban centres, which are mushrooming. It can also help to realize the potential of women, who play an important role in traditional rainfed farming.

About the structure of the paper: The study starts by providing background information about the agro-ecological conditions of the country, the development and evolution of the agriculture sector, the changing strategic focus and the current challenges facing the country. It also discusses the typology of small-scale farming systems in the country and highlights the livelihoods associated with them. The study also provides a description of the production patterns and the roles and challenges facing the six small-scale farming subsystems identified, namely subsystem rainfed crop production, animal production, irrigated agriculture, semi-mechanized, rainfed agriculture, forestry and fishery. The analysis is situated in the changing local and global contexts in which small-scale family farming operates. The constraints and challenges the subsector is facing and the policy responses to these constraints are discussed prior to proposing policy recommendations.

The agro-ecological conditions of Sudan: Sudan (at latitude 15˚ 00 North and longitude 39˚ 00 East), has diverse agro-ecological characteristics differing in rainfall, soils and vegetation, which, along with its natural resource base, have conditioned the farming subsystems and shaped people's livelihoods. With a relatively vast area totalling 1.86 million square kilometres, Sudan's terrain is largely made up of gently sloping plains surrounded in the northeast by the Red Sea Hills, in the west by Jebel Marrah, in the southeast by the Ethiopian Plateau and in the central-southern region by the Nuba Mountains. The Nile Basin and its tributaries traverse the central-eastern part of the country. The northern part of the country is predominantly desert with sandy stones. South and west of the northern region stretches the western part of the country, consisting of the (Greater) Kordofan and (Greater) Darfur regions and comprising a variety of physical characteristics and ecological zones. The central region consists mostly of clay plains stretching from the Ethiopian border in the east to the Nuba Mountains in the west, and from Khartoum north to the border with South Sudan. The eastern region, which consists of a desert and a semi desert, includes El Butanah, Gash Delta, the Red Sea Hills and the Red Sea coastal areas.

The evolution and performance of the agriculture sector: The agricultural sector, broadly defined, accounted for an annual average of 31 percent of GDP during 2011–14. It has been the backbone and engine of growth of the Sudanese economy. The colonial administration (1898–1956) set into motion the commercialization of agricultural production in the country through the establishment of modern irrigated cotton production schemes and, later, by initiating semi-mechanized sorghum and sesame farming in the eastern region. The post-

colonial governments followed suit with horizontal expansion of state-owned capital-intensive irrigation schemes and private investment in irrigated agriculture and semi-mechanized farming. State-led capital formation in irrigated agriculture continued over the period up to the 1980s, including the establishment of the Managil extension of the Gezira scheme, the Khasm El Girba project, the El Rahad scheme after the completion of El Rosieres Dam, the Es Suki scheme and several sugar cane production schemes.

Subsequent to the decline in the international prices of cotton, irrigated schemes faced great difficulties. Investment in semi-mechanized farming and agro-processing provided alternative avenues for capital formation. Traditional crop farming and the livestock subsector continued to provide livelihoods for the majority of the population, though faced with competition for land and lack of government support. Macroeconomic crises in the 1970s and 1980s forced the government to undertake reforms in the agriculture sector and in macro-economic policies. Sector investment, funded by development agencies, focused on rehabilitating the irrigation schemes, reforming production relations and diversifying production. Though the traditional crop and livestock subsectors were considered important in restoring the trade balance through their substantial capacities for generating foreign exchange earnings, they were not supported to the same extent as irrigated and large scale agricultural schemes.

The balance of payments crisis led to a search for food self-sufficiency, especially in wheat. Fear of global food shortages led to foreign interest in agricultural investment in Sudan, which was promoted as a regional breadbasket. Eventually, price liberalization resulted in an increase in exports grown by small-scale farmers. Following the secession of South Sudan and the loss of oil revenue, the government set a new plan to increase and diversify agricultural production. With poverty reduction becoming a major policy objective, more attention was given to small-scale family farming. However, the strategic focus of the country is still divided into attracting foreign capital for large scale investment in food, reviving the irrigation schemes and taking advantage of the potential for export growth in the traditional rainfed and livestock subsectors.

SMALL-SCALE FARMING SUBSYSTEMS IN SUDAN

Typology: The pattern of capital formation in agriculture in Sudan briefly summarized in the preceding paragraphs has led to a dualistic production structure: modern irrigated and semi-mechanized rainfed subsectors, basically consisting of large scale schemes, co-existing with a traditional small-scale farming system. These two systems differ in their internal organization, dynamics, performance and the way the state deals with them. The small-scale subsector has evolved into various business models and systems of livelihoods shaped by resource endowments, agro-ecological conditions and locational factors. While small-scale modern agricultural ventures are in the process of emerging and asserting their presence, the subsector has remained predominantly traditional.

At some risk of oversimplifying, the main aspects of small-scale farms are that they are mostly, though not exclusively, family farms; the families being poor and vulnerable often facing droughts and subject to hunger and food shortages. A significant number of them live in

marginal, less productive land and virtually most use traditional farming techniques. However, they have historically shown great resilience, capacity for adaptation and adjustment and, when able to and considered rational, willing to use new technology and cultural practices. It is because of such adaptability that there exists a continuum of types of small farmers. Some are still in the phase of limited production for the market and most produce food for own consumption. Others are part time farmers: they keep farms, go to work in cities and return during the rainy season to grow food and cash crops. And yet, members of another category of small-farmers are more enterprising and have strong links with the market. It is from the latter group that agri-business is emerging. These small farmers work across the market chain, not only producing farm products in large amounts but entering into the business of processing and trading.

Tenants and small farmers: The criterion regarding who makes farm-related decisions will exclude tenants, share croppers and landless agricultural labourers from the small-scale producers included in this study. However, this creates some conceptual complexities in the Sudanese context. Tenants are small-scale producers organized in large schemes in small tenancies of 10 to 20 feddans. The schemes are owned by the government and managed by parastatals that decide on part of the crop mix and crop rotations and provide production and marketing services. The states in which irrigated schemes are established have better access to social services than those practicing rainfed agriculture. As such, tenants do not exactly fit in the definition of small-scale family farming described above. It is, however, to be noted that they are mostly poor and have often entered into conflict with the management of the schemes and the various governments. These large-scale publicly owned irrigated schemes, which are significantly important for the economy and the communities they are supporting, are experiencing serious difficulties, which require a high level of attention.

Small-scale rainfed crop production: Small-scale rainfed agriculture is practiced by sedentary households and groups of nomadic and transhumance farmers moving with livestock and growing short-maturity subsistence crops. Household activities also extend to forestry production, especially of gum arabic. Small-scale family farming is practised in a vast areas stretching from western Sudan (Greater Darfur and Greater Kordofan) to areas in the Gezira, Sinnar, Blue Nile, White Nile, Gedaref, Kassala and the Red Sea states. Since the crop production zones are endowed with diverse natural resources and different climatic zones, ranging from semi-desert to high rainfall savannah, conditions are appropriate for the production of a variety of crops including sorghum, millet, groundnut, sesame, cowpeas and roselle, as well as for animal husbandry. Farming practices rely on ethno-technologies in crop rotation and cultivation methods. Agricultural operations are carried out mostly through family labour and depend on the use of locally made hand tools. Most of the families keep some animals for food, milk, field work or transport.

Small-scale animal production: The small-scale livestock and animal production system in Sudan is predominantly traditional, although there is a small urban modern subsystem. The ecological variation of the country resulted in an extensive and diverse traditional pastoral system, consisting of nomadic and transhumance subsystems, and of sedentary and semi-sedentary agro-pastoral subsystems. The vast majority of the national herd in

Sudan is produced under the pastoralist production system. Quantity and quality of grasses, accessibility of water, evading mud, diseases and biting insects and security conditions are the factors that determine pastoral mobility. Patterns of movement vary from pure nomadism, with no fixed location, to different forms of transhumance, to seasonal migration along migratory corridors, to levels of agro-pastoralism where crop-livestock production is practiced. Nomadism is practiced by the camel herding groups and few cattle herders. The main animals in agro-pastoralism in general are small ruminants, especially sheep. Sedentary farming consists mainly of goat keeping with goats constituting sources of milk and meat for the poor strata of the rural communities.

Unlike subsistence pastoral production, small-scale dairy production in peri-urban areas is a commercial activity, supplying town dwellers with fresh milk. Most producers depend on local breeds and follow traditional husbandry and management methods. Herds are fed with crop residues as roughage and grains and oil seed cakes as concentrates. The milk is collected in local equipment and either sold to consumers directly at the farm or carried out by donkey carts to where consumers live, depending on how far the farm is. Hygiene measures are lacking. The labour is either household or hired, based on the size of the herd. Modern dairy holdings are mainly concentrated in Khartoum, Gezira and River Nile states where green fodder is available and big consumption centres are located. Modern systems of small-scale distribution, relying on large enterprises such as the DAL Company and supermarkets, have emerged. Regarding poultry, both traditional and modern farms exist supplying the urban centres with eggs and meat. Though the traditional poultry system is the most prevalent poultry keeping system in Sudan, modern poultry systems are gradually expanding.

Semi-mechanized rainfed farming: Traditional agriculture is based on the use of locally made hand tools. However, the heavy, black, cracking soil in which mechanized farming has been established is difficult to cultivate manually. Mechanization offers opportunities for substituting labour. The failure to establish a state-run tenancy system led to the promotion of private investors in large-scale semi-mechanized schemes of about 1 000 feddans. Subsequently, as an outgrowth of rainfed traditional farming, small-scale semi-mechanized farms, with landholdings varying from 5 feddans to 50 feddans, emerged, clustering around the large-scale semi-mechanized farms. . These small-scale semi-mechanized farms spread over a large area of the clay plains in the rainfall savannah belt, extending from the Butanah plains in the east to Southern Kordofan in central Sudan. Though the crops found suitable for cultivation in the ecological conditions of the clay plains are sorghum, sesame, short-staple cotton, sunflowers and guar, small-scale mechanized farms produce mainly sorghum and sesame.

Small-scale irrigated farming: Sudan has the largest area of irrigated land in sub-Saharan Africa, totalling about 4.8 million feddans. The large irrigation infrastructure in dams and large pumps has given rise to the establishment of large government-run and private sector-owned schemes. These modern irrigated schemes are based on a system of tenancy of smallholdings. The schemes also have consolidated lands, group finance for selected crops (cotton, groundnuts and wheat) and the provision of agronomical, marketing and management services. In addition, there is an important subsector of small-scale irrigated farming in the

Northern, River Nile Khartoum, Blue Nile, Sinnar, White Nile and Gezira states. In the State of Khartoum, small farms with less than 10 feddans constitute 56.54 percent of total farms. The main crops grown on these small farms are onion, tomato, potato, eggplant, sweet pepper, green bean, okra, and alfalfa. Small producers in the North and the River Nile states cultivate wheat, sorghum, vegetables and fruits for home consumption and sell the surplus in the market. Their landholdings, however, are exposed to land fragmentation due to inheritance. Though most households have some livestock, animal husbandry is a secondary activity; while crop growing is most important. Cash crop production consists mainly of banana, mango, lemon and guava. Small-scale producers in Kassala State pursue crop and mixed crop-animal production activities. Traditional agriculture is also practiced on seasonal rain-floods in Kordofan, on the clay plains of Khor Abu Habila basin.

Small-scale forestry production: Rainfed forests and trees are sources of fuel wood and charcoal production and provide raw materials for traditional construction and for the furniture industry. A variety of non-wood products are also supplied by these forests, including gum arabic, *Acacia seyal* (*talha*), cashew nuts, honey, beeswax, *Acacia nilotica* seed pods (*garad*), fodder, edible oils, medicines, dyes and fibres. Almost all members of small farming families in rural areas are involved in seasonal activities related to gathering and selling forest products. The gum arabic production system is an example of a business model perfectly organized to complement crop cultivation. Forests production is based on the natural forests and trees where access to the forests is loosely controlled by the government. Most forests are organized in management units and each unit follows a sequential agro-forestry system of forests (the bush-fallow cycle) and cultivation (the agriculture cycle). The gum arabic bush-fallow system widely known in Kordofan and Darfur follows the twenty year cycle of the bush of the *Acacia Senegal* tree species, followed by a 4 – 5 year cycle of cultivation of different crops.

Small-scale fisheries: Sudan is endowed with diverse surface and underground water resources, and arable lands that are suitable to support a vigorous capture fisheries and aquaculture industry. Currently, capture fishery activities are centred around the River Nile and its tributaries, man-made lakes on the River Nile and its tributaries and the territorial waters of Sudan on the Red Sea. Apart from these conventional fishing areas, there are other water bodies, including several thousand kilometres of irrigation canals, non-Nilotic streams (*khors*) and over 1 800 large and small natural and excavated rainwater impoundments (*haffirs*), particularly in the savannah belt. The fisheries are divided into three classes: subsistence, artisanal and commercial. Subsistence fishing, using basic methods such as the spear, traps, cast-nets and hook and line, practiced either from river banks or from canoes and papyrus rafts, is practiced mainly in the inland waters of Sudan. Artisanal fisheries, where the fisher typically operates a traditionally-designed one-oar-propelled boat, and which sometimes goes hand-in-hand with subsistence fishing, is undertaken mainly on the Jebel Aulia Reservoir as well as downstream the White Nile, before the confluence at Khartoum. Motorized boats are employed in commercial marine fishery which, though still largely underdeveloped, is carried out by some relatively well-off fishers and fisher-folk associations such as cooperative societies. Aquaculture in Sudan is still limited but growing in importance.

SSFs contribution to the national economy (overview): Small-scale farming contributes significantly to agriculture value added, and therefore to GDP. Furthermore, in addition to providing backward and forward linkages, SSF is an important source of exports generating a significant amount of foreign exchange. It is also the main source of livelihood for the rural communities, serving as the backbone of the rural economy and contributing to poverty reduction and the empowerment of women. It also contributes remarkably to national food security and nutrition and provides important ecological services.

- **Contributing to agriculture value added and GDP:** In 2014, the share of the entire agriculture sector was 31.5 percent, of GDP compared to 16.8 percent for the industrial sector and 51.6 percent for the services sector. SSF contributed about 73 percent of the agriculture sector and 23.3 percent of GDP. This was more than the contribution of the remaining part of the agriculture sector (8.2 percent) and by far exceeded the contribution of oil (3.5 percent); manufacturing (10 percent); transport and communications (14 percent); finance, insurance and real estate (7.5 percent), trade, hotels and restaurants (16.2 percent) and building and construction (4.7 percent). The largest contribution to agriculture value added originated from animal production, followed by irrigated agriculture, largely consisting of medium- and large-scale schemes. Rainfed agriculture came next.

- **Creating backward and forward linkages:** The backward linkages are reflected in both consumption expenditure (the rural demand for manufactured goods and services) and inputs for agricultural production. The forward linkages are reflected in the supply of inputs, energy and services for the rest of the economy. SSF, together with the rest of the agriculture sector, is an important source of inputs for local industries. The livestock subsector supplies the domestic market with hides and skins for the leather industry and handicrafts, besides exporting these inputs. Animals also are used for transport in rural and town areas. Behnke and Osma (2012) calculated transport services livestock provide their owners as equivalent to SDG 8.409[3] billion in financial terms, which is missed in GDP calculation. Livestock provide traction power in small-scale crop farming and provide manure for soil fertility, organic farming and enriching grassland nutrients.

- **Generating exports and foreign exchange earnings:** The subsector also generates a significant share of foreign exchange proceeds. These consist of cash crop exports, livestock and meat exports and forestry products. In 2014, the total exports of the country were USD 3.451 billion, of which USD 3.096 billion consisted of non-oil exports. Of these, total agricultural exports were USD 1.5198 billion. Also in 2014, livestock exports (largely produced by the traditional sector) earned the country USD 856.3 million, consisting of sheep, camels and goats. Crop exports generated USD 663.5 million in the same year, which were largely produced in the small-scale subsector, including gum arabic, sorghum, sesame and groundnuts. Gum arabic, which is obtained from the *Acacia Senegal* and *Acacia seyal*, is an important foreign exchange product for the country.

[3] Exchange rate: USD 1 = SDG 5.67 (January 2015)

- **Reducing poverty through employment opportunities and complementary sources of incomes:** The Central Bureau of Statistics (2009) stated that 46.5 percent of the population of Sudan was below the poverty line of SDG 114 per month, around USD 2.00. Poverty in rural areas is more severe than in urban areas. Nevertheless, small-scale farming with all its subsectors is helping to reduce poverty. Small-scale farmers not only gain employment from their family farms but also complement their incomes by seeking other agricultural and non-agricultural activities. SSF is the most important source of income for the rural population. The active workforce employed in agriculture was estimated to be 58 percent in 2014, while 83 percent of the population depended on farming for its livelihood: 70 percent on traditional rainfed farming, 12percent on irrigated agriculture and only 0.7 percent on mechanized agriculture.

- **Source of food security:** SSF is central to the country's food security, growing virtually all of the country's millet (more than 95 percent), nearly two fifths of the sorghum (38 percent), two thirds of groundnuts (67 percent) and more than that of the sesame (38 percent). In addition to the supply of the five major food crops of sorghum, sesame, millet, groundnuts and wheat (the latter is grown in Gebel Marra), the subsector, through the animal producers, is the source of protein provided by meat, poultry, milk and eggs. The subsector constitutes the major source for sedentary and nomadic communities of meat, poultry and eggs and a sizeable amount of fresh milk and other dairy products. Fish and fish preparations also contribute to the food security of a large proportion of the rural and urban communities. In addition, forestry products complement the food supply in the extreme dry years when famine is looming, providing tree leaves, fruits and tubers. The rural poor depend, to a varying extent, on the fruits of various other tree species that provide edible products as a source of food.

- **Bringing about ecological benefits:** There are numerous external benefits and ecosystem services brought about by small-scale farming including feeding into the nutrient cycles, water regulation and climate control. Gum arabic production, carried out in the semi-arid zone, is mainly a small-scale farming activity. The gum forests constitute a line of defence against desertification and help to conserve the soil and protect agricultural crops from erosion. Forests, trees and shrubs contribute to creating good weather conditions as well as providing shade, shelter and fertilization for the soil, together with the role they play in the preservation of water sources. However, the role of forests in eco-tourism is still a relatively small component and is basically reflected in the cottage industry, which contributes significantly to the income of rural households.

CONTEXTS, CONSTRAINTS AND POLICY RESPONSES

Contextual dynamics: The development of small-scale family farming in Sudan has been influenced by a host of drivers including demographic developments, frequent droughts, conflicts, the secession of South Sudan, decentralization, gold mining, globalization and technological developments:

1. **Demographic changes:** The rapid growth of the population and the rise in crop production and in the number of livestock put heavy pressure on the land. The expansion of cultivation and animal husbandry have reduced the fallow lands and resulted in more use of marginal lands, exacerbating the problem of soil degradation.
2. **Drought and climate change:** The increase in the frequency of droughts, the decline in rainfall and desertification, together with the imminent risk of climatic change, will lead to reduction in crop and food production and increase pest and pathogen outbreaks.
3. **Conflicts:** The increase in population, the expansion of livestock and crop cultivation, the inadequate land tenure system, lack of alterative livelihoods and work opportunities and environmental degradation have all contributed to the conflicts that the country has been mired in for decades, especially in the Darfur regions and in central Sudan.
4. **Secession of South Sudan:** The secession of South Sudan led to the loss of a sizeable segment of the population and a significant territorial decrease in Sudan's forested area. Other effects include the loss of oil revenue, shortage of labour and loss of richer grazing lands and water sources.
5. **Urbanization:** Urbanization has led to an increased demand for rural produce for the expanding urban population and a rise in urban-rural remittances. However, it has also led to the separation of families, with some members living in rural areas and others living in city slums. Increase incomes and urbanization led to the expansion of the urban food market, especially high value items such as vegetables, horticultural products, poultry, fish and dairy. This has given rise to increased commercial production in land adjacent to cities. Some small-scale commercial farms have sprung up in these areas. Yet these have to deal with a changed trading sector with the emergence of large supermarkets that are directly linked to the small traders.
6. **Decentralization:** Following a reform in 1992, the country adopted a three-tier system of government consisting of the federal authority, state administration and local governments. Though the states are in charge of providing basic education, health services and water supply, they lack institutional capacity and financial resources to deliver services and carry out their development mandate.
7. **Gold mining:** Since 2010, artisanal gold mining has significantly expanded in Sudan leading to the switch of thousands of farmers and agricultural workers to gold mining. Furthermore, gold mining is creating serious hazards for the natural environment and the health of humans and animals.
8. **Globalization:** Globalization has changed the global environment in which the smallholder farmers operate, impacting the demand for their produce and the supply of inputs. Trade liberalization, in tandem with advances in international communications and logistics, has served to encourage global trade in agricultural products. However, there is a fear that increased global competition may not favour the small-scale producers who lack access to markets and assets, finance and market information. The emergence of supply chains for the agricultural products operating at a larger scale may also be unfavourable to small farmers unless they constitute producer associations.

9. **Technological development:** Breakthroughs in genetic engineering, other fields of biology and chemistry and the new emerging technologies, especially information technology and bio-technology are creating great opportunities and risks for agricultural production with far reaching implications to small-scale farming.

RECOMMENDED ACTIONS

There has been a noticeable policy and investment bias against small-scale family farming, a preference to promote large-scale agriculture and neglect of the ecological dimension of development in the country. The sustainability consideration has been underrated even in the presence of the demographic dynamics. Moreover, the failure to have balanced regional and ecological policies created inequalities that fuelled conflicts which adversely fed back into the ecology and the political systems, demonstrating the nexus of relations between poverty, population growth, resource degradation, conflict and human migration. This study, therefore, strongly recommends that inclusiveness and sustainability guide policymaking and development planning.

Small-scale family farming has an important role to play in economic growth, poverty reduction, regional equality and environmental protection. What smallholders can produce is determined by comparative advantages, which are related to inherent factors and endowments such as agronomical conditions, land and labour. Yet, it is obvious that market failures and various constraints have severely limited small producer productivity and endangered the natural resource base. To realize the potential of this subsector, reach the production possibility frontier of small-scale farms and expand on that frontier, requires a focus on removing these constraints, overcoming the market failures, ending the policy bias and increasing public investment in rural infrastructure. Thus, the study recommends the following:

- **First, increasing the focus on smallholders and levelling the playing field:** The efficient evolution of the subsector cannot be left to chance or to markets alone. There is hence a need for substantial, systematic and multi-dimensional public intervention to level the playing field with large scale farmers and non-agricultural economic activities and to address the biases of the past. A separate strategic plan targeting small-scale family farming would facilitate systematic, prioritized and costed interventions.
- **Second, resolving the issues of access to natural productive assets:** Increasing access to natural productive assets can be done by addressing the issue of land ownership, providing animal producers with legally supported rights to land use similar to those of crop producers and demarcating and mapping livestock routes and enforcing the use of these routes. Addressing the problem of water shortages could be done through increased water harvesting, full utilization of rainfall and seasonal streams outside the Nile Basin, using groundwater, developing drought resistant varieties. More generally, water should be treated as scarce resource and the efficiency of its use should be enhanced. In irrigated agriculture, the strategic issue is to let more of Sudan's share of water go to smallholder irrigation. Eventually, the issue of increasing the efficiency of the use of water in irrigated agriculture will capture attention. Furthermore, the impact of the dam being built in the

Blue Nile in Ethiopia on small-scale family farming should be studied more carefully. Fishery resources should also be protected and their utilization should be rationalized.

- **Third, addressing supply-side constraints:** The supply side constraints which should be addressed include price incentives, physical infrastructure and access to inputs and farm technology. Farmers produce in response to price incentives and their response is stronger if there is adequate physical infrastructure. Additionally, improving such agricultural practices as crop patterns and rotation, tillage and harvesting will increase production. Animal production, on the other hand, will be enhanced greatly by the provision of veterinary health services and water points, in addition to advisory extension services on nomadic herding and offtakes.

- **Fourth, boosting access to finance:** Expanding the access of small-scale farmers to finance could be accomplished by instituting a better system of property rights and entitlements of land ownership, strengthening the capacities of micro-finance operators, introducing various insurance products and increasing reliance on group financing.

- **Fifth, building human and social capital:** Investment in human capital will expand the capacity of the rural population and small-scale family farming to utilize new technologies, introduce better agricultural practices and improve their marketing skills. Long-term objectives can be achieved through improved schooling, health facilities, food security and nutrition. Farmers can also be directly targeted for business and vocational training. The interest of young people in agriculture should be simulated and women should be empowered. Farmers and communities can be encouraged to set-up their own organizations and groups, which can assist in acquiring inputs, marketing output, bargaining collectively and transmitting and sharing market information.

- **Sixth, facilitating the marketing of agricultural products:** Well-functioning markets signal scarcities, strengthen value chains and enable farmers to manage risks, access credit and exchange information. There is hence the need to build and regulate marketing institutions and infrastructure. Post-harvest losses can be reduced through the construction of warehouses and cold storage facilities, especially for perishable agricultural products. Producer groups and cooperatives can help to strengthen the bargaining power of the small farmers and help them in information sharing. Efforts are also needed to encourage penetration of foreign markets and diversification of these markets.

- **Seventh: Improve the policy and institutional framework:** It is evident that the overall state of governance in the country, the political and administrative structure, is important for all economic activities. A genuine representational political system leads to inclusiveness, accountability and a participatory process in decision making. These conditions will influence such national policy choices as the allocation of public investment, the burden sharing arrangement of extracting government revenues for current or development expenditure, the regulatory and legal enabling framework and the enforcement and implementation capacity of the state. While the larger issues of political governance lie outside the scope of this paper, it is to be noted that conflicts have very much harmed the small-scale producers, destabilized their communities and disrupted production. Political

will, therefore, is needed to address the thorny issues of access to assets, particularly that of land, and to undertake measures which address regional inequalities. It is the contention of this paper that a focus on small-scale family farming contributes to reducing regional inequalities and, hence, reducing conflicts.

The improvement of the macroeconomic environment is critical for all economic activities. The creation of a fiscal scape would allow adequate resources for, at the least, running the government and for enhancing the effectiveness of the local administrations. Without such macroeconomic stability and budgetary resources, government will remain unable to carry out its basis functions, undertake any investment or enforce policies. Second, institutional capacity is needed for policymaking, regulating activities, enforcing laws and implementing programs.

- **Eighth, facilitate the organization of producer groups:** If the strategic development focus shifts to small-scale family farming, the budgetary process will have to ensure a favourable public expenditure tilting toward the rural economy, including the construction of rural roads and other public infrastructure. Additionally, the effective tax rate on agriculture (providing a degree of protection to the industry from direct and indirect taxation on agriculture as well as from the over-valuation of currency) will not overburden small-scale family farming. However, what sustains the bias against small-scale producers is governance that discourages civil engagement and collective decision-making and in which the urban dwellers capture more influence than the scattered, largely voiceless rural population. Producer organizations can give a voice to smallholders and hold policymakers and implementing agencies accountable by participating in agricultural policymaking, monitoring budgets and engaging in policy implementation.

Introduction

The key challenges facing Sudan include restoring peace, building social cohesion, reducing poverty, achieving food security and maximizing the wellbeing of the population. To address these challenges, it will be crucial to adopt a pattern of growth that is sustainable and leads to wider distribution of benefits. Past strategies, largely focusing on horizontal expansion in irrigated agriculture and large-scale semi-mechanized rainfed schemes, are approaching their limits and come with high opportunity and ecological costs. By neglecting small-scale family farming, these strategies have led to the exclusion of the majority of the population from the benefits of public expenditure while missing the opportunity to avert regional inequalities and internal conflicts, arrest environmental deterioration and make a substantial impact on poverty reduction.

Apart from political economy considerations, the neglect of small-scale family farming is a result of undervaluing its potential, underestimating the rate of returns of investing in small-scale family farming and ignoring the other benefits accruing from its development. Yet, evidence has shown that the lower productivity of small-scale family farming, in comparison to the large-scale subsector, does not only emanate from the economies of scale of the latter but is also explained by the disadvantages of smallholders in accessing inputs, adequate physical and market infrastructure, finance, social services and the means for building human capital. Furthermore, small-scale farmers do not produce only agricultural products but also are known to produce such externalities as environmental services.

With the above perspective in mind, the objective of this small-scale family farming study in Sudan is to contribute to understanding the sector and provide an analytical basis for policy actions. The purpose is not to discuss the respective merits and demerits of small- and large-scale agriculture but rather to convey the message that it is high time to level the playing field between them and with other non-agricultural sectors. For promoting small-scale family farming, will help address the challenges of regional inequalities, the conflicts in which the country find itself mired, the risks of food insecurity, rural–urban exodus, ecological imbalances and the deterioration of the natural resource base. Well-managed small-scale family farming can reverse the trend towards soil erosion and the breakdown of agro-ecological functions, which have resulted in poor crop yields, deforestation and ever-increasing movement into marginal land. In addition, given that the country is experiencing a youth bulge with no urban jobs available to the youth, strengthening the subsector can arrest the migration of young people to the urban centres, which are mushrooming. It can also help realize the potential of women who play an important role in traditional rainfed farming, constituting a significant number of the farmers.

This section provides background information about the agro-ecology of the country, the development and evolution of the agriculture sector, the changing strategic focus and the current challenges facing the county. The second chapter discusses the typology of small-scale farming systems in the country and highlights the livelihoods associated with them. Chapters three to eight describe the production patterns, the role and the challenges facing the six small-scale farming systems identified, namely rainfed crop production, animal production, irrigated agriculture, semi-mechanized rainfed agriculture, forestry and fishery. Chapter nine analyses the changing local and global contexts in which small-scale family farming is operating. Chapter ten discusses the constraints small-scale family farming is facing and the policy responses to these constraints. The last chapter concludes and provides policy recommendations.

0.1 The Country's Agro-Ecological Zones

With a relatively vast area totalling 1.86 million square kilometres, Sudan's terrain is largely made up of gently sloping plains surrounded in the northeast by the Red Sea hills, in the west by Jebel Marrah, in the southeast by the Ethiopian plateau and in the south–centre by the Nuba Mountains. (See the map of Sudan below.) The Nile Basin and its tributaries traverse the central-eastern part of the country. The Blue Nile, which originates from the Ethiopian plateau, and the White Nile, starting in Lake Victoria in Uganda, meet at Khartoum, the capital city, constituting the Nile River, which flows northwards to Egypt and the Mediterranean Sea. Other major seasonal rivers and tributaries of the Nile include El Rahad River, El Dinder River, Atbara River, Baraka River and El Gash River, all originating in the Ethiopian plateau and most of them flowing northwest towards the Nile.

Sudan (at latitude 15˚ 00 North and longitude 39˚ 00), has diverse agro-ecological characteristics, differing in rainfall, soils and vegetation, which, along with its natural resource base, have conditioned the farming subsystems and shaped people's livelihoods. The northern part of the country is predominantly desert with sandy stones. A limited stretch of the Nile Valley in the eastern half of this northern region separates the Libyan Desert to the west of it and the Nubian Desert to the east. It also hosts large human settlements and made possible the flourishing of admired ancient civilizations. Both deserts, however, have virtually no rainfall to support permanent vegetation or human settlement except for few oases in the Libyan Desert.

South and west of the northern region stretches the western part of the country, consisting of (Greater) Kordofan and (Greater) Darfur regions and comprising a variety of physical characteristics and ecological zones. This geographical region extends from the Nuba Mountains, which lie west of the White Nile to the borders with Chad and Central African Republic. The region consists mostly of sandy plains interrupted by the Marrah Mountains in the west and the Nuba Mountains in the south. The northern and eastern parts of this region are semi-desert with little rainfall. South of these areas are sandy *quoz* (sand dunes) where nomadic and transhumant groups raise animals. Several runoff *wadies* (seasonal streams) and wells drawing from underground water basins support dispersed human settlement and livestock. The land, some of which consists of clay soils, is arable and easily workable but

not very fertile, and is exhausted quickly. By contrast, the Marrah Mountains area source of plentiful water and fertile volcanic soils which support cultivation and grazing land. The north-western part of the region bordering Chad has high rainfalls, lasting for about five months, providing good grazing land and supporting the cultivation of a variety of food and cash crops. The richer savannah areas of the region, south of the semi-arid zone, support the growth of grasses, thorny trees, baobab trees and Acacia trees, which dominate the savannah zone, with one species, *Acacia senegal,* yields gum arabic which has long been one of Sudan's principal exports.

The **central region** consists mostly of clay plains stretching from the Ethiopian borders in the east to the Nuba Mountains west, and from Khartoum north to the border with South Sudan. The main hills, which interrupt these plains, are the Ingessana Hills southeast. The White Nile and the Blue Nile flow northward and the seasonal El Dinder and El Rahad rivers flow northeast towards the Nile.

Map 0.1 **Sudan geography**

The soil in the central region is clay, accommodating extensive tracks of cultivated land, both rainfed and irrigated. There are also alluvial clay deposits along the lower reach of the White Nile, the Blue Nile, along the Nile to the Nubia Lake and in the Gash Delta and the Baraka Delta in eastern Sudan. These are fertile lands, which in the past were dominated by traditional rainfed cultivation and livestock husbandry. They currently host several irrigated schemes and rainfed semi-mechanized farms.

The **eastern region contains both** a desert region and a semi-desert region that includes El Butanah, Gash Delta, the Red Sea Hills and the Red Sea coastal areas. El Butanah, which lies east of Khartoum, receives adequate rains supporting the growth of rich grasses and crop cultivation. It has been the homeland to a large nomadic group raising cattle, sheep and goats. The Gash Delta is watered annually by floods from the Gash River and has rich grasses and plentiful trees.

0.2 Evolution and performance of the agriculture sector

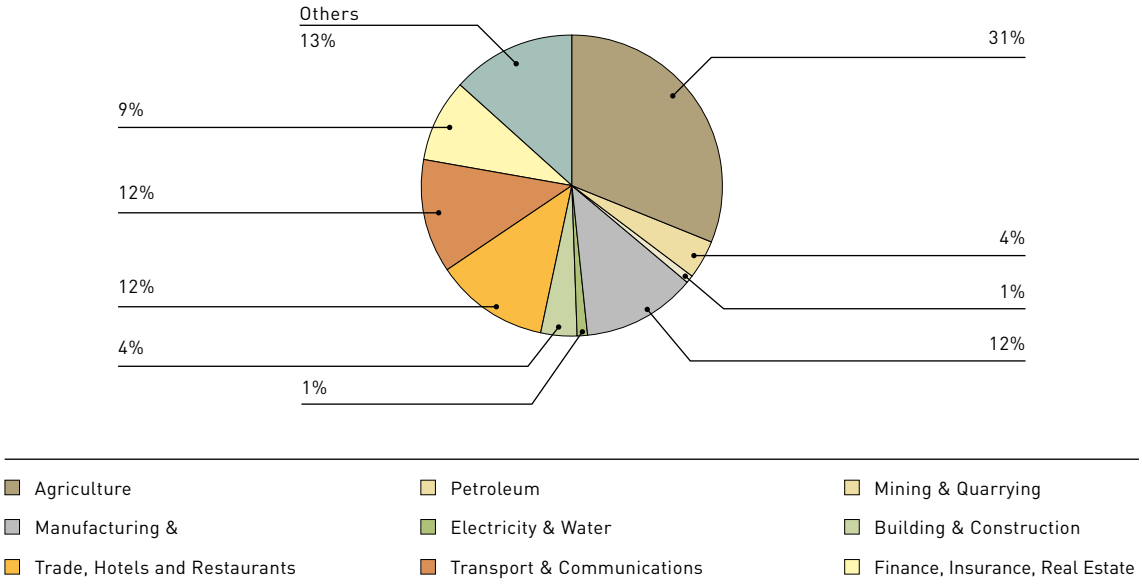
GDP Composition: Table 0.1 and Figure 0.1 depict GDP by economic activity. They show that the agriculture sector, defined broadly (as in the national income account) to include crop production, animal production (including poultry and fisheries) and forestry, accounted for an annual average of 31 percent of GDP from 2011 to2014. Manufacturing and handicrafts; trade, hotels and restaurants and transport and communications each contributed about 12 percent of GDP during the same period. Finance, insurance and real estate contributed 9 percent, while the petroleum subsector contributed 4 percent. Beyond these figures, it is to be noted that agriculture has been the engine of growth for most of the decades since the early 1900s. The exception was the period of 1999 to 2011 when the discovery of petroleum in the country resulted in oil-led growth. After the secession of South Sudan, where most of the oil is produced, oil took a back seat in driving the growth of the economy. Since the recent increase in gold mining activities, the mining sector has become a major source of growth and an important generator of foreign exchange.

Table 0.1 **Gross domestic product (GDP) by economic activity (Average of 2011 – 2014)**

GDP Composition	2011-14
Agriculture	31
Petroleum	4
Mining & Quarrying handicrafts	1
Manufacturing and	12
Electricity & Water	1
Building & Construction	4
Trade, Hotels and Restaurants	12
Transport & Communications	12
Finance, Insurance, Real Estate	9
Others	13

Source: Annual Report, Bank of Sudan (2011/2012/2013/2014/2015).

Figure 0.1 **Gross domestic product (GDP) by economic activity (Average of 2011 – 2014)**



Source: Annual Report, Bank of Sudan (2011/2012/2013/2014/2015).

The pre-colonial economy: For centuries the agriculture sector has been the backbone of the Sudanese economy. The pre-colonial Sudanese economy was based pre-dominantly on traditional rainfed subsistence farming and nomadic pastoral production systems. Sorghum and millet, two grain cereals and staple food, were grown in the low rainfall savannah in the central clay or in the sandy areas. Small-scale traditional irrigated agriculture also had a long history of existence in the northern part of Sudan, using ancient technology to lift water, such as the *shadouf* and the *sagya*[4]. Nomadic and sedentary farmers raised livestock and very insignificant fishery activities were carried out, catching Nile perch from rivers. Most of the catch was consumed locally. Forestry activities involved the use of wood for fuel and charcoal and the collection of gum arabic from acacia trees for commercial purposes. Flood irrigation was also utilized, taking advantage of the Nile flooding system. The Turko-Egyptian government (1821–1982) was reported to have used floodwaters to cultivate cotton from the1860s to the 1880s in the Toker area in eastern Sudan. This activity lasted until 1882, when the national Mahdists succeeded in taking over the government (1882–1898).

[4] The two known methods were the use of a *shadouf* (a bucket tied to a pole as a lever, counterweighted with a rock) and a *sagya* (an ox-driven waterwheel).

Capital formation during the colonial era: The colonial administration of the Anglo-Egyptian condominium (1898–1956) set into motion the commercialization of agricultural production in the country through the establishment of modern irrigated cotton schemes. First, it revived the production of cotton in the Toker delta in eastern Sudan, which had been started earlier by the Turko-Egyptian colonial government (1821–1882). About 98 000 feddans[5] were put under cultivation using floodwaters. Second, in 1905, it introduced steam-run irrigation pumps in a scheme in Ziedab, north of Khartoum. It also established four pump schemes in near the villages of Tyba, Barakat, Hag Abdalla and Wad El Naw in the Gezira clay plains along the Blue Nile, south of Khartoum. Additionally, it set up 14 small pump schemes in the northern region of the country. In the 1920s, the administration also introduced rainfed cotton production in the Nuba Mountains.

The experimentation with cotton production in the Gezira using pump irrigation was carried out by the Sudan Plantation Syndicate, a company representing British shareholders. Encouraged by the colonial administration, in 1913 the Syndicate embarked on the construction of a dam in Sinnar, along the Blue Nile. It took until 1925 for the dam to be completed due to the breakout of the First World War. After the completion of the dam and the construction of canals, gravity irrigation was used to cultivate 240 000 feddans of extra-long staple cotton, which was exported to the United Kingdom to supply the textile mills of Lancashire.

The scheme was based on a crop-sharing arrangement involving the Syndicate as well as the tenants and the government. The colonial administration encouraged the adoption of this traditional arrangement, which was long practiced in the country. Tenants were to be allocated 40 percent of the net proceeds from the sale of the cotton, the Syndicate received 25 percent and the government received the remaining 35 percent. The use of the Nile water was initially governed by an agreement signed in 1929 between the Egyptian and the British governments, the two partners colonizing the country. However, the area under cotton cultivation in the Gezira gradually increased from 240 000 feddans at the start to 450 000 feddans by 1931.

In 1950, the Sudan Plantation Syndicate gave way to a newly established parastatal, the Sudan Gezira Board. The latter was to manage the scheme in exchange for the same share allocated before to the Syndicate. The crop sharing arrangement was maintained and had been replicated in other state-owned and private sector schemes during and after colonial rule. However, overtime the arrangement became problematic and created tension between the tenants and government.

After its successful experimentation with gravity irrigation in cotton production, the colonial government, which was encouraged in 1937 by an opportunity that arose after the construction of the Jabel-Awlya Dam, invested again in pumps irrigation. The dam, which was built by the Egyptian government on the White Nile, was intended to regulate water flows, which normally diminish from April through August affecting the Egyptian cropping

[5] The feddan is a unit of land used in Sudan, Egypt and some other countries for centuries. It is equivalent to 0.42 hectares or 1.038 acres.

pattern. Consequent to the construction of the dam, it became technically feasible to invest in pump schemes along the White Nile. Therefore, the colonial administration set up seven pump schemes along the White Nile with the intention of providing alternative livelihoods to the nomadic population in the area. The new schemes grew both cotton and cereals[6].

Map 0.2 **Sudan: Administrative classification by states**

Thus over four decades or so, the colonial administration established irrigated agriculture on over 500 000 feddans using gravity, pumps and flood irrigation, with cotton constituting the centre of its activities; all of which was driven by the public sector . These modes of modern farming co-existed with rainfed agriculture and pastoralism. Additionally, the colonial government initiated semi-mechanized farming in the eastern region. In 1945, it established

[6] However, the establishment of the schemes was at the expense of the nomadic life in the area. According to Salih (1994), "an animal census in 1949, recorded that only 20 percent of the livestock remained on the area of the scheme following large scale disposal of their animals due to shortages of grazing lands within distance of the scheme".

on an area of 12 000 feddans the Gadamblia state-owned farm in the Gedaref area, followed by three small, 1 000 feddan farms in Umlioyoun, Sugaur and Umbileiel. These schemes were also state owned and were based on crop sharing.

Post-colonial capital formation in agriculture: The post-colonial governments also followed the suit of the colonial administration by pursuing agricultural development based on large-scale farming, consisting of state-owned capital-intensive irrigation, private sector irrigated agriculture and semi-mechanized farming. In the early 1950s because of the Korean War, the private sector invested in pumps schemes along the Blue Nile, the White Nile and the Nile. The total area under these medium-scale cotton schemes reached 170 000 feddans. Production relations were organized as crop sharing arrangements involving the tenant farmers and private investors.

State-led capital formation in irrigated agriculture continued during the 1960s. In 1959, as Egypt sought to construct the High Dam at Aswan, it struck a deal with the independent government of Sudan and signed a new water agreement in which Sudan was permitted to use more water from the Nile. This made it possible for the government to establish two irrigated projects. The first project involved the addition to the Gezira scheme of an extension in the southwest Managil area between the Blue and White Niles. The same crop sharing arrangement was made under the management of the Gezira Board. This added 800 000 feddans of irrigated agriculture. Prior to the scheme, the area was cultivated by transhumant groups and used for cattle and goat grazing.

The second irrigated scheme was Khasm El Girba project, which was established in the central eastern part of the country irrigated by water reserved in the Khasm El Girba dam in the Atbara River, a tribute of the Nile. The area in which the project was established was inhabited by transhumant and nomadic tribes. The construction of the High Aswan Dam displaced the inhabitants of Wadi Halfa in the far northern part of the Nile in Sudan. The government resettled the displaced population in the town of Khasm El Girba (renamed as New Halfa) and provided tenancies to them in the Khasm El Girba agricultural scheme. Though the project was intended as an alternative source of livelihood for the population of Wadi Halfa, part of the land was allotted to the local population. Initially, the scheme started with 50 000 feddans, but by 1968–69 the total area under cultivation rose to 205 000 feddans. The scheme adopted the tenancy and crop sharing arrangement used in the Gezira scheme.

The completion of the El Rosieres Dam in 1966 expanded the potential for using gravity irrigation for cultivating more land. Thus, a new scheme, the El Rahad scheme, was established, irrigated by large pumps from the Blue Nile, fuelled by electricity generated from the El Rosieres Dam. The canal channels water to the El Rahad River and, through the use of a barrage, the water is used for irrigating the El Rahad scheme. In addition to the El Rahad scheme, the completion of El Rosieres Dam made possible the establishment of an irrigation project in Es Suki in 1971, along the Blue Nile, growing cotton, sorghum and oil seeds. Pumps from the Blue Nile irrigated about 80 000 feddans.

The government also saw great potential in the production of sugar cane, which was done before with the Junyad Sugar factory on the right bank of the Blue Nile, with production covering an area of 8 400 ha. The Junyad factory was built earlier for cotton production as a

means to provide alternative livelihood for the nomadic pastoralists in the area. In 1962, the scheme was transformed into sugarcane production. In 1965, sugar cane was also grown in the El Girba Scheme, for which a factory was built with a design capacity of 60 000 tons. A further 8 400 ha of sugarcane production were established in an irrigated scheme in Sinnar. A factory with a design capacity of 110 000 tons was built to process the sugar cane produced in the Sinnar area. The large Kenana sugar project, co-financed by the central government and some regional governments, was also set up in an area between the Blue Nile and the White Nile, with a design capacity of 300 000 tons.

Semi-mechanized farms: Semi-mechanized farming provided another avenue for capital formation in agriculture, promoted by both the state and the private sector. This was begun in the mid-1940s by the colonial administration, as mentioned earlier, and it expanded significantly. After 1954, land was demarcated and leased to private investors in lots of 1 000 feddans Strong interest was shown in investing in the subsector and by 1968, the demarcated area distributed to investors totalled 1.3 million feddans. An additional 500 000 feddans were cultivated in an officially demarcated land area. By 1977, the area under mechanized farming reached 4.584 million feddans in Sudan (excluding South Sudan), distributed between Gedaref State (2.249 million feddans), the Blue Nile State (1.666 million feddans), South Kordofan (559 000 feddans) and South Darfur (110 000 feddans).

The major problem which semi-mechanized farming faced was the loss of soil fertility in the area cultivated due to the mono cropping of sorghum and the failure to leave some land fallow. There were also problems with the use of machinery in tillage resulting from the nature of the soil and type of machinery used. Another problem was the scarcity of labour, which was a result of competition with irrigated schemes and small-scale farming. Significant substitution of labour through the use of machines was not possible for both economic and technical reasons.

Neither the expansion of irrigated agriculture nor semi-mechanized farming was seen at the beginning as a threat to traditional farming and animal grazing. A World Bank report in 1979 argued that, "*the performance in acreage expansion has certainly been impressive, and the achievements of the sector have been substantial, despite admitted deficiencies. A large area of little used clay soils have been brought into cultivation harnessing considerable private savings and entrepreneurial ability at little cost to the government. The food thus produced was extremely important during the drought of the early seventies, and it has both saved foreign exchange and in some years contributed to foreign exchange earnings through exports. Although the main beneficiary has been large scale farmers, much wage employment has been seasonally generated.*" (The World Bank, 1979, p. 162).

Small-scale family farming endured the pressure of the expansion of commercial production. It dominated most of the country, but especially in Western Sudan. As will be explained later, this sector supplied a large amount of cereals (sorghum and millet). It also contributed to the exports of cash crops such as sesame and groundnuts. Despite the large investment in both irrigated schemes and mechanized farms, the share of small-scale producers of crops, livestock and forestry products has remained substantial. Thus, the contribution of the irrigated sector averaged 29.3 percent and 25.75 percent of GDP during 2013–2014, while the total contribution of traditional rainfed and livestock was 46.9 percent in 2013 and 60 percent in 2014.

SECTION ONE

Small-scale family farming

1.1 Definition and Overview

1.1.1 Defining small-scale agricultural holdings in Sudan

The Sudan 2009 Households Survey spells out six categories of what is described as small-scale agricultural production activities, namely, small-scale rainfed crop production, small-scale animal production, small-scale forestry-based production, small-scale semi-mechanized farms, small-scale irrigated agriculture and small-scale fishing. No specific definition for small-scale farmers was made explicit. Nor has there been any serious discussion elsewhere in the country about who the small farmers are[7]. However, it is necessary to adopt an appropriate definition of this group in order to facilitate policy-making. Such a definition is also needed for academic or analytical purposes, which, in effect, should help inform policy choices.

For the purpose of this study, the definition used for small-scale farmers in Sudan is, "Small-scale farmers are those who, while fully or partially engaged in any of the six agricultural activities mentioned above, have limited productive endowments, though they are in full control of their own production, managerial and marketing choices." This includes, but is not restricted to, those involved in traditional family-based farming.[8]

Small-scale farmers together with tenants in large agricultural schemes, agricultural workers, large-scale commercial farmers, traders in agricultural products and inputs and sector technicians and professionals, constitute the categories of the workforce participating in agricultural production and distribution. However, the category of the SSFs is by far the largest of the workforce categories in the agriculture sector.

Since the broader definition of agriculture does not restrict farming to crop production, landholding size is not the only indicator for defining small-scale family farming. For instance, the main asset of a traditional nomad or pastoralist is his animal herd. Yet the importance of landholding size arises from the fact that small-scale crop producers, as will be explained later, constitute the majority of those involved in small-scale family farming. Furthermore, most small-scale farmers who are involved in other non-crop production activities also produce crop. For some of them, crop production is their main activity. In particular, as will be

[7] Perhaps because it is taken for granted that the term small-scale farmer is understood.

[8] The subsection on small-scale animal production provides statistics of the size of livestock ownership. The large owners are able to overcome some of the difficulties of access to animal feed and water much more than others.

described later, those involved in animal production and in forestry production are often crop producers and vice versa. The production activities of these various subsystems often overlap.[9]

There is no universal agreement on exactly what size of landholding should be considered "small-scale". In many African countries small-scale farming is usually defined as farms of two hectares or less.[10] In Asia, the average size of small farms is about 1.6 hectares. In Europe, however, small-scale farms are considered farms that consist of five hectares or less, while in the United States the measure is 121 hectares or less. In Sudan, while land is relatively more abundant than in many other countries, the valuation and the productive capacity of landholdings differ from one region to another. There are especially differences between riverine land and other land and between areas with different types of soil and productivity. Nevertheless, it can be submitted, generalizing to some extent, that crop producers with landholdings of up to 10 feddans are smallholders. A landholding of that size is usually associated with minimal ownership of capital assets and agricultural machinery. The size ceiling is a function of the maximum amount of land that a family can cultivate only with family labour. The value of production on such farms barely exceeds the subsistence level, though it is much higher in the case of riverine irrigated land. Owners of small landholdings may complement family labour by hiring few additional workers, due to the short period required for certain agricultural operations. Since small-scale farming is based mainly on family labour, farm production decisions intermingle with household decisions regarding other affairs of the family, as the family and the farm unit are the same.

Thus, for the various activities, what matters is the scale of production. The measure of the scale will depend on the type of produce (for example, the number of livestock or the produce of fisheries). In that respect, the ownership of other assets or income generated on the farm are equally important criterion as that of the size of the landholdings. For example, a small-scale livestock producer could be envisaged as a one who keeps a herd (the size of which depends on the function or use) for family consumption (subsistence) or as an economic activity, where produce is sold or bartered to meet household expenses or needs (taking into account the commercial viability of livestock production).

Regarding capital ownership, it is evident that traditional farming relies on limited technological tools and does not include the use of machinery such as tractors and harvesters. Small-scale farmers who are expanding their cultivated areas and are in early phase of transitioning to medium and large-scale production lease agricultural machinery and hire more agricultural workers. In the irrigated areas, the small–scale farmers are replacing the *shadouf* and the *sagya* with small water pumps.

Thus, at the risk of some overgeneralization, small-scale farms in Sudan can be considered mostly, though not exclusively, family-based farms, the families being poor and vulnerable and the production being insufficient for to sustain the families and eliminate insecurity.

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[9] Consequently, the implication for policymaking is that an overall strategy for small-scale farming should be designed in such a way as to give special attention to both the interdependence of these various sub-systems and the specific needs of each.

[10] Note one feddan is equivalent to 0.42 hectares and 1.038 acres.

Droughts occur often and the families are subject to hunger and food shortages. Some of them live in marginal, less productive land. They also lack access to political power and productive assets. While some small-farmers are resistant to change, others, in the context of the on-going transformation of Sudanese rural society, are adjusting to the changing environment and show capacity for adaptation and willingness to use new technologies and adopt new cultural practices when they consider them viable.

It is because of such adaptability that there exists a continuum of types of small farmers. The more enterprising farmers with strong links to the market are graduating to medium-scale production, especially in rainfed, mechanized farming. These farmers are normally literate, are more exposed to technology and have advanced managerial skills. Some of them may readily move upward and establish larger scale businesses, giving them better access to finance and assets. Though they may not fully scale up to large commercial operations, they tend to position themselves across the market chain, not only producing farm products in large amounts but also entering into the business of processing and trading.

The category of tenants in the large-scale irrigated schemes also differs from small-scale farmers. The criterion regarding who makes farm-related decisions will exclude tenants as well as the landless agricultural labourers.[11] Tenants are small-scale producers organized in large schemes who are allotted small tenancies (*hawashas*) of 10 to 20 feddans. The government owns the large scale irrigated schemes and these are managed as parastatals. Management decides about some of the crop mix and crop rotations and provides production and marketing services. As to irrigation, these parastatals are responsible for most of the irrigation network; specifically, the operation and maintenance of the major canals. They also provide marketing services and facilitate the provision of inputs, which they purchase in bulk.

As such, tenants do not exactly fit the definition of small-scale farming described above. However, the tenancies are mostly family businesses, which rely much more than the traditional rainfed farming on hired labour in several of the agricultural operations[12]. Tenants may be allowed to grow their own crops, which they tend and decide on themselves, while paying for irrigation services. Generally, the states in which the irrigated schemes are established have better access to social services than those in the rainfed agriculture areas. However, tenants are poorer than urban dwellers. Tenant groups have often entered into conflicts with the management of the schemes and various government entities. The problems facing the tenants are somewhat different from the problems of the other smallholders. However, they are in dire need of reforms and government attention.

The small-scale farmers constitute a significant segment of the seasonal agricultural workers, who work in tenants, large-scale semi-mechanized farms as well as in urban areas. Yet, the landless agricultural workers are not as small-scale farmers though they are poorer and less food secured than the SSFs. They needed for analytical and policy purposes to be treated separately.

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[11] FAO/RAFE (1978) defined small farmers, small fishermen and peasants in broad terms, including the low-income producers of agricultural, livestock and aquatic products.

[12] The situation of the tenants is different from that of the smallholders who enter into arrangements with private out-growers who buy their products in return to finance, inputs or the like.

1.1.2 The typology of Sudan's smallholder farming

The pattern of capital formation in agriculture in Sudan described in the preceding paragraphs has led to a dualistic production structure: modern irrigated and semi-mechanized rainfed subsectors consisting, basically of large-scale schemes, co-existing with a traditional small-scale farming system. These two systems (the traditional and the modern) differ in their internal organization, dynamics, performance and the way the state deals with them. The small-scale subsector has evolved into various business models and systems of livelihoods shaped by resource endowments, agro-ecological conditions and locational factors. These can be classified as follows:

- traditional rainfed cultivators (crop producers);
- traditional rainfed herders;
- small-scale rainfed mechanized farmers;
- small-scale irrigation farmers;
- small-scale fishermen; and
- self-employed individuals engaged in forestry production.

Small-scale rainfed crop production: Small-scale rainfed crop production is practiced by sedentary households and nomadic and transhumant groups. These crop producers are located in a vast area stretching from western Sudan (Greater Darfur and Greater Kordofan) to areas in the Gezira, Sinnar, Blue Nile, White Nile, Gedaref, Kassala and Red Sea States. The crop production zones are endowed with diverse natural resources and are located in different climatic zones, ranging from semi-desert to high rainfall savannah. As such, conditions are appropriate for the production of a variety of crops including sorghum, millet, groundnut, sesame, cowpeas and roselle, and for animal husbandry. Farming practices rely on ethno-technologies in crop rotation and cultivation methods. Agricultural operations are handled mostly by family members and depend on the use of locally made hand tools. Most of the families keep some animals for food, milk, fieldwork or transport. A large number of crop producers are also engaged in gum arabic production and the production of other forestry products.

Small-scale animal production: The small-scale livestock and animal production system in Sudan is predominantly traditional, although there is small modern, urban subsystem. The ecological variation of the country has resulted in an extensive and diverse traditional pastoral system, consisting of nomadic and transhumance subsystems as well as sedentary and semi-sedentary agro-pastoral subsystems. The vast majority of the national herd in Sudan is produced under the pastoralist production system. Quantity and quality of grasses, accessibility of water, evading mud, diseases and biting insects and security conditions are the factors that determine pastoral mobility. Patterns of movement vary from pure nomadism, with no fixed location, to different forms of transhumance, to seasonal migration along migratory corridors, to levels of agro-pastoralism where crop-livestock production is practiced. Camel herding groups and few cattle herders practice nomadism. The main animals in agro-pastoralism in general are small ruminants, especially sheep. Sedentary farming consists

mainly of goat keeping with goats constituting sources of milk and meat for the poor strata of the rural communities.

Unlike subsistence pastoral production, small-scale dairy production in peri-urban areas is a commercial activity that supplies town dwellers with fresh milk. In addition, while small-scale traditional farms currently supply urban centres with eggs and meat, a modern poultry system is gradually expanding.

Semi-mechanized rainfed farming: Traditional agriculture is based on the use of hand tools made locally. However, the heavy black cracking soil in which mechanized farming has been established is difficult to be cultivated manually. Mechanization offers opportunities for hand tools. The failure to establish a state-run tenancy system led to the promotion by the state of private investors in large-scale semi-mechanized schemes of about 1 000 feddans. Subsequently, as an outgrowth of rainfed traditional farming, small-scale semi-mechanized farms emerged, with landholdings varying from five feddans to fifty feddans, clustering around the large-scale semi-mechanized farms. These small-scale farms spread over a large area of the clay plains in the rainfall savannah belt, extending from the Butana plains in the east to Southern Kordofan in central Sudan. Though the crops found suitable for cultivation in the ecological conditions of the clay plains are sorghum, sesame, short-staple cotton, sunflowers and guar, small-scale mechanized farms mainly produce sorghum and sesame.

Small-scale irrigated farming: The large irrigation infrastructure in dams and large pumps has given rise to the establishment of large government-run and private sector-owned schemes. These modern irrigated schemes are based on a system of tenancy of smallholdings. The schemes also have consolidated lands, group finance for selected crops (cotton, groundnuts and wheat) and provide agronomical, marketing and management services. In addition to these tenant-based large schemes, there is an important subsector of small-scale irrigated farming in the Northern, River Nile, Khartoum, Blue Nile, Sinnar, White Nile and Gezira states. The main crops grown on these small farms are onion, tomato, potato, eggplant, sweet pepper, green bean, okra, abu70 sorghum and alfalfa. Small-scale producers in the North and River Nile states cultivate wheat, sorghum, vegetables and fruits for home consumption and sell their surplus in the market. Though most small-scale irrigated farmers keep some livestock, crop growing is their main activity. The cash crops produced consists mainly of banana, mango, lemon and guava. Small-scale producers in Kassala State pursue crop and mixed crop-animal production activities. Traditional agriculture is also practiced on seasonal rain-floods in Kordofan on the clay plains of Khor Abu Habila basin.

Small-scale forestry production: Rainfed forests and trees are sources of fuel wood and provide raw materials for charcoal production, for traditional construction and for the furniture industry. Non-wood products are also supplied by these forests, including gum arabic, *Acacia seyal* (*talha*), cashew nuts, honey, beeswax, *Acacia nilotica* seed pods (*garad*), fodder, edible oils, medicines, dyes and fibres. Almost all members of small farming families in the rural areas that produce crops, are also involved in seasonal activities related to gathering and selling forest products. The gum arabic production system is an example of a business model perfectly organized to complement crop cultivation. Forest production is based on the natural forests and trees. Access to the forests is loosely controlled by government. Most

forests are divided into management units and each unit follows a sequential agro-forestry system that includes gathering forest products (the bush-fallow cycle) and cultivation (the agriculture cycle). The gum arabic bush-fallow system widely known in Kordofan and Darfur follows the twenty year cycle of the *Acacia Senegal* tree species followed by a four to five year cycle of cultivation of different crops.

Small-scale fisheries: Sudan is endowed with diverse surface and underground water resources and arable lands that are suitable to support a vigorous capture fisheries and aquaculture industry. Currently, capture fisheries activities are centred around the River Nile and its tributaries, man-made lakes on the River Nile and its tributaries and the territorial waters of Sudan on the Red Sea. Apart from these conventional fishing areas, there are other water bodies, including several thousand kilometres of irrigation canals, non-Nilotic streams (*khors*) and over 1 800 large and small natural and excavated rainwater impoundments (*haffirs*), particularly in the savannah belt. The fisheries are of three types: subsistence, artisanal and commercial. Subsistence fishing, using basic tools such as spears, traps, cast nets and hook and line, is practiced either from riverbanks or from canoes and papyrus rafts, mainly in the inland waters of Sudan. Artisanal fisheries, where the fisher typically operates a traditionally-designed one-oar-propelled boat and which sometimes goes hand-in-hand with subsistence fishing, is undertaken mainly on the Jebel Aulia Reservoir as well as downstream the White Nile before the confluence at Khartoum. Motorized boats are employed in commercial marine fishery, which, though still largely underdeveloped, is carried out by some relatively well-off fishers and fisher folk associations, such as cooperative societies. Aquaculture in Sudan is still limited, but is growing in importance.

Preliminary estimate of households engaged in small-scale farming: Just as there is no definition of the small-scale farmers in Sudan, there is no census or official estimates of the number of farmers and households engaged in small-scale family farming in Sudan. Estimation of small-scale farmers is complicated by the fact that they do not normally restrict themselves to one occupation. They are also highly mobile. Thus, the attempt in this study to provide an estimate of the number of small-farming households should be seen as tentative and the estimates taken with caution.

The starting point of such an estimation is the population of the country, which is estimated to have been about 40.235 million in 2015 (United Nations, 2015). Since the 2009 Household Budget Survey estimated the average household size at 5.7, the number of households should be around7.059 million (Central Bureau of Statistics, 2009). As the rural population constitutes 66.8 percent of the total national population, the rural population is estimated at about 26.861 million, with a total number of households of around 4.708 million. It is estimated that 57.83 percent of the rural population is sedentary and 8.93 percent is nomadic. Hence, the number of sedentary households is estimated at 4.080 million and nomadic households are estimated at 0.628 million. Assuming that 95 percent of the rural sedentary population consists of small-scale farmers, all nomadic households are small-scale while 10 percent of the urban population work in small-scale agricultural production and the total number of households relying on small-scale farming can be estimated at 4.738 million. Small-scale farmers are found in all states with particular concentration in Darfur and Kordofan and less concentration in the

central and eastern states. The total number of tenant households is about 200 000, mostly in the Gezira, Blue Nile and White Nile states. Fishers are concentrated in the Red Sea State, but also along the Nile, especially around urban centres.

Table 1.1 **Estimates of households engaged in small-scale farming, 2014**

Population		Households		Labour Force		Agricultural Labour	
Total population 2015	40.235 million	**Size of households**	5.7 individuals/ household	**Labour participation rate (% of population)**	54%	**Small-scale farming households in rural areas**	4.504 million
Urban population (% of total)	33.2%	**Total # of households**	7.059 million	**% of employment in agriculture**	44.6%	**Small-scale farming households in urban areas**	0.234
Rural sedentary population, as % of total	57.8%	**Rural sedentary households**	4.080 million	**% of employment in Industry**	15.3%	**Total small-scale farming households**	4.738
Rural nomadic population, as % of total	8.9%	**Rural nomadic households**	0.628 million	**% of employment in Services**	40.1%	**Tenant households**	0.200

Sources: World Population Prospects and Central Bureau of Statistics. 2009 National Baseline Household Survey. Khartoum.

1.1.3 Small-scale family farming and the livelihood zones

The concept of livelihood stands for the resources needed by households (or persons or a community) to sustain life. Livelihood zones map groups of people sharing a similar pattern of livelihood: "methods of food and the agricultural production, methods of securing other incomes, market systems, food consumption or preference habits, poverty levels, etc." (Holt and Coulter, 2011). In doing so, the delineated areas typically fall into biophysical (agro-climatic) and socio-economic (poverty–wealth) zones. Livelihood zoning thus creates an economic-geographical map that shows the varied contexts in which livelihoods are pursued. The zones do not exactly correspond to administrative zones. In addition, biophysical or socio-economic sectors do not seem to dominate the criteria used to delineate the zones.

A study sponsored by the United States Agency for International Development (USAID) and the Famine Early Warning Systems Network (FEWSNET) (supported by the World Food Program – WFP) classified the country into 19 livelihood zones (see Holt and Coulter. Sudan. 2011). Table 1.1 below shows the livelihood zones proposed by the study. Since the livelihood zone maps shed lights on the categories of agricultural subsystems, it may be worthwhile to show the matching. Of the 19 livelihood zones, 16 of them lie within the category of small-scale agricultural production.

The northernmost part of the country, entirely covered by desert except along the Nile, does not support life (Map 1.1). However, just below that area, rainfall is sufficient to enable the growth of pastures and the presence of seasonal water that support pastoralism. Slightly south of that area, rainfall of under 300 mm allows agro-pastoralists to grow food crops (normally millet)

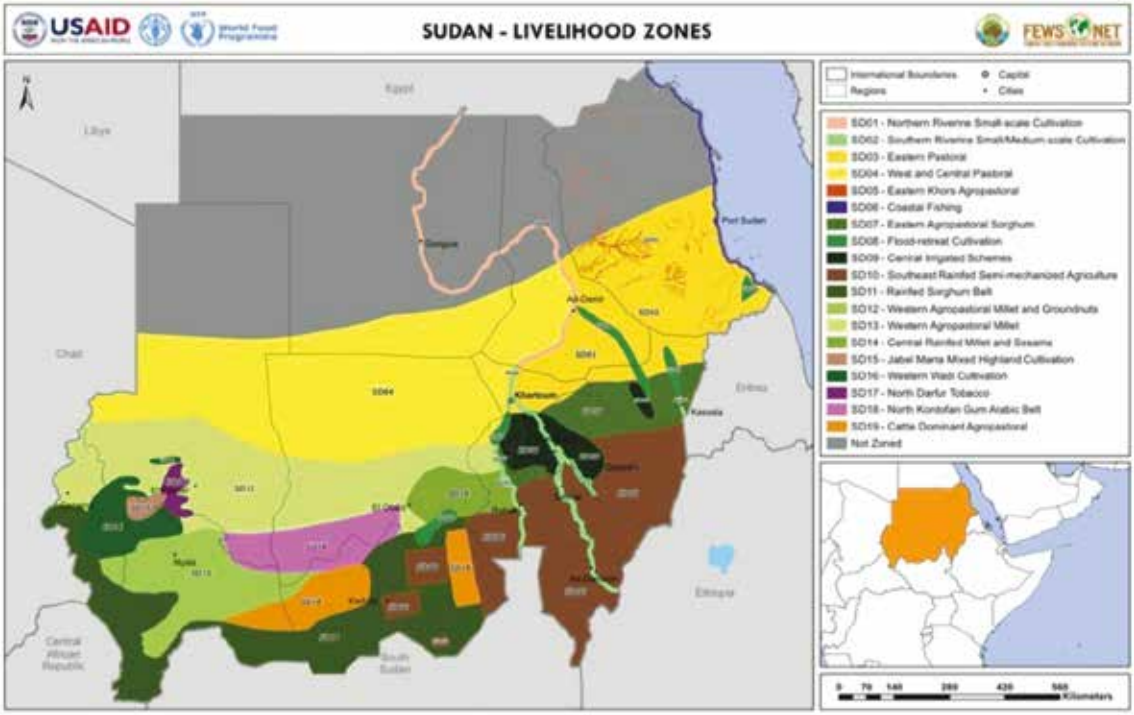
as well as maintain herds. The agro-pastoralists of the western part of the country raise camels and cattle while those in the Red Sea Hills raise goats and sheep. Where there is surface water, farmers depend on irrigated agriculture. In the northern part of the Nile, irrigation enables smallholders to cultivate cereals and high value crops. The small streams (*khors*) of the Red Sea hills also allow for small-scale production of sorghum and vegetables. Another livelihood source dependent on the Nile is in the Gezira, El-Rahad and El-Girba schemes, where cotton is grown together with cereals, groundnuts and vegetables. In the eastern part of the country, flush irrigation supports a livelihood around the Atbara River, the Gash River and the Toker Delta. In western Sudan, seasonal water in Khor Abu Habil is also a source of livelihood.

Table 1.2 **Livelihood zones and small-scale agricultural subsystems**

Livelihood zone	The area	Corresponding agriculture subsystem
Eastern pastoral	Red Sea, River Nile, Kassala and Khartoum States	Small-scale animal production
Western and central pastoral	North Darfur, Northern, North Kordofan and River Nile States	Small-scale animal production
Eastern khors agro-pastoral	Red Sea State	Small-scale animal and crop production
Eastern agro-pastoral sorghum	Gezira, Gedaref and Kassala States	Small-scale animal and crop production
Rainfed sorghum belt	Central, East, South and West Darfur and South and West Kordofan States	Small-scale crop production
Western agro-pastoral millet and groundnuts	Central, East and South Darfur States	Small-scale animal and crop production
Western agro-pastoral millet	North and West Darfur and North and West Kordofan States	Small-scale animal and crop production
Central rainfed millet and sesame	North Kordofan and White Nile States	Small-scale crop production
Jebel Marra mixed highland cultivation	Central Darfur State	Small-scale crop production
North Darfur tobacco	North Darfur State	Small-scale crop production
North Kordofan gum arabic belt	North Darfur and North, South and West Kordofan States	Small-scale agro-forestry
Cattle dominant agro-pastoral	East Darfur and South and West Kordofan States	Small-scale animal and crop production
Southeast rainfed semi-mechanized agriculture	South Kordofan, White Nile, Sinnar, Gedaref and Blue Nile States	Large scale rainfed semi-mechanized agriculture
Flood retreat cultivation	Red Sea State	Small-scale irrigated agriculture
Northern riverine small-scale cultivation	Northern, River Nile and Kassala States	Small-scale irrigated agriculture
Southern riverine small/ medium-scale cultivation	Khartoum, Gezira, Gedaref, Sinnar, Blue Nile, White Nile and Kassala States	Small/medium-scale irrigated agriculture
Central irrigation scheme	Gezira and Gedaref States	Large scale irrigated agriculture
Coastal fishing	Red Sea State	Fisheries

Source: Holt, Julius and Lorraine Coulter. 2011. Livelihoods zoning "plus" activities in Sudan. Special report by the famine early warning systems network (FEWSNET) supported by USAID, FAO, WFP, the Ministry of Agriculture and others.

Map 1.3 **Sudan Livelihood Zones**



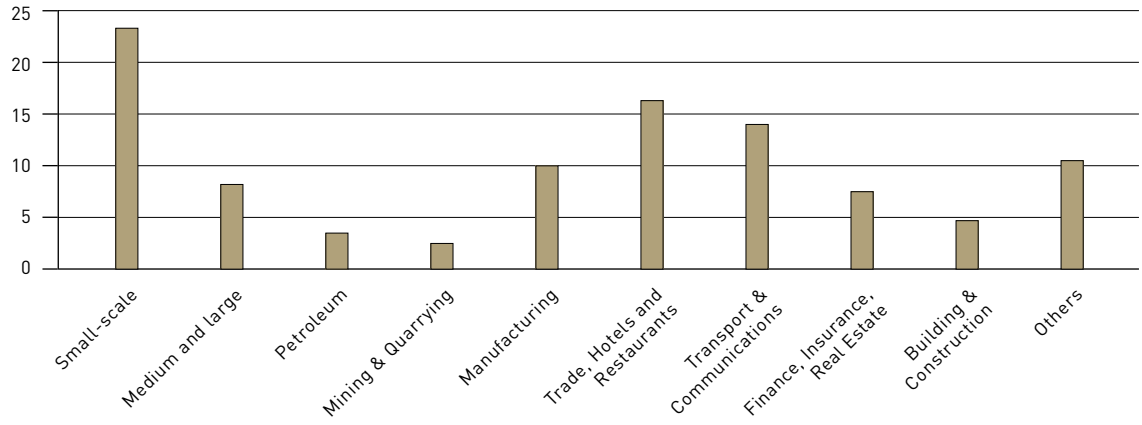
Source: Holt, Julius and Lorraine Coulter. 2011. Livelihoods zone "plus" activities in Sudan. Special report by the famine early warning systems network (FEWSNET) supported by USAID, FAO, WFP, the Ministry of Agriculture and others.

1.1.4 Contribution of SSF to the national economy: overview

Small-scale farming contributes significantly to agriculture value added, and therefore to GDP. Furthermore, in addition to providing backward and forward linkages, small-scale farming is an important source of exports generating a significant amount of foreign exchange. It is also the main source of livelihood for the rural communities, serving as the backbone of the rural economy and contributing to poverty reduction and the empowerment of women. It also contributes remarkably to national food security and nutrition and provides important ecological services.

a) Contributing to agriculture value added and GDP: In 2014, the share of the entire agriculture sector was 31.5 percent, compared to 16.8 percent for the industrial sector and 51.6 percent for the services sector. SSF contributed about 73 percent of the total share of the agriculture sector and 23.3 percent of GDP. This was more than the contribution of the remaining part of the agriculture sector (8.2 percent) and exceeded by far the contribution of the petroleum sector (3.5 percent); the manufacturing sector (10 percent); transport and communications (14 percent); finance, insurance and real estate (7.5 percent); trade, hotels and restaurants (16.2 percent) and building and construction (4.7 percent).

Figure 1.1 **Subsectoral composition of GDP, 2014**



Source: Bank of Sudan, Annual Report, 2014.

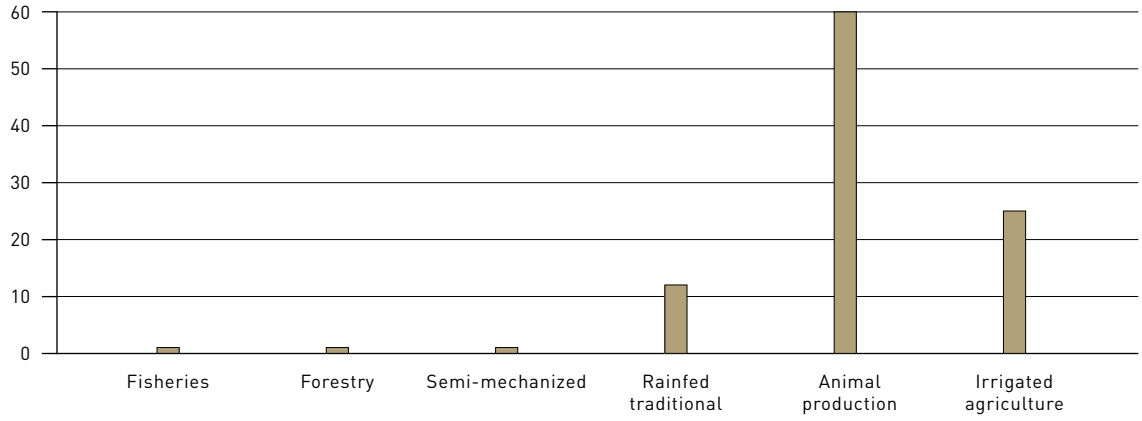
The largest contribution to agriculture value added originated from animal production, followed by irrigated agriculture, largely consisting of medium and large-scale schemes. Rainfed agriculture came next. Livestock is prevalent in the traditional rainfed farming system throughout the country, where livestock are raised under nomadic and transhumance systems. Camels, cattle, sheep and goats are reared in the traditional rainfed sector. The great bulk of all livestock production; possibly 90 percent of the total, comes from smallholders and migratory producers.

Small-scale traditional rainfed farming covers about 18 million feddans (71 percent of Sudan's total cropped area) – 57 percent of the total area devoted to the five major food crops of sorghum, sesame, millet, groundnuts and wheat are all grown in Gebel Marra. Western Sudan has 91 percent of the rainfed area under cultivation (54 percent Greater Kordofan and 37 percent in Greater Darfur) and rainfed production in this region constitutes 81 percent of total rainfed output (47 percent in Greater Kordofan and 33 percent in Greater Darfur).

Records of the exact contribution of the forest resources to the GDP registered in values and figures are very difficult to trace and evaluate at the national level because the greater part of the forest products and services provided by the rural economy, whether in the form of energy, wood and non-wood products and eco-tourism, are spontaneous activities and were not subject to official registration. The formal National Accounts show a limited contribution of the forestry sector to the GDP. These accounts register figures of 1 to 2 percent contribution, which equals the value of wood produced from government forest reserves or registered in the form of royalty collection.

The contribution of fisheries to the GDP is marginal, though the exact value is not recorded because of the prevailing poor statistical data collection effort. However, in 2009, the total fish export value was US$ 0.2 million and per capita yearly fish consumption was 1.8 kg. Fisheries also provide work opportunities in the form of secondary employment as a source of income, in addition to their contribution to household food security.

Figure 1.2 **The relative contribution of the agriculutral subsectors to the agriculutral value added, 2014**



Source: Bank of Sudan, Annual Report, 2014.

b) Creating backward and forward linkages: The backward linkages are reflected in both consumption expenditure (rural demand for manufactured goods and services) and inputs for agricultural production. The forward linkages are reflected in the supply of inputs, energy and services for the rest of the economy. Small-scale farming, together with the rest of the agriculture sector, is an important source of inputs for local industries. The livestock subsector supplies the domestic market with hides and skins for the leather industry and handicrafts and for export. Animals also are used for transport in rural and town areas. Behnke and Osman (2012) calculated transport services provided by livestock to their owners as equivalent to SDG 8.409 billion , which is missed in GDP calculation. Livestock provide traction power in small-scale crop farming and manure for soil fertility, organic farming and enriching grassland nutrients.

A recent energy consumption study (FAO, 1995) showed that the per capita consumption of fuel wood is 0.7 cubic meters per annum. The contribution of forests to the national energy supply is estimated to account for 71 percent of the total energy consumed and when converted into Ton/oil Equivalent (TOE), it is valued at nearly USD 2.0 billion. Forest trees also contribute some 30 percent of animal feed per annum, which can reach 70 percent in extremely dry years.

c) Generating exports and foreign exchange earnings: The subsector also generates a significant share of foreign exchange proceeds. These consist of cash crops export, livestock and meat exports and forestry products. In 2014, the total value of the country's exports was USD 3.451 billion, of which USD 3.096 billion consisted of non-oil exports. Of these, agricultural exports totalled USD 1.5198 billion. Livestock exports (largely produced in the traditional sector) earned the country USD 856.3 million, consisting of sheep, camels and goats. Crop exports generated USD 663.5 million in the same year. These were largely produced in the small-scale subsector as gum arabic, sorghum, sesame and groundnuts. Gum arabic, which is obtained from the *Acacia Senegal* and *Acacia seyal* trees, is an important foreign exchange source for the country.

Table 1.3 **Livestock export earnings in comparison with total exports, non-oil exports and agricultural export earnings (USD million) during 2010-2014**

Item	2002-2011 (average)	2012	2013	2014
Total exports	6 826.5	4 066.5	4 789.7	3 450.5
Non-oil exports	896.7	3 810.4	3 073.1	3 096.1
Total agriculture exports (crop +livestock)	435.4	776.8	1 544.9	1 519.8
Livestock exports	163.8	446.6	682.1	856.4
% livestock to total exports	2.4	11.2	14.2	24.8
% livestock to non-oil exports	18	15	22.2	27.7
% livestock to agriculture exports	37.1	57.5	44.2	56.3

Source: Compiled and calculated from Bank of Sudan Annual Reports

d) Reducing poverty through employment opportunities and complementary sources of income: The Central Bureau of Statistics (2009) stated that 45.5 percent of the population of the Sudan lives below the poverty line of SDG 114 per month, about USD 2.0. Poverty in the rural areas is more severe than in urban areas. Poverty varies at state levels, with the Red Sea, Darfur and Kordofan states severely hit by poverty, followed by the Blue Nile, Kassala and White Nile states. The remaining states are at an average level. Nevertheless, small-scale farming with all its subsectors is helping to reduce poverty. Small-scale farmers not only gain employment from their family farms but also complement their incomes by seeking other agricultural and non-agricultural activities. SSF is the most important source of income for the rural population. The active workforce employed in agriculture was estimated to be 58 percent in 2014, while 83 percent of the population depends on farming for its livelihood (70 percent on traditional rainfed farming, 12 percent on irrigated agriculture and only 0.7 percent on mechanized agriculture).

Livestock serves as a source of income for households and local communities. The subsector provides work to family members and employment to local individuals. An estimated 40 percent of the population (Robinson, Abdalla in Nur, 2013) is involved in animal production. A wide spectrum of inhabitants makes a living from permanent jobs and casual labour in different livestock activities (such as herding, dairy, poultry rearing, various market chains, processing industries, transportation and transport services, animal feed and feeding, watering, traction power, etc.).

Livestock are living capital, a wealth-storing device against inflation, a buffer against crop failures, a cushion in case of calamities and a safety net for social stability (risk management). They are a means of social solidarity (dowry, blood money, *zakat*-Islamic taxes*)*, support for poor relatives and clans, etc.) and a means of access to power and authority (Ahmed, 2014). They provide finance for traditional crop farming where official credit is inaccessible.

Livestock serve as a vehicle to empowering women through raising small ruminants and poultry and producing and milk and milk products and contribute to youth employment in activities such as sheep fattening, cash or in-kind payment for herding labour, cart transport etc. Furthermore, they are central to tribal identities and beliefs (IGAD, (2007).

Trees and forests also contribute significantly to poverty reduction in many ways. Forest products generate a sizeable income for individuals. Charcoal production is an important industry that provides employment opportunities and reduces poverty in the rural areas. Rural people freely collect fuelwood from natural woodlands. This trade employs large numbers of itinerant, casual or semi-skilled workers from among the rural poor. The dependence of the poor on fuelwood trade becomes greater during drought years, which recur frequently in the central and northern parts of the country. Such forest activities as planting, thinning, guarding and harvesting of tree crops provide employment opportunities for small-scale farmers.

The employment of women and youth is an important issue in the forestry sector, which has been given a good deal of attention, including supporting skills development and employment and promoting rural women's businesses such as community forests activities for women. Sudan developed policy reforms to enhance women's management of forests in order to develop their cottage industry businesses. Intermediate technology organizations have enhanced the development of business based on non-wood forests products. Many women and youth from west Sudan are members. These organizations are engaged in the processing of non-wood products for soft drinks and packing of edible tree fruits. The objective is to utilize underutilized fruit trees to contribute to food security, hunger relief, poverty reduction and income generation. Fisheries also provide work opportunities for secondary employment and income generation.

e) Source of food security: SSF is central to the country's food security, growing virtually all of the country's millet (more than 95 percent), nearly two-fifths of the sorghum (38 percent), two thirds of the groundnuts (67 percent) and more than one-third of the sesame (38 percent). In addition to the supply of the five major food crops of sorghum, sesame, millet, groundnuts and wheat (the latter is grown in Gebel Marra), subsector through the animal producers, is the source of protein provided by meat, poultry, milk and eggs. The sector constitutes the major source of food for sedentary and nomadic communities, including meat, poultry, eggs and a sizeable amount of fresh milk and other dairy products. Fish and fish preparations also contribute to the food security of a wide sector of the rural and urban communities. In addition, forestry products contribute to complement food in extreme dry years when famine is looming by making available tree leaves, fruits and tubers. The rural poor depend to varying extents on the fruits of various other tree species that provide edible products as a source of food.

f) Bringing about ecological benefits: There are numerous external benefits and ecosystem services brought about by SSF including feeding into the nutrient cycles, water regulation and climate control. Gum arabic production, which occurs in the semi-arid zone, is mainly an activity of small-scale farmers. The *Acacia Senegal* belt constitutes a line of defence against desertification and helps in soil conservation and protecting agricultural crops from erosion. Thus, maintaining forests as valuable sources of income extends benefits to agricultural production by conserving the soil and maintaining the cycles, habitat diversity, watershed services, carbon storage and scenic landscapes. As an ecosystem component, forests provide the benefits people obtain from ecosystems such as wood and non-wood products in addition to nutrient cycles, water regulation, climate control and mitigation and cultural services.

Forests, trees and shrubs contribute in creating good weather conditions as well as providing shade, shelter and fertilization for the soil, together with the role they play in protecting and preserving water sources. Sudan's forests are contribution more and more to recreation activities and to the provision of amenities and facilitating eco-tourism. Still, very limited evaluation of the contribution of forests and the forestry sector has been performed in relation to the national economy in terms of biodiversity, pharmaceutical values and ecosystem services. The role of forests in eco-tourism is still a relatively small component and is reflected in the cottage industry, which contributes significantly to the income of rural households.

Table 1.4 **Subsectors' share of agricultural GDP (2006-2014) (%)**

	2006	2007	2008	2009	2013	2014	Average 2006-2009	Average 2013-2014
Irrigated sector	29.3	29.6	28.9	29.5	27.5	24.0	29.3	25.8
Semi-mechanized rainfed	3.5	2.6	2.7	2.7	1.0	1.0	2.8	1.0
Traditional rainfed	13.7	13.0	15.0	15.3	10.0	12.0	14.3	11.0
Livestock	47.4	47.0	46.9	46.2	60.0	59.0	46.9	59.5
Forestry	6.4	6.5	6.1	6.1	1.5	1.5	6.3	1.5

Source: Ministry of Finance, Central Bureau of Statistics and Annual Report of the Bank of Sudan, several years.

1.2 Small-Scale Crop Production

1.2.1 Overview

Small-scale rainfed agriculture, which is affiliated most to the small producer typology, is a socio-economic activity that evolved out of indigenous cultures. It involves crop production oriented towards satisfying the food needs of the family, but has increasingly become market-oriented. It is engaged by sedentary households and by nomadic and transhumant groups moving with livestock and growing short-maturity subsistence crops. Though the focus in this chapter is on sedentary agriculture, it is to be noted that rainfed crop production is combined with animal production. Household' activities also extend to forestry production, especially of gum arabic. The population of small-scale producers engaged in mixed crop and animal production constitutes about 84 percent of the entire small-scale crop farmer population. They are spread over a vast area stretching from western Sudan (Greater Darfur and Greater Kordofan) to areas in Gezira, Sinnar, Blue Nile, White Nile, Gedaref, Kassala and Red Sea States.

1.2.2 Farming patterns and organization

Since the crop production zones are endowed with diverse natural resources and different climatic zones, ranging from semi-desert to high rainfall savannah, they include areas with appropriate conditions for the production of a variety of crops, crop diversification and animal husbandry. In the lighter soil areas, in Northern Darfur and Northern Kordofan, the main subsistence crop grown is millet (*dukhon*), normally grown on 60 to 70 percent of the cultivated area of the households.

Additionally, the households grow groundnuts, and in smaller areas, sesame, cowpeas (*lubia*) and roselle (*karkadeh*)[13]. In the heavier clay soils of the central clay plains of the Kassala, Gedaref and Blue Nile states and the Nuba Mountains, farmers grow sorghum, their staple food, on about 70 to 80 percent of the crop area. They also grow sesame and groundnuts. Vegetables are also grown for domestic consumption. Farming practices rely on ethno-technologies in crop rotation and cultivation methods. Agricultural operations are handled mostly through family labour and with the use of locally made hand tools. Most of the families keep some animals for food, milk, fieldwork or transport.

In the traditional communities, which do not organize into groups, access to credit is often done through the traditional "*shail*" system, through which the merchant in the village provides funding in exchange for purchasing a crop under cultivation at a fixed price. The farmers have limited, or no, access to formal bank lending since commercial banks have limited coverage and there are few branches in the rural areas. Farmers are restricted from applying for loans from commercial banks due to the high transaction cost of obtaining the loans, lack of collateral and because of their illiteracy.

The value chains in small-scale crop production are generally governed by spot market transactions involving a large number of small retailers and producers. Farmers often face difficulties with post-harvest management. They rely on traditional storage facilities such as "*siwaibas*", huts constructed mainly from straw, and "*matmooras*", underground pits. While post-harvest losses associated with this type of storage facilities are undocumented, farmers and observers note that these are in effect substantial, due to lack of cleaning or fumigation. Surplus production is often sold in nearby towns and cities, generating income for the small producer families. Surplus is transported in certain areas by animals, although truck transport has become common in most parts of the country where roads are passable and security exists.

The food produced by a large group of small-scale farmers and the cash obtained from selling the surplus crops are not enough to sustain the families. Most resort to supplementary sources of income such as selling firewood, tapping gum arabic or working as seasonal labourers, at times in faraway places. As the younger males are the ones who migrate searching supplementary incomes, a proportionately larger number of women and old men populate the communities.

1.2.3 Contribution to the national economy

The small-scale traditional rainfed farming subsector is the most important in terms of land area cultivated, aggregate production, contribution to the food security and livelihoods of the rural poor, employment opportunities, provision of raw materials to the processing sector and mobilization of the whole economy through forward and backward linkages.

[13] The technical names for these crops are as follows: millet is *Pennisetum typhoideum*, sesame is *Sesamum indicum*, karkadéis is *Hibiscus sabdariffa*, groundnut is *Arachis hypogaea*, watermelon is *Citrullus vulgaris*, sorghum is *Sorghum vulgare* and gum arabic is *Acacia Senegal*.

Small-scale traditional rainfed farming covers about 18 million feddans (71 percent of Sudan's total cropped area), holds 57 percent of the total land area devoted to the production of five major food crops (sorghum, sesame, millet, groundnuts and wheat – the latter produced in Gebel Marra). Western Sudan has 91 percent of the rainfed area under cultivation (54 percent in Greater Kordofan and 37 percent in Greater Darfur) and rainfed production in this region constitutes 81 percent of rainfed output (47 percent in Greater Kordofan and 33 percent in Greater Darfur). Fifty-eight percent of the active workforce is employed in agriculture, while 83 percent of the population depends on farming for its livelihood (70 percent on traditional rainfed farming, 12 percent on irrigated agriculture and only 0.7 percent on mechanized agriculture). The subsector is vital to the country's food security. It grows about 95 percent of the country's millet, 38 percent of the sorghum, 67 percent of the groundnuts and 38 percent of the sesame.

Livestock is prevalent in the traditional rainfed farming system throughout the country where livestock are raised under nomadic and transhumance systems. Camels, cattle, sheep and goats are reared in the traditional rainfed sector. The great bulk of all livestock production, possibly 90 percent of the total, comes from smallholders and migratory producers.

The share of the subsector in the country's GDP increased on average from 12.5 percent during the period 1991–92 to 1999 to 14.3 percent during the period 2006–11. It comprised about 47 percent of the agricultural GDP for the period 1990–91 to 1998–99, which increased to 68.6 percent for the period 2007–12. This increase in the contribution of the subsector over the years demonstrates the increasing importance of the traditional rainfed subsector.

Figure. 1.3 **Average share of main agricultural subsectors in land area and GDP, 2007-2012**

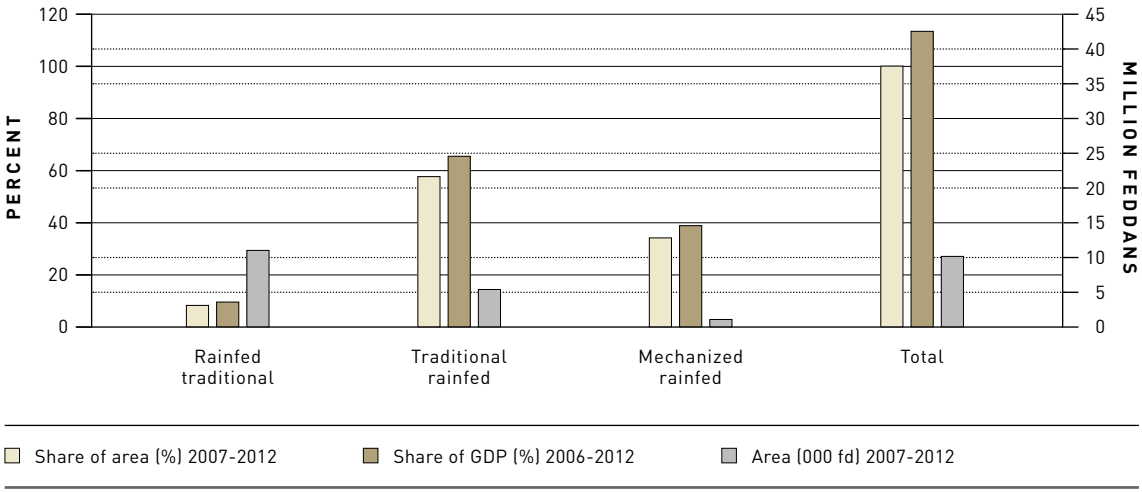


Figure. 1.4 **Comparison of cropped area by agricultural subsector**

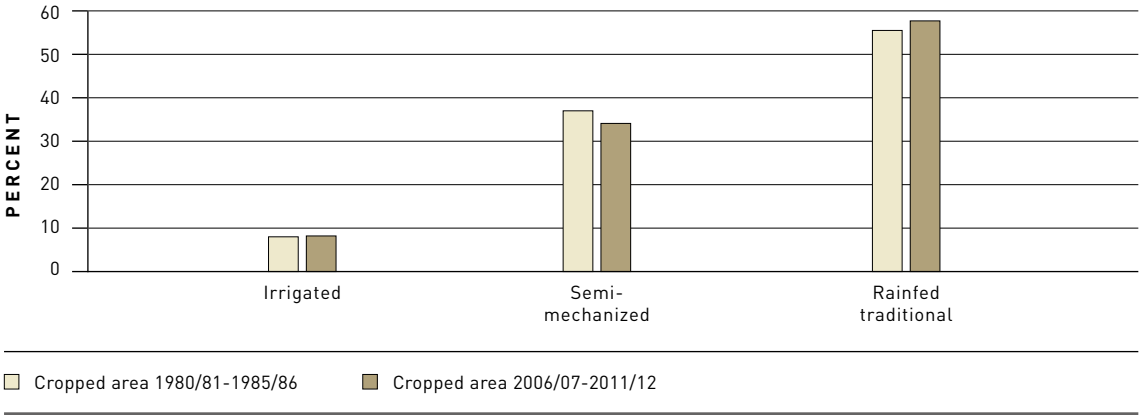
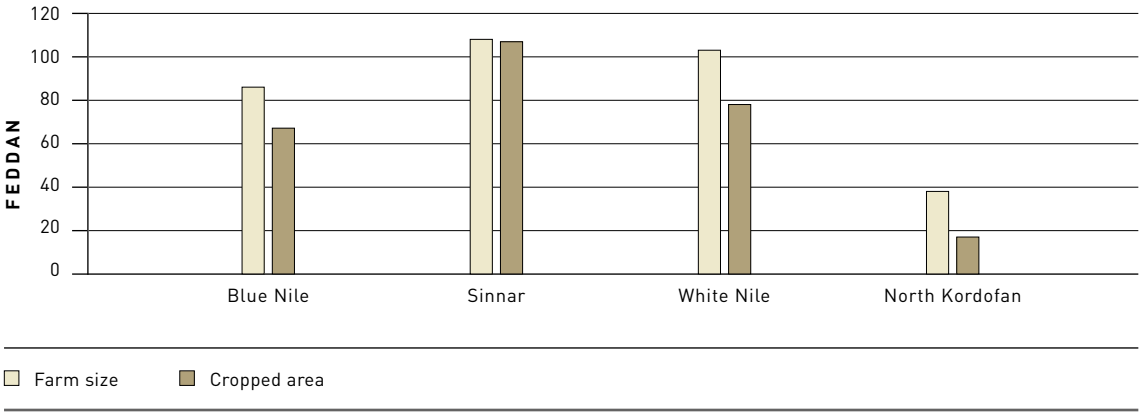


Figure. 1.5 **Comparison of farm size and cropped area (in feddans) by region, 2013-2014**



Note: Comparison of cropped area by agricultural subsector and comparison of farm size and cropped area by region.

Despite this overwhelming importance of the traditional rainfed subsector and its potential for growth, food security and poverty reduction, insufficient attention has been paid to it and it is often treated as a residual subsector in terms of supporting policies and budget allocation for development.

1.2.4 Challenges and constraints

Despite its contribution to the national economy, the small-scale rainfed agriculture subsector faces variety of challenges. The high variability in the total annual rainfall and the irregularity of precipitation lead to uncertainty in crop production from one season to another. Cycles of drought spells and heavy rains cause fluctuations in productivity. Related to this is a trend of declining rainfall in parts of the country.

Figure 1.6 **Percentage share of cultivated area by main crops, 2011-2014**

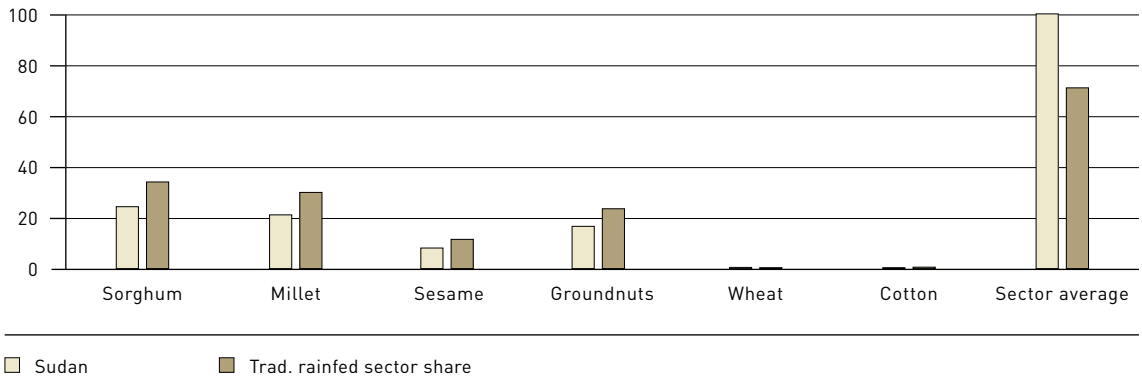


Figure 1.7 **Comparison of returns by main crop and region, 2013-2014**

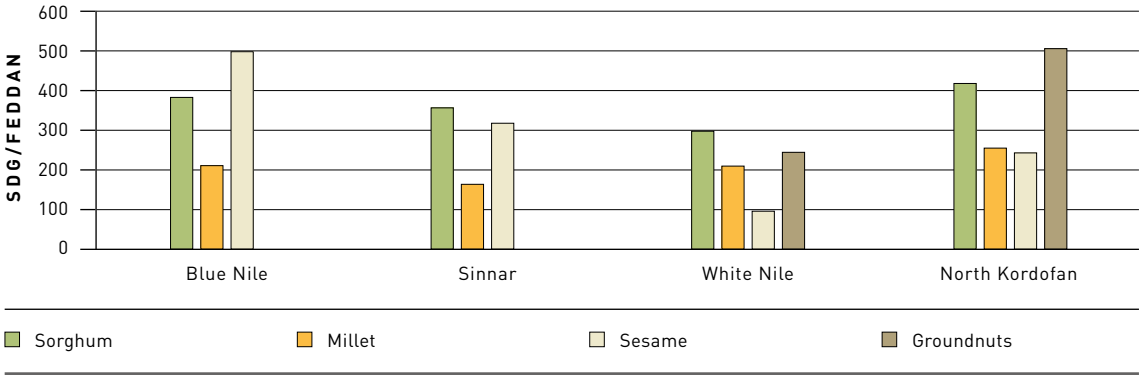
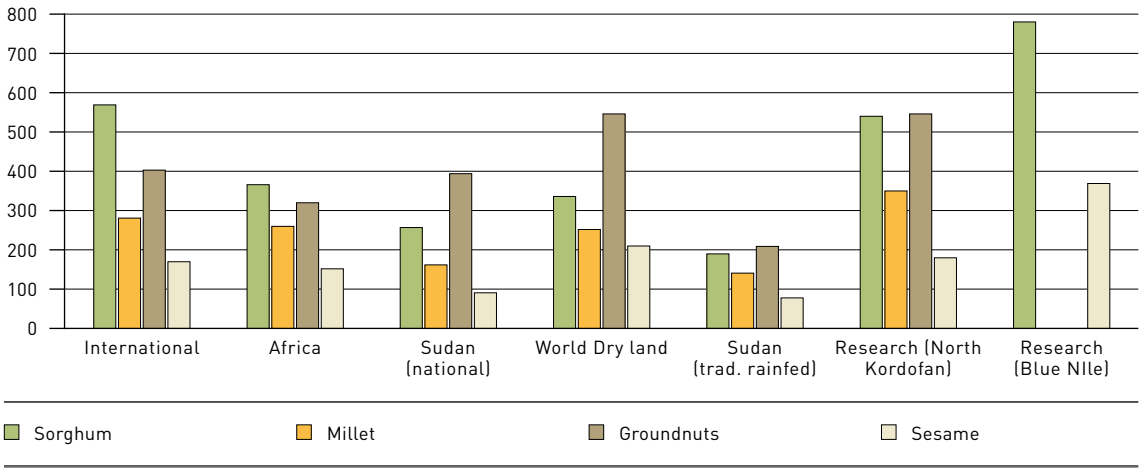


Figure 1.8 **Comparison of farm family income by main crops and region, 2013-2014**

A second challenge is the low level of productivity in the subsector, compared with averages elsewhere. Figure 1.7 depicts that the productivity of the main crops in the small-scale rainfed subsector is very low, compared to their productivity in other parts of the world and the productivity obtained at the research level in North Kordofan State and Blue Nile State. Productivity is lower in the production of sorghum, millet, groundnut and sesame in small-

scale family farming than the average productivity in Sudan, Africa, the world in general, the world's drylands and the research centres in North Kordofan and the Blue Nile.

Figure 1.9 **Comparison of the average productivity (kg/ha) of the main crops (1978–2007)**



The low yields of crops in the traditional rainfed sector are due to a variety of natural and socio-economic constraints. The most important of these are abiotic factors such as low and poorly distributed rainfall, ecological and natural resource degradation and low soil fertility. They is also due to lack of appropriate crop sequence or rotation. Additionally, productivity is held down by poor traditional cultural practices such as inadequate sowing and weeding preparations and the limited use of fertilizers. Other factors include lack of improved seeds. In the case of sesame, for example, the varieties used are slow maturing. Consequently, large amounts of sesame are lost by dehiscence of capsules during harvesting and drying.

The sector is also constrained by various socio-economic factors, including poor rural infrastructure (roads, transportation facilities and storage structures), lack of appropriate policies for traditional rainfed agriculture (in terms of credit, subsidies, pricing, marketing, etc.) and the unavailability of inputs (seeds, fertilizers, pesticides and others). Farmers also have limited access to credit and marketing services and little assistance from research and extension services.

An important factor leading to the decline in the productivity of crops is soil depletion resulting from the shortening of fallow periods. In the past, shifting cultivation allowed farmers to respond to the rapid exhaustion of the soil without using chemical fertilizer. However, increased competition over land, water and vegetation led to a marked change in land use practices from a rotation system with long fallow periods (15–20 years) interspersed with short periods of cultivation (4–5 years) to more or less continuous cultivation over the last three to four decades. Farmers have also been forced to farm marginal, less fertile land.

Another challenge facing rainfed agriculture is that water resources are scanty, depending on rainfall and running seasonal streams. Competition over water, which is needed for human and animal use, leads to conflicts in the western part of the country. Overgrazing by animals

around water sources leads to land degradation. As a result, community members must spend considerable time, money and effort to get water from distant sources (an average of 15 km away). Women and children, who are responsible for fetching water, are particularly overburdened. Little effort, however, is made to encourage water-harvesting activities, which can enhance the welfare of rural communities while regenerating biological diversity.

Though the subsector produces significant volumes of agricultural raw materials such as oil seed crops (sesame, groundnuts), gum arabic and forest products, the processing of these raw material has lagged behind. For instance, in El Obeid (the capital city of North Kordofan State), there were about 87 oil mills in operation more than two decades ago. Currently, there are only seven operating, and these are operating well below capacity. The challenge to policy makers is to adopt appropriate policies to promote rural agro-industry. The cooking seed oil industry is an area which could have been successfully developed, given its technological simplicity and modest level of capital investment. In the city of El Obeid, for example, large amount of capital was spent in establishing oil extracting factories. However, at present, the factories are working at only 15 percent of their full capacity. Furthermore, except for some traditional seasonal cheese making, no extra effort is done in generating additional value from the large animal resources of the greater Darfur and greater Kordofan regions.

Box 1.1: The role of local leaders in natural resource management

Historically, the exploitation of natural resources in rural Sudan have been overseen by tribal and community leaders. The "*Nazir*" (the paramount tribal leader) oversees the natural resource management system of the tribe as a whole. The "*Omda*", the head of tribal clan, administers the activities of the clan in terms of land use and other social responsibilities. Each *Omda* oversees a number of "*sheikhs*". The *sheikh,* at the village level, is the village head and controls the natural resource management activities within the village. Land management, conflict resolution and other social concerns are among the *sheikhs'* responsibilities.

In 2002, assessment of natural resource management in Sudan, initiated by IFPRI in collaboration with other partners, concluded that the strong leadership of local administration during the 1970s contributed to the resolution of conflicts over natural resources. Local leaders were able, without federal government intervention, to develop control over rangelands, forest and land use at different levels of local administration (locally called *mashiakhas, omodias and nazaras*). The study documented that local leaders inherit their titles and learn from informally from predecessors. Exchange of views and learning was carried out through the social linkages traditionally found between the different levels of leaders and with neighbouring groups. The local leaders were able to control and protect their land from over-exploitation by outsiders. They also controlled overgrazing by enforcing the practice of leaving land fallow and by keeping rotational grazing lands. Additionally, they represented their communities, communicating the demand for public services to the government.

The major weaknesses of the management of natural resources through the local administration were that there were no written guidelines or official mandates indicating what was to be done and how to do it and that the traditional leaders had limited technical knowledge and no training in modern techniques of management and monitoring.

There is however, an opportunity to build on such a system, reform it and make full use of it in natural resource management and conservation, in awareness raising and supervision programs and in conflict resolution and arbitration. The system can also help bring the community together for purposes of marketing and access to credit as well as in production.

1.2.5 Adapting and coping strategies

Through the years, farmers have tended to adopt livelihood strategies that aim to reduce their overall vulnerability to climate shocks (adaptive strategies), and manage their impacts ex-post (coping strategies). The distinction between these two categories is, however, frequently blurred: what starts as coping strategies in exceptional years can become adaptations for households or whole communities. In Sudan, similar to the rest of Africa, eight major elements of adaptation have been identified:

1. allocating farm labour across the season in ways that follow unpredictable, intra-season rainfall variations: ''negotiating the rain';'
2. making use of biodiversity in cultivated crops and wild plants;
3. increasing integration of livestock into farming systems (at a cost of increased labour demands);
4. working the land harder, in terms of labour input per hectare, without increasing external non-labour inputs;
5. diversifying livelihoods;
6. on-farm storage of food and feed;
7. strategic use of fallow;
8. late planting of legume crops when cereals fail, as drought response.

The defining feature of small-scale farmers in Sudan, similar to those in other African drylands, is that they make use of biodiversity in cultivated crops and wild plants and are increasing the integration of livestock into farming systems (at a cost of increased labour demands). It is to the variability in rainfall supply that they have traditionally adapted, for example, through pastoralism, income diversification and mobility. It is common that farmers go to urban areas or the farming areas in the Nile districts as labour force during the dry season. The money that they earn is often sent back to the families and invested in livestock. The farmers work the land harder, in terms of labour input per area, without increasing external non-labour inputs, allocating farm labour across the season in ways that follow unpredictable intra-season rainfall variations and diversifying livelihoods. Farmers also move to fallow land to regain soil productivity and they respond to late or little rains by late planting of legume crops.

In 2014, FAO created risk profiles for those livelihood zones covering the traditional rainfed farming areas of the country, namely: the states in the Darfur region (Central, East, North, South and West Darfur States); the southern states (i.e. South and West Kordofan, the White Nile and Blue Nile States); and eastern states (i.e. Gedaref, Kassala and Red Sea States). As will be discussed later, on-going climate change will likely increase the risks to this mode of livelihood.

Table 1.5 **Livelihood risk profiles across traditional raindfed farming areas of Sudan**

Hazard and Stress	State	Time of year	Frequency of Occurrence	Livelihood Group Affected	Sub-sector Assets Affected	Scale of Impact
Darfur Region						
Drought	North Darfur	Dry and rainy season	Every 2-3 years	Farmers, pastoralists and agropastoralists	Livestock and crops; forests and pastures	High
Floods	Central North, South and West Darfur	Rainy season	Every year	Farmers and agropastrolaists	Livestock and crops; wadi cultivation and pastures	High
Conflict (IDPs, etc.)	Central, East, North, South and West Darfur	All year	Every year	Farmers, pastroralist and agropastoralists and service providers and traders	Livestock and crops; and land, infrastructure and social issues	High
Crop pests and diseases	Central, East, North, South and West Darfur	Rainy/ cropping season	Every year	Farmers and agropastoralists	Crops; wadi cultivation and pastures	High
Animal diseases	Central, East, North, South and West Darfur	All year	Every year	Pastoralists and agropastoralists (and women)	Livestock, animal services and trading and nutrition	High
Wild fires	All Darfur states	September-February	Every 2-3 years	Pastoralists and agropastoralists	Livestock and forests/ rangelands	Medium
Soaring food prices	All Darfur states	All year	Every 2 years	All livelihood groups	Crops, livestock and nutrition	Medium
Land degradation	All Darfur states	All year (overgrazing)	Increasing	All livelihood groups	Land, crops, livestock and trees	High
Access to land and water	All Darfur states	All year	Every year	Pastoralists and agropastoralists and small holder farmers	Crops and livestock	Medium
Eastern Region						
Drought	Kassala and Red Sea	Dry and rainy season	Every 2-3 years	Pastoralists and agropastoralists and farmers	Crops, livestock and land	High
Floods	Gedaref Kassala and Red Sea	Rainy season	Every 2-3 years	Irrigated and rain-fed farmers	Crops, land, tools and infrastructure	High
Soaring food prices	Gedaref Kassala and Red Sea	All year	Every year	All livelihood groups	Crops livestock and nutrition	High
Conflicts (IDPs, etc.)	Gedaref and Kassala	All year	Every year	Agropastoralists and farmers	Land and social issues	Medium
Animal diseases	Gedaref, Kassala and Red Sea	All year	Every year	Pastoralists and agropastoralists (and women)	Livestock and nutrition	Medium
Sandstorms	Kassala and Red Sea	Dry season	Once per year	Pastoralists and agropastoralists and farmers	Land and infrastructure	Medium

Hazard and Stress	State	Time of year	Frequency of Occurrence	Livelihood Group Affected	Sub-sector Assets Affected	Scale of Impact
Crops pests and diseases	Gedaref Kassala and Red Sea	Cropping season	Once per year	Mechanized and irrigated farmers	Crops	Low
Cultural practices	Kassala and Red Sea	All year	Every year	All livelihood groups (women)	Horticulture, small livestock, fisheries and nutrition	High
Land degradation	Kassala and Red Sea	All year (overgrazing)	Increasing	All livelihood groups	Land, crops, livestock and trees	High
Access to land and water	Kassala and Red Sea	All year	Every year	Pastoralists, agropastoralists and smallholder farmers	Crops and livestock	Medium
Southern Region						
Conflict (IDPs, etc.)	Blue Nile and South Kordofan	All year	2-5 times/year	All livelihood groups	Crops, livestock and infrastructure	High
Erratic rainfall	Blue Nile, White Nile, South and West Kordofan	Annually	Yearly in Blue Nile; 1-2 years in South and West Kordofan	Pastoralists, agropastoralists and farmers	Crops and livestock	High
Floods	Blue Nile, South and West Kordofan	Rainy season	Yearly in Blue Nile; and every 2 years in South and West Kordofan	Pastoralists, agropastoralists and farmers	Crops, livestock, tools and infrastructure	High
Wild fires	South and West Kordofan	November-February	Once per year	Pastoralists, agropastoralists and farmers	Crops, livestock, tools and environment	High
Soaring food prices	Blue Nile, White Nile, South and West Kordofan	May-October	Every year	All livelihood groups	Crops, livestock and nutrition	Medium
Animal diseases	Blue Nile, White Nile, South and West Kordofan	All year	Every year	Pastoralists, agropastoralists (and women)	Livestock and nutrition	Medium
Crop pests and diseases	Blue Nile, South and West Kordofan	Cropping season	Once per year	Farmers and agropastoralists	Crops	Medium
Land degradation	South and West Kordofan	All year (overgrazing)	Increasing	All livelihood groups	Land, crops, livestock and trees	High
Access to land and water	Blue Nile, White Nile, South and West Kordofan	All year	Every year	Pastoralists, agropastoralists and smallholder farmers	Crops and livestock	Medium

Source: FAO (2014).

A recent "environmental and climate change assessment" undertaken by IFAD analysed historical temperature and rainfall patterns and modelled estimated future projections of precipitation and rainfall as well as future runoff of the Nile flows until 2050. The assessment indicates that climate change is already leading to more severe and chronic droughts and

threatening all rainfed agriculture systems. Increased temperatures and declining rainfall have shifted the boundary between desert and semi-desert zones southwards, by between 50 and 200 km, over the past 80 years. This trend is continuing and large areas of the remaining semi-desert and low rainfall savannah, key livestock production zones, are at risk of desertification.

Vulnerability assessments show that rainfed cropping areas will shrink, and the impact of droughts will increase. Agricultural yields are expected to fluctuate more widely over time and to converge to a significantly lower longer-term average. This will vary across crops and agro-ecological zones, but impacts will be most significant in rainfed areas. By 2050, declines in yields could range from between five and 50 percent, and between 15 and 25 percent in terms of value of agricultural output, reducing GDP by between USD 7 billion and USD 14 billion. Low productivity is one of the basic problems of the agriculture sector of Sudan. This is obvious from the fact that about 80 percent of the labour force is engaged in agriculture. The primary causes of this low productivity in agriculture is that the technology used is primarily traditional and the application of modern inputs has been extremely limited. The poor performance of agriculture has been also attributed to weak macroeconomic and sector policies, including market and price controls and deterioration of agriculture infrastructure and to the incidence of drought.

1.2.6 Policies and institutional support

Support for the sector has been inadequate and no institutional framework for organizing and boosting production in the sector has been established. Thus, the services provided to support crop production are limited. Efforts to develop innovative cultural practices or institute the use of technology have not been carried out systematically. The traditional agriculture sector is regarded as self-dependent in terms of using inputs that do not require expenditure of hard currency. However, in actuality, the farmers occasionally experience shortages in seeds and are rarely assisted with the provision of certified improved seeds.

In general, pricing policies have not been attractive for the producers, while no support is given to reduce the cost of production. Access to formal finance is almost absent and farmers often have to resort to family support or traditional sources of loans. Social services (water, education and health) are largely inadequate and physical infrastructure (such as road networks and power) barely exists.

1.3 Small-Scale Animal Production

1.3.1 Characterization of small-scale animal production

The small-scale livestock and animal production system in Sudan is predominantly traditional, although there is a small, urban, modern subsystem. The ecological variation of the country resulted in an extensive and diverse traditional pastoral system, consisting of nomadic and transhumance subsystems and of sedentary and semi-sedentary agro-pastoral subsystems. A pastoral transhumance system is one in which over 50 percent of the total household net income, or more than 20 percent of human food energy, is derived from livestock or livestock

products. In this system, there is little integration of livestock and crops. An agro-pastoralist system is one in which 10 to 50 percent of total household revenue is derived from livestock products. The urban and peri-urban subsystems consists of intensive, small-scale production units of dairy and poultry as well as feedlots.

Herd size, labour requirements, production volume (scale), marketable produce and the annual income of livestock origin can be used as criteria for characterizing small-scale livestock production. Small-scale production is relative, based on the size of individual holdings in a particular livestock production set-up. However, some livestock producers have their own perception of the scale of production. Shepherds in West Kordofan (Al-Khiweiy locality), for example, consider any producer who cannot afford to hire a shepherd to be a small-scale producer. According to them, a herder with less than 150 head cannot, on his own, hire a shepherd. Otherwise, he would suffer stagnant or negative growth that would erode his stock inventory due to a low lambing rate.

Shepherds are paid in-kind for the annual litter at weaning age. The amount of payment varies according to the size of the flock and the terms of the agreement between the two parties. Generally, a herd of 150 head is paid for with 20 weaned lambs, while for 100 head, 16 lambs are paid, in addition to covering daily food, working clothes, shoes and, in the case of illness, the cost of treatment and medicines. Taking this as a rule and applying it to other types of livestock, using the standard Tropical Livestock Units (TLU = 250kg) as a conversion factor (TLU is equivalent to 1 camel, 0.7 cow, 0.1 sheep or goat), it could be estimated that any holdings of 21 cows, 15 camels, 150 sheep and 150 goats is considered a small one. Based on this rule, small-scale livestock inventory ranges between 1 and 21 cows, 1 and 15 camels, 1 and 150 sheep and 1 and 150 goats.

A study of a small sample of cattle herders (transhumance) in East Darfur (Rizaigat area) showed a variation in the size of cattle herds from 40 to over 1 000 head. The study also showed that among a small group of North Kordofan pastoralists, a medium size camel herd is 50 head (nomads) and a mid-size sheep herd is 200–600 head (sedentary producers) (Young *et. al*, 2013). All surveyed herders in the two states keep other types of animals as secondary assets besides their primary stock. Zaroug (date N/A), in his description of the scale enterprise of livestock production systems in Sudan, reported that the herd size might range from below fifty head to a few thousand head per household. Big herds are often broken down into smaller flocks for easy tending and management. Nur (2003) found that a Hawazma household (*baggara*) owns on average 66 cattle, 57 sheep, 18 goats and 4 camels, while a Hamari household (*ghannama, raising goats*) owns 41 cattle, 309 sheep, 32 goats and 35 camels on average.

It is to be noted that the term “small-scale livestock producers” is not synonymous with the term “poor livestock keepers”. All poor livestock keepers are small-scale but not all small-scale livestock producers are poor. A poor herder, in the view of pastoral producers, is anyone who keeps flocks below the *zakat* minimum herd size, which is 30 cows, 40 sheep and goats (single or grouped) and 5 camels.

1.3.2 Pastoral livelihood

Typology of Pastoral herding: The vast majority of the national herd in Sudan is produced under the pastoralist production system, which is found in every region and state throughout Sudan, including peripheral states and Khartoum state. Herding under this production system is carried out by people whose livelihood is based on mobility or migration, taking advantage of the variable distribution of pasture, fodder and water between seasons and within seasons. These herders adopt opportunistic or tracking strategies whereby the variability in available resources coincides with stock numbers and forage supplies (Pantuliano, 2009). Migration movement is a response to environments in which the natural resources required to maintain the herds are not continuously present in one place (Young *et al.*, 2013). Animal movement is not restricted only to nomadic groups. Sedentary communities also keep their herds by using mobility as key strategy (Krätli *et al.*, 2013). Movement distances vary, being longer in the case of pastoralists and limited to open range grazing in settled communities (Zaroug in Krätli, 2013).

Mobility is a critical element of pastoral livelihoods. Quantity and quality of grasses; accessibility of water; evading mud, diseases and biting insects and security conditions are the factors that rule pastoral mobility (Nur, 2003). "Migratory movements reflect the interplay of socio-economic considerations, bio-physical variables, negative constraints, and positive incentives, all operating at different spatial and temporal scales" (Young *et al.*, 2013). "Patterns of movement vary from pure nomadism, with no fixed location, to different shades of transhumance, swinging through seasonal migratory corridors on cyclic basis, to levels of agro-pastoralism where crop-livestock mix is practiced" (Rota & Sidahmed, 2010)."Pastoralist livelihoods are flexible, adaptive, and therefore fluid in the context of a changing environment. They will shift and adapt their systems of livestock production (transhumance, ranches, zero grazing) and diversify their livelihoods in response to changing contexts with varying implications for the environment and sustainable livelihoods" (pastoralist in Sudan, UNEP website, n.d.). Mobile animals perform higher in productivity than sedentary herds (Wilson and Clarke in Young *et al.* 2013, FAO, Adams, Muffarrih in Nur, 2003, Nur, 2003).

Nomadism: Nomadism is practiced by a small number of camel herding groups and cattle herders, such as the Umbararo, in central and western Sudan, in the desert, semi-desert and low rainfall savannah drylands (north of the 12°N parallel). Camels are looked after by family members, especially youths. When there is a shortage of family labour, some families resort to hired labour. Payment for such labour is often in-kind, comprising a four-year-old she-camel which will be the start of the labourer's own future herd. Camel pastoralists (*abbala*) also keep small ruminants, such as sheep and goats, as a diversification and livelihood strategy, rearing them separately from the camel herds. Again, if no family member is available to herd the sheep, hired labour is used. Women and young boys are responsible for raising the family's goats, which are grazed around the camp.

Camels supply only two percent of the annual red meat production and their share in export earnings as live animals is 16.7 percent, on average. Consumption of camel milk is mounting in urban centres due to the common belief in its curative effects for some health disorders.

Transhumance (semi-nomadism): In transhumance, pastoralists maintain a home base and only migrate seasonally. It is practised by cattle herders. Cattle are found mainly south of parallel 12°N, in the area of high rainfall savannah. They spread west of the White Nile up to Sudan's international borders with Chad and Central African Republic in what is called the 'cattle belt'; while east of the White Nile, they spread up to parallel 14°N to the Sudan–Ethiopian border (Nur, 2003). The cattle utilize rangelands along historic migratory routes, moving between dry and wet season camping areas. Cattle herders (*baggara*) often keep small ruminants as a diversification strategy, driven in part by their commercial value and shorter lifecycle (Young, 2013) and their high prolificacy. Moreover, cattle herders practice some crop farming (subsistence) to support themselves. Cattle provide cash in two ways: through the sale of the animals and through the sale of the milk and milk by-products. In the past, milk collection from pastoral herds was exchanged for food grains.

In the mid-1980s, a total herd of 25 to 30 migratory cows with five to six milking head were found to generate approximately 40 percent of the family's cash income through the sale of milk products. This cash was used to obtain grain from settled agro-pastoralists and farmers along migration corridors (Kerven in Young *et al.*, 2013). Presently, milk is sold for making white cheese in seasonal cheese factories or is sold as raw milk in nearby urban centres during the rainy season, whenever the means to transport the milk are available (paved roads, vehicles, etc.). This is one aspect of gender empowerment as milk is the sole domain of women in pastoral communities. However, it is worth noting that though Sudanese cattle are mainly meat animals, milk is abundant in the rainy season due to the large numbers of cows.

The main constraints facing pastoral producers are low productivity, poor marketing, poor feeding and managerial problems (Bashir and El Zubeir, 2013). Cattle supply the domestic market with 70 percent of the annual total red meat produced. Cattle provide negligible contribution to livestock exports, except very recently to Egypt.

Agro-pastoralism: "Today the separation between a pastoralist and a farmer is less distinct, as pastoralists are increasingly becoming at least semi-settled and producing crops, while farmers are increasing their livestock herds as a means of livelihood diversification and security (Egis Bceom, 2011). Agro-pastoralism is combining livestock keeping with crop farming. (More than 50 percent of annual, household income is generated from livestock). Livestock can either be moved a short distance around the village or kept in the village when they are few in numbers. Goats are the most common form of livestock. The geographical location and mobility patterns influence the number of animals in the herd and the relative importance of livestock production and crop agriculture in the household economy (Babiker in Zaroug, n.d.).

The main animals in agro-pastoralism generally are small ruminants, especially sheep. Sheep keeping is dominant in the area between parallels 12°N and 14°N, in the low rainfall savannah and semi-desert – the sheep belt. The area is a dryland environment. The activity spreads west and east of the main Nile and its major tributaries and into the irrigated areas of central Sudan. Sheep production is predominantly agro-pastoral (crop-livestock mix). Sheep fattening for the market has momentum among youths and women, who use crop residues and agro-processing by-products to feed the sheep. It is worth noting that the sheep belt suffers the negative impacts of climate change seen in erratic rainfall, floods, frequent droughts, land degradation,

desertification, pasture deterioration, increasing population pressure and expanding subsistence crop farming to compensate for low productivity. Sheep usually move shorter distances to search for pasture and water. However, migration beyond 12°N into the high rainfall savannah for grazing is not uncommon. The belt being arid, it suffers severe water supply shortage, particularly in the dry season. The provision of water is costly and represents a significant percent of the producers' annual income (Elrasheed, Faki, ElObeid, 2010).

The producers utilize some adaptation strategies. As Elbashir *et al.* (2004) and Nur (2003) noted, capable sheepherders often move their herds to where pasture is and take the trouble to transport water. Others move their herds to where water is and keep travelling long distances to search for pasture, with prolonged watering intervals. More recently, the use of portable water 'skins' or flexible rubberized water bags (Young *et al.*, 2013) and earth pits lined with plastic sheets have gained momentum, in addition to the earlier innovation of cemented earth tanks. The losers however are poor herders who can afford none of these options. Recent interventions for water provision implemented through the ARP (constructing dams on seasonal watercourses) have relieved some of the problem. Sheep is the number one commercial animal in Sudan and sheep are in high demand domestically and regionally, retaining 10 percent of the international live sheep export share (DTIS in Behnke & Centre, 2012). Sheep provide the domestic market with 17 percent of the annual red meat production. Live sheep are Sudan's main export animal to the regional markets (Gulf States), contributing two-thirds of livestock export earnings (Table 4).

Sedentary farming: Sedentary farmers primarily raise goats. Goats were estimated at31 million head in2014. They are often kept in small flocks in sedentary systems and are generally either owned or looked after by women and young boys (Young *et al.*, 2013). Goat production takes place everywhere across rural Sudan. They constitute cash at hand and a source of milk and meat for the poor strata of the rural communities. Moreover, they are a means of improving the income of women and empowering them in decision-making processes (Gebru *et al.*, 2013 and Nur, 1991). Goats comprise 11 percent of annual national red meat production and contribute 2.2 percent, on average, to livestock export earnings as live animals. Goats are the main restocking choice in many places, in attempts to alleviate rural poverty, support livelihoods, address emergencies among internally displaced people and as a recovery tool in drought-affected communities. Restocking is often introduced as a livelihood-based intervention, as part of a package of veterinary care, training of CAHWs, provision of mineral licks and fodder (Gebru *et al.*, 2013).

1.3.3 Natural resources and pastoral herding

Pasture and water are the basis of the livelihoods of livestock producers. Under customary tenure, land is a property of the tribe and is considered the tribe's homeland (*Dar*), thus ensuring the collective security of the tribe (Pantuliano, 2007). Land, besides being a means for survival and a source of livelihood, gives pride and identity to the tribe and its members (Pastoral Society Sudan Khartoum, 2007). Every member of the tribe has the right to move anywhere within the tribal territory and develop his stock to the extent he can afford to manage it (Nur, 2003).

Land: in 1971, the Sudan Unregistered Land Act of 1970 penalized pastoralists by weakly defining rangelands, considering all nonregistered land 'government property' and abolishing the customary land right (Gordon in Krätli *et al.*, 2013). The Civil Transaction Act of 1984 further consolidated the grip of the state (Pantuliano, 2007). According to these legislations, the government has the right to allocate nonregistered land to whatever uses it considers beneficial to the nation, regardless of the right of prior users. The Comprehensive Peace Agreement (CPA) between the Government of Sudan and the Sudan Peoples' Liberation Movement/Army (SPLM/SPLA) (2005) stated that a land commission should be established as a means to address land issues nationally. However, the commission never saw the light of day. The Darfur Peace Agreement (DPA) has similarly assigned the resolution of land issues to a future Darfur Land Commission. Issues of land alienation are strongly present in the Eastern Sudan Peace Agreement as traditional land is lost to semi-mechanized agriculture thus undermining the sustainability of the pastoralist livelihoods in the region (Pantuliano, 2007). Recent amendments to the constitution have put land issues under the jurisdiction of the Presidency, thus striping the state authorities altogether of the right of land allocation.

Land is pivotal to the livelihood of herders. Without grazing land, pastoral producers cannot feed their animals and agro-pastoralists can neither feed their herds nor cultivate subsistence crops. Land entitlement is key to sustainable pastoral herding and, consequently, to herders' livelihoods. A herder can graze a piece of land for years, but not be entitled to that resource, whereas a crop farmer can cultivated a piece of land once and claim ownership of it, at least customarily.

Herders' livelihoods are at risk in every aspect of their pastoral mobility. Their wet season grazing land is encroached on by subsistence crop farming, their dry pastureland is engulfed by semi-mechanized rainfed schemes, their traditional natural water sources are invaded by horticulture, their migration routes are sealed off by crop farming, their environment is suffering from a depleted natural resource base, and their security is jeopardized by violent conflicts and civil unrest. Pastoralist herders are driven into smaller and more marginal areas with resultant competition over land access, overstocking and escalating tensions and confrontation among themselves and between them and crop farmers. Issues of administration and governance have precipitated these tensions and agricultural expansion remains a key dynamic in igniting these conflicts (Pantuliano, 2007). The situation is further exacerbated by the absence of holistic overall national policies regarding pastoralism, livestock production and migratory corridors (Egis Bceom, 2011).

An overall framework to deal with the land issue is equally important, including rational land policy, sufficient legislation, functional institutions, law enforcement capacity and supporting services (Pantuliano, 2007). Some state governments[14] have issued acts regulating the access rights of livestock pastoralists and defining and protecting stock routes, but those acts remain redundant, partly due to the lack of clear enforcement mechanisms and partly due to deficient

[14] North Kordofan has enacted laws to give pastoralists the right to pass through several states. South Kordofan authorities issued the Law of Stock Routes in 1999 (amended in 2003) and the Law Organizing Agriculture and Pastoralism in 2002. Blue Nile State had regulations in place since the Nimieri regime (1969–1985) but without enforcement. Sinnar State recently was able to enforce regulations to allow the demarcation of a 346 km long stock route, as part of an ILPM project funded by MDTF-N.

service provision (water, pasture, markets and vet services) along the routes to attract herders (Siddig, El-Harizi & Prato in Young *et al.*, 2013).The lack of coordination between the states and federal authorities on implementation of the legislation has been harmful to pastoralists as there are no clear dividing lines between the two authorities (Gaiballa in Young *et al.*, 2013.). "Laws with differing provisions, in the different states, merely serve to complicate things further, logically this should be a national or joint government competence." (Egis Bceom, 2011).

Grazing: Free forage is the dominant livestock feeding system across Sudan. During the wet season grasses grow abundantly, making considerable biomass with relatively high nutritive value. In post rainy season, forage withers gradually with a marked drop in both quantity and quality towards the late dry season and often falls short of meeting the basic maintenance requirements of grazing animals. "The nutritional inadequacy of dry season grazing imposes a major constraint on sustainable livestock production under traditional systems where grazing constitutes the only source of feed for livestock" (Zaroug, n.d).Those most affected are the small-scale sedentary producers who lack the advantage of mobility to access relatively good pasture (Zaroug, n.d). Rangelands have experienced continuous degradation since the 1960s. Remote sensing in eastern Sudan has shown a decline in the areas of natural vegetation from 26.1 percent, to12.6 percent, to 9.4 percent, in 1979, 1999 and 2007, respectively (Sulieman & Ahmed, 2013).

Indicators of pasture degradation are seen in the contraction of wet season grazing lands, the short stay of herders in rainy season retreat sites, high concentration of herds in small areas, soil erosion, desert advancement, drop in soil fertility, dominance of unpalatable herbage and reduction in the nutritive value of most grasses. Recurrent droughts, erratic rainfall, overgrazing, crop expansion, decline in productivity, tree felling and population pressures, among other factors, exacerbate the situation. Seasonal fires destroy large areas of pastures annually in the absence of viable protection measures. Grazing is often supported with crop residues and stubbles (*talaig*) purchased from farmers after the harvest.

Water: Water is the key limiting natural resource and often a source of conflict. Access to water is more critical than access to grazing (Egis Bceom, 2011). Water provision in the dry season is extremely difficult for migratory pastoralists, agro-pastoralists and small settled producers. Besides consuming the greatest portion of their time, efforts and income, water provisioning increases the demand for labour. Common water sources include water yards, seasonal water reserves (*hafirs*), dams (*ced*), the Nile and its tributaries, deep and shallow-hand dug wells (*edd*), natural ponds and depressions (*wadi/khor*). The recent introduction of mobile bladder water tanks facilitates access to remote pasturelands. During the wet and short rainy season thereafter, both producers and their livestock meet their water requirements drawing from surface sources (ponds and natural depressions) with severe health repercussions (Egis Bceom, 2011). After the rainy season, traditional water sources are sealed off by semi-mechanized rainfed cultivation. Access to rivers and Nile banks is blocked by irrigated crops. Pastoral herders often accuse small-scale farmers of intentionally blocking access to local water sources, or purposely-degrading hafirs to keep them off (Egis Bceom, 2011). Further accusations include polluting water and burning neighbouring pastures. Water sources often encourage human settlement, making herders' access to water even more difficult.

A number of institutions influence natural resources. The Native Administration (NA) is the most important player in local governance of natural resources. In the past the NA, under customary land use rights, organized the utilization and access of pasture and water within tribal territories. The NA was given full power over resource allocation, use and access, preventing conflicts, regulating grazing rights, managing water points, enforcing boundaries and demarcation between crop fields and range areas, regulating seasonal migratory movements and stock routes, settling disputes over lost crops and specifying the dates when herders could access crop residues in harvested plots (Shazali and Ahmed in Young *et al.*, 2013 and Stephen, 2006a). The Unregistered Land Act of 1971 considered all unregistered land 'property of government' and thus abolished customary land use rights. The Local Government Act of 1971 abolished the NA and the Civil Transaction Act of 1984 and gave the state authorities the right to restrict grazing in time and place and to assign land for grazing (Young *et al.*, 2013).

National administration was further reinforced by the Local Government Act of 1998 (Siddig, El-Harizi, and Prato, el Hassan and Birch in Young *et al.*, 2013). Although, after frequent restructuring and changing legislation, the NA was reinstated, its strength and reputation were never restored. They "have severely undermined the representative character of the Administration and politicized its role to the extent that tribal administrators (who are now appointed by the government) no longer reflect tribal structures and interests" (Pantuliano *et al.*, 2009, UNDP in Egis Bceom, 2011).

The changes however, have weakened the NA critically with far-reaching implications for rangelands, reflected in loss of capacity to control land alienation and traditional regulation of use (Pantuliano, 2007, Zaroug, n.d). It is worth noting that "with the loss of official power of the Native Administration, tribes had sought strategic political power within the new government administration" (Young *et al.*, 2013). At present, many native leaders are stationed in towns, including Khartoum, and thus are not physically present among their people. They are often accused of being more accountable to the government than to their own communities. This has led to a leadership crisis and distrust in traditional and political leaders among some pastoral communities (Pantuliano *et al.*, 2009).

Under the current federal system of government, the power is vested in the states, but the division of responsibility between the federal and state levels is obscured. Furthermore an incoherent policy regarding the delegation of natural resource management has been detrimental. The role of the central authorities in governing natural resources is blurred. "Sectoral ministries are seen as weak, narrowly focused, and lacking the ability to implement (and oversee) strong and helpful policies (Siddig, El-Hanzi, and Prato in Young *et al.*, 2013). The Range and Pasture Administration, the official body responsible for rangelands, has been swinging between animal resources and agriculture.[15] This administrative instability has been detrimental to its capacities and made it redundant for the last four decades.

The Pastoralists Union, the civic body representing pastoralists nationally and acting as coordinator between pastoralists and other relevant institutions, often fell short of spelling

[15] Throughout the colonial period till the 1960s, the Range and Pasture Administration was part of animal resources, from 1970 to 2010 was an affiliate of the Ministry of Agriculture and now back to the Ministry of Animal Resources.

out the concerns of its constituency. It was dissolved after the Agriculture and Animals Producers Association Act was fully enforced. In 2005 an Administrative Committee for Route Delineation–Darfur States (ACRD-DS) was established and later prompted to demarcate the transhumance routes in greater Darfur and prepare project proposals for services and development along those routes (Pastoral Society Sudan, Khartoum, 2007). The Nomads Development Council (NDC), another body concerned with pastoralists, is relatively new and focuses on Darfur. It is assigned the role of addressing the affairs of the nomads in Darfur and promoting sustainable development of the nomadic community. Its objective is to achieve the prosperity and welfare of different groups, especially women, to promote peaceful co-existence (Young *et al.*, 2012).

The name of the Ministry of Animal Resources and Fisheries was recently changed to the Ministry of Livestock, Fisheries and Rangelands (MLFR). It has since become more focused on animal health. However, it lacks effective coordination mechanisms between the federal and state levels and local institutions managing pastoral resource use. "Despite the focus on livestock, there is little acknowledgement of the importance of pastoralist livestock production. Generally MARF[16] is oriented towards commercial productivity, quality and quantity, and generating export revenues." (Young *et al.*, 2012). Local governments do not reflect the concerns of their constituencies and are not accountable to the local population (Siddig *et al.* in Young *et al.*, 2013)". Furthermore, coordination between the different state technical divisions regarding the provision of services to pastoralists is not in place.

An important player in pastoral resource use is the State Water Corporation which is responsible for the provision and management of water yards at the state and local levels. Water yards are the major source of revenue of the state and local governments. Some states (North Kordofan) have taken the bold decision to transfer the ownership of old water yards to the communities. In some occasions, a tripartite agreement between the State Water Corporation, the municipalities and the communities is signed with management vested in the communities and revenues from agreed-on rates shared between the three parties. The Ministry of Electric Power and Dams is an important player in governing the use of natural resources through its water harvesting program. Through the ARP, the Ministry has constructed a number of dams on seasonal water courses and excavated some hafirs with the intent of serving pastoral people. No prior studies preceded its water provision work to ensure that chosen water locations were actually on stock routes or grazing lands. Claims were made that some locations were selected in response to political pressure rather than a technical basis. Further, some water sources, though originally targeted for pastoral producers have been taken over by settled communities. The private sector also invested in water yards, especially in Darfur and some parts of Kordofan. Very few community-based organizations (CBOs) have committed themselves to highlight and address pastoral concerns at the national level. Those that have include *Almasar*, *Elhawdag*, *the Sudan Camel Association* (SUCA) and *the Pastoralism Association Sudan* (PAS). Out of 104 CBOs in Darfur, for example, only four focus on pastoralist affairs. The very weak representation of civil society on the ground is an impediment to outreach to the pastoral community (Young *et al.*, 2012).

[16] MARF: The Ministry of Animal Resources and Fisheries was recently changed to the Ministry of Livestock, Fisheries and Rangelands (MLFR).

1.3.4 Adaptation of pastoralists to changing conditions

According to (Ahmed *et al.* (ed.), 2004), "pastoralists as a group, living in remote areas, achieved a high degree of self-reliance and developed a specific culture of their own. Their way of life is centred on their developed experiences which helped them to adapt to the harsh conditions of their environment". In order to survive, a pastoralist producer has to struggle on different fronts simultaneously: for grazing land, to avoid overstocking, to overcome feed shortage, to solve water shortage, to ensure his herds are productive, to avoid diseases and to ensure security. These fighting fronts require considerable effort and the household labour force is organized so as to address all these issues. Livestock rearing being a family affair, every family member is assigned a specific job with clear divisions of labour. Tasks vary from tending and safeguarding the different types of animals and age groups, watering the herds, treating the sick and feeding the weak, searching for the lost and visiting weekly livestock markets for selling some animals, gathering information and discussing issues of concern to the herding community at large.

Labour intensifies during the dry season and producers who are short of household labour have to seek hired labour (Young *et al.,* 2013). The mobile flocks are assigned to daring youths who are expert herders armed with guns and are highly paid by stock owners to ensure that the herds are safeguarded and graze well, even if they must trespass on crop fields (Stephen (ed.), 2006b).

The pastoral producers often complain of labour shortage and outflow to other sectors of the economy, especially to gold mining fields, thus depriving the pastoral business of experienced and astute caring shepherds. Payment of hired labour can be in cash or in-kind, as explained earlier. In-kind pay is the basis of the payee's future herd. Livestock production systems, in fact, provide considerable full time jobs to many persons within and outside primary production and along the market chain. Behind each full time job there are a number of part time workers, not only operators, who make a living out of livestock trade, but a continuum of subsidiary workers including livestock drovers, transporters, feedlot workers, slaughterhouse and meat processers, hide and skin workers, water vendors and suppliers of crop residues and processed feed for fattening (Krätli *et al.,* 2013).

Animals are the only assets of pastoral producers that can be liquidated in times of need or pressure. They are a source of food, income, labour and productive inputs. "When a pastoralist loses his livestock, he loses his asset base—which is similar to a farmer losing the land he cultivates" (Fitzpatrick& Young, 2013). Livelihood security and survival dictate the herd diversification strategy. Both pastoral producers and subsistence crop farmers pursue herd keeping and expansion. "Today the separation between pastoralist and farmer is less distinct as pastoralists are increasingly becoming at least semi-settled and producing crops, while farmers are increasing their livestock herds as a means of livelihood diversification and security (Egis Bceom, 2011). Pastoral herders invest income reserves in holding different types of livestock at a time, with one stock being primary while others are subsidiary. The subsidiary shields the primary in marketing. Herd diversification gives producers wider options and flexibility in sales decision-making (Nur, 2003). Producers with large and diversified herds are more resilient and secure in the event of shocks and disasters. Animals act as a cushion and buffer against crop failures for farmers and a buffer against inflation for all.

It is worth noting that the bulk of Sudanese households keep livestock and maybe one-third to one-half depend on livestock for their livelihoods (IGAD, 2007). "Livestock have a unique and special importance in Sudan as the mainstay of peoples' livelihoods throughout the country" (Young *et al.*, 2013). Based on diversification, Nur (2003) identified nine groups of herders. Five of them keep multiple herds, while four have one type of herd only. The most vulnerable are those who keep a single herd type and the most insecure are those who keep one type of small ruminants, especially goats. Multiple herd keepers are more livelihood resilient than single herd keepers. Most livestock keepers however, are transhumance or sedentary farmers who supplement their income with crop farming or wage labour (IGAD, 2007). Income is also obtained by buying, fattening and selling sheep after the rainy season during the Islamic holy days of Eid Aladha (Young *et al,* 2013:36). Casual labour digging shallow wells and watering herds in the dry season is another source of income. "Pastoral systems support at least 500 000 households of primary producers – but most likely several times this figure. The value of subsistence milk alone at the time of the 2008 census was certainly above one billion SDG per year (or 500 million USD)" (Krätli *et al.*, 2013).

The livelihood strategy of the nomads, especially in the attitude towards settlement, is undergoing transformation. In studying the Messeriya pastoralists, Pantuliano *et al.* (2009) Messeriya reported a decrease in the mobility of families, with women and children staying behind in villages and keeping few cows to supplement their income through the sale of milk. She referred to more engagement in farming activities, permanent residence around urban centres, investment in housing and shops, a gradual shift towards keeping sheep, the use of crop residues and oilseed cakes as animal feed and a flourishing trade in agricultural by-products. Furthermore, households with small herds are increasingly becoming poor and many dropped out of pastoralism in favour of cultivation, charcoal making, water vending (donkey–drawn carts) and urban casual labour. (This is especially the case with youths as they lack skills outside the herding sector.) Many are without jobs (half of Messeriya youth are unemployed) and tussle to have a foot in the informal town economy. Theft, eased by the spread of weaponry, is acknowledged as an important source of livelihood (Pantuliano *et al.,* 2009).

1.3.5 Intensive production (or commercial) system

Feed lots: Data on feedlots is lacking. The literature available focuses on feedlot performance in terms of the animals: fattening efficiency, effect of age and castration on fattening performance and the like. Apparently, the feedlot business has not yet attracted the attention of researchers for critical assessment, despite its importance. In many parts of the world, feedlots are an integral part of the animal market value chain.

Based on observation, however, the business has gained momentum in the last two to three decades, especially in big towns and around livestock markets. Feedlot holders, while fattening their flocks, are at the same time offering the feedlots for sale. Sheep and cattle are the main feedlot animals. The business is dominated by smallholders as is apparent from those who sit alongside main streets or in the vicinity of livestock markets offering their animals for sale. The business is not organized and there is no civic body that can spell out the concerns of feedlot holders and coordinate their affairs with relevant institutions.

Dairy production: Despite its large livestock inventory, Sudan has a deficit in milk supply. Annual milk production is estimated to be about 4,963 MT on average. The gap is covered by imports of 32,135 MT[17] annually, at an average value of USD 84.46 million (Table 4.3). Besides being low milk producers, the year around mobility of animals in the search for pasture and water constrain milk collection. Lack of appropriate technologies and transport facilities hinder access to the consumption markets. Poor feeding, traditional husbandry and management practices, as well as lack of breed improvement, aggravate the situation. It is worth noting that the milk yield of dairy cows is governed by genetic ability, feeding program, herd management and health (Bebe *et al.* in Bashir & El Zubeir, 2013).

Unlike subsistence pastoral production, small-scale dairy production in peri-urban areas is commercial. It is increasingly growing to supply town dwellers with fresh milk. It takes two forms: traditional and modern. The former depends largely on local breeds and follows traditional husbandry and management methods. Herds are fed with crop residues as roughage, and grains and oil seed cakes as concentrates. The ration balance is not taken into consideration. Producers use local bulls for breeding and productivity is generally low. The milk is collected in local equipment and sold to consumers either directly on the farm or carried out by donkey carts to where consumers live, depending on how far the farm is. Hygiene measures are lacking. Labour is either household or hired, based on the size of the herd. In some places, instead of being scattered widely, holdings are assembled in certain locations as an organizational measure. Low productivity and marketing, feeding and managerial problems are the major constraints (Bashir & Elzubeir, 2013).

Modern dairy holdings (modern, as opposed to traditional, though not necessarily truly modern) are found in the suburbs of big towns in the irrigated areas. They are mainly concentrated in large consumption centres in Khartoum, Gezira and River Nile states, where green fodder is available. The cows are crossed bred with foreign breeds (Mohammed and Elzubeir, 2015). Though the majority of holders have their own bulls, the use of artificial insemination, which was first introduced in 1976, is rising. Housing pens are mostly built from local materials (Mohammed and Elzubeir, 2015). Animals are fed irrigated fodder as roughage and processed feed as concentrate. It is worth noting that private investment in artificial insemination, feed processing and dairy equipment is rising. Salma & Fadel (2015), in their study on modern dairy holdings in Khartoum State, found that over half of the producers follow traditional methods of animal rearing. Farm workers are hired to do most of the work, especially in milking and herd rearing operations. The milk value chain starts with intermediaries collecting the milk from the dairy holdings. The milk is collected in containers and transported by car to the informal milk market place (*suq* or *dakat ellaben*). From there, the milk is distributed by cars to shops or sold to men with donkeys who in turn sell it to consumers in residential areas. Despite improved milk collection containers, hygiene is generally poor. Producers and distributors are often accused of adding water to milk to increase its volume and adding hazardous substances to overcome spoilage during shipping and delivery in the absence of cold chain technology.

[17] MT stands for metric ton, which is equivalent to 1 000 kilograms.

Very recently, DAL Group Co. Ltd., through its dairy branch, entered the market buying milk from dairy producers in Khartoum State. The company collects the milk, pasteurizes and bottles it and distributes it to consumers. It adopts very strict measures, using a series of modern techniques, to guarantee the hygiene, safety and quality of the milk. This will no doubt raise the hygiene awareness of the dairy producers over time. Dairy producers often complain of the low prices offered by intermediaries and the small gross margin they earn relative to the high prices of inputs. The three major aspects that worry dairy producers are the high cost of feeding, the prices of medicines, and deficient new technologies. The lack of extension services, poor veterinary care and water supply shortages exacerbate the situation (Salma & Fadel Elseed, 2012). Training of both producers and dairy workers is recommended to build awareness regarding pen design, husbandry system, herd management, biosecurity and health care measures (Mohammed and Elzubeir, 2015). The civic body that represents the concerns of dairy producers is the Chamber of Dairy Producers, which is an affiliate of the Businessmen Trade Union.

Table 1.6 **Livestock products (in MT*) (2010-2014)**

Tem	2010	2011	2012	2013	2014	Average
Beef	1 859	1 427	1 456	1 466	1 476	1 537
Milk	7 471	4 274	4 318	4 359	4 391	4 963
Eggs	35	40	45	55	60	47
Chicken	30	38	40	45	50	41
Hides and skins (pieces)	77.6	52	53	53.5	53.8	58

Source: Information Center, MLFR, Khartoum.

Table 1.7 **Quantities (MT thousand) and value of dairy imports (USD million) (2010–14)**

Year	MT thousand	USD million
2010	42.3	102.7
2011	35.1	89.6
2012	34.4	89.8
2013	31.227	82.104
2014	17.69	58.15
Average	32.135	84.458

Source : Bank of Sudan Annual Reports

Poultry provide consumers with two products: eggs and meat. Consumption and demand for poultry products are growing on the domestic market, but the smallness of the sector and, thus, the high prices, hamper accessibility. Poultry keeping however is a real support to small-scale households and poor families and a means for poverty reduction. Two poultry production systems can be identified: traditional and modern.

Traditional poultry production is the most prevalent poultry keeping system in Sudan and is basically a subsistence level of production. In this system, indigenous birds scavenge to

feed themselves. This low input, local, free-range system of production is widespread among resource limited rural communities. The traditional holders prefer local breeds over cross-bred breeds (Ali, Bakheet and Elnazeir, 2011). Despite the lack of veterinary care, extension services, training, marketing and financial and institutional support (Malik, Elzubeir and Salih, 2015 and Khalifa and Hass, n.d.), the system is operating and provides households, and especially women, with an important source of food and cash income (Lastshaw and Musharaf, n.d). In a survey on village poultry production in Sudan in 1999, Khalifa and Hass (n.d.) reported that average flock size was approximately 19 birds per household. All gender classes and all members of the household engage in managing the flocks, but women are primarily responsible for production and marketing, selling primarily to consumers in towns and, in a few cases, to traders. The results of the survey identified poor health services, little production, improper housing and limited knowledge of poultry husbandry as major constraints.

Modern poultry production is a commercial farming system comprising three distinct systems: open; semi-closed and closed (Sirdar, n.d, and Sharabeen in Emam and Hasan, 2011). The closed system focuses on egg and broiler production, whereas the open system concentrates on egg production (Elsiddeg, 1998). Smallholders engage in open system production, with flock size ranging between 50 and 500 birds (Lastshaw and Musharaf, n.d). Smallholder farms make up 96 percent of the total poultry farms in Khartoum State (Ministry of Agriculture, Khartoum State, in Emam and Hassan, 2011). Factors limiting the maximization of small-scale production include infectious diseases and inadequate management techniques (IAEA, 2006). In the last quarter of 2005 and the first quarter of 2006, small-scale production was hard hit by avian influenza. Because of the severe losses incurred, many producers went out of business altogether and never returned to the business as they were burdened with loan repayment. The industry suffers from high costs of local inputs and dependency on imported inputs (fertile eggs, one-day-old chicks and super concentrates).

Emam and Hassan (2011) noted that the most costly input in the open system of poultry meat production is the feed (see also Elsiddeg, 1998) which represents approximately 59, 60 and 62 percent of total costs in small, medium and large-scale holdings, respectively. Mortality of the one-day-old chicks, purchase of vaccines and medicines and labour constitute the largest portion of the cost of production. The highest profit margin is achieved by large-scale holdings, while the lowest is generated by smallholders, which is an indication of the efficiency of large-scale farms (Elsiddeg, 1998).

Khartoum State produces almost 90 percent of Sudan's poultry (Sirdar, n.d.). In Khartoum, giant producers are taking over the poultry market, pushing smallholders out of business (El-Obeid & Lundström, 2012). Delgado (in El-Obeid and Lundström, 2012) identified four means for establishing a functioning market that would appeal to smallholders: access to land or financial assets, nonstop flow of information on market outlook and spot prices, access to services, functioning infrastructure and remunerative markets. To withstand the surge of giant producers and get a foot in the poultry market, small producers must join to form bigger groups, such as cooperatives. Small-scale producers currently have limited bargaining power with the government and large-scale producers, especially with the larger

concessions offered to giant holders through the Investment Encouragement Act. Cooperatives are likely to strengthen small-scale producers enhancing their bargaining position although cooperatives had been poorly managed and government's lenient financing practises created moral hazards[18]. (Sethboonsarng in El-Obeid and Lundström, 2012). It is worth noting that the poultry producers are organized under the umbrella of the Poultry Chamber, a civic body that takes their concerns to relevant institutions and coordinates with them.

1.3.6 Contribution to the national economy

Livestock have domestic, economic, social and political uses (Ahmed, 2014). The importance of livestock however, can be gauged at the household–community and national levels.

Household and community levels: Livestock contribute notably to securing livelihoods at the local level. They are an essential source of protein. About 41 kg of meat and 26 kg of milk (or dairy products) are available per capita for domestic consumption, and families spend about 18 percent of their total food budget on livestock products (Behnke and Osma, 201). Livestock serve as a source of income for households and local communities. They provide work for family members and jobs for local individuals. They serve as the backbone of the rural economy (Badri and others in Nur, 2003) and provide finance to traditional crop farmers where official credit is inaccessible. They are living capital, a method of storing wealth against inflation, a buffer against crop failure, a cushion in case of calamities and a safety net for social stability (risk management). They are means of social solidarity (dowry, blood money (*diyya)*, and religious taxes (*zakat*) support for poor relatives and clans, etc.) and a means of access to power and authority (Ahmed, 2014). They provide inputs for traditional leather and handicraft works with the objective of contributing to poverty reduction and social stability. They are a means of transport in rural and town areas. Behnke and Osma (2012) estimated the value transport services provided by livestock to their owners at equivalent to SDG 8.409 billion, which is missed in GDP calculation. Livestock provide traction power in small-scale crop farming and manure for soil fertility, organic farming and enriching grassland nutrients. Livestock serve as a vehicle for empowering women through small ruminant and poultry production as well as the production of milk and milk products. Livestock also contribute to youth employment, via sheep fattening, cash or in-kind payment for herding, cart transport, etc. Furthermore, livestock are central to tribal identities and beliefs (IGAD, 2007).

National level: Livestock are vital to the national economy. The profile and importance of livestock ascended domestically after the decline of oil revenues as the livestock subsector was viewed as a source for generating extra revenues (Yong *et al.,* 2013). Livestock production continues to contribute approximately 20 percent of overall GDP and over 50 percent of the agriculture sector's contribution to GDP. Livestock production generated over 60 percent of agriculture value added during the period 2011–2014, and is a significantly more important contributor to the agriculture sector's share of GDP than crop farming. Production of dung

[18] Moral hazard is defined as a party's actions to maximize its benefits from a contract agreement in aspects that other party is not fully aware of (Holmstrom, 1979). This can lead to inappropriate political activities and financial problems (Delgado, in El-Obeid and Lundström, 2012).

for fuel, animal traction in agriculture, draft power for transport and financial services such as savings, investment, credit, insurance and risk pooling amongst pastoralists are presently overlooked in GDP calculation (Behnke in Krätli, (2013):30).

In terms of amounts, livestock's contribution jumped from SDG 69.5 billion (approximately USD15.4 billion) in 2013 to SDG 90.2 billion (approximately US$ 18 billion) in 2014, which are significant amounts of money. The value added generated by the livestock subsector is the largest of all other subsectors in the Sudan's domestic economy, larger even than the petroleum subsector. As noted by Krätli (2013), "overall, primary production is largely invisible except with regard to exports. There are no official systematic data on the size of the livestock domestic market."

Livestock contribute remarkably to national food security. The country is self-sufficient in meat, poultry and eggs and produces a sizeable amount of fresh milk and dairy products. Livestock supply the domestic market with sufficient quantities of hides and skins for the leather industry and handicrafts, and for export. The sector provides employment to 40 percent of the population (Robinson, Abdalla in Nur, 2013). A wide spectrum of the population makes a living from permanent jobs and casual labour in different livestock activities such as herding, dairy, poultry rearing, various market chains, processing industries, transportation and transport services, animal feed and feeding, watering, traction power, etc. It is also to be noted that livestock utilize domestic resources that could otherwise be idle to produce useful and valuable products.

Table 1.8 **Contribution of subsectors of the agriculture to GDP**

(%)Year	Irrigated	Rainfed	Traditional	Forestry & others	Livestock	Total
2002-2010 (average)	11.1	1.3	5.5	2.3	18.7	37.4
2013	13.0	0.4	1.9	1.5	20.3	33.8
2014	12.1	0.4	2.4	1.5	18.9	31.5

Sources: Compiled and calculated from the annual reports of the Bank of Sudan.

Foreign trade: Livestock export earnings jumped fourfold, from an average of USD 163.8 million for 2002–2011 to USD 856.4 million in 2014. Contribution to agriculture returns climbed from 37.1 percent to 56.3 percent for the same period. Average livestock returns rocketed from 2.4 percent of the country's total foreign earnings for the period 2002–2011 to approximately 25 percent in 2014. For non-oil returns, the average contribution of livestock ascended from 18 percent in 2002–2011 to approximately 28 percent in 2014 and its contribution to agricultural proceeds went up from an average of 37.1 percent for 2002–2011 to 56.3 percent in 2014. The main livestock exports are live sheep, camels and red meat, in addition to hides and skins. The value of the livestock export market for 2009, though appreciable, was still only about 2 percent of the value of the domestic market (Krätli, 2013).

Table 1.9 **Contribution of different types of stock to foreign proceeds (2010-2014) (in USD'000')**

Item	2010	2011	2012	2013	2014	Average	Percent
Sheep	115.0	241.5	285.6	477.5	549.8	333.88	66.4
Goats	5.2	8.4	9.1	10.7	22.3	11.14	2.2
Cattle	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Camels	12.6	39.0	62.2	98.4	207.9	84.02	16.7
Meat	43.5	7	38.1	15.5	19.8	24.78	5.0
Hides &skins	14.0	39.6	37.0	72.6	43.5	41.34	8.2
Other livestock	2.6	0.3	14.6	7.4	13.0	7.58	1.5
Total	192.9	335.8	446.6	682.1	856.3	502.74	100

Source: Compiled and calculated from the annual reports of the Bank of Sudan

The export business is a private sector domain and is characterized by fluctuations ascribed to the inefficiency of Sudan's marketing system (poor market infrastructure, poor management and organization, high market margins, lack of information and transparency, etc.). The sector is also affected by the volatility of export policies, the appreciation of the Sudanese currency, civil unrest in major production areas, financing problems and other issues.

Table 1.10 **Livestock exports in comparison with total exports, non-oil exports and agricultural export earnings (USD million) during 2010-2014**

Item	2002-2011 (average)	2012	2013	2014
Total exports	6 826.5	4 066.5	4 789.7	3 450.5
Non-oil exports	896.7	3 810.4	3 073.1	3 096.1
Total agric. exports (crop + livestock)	435.4	776.8	1 544.9	1 519.8
Livestock exports	163.8	446.6	682.1	856.4
% livestock to total exports	2.4	11.2	14.2	24.8
% livestock to non-oil exports	18	15	22.2	27.7
% livestock to agriculture exports	37.1	57.5	44.2	56.3

Source: Compiled and calculated from annual reports of the Bank of Sudan.

Table 1.11 **Sudan livestock exports (heads) (2010-2014)**

Item	2010	2011	2012	2013	2014	Aver.
Sheep	1 813 926	2 729 134	3 415 739	3 757 363	4 539 955	3 251 233
Goats	120 693	162 149	162 116	197 958	318 783	192 340
Cattle	5 130	21 056	26 145	11 202	19 558	16 618
Camels	172 196	151 208	166 240	1 297 647	152 096	154 277
Meat (MT)	5 123.1	3 596.1	6 918.9	2 560.4	3 683.1	4 561.5
Hides &skins (piece)	3 300 035	4 323 981	3 858 836	10 348 238	10 836 244	6 533467

Source: Compiled and calculated from the annual report of the Bank of Sudan.

1.3.7 Challenges and constraints to animal production

The pressure on livestock production systems is mounting due to the rapid growth of the population, increasing urbanization and expansion in crop production. Livestock production and productivity face a variety of challenges and constraints.

Feed and grazing: The most serious challenge facing the subsector is that of satisfying feed requirements. As mentioned earlier, livestock production is largely dependent on annual forage available from rangelands, which are subject to seasonal rainfall variations (in quantity, timing and distribution). There are also significant variations in the quantity of rainfalls between agricultural zones (semi-desert, low and high rainfall savannahs). Water supply, on the other hand, is another serious problem, particularly in the dry season. There are no reliable estimates of the forage currently available to livestock in Sudan. However, based on observation, there is stocking pressure due to the contraction of rangelands, land degradation, environmental decay and other factors. Thus the current levels of feed production (low/insufficient protein and energy supplies) will constrain the level of output in the subsector. Maintaining the current level of animal production in itself is challenging and may not be sustainable in the long run.

The demand for grains as an essential component of poultry and dairy feed is growing due to the expansion of dairy production and the intensification of poultry farming. This collides with human requirements as grains are the staple food for the majority of the population. The situation will further be aggravated with the decline and/or variability of national grain production. Animal health is another technical constraint as diseases sharply reduce the productivity of livestock. Epidemic infectious diseases like rinderpest (under control now), peste des petits ruminants, contagious bovine pleuropneumonia, contagious caprine pleuropneumonia, and others result in considerable mortality, impede production and cause serious economic losses. Luckily, most vaccines of commercial importance have been developed locally. Parasitic diseases, particularly those transmitted by ticks and other insect vectors, such as trypanosomiasis, theileriosis, babesiosis and Rift Valley fever, in addition to internal parasites, have wide geographical distribution and are influenced by environmental conditions, nutritional status, animal genotype and management practices. Many resources are allocated for the purchase of drugs to control parasitic disease, as no effective vaccines have yet been developed. The use of pesticides to control vectors is expensive. The situation is compounded further by limited surveillance and diagnostic capacities and functional veterinary services. The strengthening of animal health delivery systems remains crucial to the success of efforts to overcome production constraints.

Breed development: Animal genotype is another technical impediment hindering livestock production. Poor animal genotypes limit productivity. Nevertheless, most animals are optimum producers under their prevailing environment and feed conditions. Low genetic potential would be a critical issue under good feeding, management and health care conditions. Genetic resources that resist and tolerate diseases and pests and are adaptable to harsh climates and feed shortage should be looked at as merits rather than drawbacks to the livestock production systems in arid and semi-arid environments.

The traditional livestock management systems: Traditional livestock management systems are also constraining livestock production. Little assistance is provided for the producers and pastoralists to develop management practices and adapt them to the evolving production conditions. Research and extension services in support of production options, technology, inputs and marketing are non-existent.

Competition over land use: A major policy constraint is that of land use rights. Traditional land use systems that accommodated different land uses in the past (cropping, grazing and others) have broken down due to population pressure. New systems for balancing the different land uses in a flexible manner are far from being realized. The viability of livestock production is threatened by the expansion of crop farming that reduces rangelands, as explain earlier. Livestock will continue to move as long as the movement is dictated by the availability of forage and water and by climatic conditions. Expansion of crop farming in many places has blocked seasonal migration corridors, leading to rising tension and conflict between crop farmers and herders, with some loss of life. The customary belief that the right to use land is gained by cultivating the land but not by grazing, and that only what is left over from crop farming is for herding, needs prompt and serious reconsideration if pastoral production is to be sustained. Competition between crop farmers and pastoral herders for the utilization of land resources is associated with the risks of sliding into armed conflict, especially in the widespread presence of illegal weapons in the hands of different community groups. Official efforts to legalize herders' grazing rights and demarcate traditional seasonal migratory routes collide with the weak will of the administrative and political apparatus and pledges to guarantee grazing rights remain highly vocal and on paper only. Competition over grazing rights is escalating even among pastoral herders themselves and often ends in bloody armed conflict.

Price incentives: Price incentives are less favourable to the livestock subsector than to the crop subsector. Grains and sugar cane molasses are diverted away from animal feed to biofuel production, a constraint to animal production. Exportation of oil seed cakes is another aspect that puts upward pressure on the domestic prices of these cakes. The limited availability of foreign exchange restricts veterinary imports, feed additives and other essential inputs for the livestock subsector.

Regulatory framework: Excessive regulations is another policy issue constraining livestock production and creating an unfavourable environment for production. Multiple and non-harmonized taxes and charges and too many checkpoints (official and illegal) along the highways create trade barriers, interrupt the smooth flow of livestock to the markets, increase transport costs, reduce profit margins, raise consumer prices and act as disincentives for traders.

Research and extension services: Institutional constraints also create hurdles for livestock production. Research is not generating sufficient problem-solving technologies to fuel livestock systems, particularly for the production side. Extension units and institutions are ineffective in shaping producers' vision with regard to manipulating the resources at their disposal to produce efficiently, economically and sustainably for the market. Research and extension systems are ineffective in developing new knowledge and technology due to their low levels of capacity, inexperienced personnel, poor research output, poor budgetary allocation and low levels of investment for generating appropriate innovations for adding value.

The limited understanding of the role of extension services in orienting herders' production capacities towards the market as an ultimate goal still persists. Lucrative markets can only accept products that meet the standards of safety, quality, convenience and competitive price over and above animal welfare. Significant investments in agricultural and livestock research and extension are needed to raise yield, improve product quality, guarantee product safety and raise the awareness of the producers. Inputs, technologies, information and instruction in good management and husbandry practices must be provided to producers and pastoralists in a timely and systematic manner. Giving little importance to extension services among the priorities of the livestock sector is indicative of short-sightedness and poor understanding of the importance of the extension message and the impact that it can have on producers. A common mistake is the isolation of producers from their tools and means of production (focusing on animals and neglecting producers). Producers are the ones who should be addressed if change is to be induced and felt.

Animal health services: Animal health services are another institutional constraint to livestock production. Official veterinary services are crippled by the inadequacy of disease surveillance, vaccine supply, control of epidemics and limited diagnostic and curative measures, among others. Privatization of veterinary services should be seriously considered and speeded up with effective government monitoring mechanisms and close follow-up measures. Necessary regulations should be in place to organize and facilitate workable and effective animal health delivery systems.

Producer organizations: Producer organizations are also important for promoting livestock production. Although they officially exist, their efforts to raise the demands of those whom they represent are not felt. Additionally, pastoralists and livestock producer's organizations are extremely week compared with crop farmers associations.

Political constraints also hamper livestock production and make the environment difficult for production. Historically, the northern border zone of Southern Sudan State is the retreat grazing area during the dry season (8 to 9 months of the year) for the vast majority of pastoralists throughout the area extending east–west from southern Blue Nile to Southern Darfur. Despite the cessation of South Sudan, peace between the two states is fragile and tension over the borders dominates the scene. Pastoralists have been the victims of the lack of peace. Another constraint is the Abyei deadlock between the two Sudanese states, which has greatly hampered the Messeriya herders from accessing their traditional dry season grazing land and water sources.

Production flourishes under a secure environment. Most dry season grazing, as mentioned earlier, is found in the high rainfall savannah belt (Latitude 12–10°N) which runs from Ethiopia in the east to Central African Republic in the west. This area has witnessed years of armed conflict that lead to insecurity in the area. Darfur conflict, which started in 2003 reduced livestock sales and forced population movement to urban cities. Livestock looting is very common in conflict areas, both on the part of the factions fighting the government and herders themselves and outlaws who exploit the situation. The insecure environment is a limiting factor to increasing production.

Climate change: Climate change also impedes livestock production. It causes weather hazards (drought, storms, floods, high temperatures, cold waves, rainfall variation, etc.), with the resultant desertification, soil erosion and degradation and severe changes in ecosystems and biodiversity. The high rise in temperature and humidity reduces livestock appetite, causes water stress and depresses yields. The shortfalls of Indigenous Technical Knowledge (ITK) with regard to predicting variability in rainfall patterns threaten animal keeping as herders depend on their own knowledge to forecast precipitation times and design breeding plans to coincide with early pasture availability. Drought resulting from climate change severely affects livestock due to grazing and water shortages, causing mass deaths and depletion of productive assets. Floods, which are highly unpredictable, cause great losses in productive assets and create favourable environments for vector build-up and disease outbreaks.

Outmigration is another constraint that has far-reaching implications on livestock production. The pastoral sector is witnessing growing labour outmigration (to urban and gold mining centres) as well as emigration to Libya and Saudi Arabia.

Access to capital, finance, rural credit and micro finance: Livestock producers in general, let alone smallholders, have no access to capital, finance or rural credit. All livestock producers start up their herds from their own resources. They usually build their herds from income generated from crop farming, herding labour (paid in cash or in-kind), off-farm activities, remittances or by income earned abroad.

Access to road networks, rural roads: Sudan's road network is generally limited. Paved roads extend only between major centres. Feeder roads linking rural areas to the main paved roads are lacking. A road network is vital for realizing opportunities, reducing transport costs and shortening the time it takes livestock producers to reach the market, particularly for perishable goods like milk. Only sedentary and agro-pastoralists living near road networks have access to these roads.

Marketing and markets infrastructure: Livestock markets are the property of the local authorities. The exceptions are the eleven markets[19] constructed by the defunct LMMC in the 1980s, now owned by ARSCO (an affiliate of ARB), the six markets[20] recently built by the ILPM project (2007–2012), and, very recently, two new markets.[21] The majority of the livestock markets are simply open space (Ismail, 2014). They lack a favourable marketing environment in the way of market infrastructure (operational holding grounds, auction yards and reliable veterinary services), reliable market information and intelligence (informal and formal communication systems and standard grades and weights) and a favourable institutional environment (government policies, regulations and supporting legislation). The markets focus mainly on revenue generation rather than market development.

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[19] Elsalam, Emowelih (Omdurman-Khartoum), Wad-medani (Geziera State), Sinnar (Sinnar State) Rabak and Kosti (White Nile State), Elobeid (North Kordofan State), Kadguli (South Kordofan State), Nyala (South Darfur State), Elddeain (East Darfur State), Elfashir and Milliet (North Darfur State).

[20] Damazin (Blue Nile state), Singah (Sinnar State), Tendelti (White Nile State), Elkhiweiy Ennihood and Gibaish (West Kordofan State).

[21] Elkomah of North Darfur and Umandarabah of North Kordofan

Livestock markets are characterized by seasonal supply, with shortages from April to July and abundant supplies from October through February). The marketing processes, whether domestic or for export, are organized and financed by the private sector and lack transparency. Prices, instead of being determined through open competition (auctioning), are privately negotiated between sellers and buyers through market intermediaries who are often blamed for soaring prices. Market circumstances are influenced by dealers, local authorities and animal industry groups as there is little standardization of unit costs, rates and the basis on which they are determined (Mina and Pellekaan, 2010).

Marketing begins at the individual or household level. Access to market prices is through mobile phone communication wherever there is network coverage. Families whose main livelihood is livestock or who depend entirely on livestock rearing (el Dirani, Jabbar and Babiker, 2009) are active in livestock markets. The selling season for the sheep herders is between February and August and the best-selling age is two years old (Elrasheed, Faki and ElObeid, 2010). Selling before the Hajj season is also favourable (Awad *et al.*, 2013).

The purchases are made directly from the producers at the camp sites or from the primary, secondary or terminal markets. Primary markets are location throughout production areas, whilst secondary markets are located in urban centres. The terminal markets are based in El Obeid (North Kordofan), Gedaref, Kassala and Omdurman (Khartoum State), where export facilities are based. Omdurman is the hub of livestock marketing in Sudan. "Livestock reach the terminal markets through informal networks of brokers, agents, sub-agents and local traders, from production areas 200–1,200 kilometres away. Animals change hands up to six times" (Krätli, 2013). With each exchange, the intermediary adds a premium, thus pushing prices up. The marketing channels are very long and the margins of the intermediaries are almost equivalent to those of producers[22] (Elrasheed, Faki and ElObeid, 2010 and Awad *et al.*, 2013).

Initially, animals are collected in small quantities by bush or small traders (galajah) either from camp sites or from villages or small urban centres to be offered to the nearest primary or secondary market, depending on the site where the purchase originated. Livestock production is spread over a wide area but animals are mainly purchased from Kordofan, Darfur, White Nile, Blue Nile, Gedaref, and Kassala states, and trekked or shipped by trucks to the terminal markets and/or consumption areas. Though truck transport is faster, producers prefer trekking as animals can graze while en-route and increase their weight. Truck transport is resorted to in cases of short delivery times or other commitments or when animals are young (Elrasheed, Faki, ElObeid, 2010). Animal purchases can also be channelled directly from the rangelands and primary or secondary markets to the quarantine chain and/or slaughter facilities for domestic or export markets. Multiple taxes, fluctuating prices, poor market infrastructure and facilities and illegal road taxes are constraining the marketing process (el Dairani, Jabbar and Idris, 2009).

The domestic demand for meat is growing, especially in high population areas of central Sudan due to population growth, urbanization, drift to towns, internal displacement and

[22] Costs items of sheep producers are drinking water, salt, labour, animal feed, veterinary care and medicines, fines paid to individuals, flour, taxes and zakat. Zakat is an Islamic tax.

income improvement. Regional demand is also growing, especially in oil-rich Arab states and other Middle Eastern countries where Muslim communities seek *halal* meat. On the other hand, supply is greatly constrained by the traditional method of production, migratory patterns, bouts of drought, civil unrest and the socio-cultural behaviour of the producers. To overcome the seasonality of livestock supply, large traders often resort to bigger purchases during times of plenty and keep the livestock in feedlots (*dikak*), feeding them crop residues, grains, oil seed cakes and molasses till the months of scarcity. This practice should be critically assessed as once animals reach full body weight, they do not add more weight no matter what they are fed (genetic limits). Feeding beyond body gain limits is a waste of resources.

Sheep meat is in high demand on the national market among the high income groups (especially in urban areas), whilst demand for beef is growing in the middle income strata. The rural and poor segments of the population generally prefer goat meat. Camel meat is in low demand domestically. The competition between the domestic and export markets is apparently high for sheep meat, resulting in soaring prices. It is worth noting that the producers' share as a percentage of the export value is 72 percent for sheep and 48 percent for cattle (Behnke, 2012).

Use of livestock inputs: Due to the increasing value of animals, producers are becoming increasingly keen to protect their animals from diseases, either through vaccination or medical treatment. Most herders have their own stock of drugs which they carry with them while moving. Smallholders have limited capacity to obtain drugs and build up a stock of drugs. However, drug distribution is spreading throughout all markets where veterinary stores are based. Biological products are restricted to official authorities.

Animal breeding and genetic improvement is lacking outside intensive production systems (dairy and poultry). However, producers improve their herds using high-performance local breeds. Following the 1984 drought, when most herders lost almost all their flocks, some producers of North Kordofan replenished their flocks with the more drought-tolerant and highly prolific *garage* sheep type of south Kordofan crossing them with the *hamari* breed of the northern desert, producing what is known in the market as *shorani*. This is simply a mitigation strategy in case of future droughts. The Messeriya and Rizaigat cross their small size breeds (*grage* and *abugabba-umbararow*) with the big *hamari* breed, producing a cross-breed known locally among Rizaigat herders as *banat serariy*, which has the tolerance of the *grage* and *abugabba* and the meat characteristics of the hamari which is preferred for the export market (Yong , 2013). This is simply a market strategy.

Social conditions and basic services: The social conditions of pastoral producers are very poor and basic services are insufficient, if not lacking entirely. Access to safe and clean water is limited and sanitation services are nearly absent. Water supply is mostly surface water shared between herders and their animals. School enrolment is very limited (Young *et al.*, 2013: 35) and health care coverage is generally limited in rural areas and when present it is of poor quality and under-resourced. As pastoralist producers are mobile, their access to these services is even more limited than that of settled groups (Egis Bceom, 2011). "The national policy focus tends to be on livestock, not pastoralists nor the pastoralist system of production" (Egemi in Young *et al.*, 2013).

1.3.8 Policy, institutional and regulatory frameworks

Government support is mainly concerned with animal health issues, especially major diseases that impede export trade, have regional and international dimensions and receive support from international bodies. Endemic diseases that affect small-scale production are overlooked in public strategy, policies, programs or projects. Very recently, practical steps were taken to produce a vaccine for goat pneumonia, which producers have been calling for since late the 1980s. Each year, the infection kills large numbers of goats, the animal raised by most small and poor producers. The situation is the same for botulism in sheep. Botulism is found in decayed or rotten matter ingested by sheep, causing intoxication and killing a considerable number of animals. Animals owned by smallholders are less resilient to effects of the disease and households often lose a significant portion of their small flocks. Very recently, steps were undertaken to develop a biological product to control Botulism. Newcastle disease in poultry kills large numbers of domestic fowl as small and poor producers have no access to the vaccine and no extension program exists for awareness building to avoid or control the infection.

1.4 Semi-mechanized rainfed farming

1.4.1 Overview

As indicated earlier, rainfed crop production is carried out by traditional small-scale farmers (as discussed in Chapter three), small-scale semi-mechanized farmers and large-scale semi-mechanized farmers. Small-scale semi-mechanized farmers, who lie between traditional and small-scale semi-mechanized farmers, are related to both. They are an outgrowth of rainfed traditional farming and they normally cluster around semi-mechanized large-scale farms, taking advantage of the facilities available to them. Thus, they share some of the characteristics of the two groups and face several of the same challenges and constraints.

Small-scale semi-mechanized farms are spread over a large area of the clay plains in the rainfall savannah belt, extending from the Butana plains in the east to Southern Kordofan in central Sudan. This area covers parts of the states of Gedaref, Blue Nile, Sinnar, White Nile, and South Kordofan. Though the total number of people involved in this subsector is not known, it is not insignificant and is increasing. In Gedaref State alone, small-scale producers in this subsector are estimated to be more than 154,000, of whom 60 percent are women. They own 2.2 million feddans of land, about 40 percent of the total cultivated area under rainfed production in the Gedaref State. In South Kordofan State, small-scale semi-mechanized farming was introduced through a project covering farmers in the Nuba Mountains.

1.4.2 Mechanization in Sudan's rainfed agriculture

As mentioned earlier, traditional agriculture is based on the use of locally-made hand tools. Manual cultivation is difficult in the heavy black cracking soil. Mechanization offers opportunity for substituting labour.

The introduction of farm machinery began in Sudan's rainfed agriculture sector in the mid-1940s. It began with the use of a wide level disc as a tillage implement, drawn by a tractor of medium power (50–75 horsepower). This meant that of the four main agricultural operations (land preparation, seeding, weeding and harvesting) mechanical power was applied to the first two[23]. The two other agricultural operations were to be undertaken by manual labour. The combine harvester used to harvest sorghum in many of the large-scale semi-mechanized farms is not commonly used by small-scale producers.

The most important implication of the introduction of mechanization is that it enabled farm size to increase. Consequently, this attracted considerable investment and led to the expansion of the sector. This began in 1944 when the colonial government, concerned about food supplies during the Second World War, established the "Mechanized Crop Production Scheme" on an area of 12,000 feddans in the northwest of Gedaref. The intention then was to adopt full mechanization for the production of sorghum. However, since that was found to be technically unfeasible, the government introduced a sharecropping arrangement with farmers, allotting 28 feddans to each farmer. The farmer was to perform weeding and harvesting activities while the government undertook land preparation and seeding. The harvested crop would then be divided equally between the farmers and the government. The experiment was not successful due to the high cost of production, unfavourable soil conditions and rainfall and the inadequacy of the marketing infrastructure. The committee that evaluated the experiment, recommended, among other things, that an economic study be undertaken to determine the prerequisites for the long term viability of one-tractor farm units. Furthermore, the committee recommended that the farms be privately owned. These recommendations influenced the late development of the subsector.

The lack of a state-run tenancy system led to private investment in farms. The Agricultural Bank was created to provide credit for land clearing. Earlier trials proved that the appropriate size of the farm (scheme) was about 1 000 feddans. The production arrangement is based on hiring wage labourers to do the necessary seasonal, manual work. As mentioned before, this has created job opportunities for the rural population allowing them to receive extra incomes. These large size farms of 1 000 feddans are leased to private investors through the local land allotment boards. In principle, no investor is allowed to lease more than one farm and the local population is to be allotted 60 percent of the land in their respective regions. Investment costs included land clearing and buying farm machinery. Farm machinery is financed either by the Agricultural Bank or by the investors themselves or is purchased on credit from farm machinery distributors. Credit for running expenses and advanced expenditure is also provided by the commercial banks. Farmers use tractor-drawn equipment for land preparation and planting and labourers are hired for weeding and seeding.[24] The private investors are

[23] In one report: "the machinery being used makes the machinery sowing of large areas feasible in a production environment where about all subsequent operations have to be done manually under conditions of labour supply shortages."

[24] Mechanization in harvesting was introduced later.

normally traders or ex-government officials. They often hire managers who oversee farming and harvesting. Since these investors are not directly in charge of the farms, they are described as "absentee entrepreneurs" and their farming business as "suitcase" farming.

Only a few crops had been found suitable for cultivation in the cracking clay area. Sorghum had been the principal one, and during the early 1980s it was planted on an average of about 80 percent of the sown area. Sesame and short-fibre cotton were also grown successfully, but in smaller quantities. Sesame was grown on about 15 percent of the land. Cotton was grown by the Nuba Mountains Corporation, by small-scale farmers and in large schemes in South Kordofan, on a total area of 402,000 feddans.

At a late stage, the government invested in semi-mechanized farming directly or leased larger areas of land to private companies. Large-scale farms were established, such as those of the Ed Damazin Agricultural and Animal Production Company (638 000 feddans), the Goz Rom (20 000 feddans), Agedi (20 000 feddans), Algeri (20 000 feddans), El Berer (12 000 feddans) and Southern Fung (12 000 feddans). The Sudanese Egyptian Integrated Agriculture Company (150 000 feddans) was also established as a partnership between the Sudanese government and the Egyptian government.

Despite all the expansion in small-scale semi-mechanized rainfed agriculture, its contribution to agriculture value added did not surpass an average of one percent during 2013–2014. Production also fluctuated from one year to another. In 2014, the area used for growing sorghum, sesame, millet and sunflowers was about 6.248 million feddans. The area used for sorghum cultivation increased from 6.083 million feddans in 2009 to 9.199 million in 2011, before dropping to 4.482 million in 2012. Production of sorghum also fell from 1.076 million tons to only 0.591 million tons in 2012. The area used for growing millet also rose from 404 000 feddans in 2009 to 624 000 feddans in 2011, before falling to 475 000 feddans in 2012. Production of millet also jumped from 54 000 tons in 2009 to 111 000 tons in 2011, before falling to 59 000 tons in 2012. The land area for sesame production declined during the period 2009–12, as the crop area in the 2011–12 season is only 82 percent of what it was in the 2008–09 season. Sesame output fell from 184 000 tons in 2008–09 to about 101 000 tons in 2011–12 season. This decrease in sesame production was attributed to a number of factors, the most important of them being rainfall level and, last year, sesame prices.

Table 1.12 **Crop performance in semi-mechanized agriculture (2009-2012)**
(Area in "000" feddans, production in "000" tons, yield in tons/feddan)

Year/crop	2009			2010			2011			2012		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
Sorghum	6 083	1076	0.176	4 618	588	0.127	9 199	1 953	0.221	4 482	591	0.132
Millet	404	54	0.133	242	32	0.132	624	111	0.177	475	59	0.124
Sesame	1 476	183	0.124	1 126	132	0.117	1 551	205	0.131	1 231	101	0.08
Sunflower	658	216	0.327	97	34	0.35	99	37.5	0.379	173	60	0.347

Source: Department of Agriculture Statistics, Ministry of Agriculture.

The low productivity in semi-mechanized rainfed farms is due to mono-cropping and unsustainable land management. The predominance of sorghum production using mechanized cultivation methods presents severe problems. Virtual mono-cropping of sorghum causes a rapid decline in soil fertility and serious infestation of sorghum-associated weeds, especially striga. In addition, it is difficult to prepare the cracking vertisols using a disc harrow. With the exception of sesame, other crops grown in the semi-mechanized subsector have shown poor financial performance during the period 2011-2014. However, such performance could be attributed to both low productivity and low prices.

Table 1.13 **Costs, returns and gross margin of sorghum, sesame and millet, 2011–14, in SDG**

Year/crop	Sorghum		Sesame		Millet	
	2011–12	2013–14	2011–12	2013–14	2011–12	2013–14
Land preparation	35	65.4	35	65.4	35	65.4
Seeds	3.4	14.67	3.4	14.67	3.4	14.67
Labour	60.71	209.63	60.71	209.63	60.71	209.63
Management	2.64	10.32	2.64	10.32	2.64	10.32
Land rent	2.08	4.22	2.08	4.22	2.08	4.22
Tractor	8.94	64.37	8.94	64.37	8.94	64.37
Fuel and oil	20.91	47.28	20.91	47.28	20.91	47.28
Harvesting	2.33	25.34	0	26.23	2.33	41.71
Packing material	16.91	13.02	11.7	5.89	0	7.97
Seed fumigation	0	0.084	0	7.89	0	2.89
Pesticides	0	27.72	0	28.58	0	17.14
Fertilizers	0	8.53	0	10.18	0	0
Transportation	0	10.83	0	9.84	0	13.47
Total cost	152.06	507.9	199.31	606.58	174.59	474.14
Total returns	115.34	271.85	296.89	976.76	148.3	428.25
Gross margin	-36.72	-236.4	97.59	370.20	-26.29	-45.19

Source: Department of Agriculture Statistics, Ministry of Agriculture

Table 1.12 shows that despite its low productivity level, sesame production is profitable. Oil seeds are predominantly produced under rainfed conditions on semi-mechanized farms. Sesame requires careful handling to avoid the seed heads shattering at maturity and hence harvesting is labour-intensive and costly. Large commercial farmers are reluctant to produce sesame due to the shortage of labour force after the secession of South Sudan and the increased interest in gold mining. Approximately 80 percent of sesame production is grown on small fields (about five feddans) with little use of machinery or modern inputs. Sesame yields on mechanized farms over the period 2002–2012 ranged from 96 to 135 kg/fed from 2002–03 to 2012–13. Despite the low yields, sesame production remains profitable with high profit margins for sesame growers in Gedaref. The contribution of sesame exports to total exports increased from 5.5 percent in 2012 to 6.7 percent in 2013 (from USD 223.5 million to USD 472.4 million).

1.4.3 Farming pattern of small-scale semi-mechanized farms

While there are different types and different sizes of semi-mechanized farms, small producers in the semi-mechanized farming sector are also diverse in terms of landholding size (varying from five feddans to 50 feddans, depending on access to land), finance and markets. Small-scale investors encroached on land that was not demarcated and established unlicensed semi-mechanized farms. A significant number of the farmers finance the clearing of their land themselves or use family labour to clear the land. In doing so, they generate income from the production of charcoal or fuel wood.

Though the crops found suitable for cultivation in the ecological conditions of the clay plains are sorghum, sesame, short-staple cotton, sunflowers and guar, small-scale farmers generally grow sorghum and sesame. These crops are fed by rains falling between June and September. Land preparation takes place after the growth of weeds following the early rains in late August or early September. The small-scale farmers hire tractors with wide level discs, normally from large-scale farmers. The land is weeded twice, the second time at the time of sowing. After the crops emerge, the farm is weeded manually once or twice depending on the amount of weeds and the availability of labour.

Large families depend on family labour more than on expensive wage labourers. Family labour covers 25 percent of total labour needs in Sinnar State and about 95 percent in South Kordofan State. However, small producers and members of their households work as farm and non-farm labour to increase their incomes and cover a greater portion of their livelihood expenditure. About 35 percent of the small producers obtain income from sale of their own crops and 20 percent obtain income from sale of animals and by–products, while 45 percent depend on wages obtained from non-farm labour.

Some of the small producers have started to adopt newly introduced technologies. Almost more than half of the small producers in the semi-mechanized farming system (55 percent) use improved seeds to grow crops. About 90 percent of the small producers use agricultural machinery and implements in land preparation (ploughing, harrowing and levelling), while only 50 percent use machinery for sowing purposes. Only few of small farmers (about 30 percent) apply fertilizers and herbicides in their fields. The use of harvesters ranges between 5 percent among small producers in South Kordofan State and 90 percent in Sinnar State.

Table 1.14 **Characteristics of small-scale producers in semi-mechanized system in selected states of Sudan**

Item	White Nile State	Sinnar state	South Kordofan State
Land size (feddans)	250-500	5-20	1-10
Crops	Sorghum-millet-sesame	Sorghum-millet-sesame	Sorghum-millet-groundnuts-sesame-lubia
Ridge surface ploughing (% of area)	99%	95%	85%
Mechanized		5%	50%

Item	White Nile State	Sinnar state	South Kordofan State
Manual		95%	50%
Fertilizer application			30%
Herbicides	50%	25%	
Manual	50%	75%	100%
Mechanized	50%	90%	
Manual	50%	10%	

Source: Data provided by the states.

1.4.4 Challenges and constraints

Like the rest of the agriculture subsectors, small-scale semi-mechanized farming is affected by population pressure, conflicts over land, climate change, desertification and land degradation, issues which will be discussed in section nine. Similar to other modes of rainfed agriculture, small-scale farms are faced with rainfalls variability. Crop yields depend largely on rainfall which is highly variable from one season to the other. Long dry spells cause complete crop failure. The timing and distribution of rainfall is also important. When excessive rain falls at the start of the rainy season, farmers are unable to prepare the land and sow the seeds. Excessive rain late in the rainy season also harms sesame harvesting.

Another challenge facing farmers is that productivity in semi-mechanized farming is declining. Traditionally, mechanized agriculture schemes have not used fertilizers, organized crop rotation or fallow systems. The inevitable and well-documented outcome has been a collapse in yield per unit of land. In Gedaref State, for example, sesame and sorghum yields in 2012 dropped by about 20 and 66 percent respectively from 2009 levels.[25]

According to the Land Policy, land, is to be leased to able investors. Small-scale producers adopt the customary practice of exercising usufructuary rights over the land. This deprives them of the right to use the land asset as collateral for obtaining formal credit from the Agricultural Bank or other lending institutions. The landholdings are sometimes too small to be operated optimally and often have low quality soil. As in most rainfed areas, the physical infrastructure is inadequate.

Small-scale semi-mechanized producers have difficulties in the acquisition of agricultural machinery because they operate with limited financial capital and are unable to access to bank financing, insurance or other risk reduction products. As such, they hire machinery from large-scale farmers. Agricultural practices are poor and unsustainable as the small-

[25] Given the region's wide climatic variations and patchy agricultural data, more detailed analysis is required, but a general trend of diminishing harvested areas and yield.

farmers prefer horizontal expansion and shifting to new land to further developing the land they started on. Though the Mechanized Farming Corporation was established to provide technical, marketing and financial assistance to the farmers, it has rarely been able to serve the small producers, supervise land clearance or extend credit to them. In fact, at a later stage, the Corporation became occupied with managing state farms. Due to the absence of any specialized technological packages and technological transfer programs for small producers, they are not able to adopt appropriate technologies.

Poor supplies of agricultural inputs, namely good seeds and land preparation implements, are major constraints to increasing crop productivity among semi-mechanized small-scale producers. Furthermore, their weak capacity to access market facilities such as storage and transportation and the absence of social safety nets forces farmers to sell much of their product immediately after harvest. This deprives them of obtaining higher crop prices. About 40 percent of small-farmers sell their crops in villages and nearby primary markets, transporting the crops by truck or using pack or draft animals.

1.5 Small-Scale Irrigated Farming

1.5.1 Overview

Sudan has the largest area of irrigated land in Sub-Saharan Africa, totalling about 4.8 million feddans. The Nile and its tributaries were the sources of water for 93 percent of irrigated agriculture, of which the Blue Nile supplied about 67 percent. Most of the water supply for all irrigation is provided by dams or large pumps, with extensive networks of canals for irrigation and drainage. This large irrigation infrastructure has given rise to the establishment of large government-run and private sector-owned agricultural schemes. These modern irrigated schemes are based on a system of tenancy. The remaining irrigated areas are irrigated by drainage, flood or flush-seasonal streams, by small pumps on the rivers and by seasonal streams.

The large irrigated schemes with smallholdings tenant are found along the Nile and its tributaries and include the Gezira, Rahad, New Halfa, Es-Suki, Northern, River Nile, White Nile and Blue Nile pump schemes, mentioned in section one. There are also areas irrigated by flush and floods in Tokar and Gash in eastern Sudan. Small-scale irrigated agriculture is practiced throughout the Northern, River Nile and Kassala states, and in Khartoum, Gezira, Gedaref, Sennar, Blue Nile and White Nile states. In addition, there are small irrigated schemes fed by seasonal streams or underground water, mainly eastern seasonal streams (*khors*) in the Red Sea State and other *khors* in the Kordofan and Darfur regions. These small farms (or schemes) are owned and mostly run by individual and family farmers. A few are run as co-operatives.

These subsystems (large-scale schemes and small-scale irrigated farms) differ from each other in terms of production and marketing arrangements. They also differ in the type and intensity of the challenges they face. Importantly, the tenants in large schemes have historically been more vocal in expressing their demand for reforms and government support through their unions and associations.

1.5.2 Water management systems

The water management systems in the irrigated sector in Sudan consist of gravity irrigation, pump irrigation, flush irrigation, flood irrigation and drainage. The gravity water management system, used mainly in the large schemes of central Sudan, consists of dams across the Blue Nile and the River Atbara. The Gezira Scheme, where approximately 2 million feddans (or 0.84 million hectares) are under irrigation, is the most important gravity irrigated scheme in Sudan, and has served as a prototype for most large government irrigation schemes. Starting from the Sinnar Dam, the hierarchy of the main canalization system follows a pattern of main, major, tertiary (minor), and field (Abu XX) canals before the water flows into smaller field ditches (Abu VI) carrying water to individual tenancies.

The second water management system is based on pump irrigation. Pumping water from the River Nile and its tributaries and from surface wells is an important method of supplying water for crops. The total area of land irrigated by pumps is about 600 000 feddans (over 250 000 hectares). The pump schemes in the Blue Nile state and the White Nile state follow a production arrangement resembling the Gezira model. The irrigated schemes (farms) in the northern part of the country mainly grow relatively high-value, cool-season crops. However, the small pumping units that dominate production systems in the north are faced with high irrigation costs and sub-optimal utilization of irrigated water due to high fuel costs and small pump size. Irrigation costs were estimated to make up 35–50 percent of the total cost of crop production. In some areas, crop sharing systems prevail and about half of the value of the produce is allocated to water provision by pump owners.

Flush irrigation is practiced in the eastern part of the country where the Gash and Baraka rivers flow seasonally from the Eritrean highlands carrying tremendous amounts of water that flood over thin deltas covering large areas. Flood irrigation systems are implemented on basins and riverbanks along the Nile and its tributaries (Blue Nile, White Nile, and Atbara and Dinder rivers). During floods, large areas of the riverbanks and adjoining local basins are normally flooded for considerable periods. After the water recedes from these areas, several crops, such as sorghum and chickpea are cultivated. The drainage systems are mostly in the form of open drains with bed width of approximately six meters. Due to topographical characteristics and significant depth of static water table, drainage is not a major problem in the irrigated areas.

Table 1.14 describes the typology of the irrigation sectors in Sudan as in 2002. Gravity flow was the main form of irrigation, as it was in the Gezira Scheme, but pumps served about one-third of the irrigated area on the Nile downstream from Khartoum and on the left bank of the White Nile downstream from Kosti. There were also small-irrigated schemes at Tokar, in the Red Sea coast, and in the inland Gash Delta, near Kassala. All these schemes, with the exception of some pump schemes on the main Nile, were built to generate export revenues from the sale of long-staple cotton and were of great importance to the economy.

Table 1.15 **Typologies of irrigated agriculture in Sudan**

Scheme	Location	Area (ha)*	Institutional system	Crops	Irrigation type
Gezira and Managil	Gezira State	840 000	Public	Cotton, wheat sorghum, groundnuts, vegetables	Gravity
New Halfa	Kassala State	160 000	Public	Cotton, wheat, sorghum, groundnuts	Gravity
Rahad	Gezira and Gadarif State	121 500	Public	Cotton, wheat, sorghum, groundnuts	Gravity
Gash Delta	Kassala State	105 000	Public	Cotton, sorghum, water melons	Flush
Es Suki	Sinnar State	81 490	Public	Cotton, groundnuts	Gravity
Tokar Delta	Red Sea State	99 120	Public	Vegetables, cotton, sorghum,	Flush
White Nile Schemes	White Nile State	98 280	Private	Cotton, sorghum, Wheat	Pump
Khartoum Schemes	Khartoum State	58 295	Private cooperative	Vegetables, fodders	Pump
River Nile State Schemes	River Nile State	566 727	Public	Cotton, wheat, legumes	Pump
Northern State Schemes	Northern State	178 728	Public cooperative	Cotton, wheat, legumes	Pump
Sugarcane Schemes					
Guneid Sugar	Gezira State	15 540	Private	Sugarcane	Pump & gravity
Assalaya Sugar	White Nile State	18 060	Private	Sugarcane	Pump & gravity
Sinnar Sugar	Gezira & Sennar States	30 142	Private	Sugarcane	Pump & gravity
New Halfa	Kassala State	14 700	Private	Sugarcane	Gravity
Kenana Sugar	White Nile State	34 318	Private	Sugarcane	Pump & gravity

Source: Idriss (2002).

* Note that one hectare is equivalent to 0.42 feddan.

1.5.3 The contribution of the irrigated sector to the economy

Table 1.16 shows the contribution of the agriculture sector as a whole and of irrigated agriculture to total GDP during 2003–14. While the contribution of the agriculture sector to GDP declined from 45.6 percent in 2003 to 33.9 percent in 2014, that of the irrigated sector has been relatively stable, hovering between 10 and 12 percent. Table 1.17 gives the performance of crops grown under the irrigation sector during 2009–12. Remarkably, the areas grown wheat and groundnuts have been stable while the area grown cotton has declined and the area under sorghum cultivation varies from one season to another. Government policies and schemes management have greater impact on the stability and the variation in crop areas and yields than climate (particularly rainfall) effects.

Table 1.16 **The contribution of agriculture and irrigated agriculture to Sudan's GDP (percentage)**

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Agriculture Sector	45.6	44.5	39.6	35.9	33.6	36.2	36.5	33.9	34.4	34.2	34.1	33.9
Irrigation	12.4	11.9	10.9	11.5	9.9	11	10.8	N/A	N/A	N/A	13.0	12.1

Source: Ministry of Finance and National Economy (2010) and Central Bureau of Statistics

The importance of the irrigated subsector is reflected in the fact that, while it makes up a relatively small share of the total cultivated area, it has been the most productive of all agricultural subsectors. It contributed, on average, 27 percent of the national agricultural output, 12 percent of GDP, about 95 percent of Sudan's cotton, all the wheat, most horticultural products and 25 percent of the groundnut output (average for 2011–13). Sorghum production is normally low in this subsector because it can be produced more efficiently in other subsectors. Although its contribution to sorghum production is low relative to the rain- fed subsector, it is more stable. In years of drought it plays an important role in meeting the consumption requirements. Average yields of cereals are higher in the irrigated sector than in the rainfed sectors, in most years (Ministry of Agriculture and Irrigation, 2014).

Table 1.17 **Major crop performance in irrigated agriculture (2009-2012)**
(Area (000, fed); Production (000.tons), Yield (tons/fed.)

Year/crop	2009			2010			2011			2012		
	Area	Output	Yield	Area	Output	Yield	Area	Output	Yield	Area	Output	Yield
Wheat	556	399	0.757	549	415	0.790	414	308	0.783	408	263	0.729
Sorghum	1179	690	0.133	1242	1037	0.132	970	739	0.177	1127	725	0.124
Groundnut	234	126	0.716	329	289	0.932	359	298	0.900	372	394	1.159
Cotton	81	43	0.597	85	62	0.775	352	274	0.826	140	111	0.854

Source: Department of Agriculture Statistics, General Administration for Planning Federal Ministry of Agriculture.

Though the large-scale irrigation schemes have been Sudan's major area of investment, various studies indicate that their performance has been considerably below potential. These schemes are saddled with problems of dilapidated irrigation and drainage infrastructure, low producer prices, lack of foreign currency and import regulations (the latter of which has limited the availability of vital production inputs and spare parts). Environmental factors, such as canal sedimentation, have also contributed to low irrigation returns. The schemes have also come with serious health hazards, such as the increase of malaria and bilharzia.

1.5.4 Tenancy based large irrigated schemes

The production arrangement in the large schemes is based mainly on a system of tenancy. The tenants are small farmers who operate a small tenancy (*hawasha*) of 15 to 20 feddans. However, they have consolidated lands, group finance for selected crops (cotton, groundnuts and wheat) and agronomy, marketing and management services. Though they face many challenges, different from those faced by independent small-scale farmers, it is important to

discuss at length their patterns and organization of production for several reasons: First, these schemes are sources of livelihood for a large segment of the rural population. Second, the establishment of these schemes has strongly influenced the development of the other small-scale producers. Third, both the large schemes and small schemes operate in similar markets for crops, inputs, labour and financial production. Fourth, these schemes still share, along with independent small-scale farming, various challenges confronting agricultural development in general. They also compete with them for public funds.

Gezira scheme: The Gezira scheme is the largest of these schemes and in the world. It accommodates about 128 000 tenants. It is located between the Blue Nile and the White Nile in southern Khartoum. The area has a hot, arid climate with low annual rainfall (just under 400 mm in the southern part to 200 mm in the northern part, near Khartoum). The land area under cultivation in Gezira on average represents more than 50 percent of Sudan's irrigated cropland. It produces about two-thirds of Sudan's cotton exports and considerable volumes of food crops and livestock for export and domestic consumption, thereby generating and saving significant foreign exchange. The scheme is of crucial importance for Sudan's national food security and generates livelihoods for the 2.7 million inhabitants of the scheme's command area.

The Sinnar Dam, located at the southern end of the scheme, supplies water to Gezira through a network of irrigation canals of about 150 000 km. The scheme possesses a lengthy canalization network of about 35 000 km, 12 500 km of which are allocated to tertiary (minor) canals only. The most distant farms are located some 300 km surface distance from the dam. Following a prescribed rotation, cotton, sorghum, groundnuts, wheat, forages and vegetables are grown by the tenants.

The entire scheme is managed by the Sudan Gezira Board (SGB) from its headquarters at Barakat, near Wad Medani. The SGB decides on the crop mix and crop rotations and provides agricultural services. On the irrigation side, it is responsible for most of the irrigation network, comprising the operation and maintenance of the major and minor canals down to the field outlet pipes, which feed water into the field canals. The Ministry of Irrigation is responsible for the operation and maintenance of the dam and the upper reaches of the irrigation system up to water delivery in the major canals. This system has been in place since 2000, replacing an earlier system under which the Ministry of Irrigation was responsible for the operation and maintenance of the network up to the minor canals.

The organizational structure of the Gezira Scheme is divided into 18 'groups' and some 100 000 tenancies, each holding about eight hectares. The 18 groups range in size from 60 000 to 190 000 feddans. Each group consists of smaller 'blocks', which comprise 'numbers', each of 90 feddans. The socioeconomic composition of the scheme is about 128 000 tenant households, which constitute, about 1 million people in all. In addition, there are some 150 000 seasonal labourers who, together with their families, constitute more than 1 million people and about 400 permanent employees (reduced from around 10 000 in 2005) (Salman, 2011). About 55 percent of the land is government owned; the remainder is owned by landholders with whom the central government has a long-term rental agreement. There have been some major disputes between the owners and the Government over rent. Until recently, the scheme's assets included service centres, which comprised: 14ditchers; 18 engineering workshops; 1 300

km of railway; a telecommunications network; a fleet of tractors, combine harvesters and other vehicles; 444 stores with a total capacity of 25 million metric tons; more than 6 000 residential units and 76 compounds; 200 offices; 78 schools and health centres; 53 water purification facilities; a road network; a research centre and 150 680 km of irrigation network.

As mentioned previously, management of the scheme was shared between the government, the tenants and the board of directors. Before the mid-1970s, the scheme followed a system of farming whereby only cotton received official attention. Sorghum and beans were grown as farmers' crops and necessary components of the crop rotation cycle. Later, a diversified farming system was adopted, and, in addition to cotton, farmers were encouraged to produce wheat, sorghum, groundnuts and vegetables in an effort to make Sudan self-sufficient in foodstuffs. Crop rotation was changed several times in accordance with the prevailing agricultural environment and coinciding with the different stages of development of the scheme (Hassan, 2015). Cropping intensities are rather low and unstable, irrigation management is poor, and operation and maintenance are organized in a highly centralized manner, as are cotton production and marketing.

Cotton was a mandatory crop for farmers, and was financed and marketed by the government before introducing liberalization of choice of crop in 1981. After adoption of the liberalization policy in the agriculture sector, farmers started to grow other crops, such as sorghum, wheat and groundnut. As a result, the cotton area decreased. However, despite the financial benefits for farmers of growing multiple crops, diversifying from cotton has implications for the country's foreign exchange earnings (Mubarak *et al.*, 2011). Total water consumption in the scheme and its surrounding extensions is about 9.3 billion m^3. Evidently, areas at the head end receive too much water whereas areas in the tail end receive very little water. This high variation is mainly attributed to poor scheme management and extremely uneven water distribution. In effect, except for some areas near the head end, the rest of the scheme suffers from high water stress.

The scheme is faced with many problems and challenges. In recent years, due to financial difficulties, the SGB has experienced problems in performing needed maintenance of the irrigation system in a timely manner. The system has deteriorated because of silt deposition, infestation of aquatic weeds and structural damages. The water flow in the system is significantly reduced and, consequently, crop intensity and productivity have decreased markedly.

All other major irrigated schemes are also owned by the government and operated in collaboration with tenants, according to an individual account system. This system, also known as the land and water system, is similar to a fixed contract in the sense that the tenant pays a certain charge for the use of irrigated land and in turn enjoys the full benefit of the crops. Prior to 1981–82, agricultural policy was tightly controlled and implemented by scheme administrators. Currently, however, tenants have a greater say regarding the input and output mix. Also, livestock production has recently been introduced into the crop rotation. Many tenants now operate their farms as multi-business enterprises, where they generate incomes from crops, livestock, off-farm household labour and, sometimes, trade.

Since the mid-1960s, Sudan's national government has made many reforms, including remarkable legal and institutional changes, to promote agricultural production in public enterprises. Other government-run irrigated schemes in Northern; River Nile and Sinnar

State states had passed through series of different government programs, starting from nationalization (1968–75) of private schemes to privatization under the Privatization Public Utilities Law in the year 1996. Following the deterioration of these schemes and accumulation of debt, in 2001, the projects were again placed under administration of the Ministry of Agriculture, as an emergency programfor their recovery. The emergency program created the Reconstruction and Agricultural Projects Unit, supported by professional agricultural and engineering staff. Wheat resettlement projects started in 1990, in the Northern and River Nile states, under another emergency support program, which was returned to the federal Ministries of Finance and Agriculture for supervision and management in 2000. Wheat resettlement projects consolidated cooperative projects, individual land and private companies and expanded the land under crop production into the high terrace areas on the far sides of the banks of the River Nile. The government invested largely in these projects and facilitated the introduction of water sprinkler irrigation technology through the private sector.

1.5.5 Small-scale irrigated schemes

The irrigated subsector is dominated by smallholder farming systems in the Northern, River Nile and Khartoum states. Small-scale pump irrigation is also found in the Blue Nile, Sinnar, White Nile and Gezira states, mostly in small family holdings producing vegetables and fruits. In Khartoum State, small farms with less than 10 feddans constituted 56.54 percent of total farms. The main crops grown in these small farms are onions, tomatoes, potatoes, eggplants, sweet peppers, green beans, okra, Abu70 sorghum and alfalfa. Small producers in the North and the River Nile states cultivate wheat, sorghum, vegetables and fruits for home consumption and sell the surplus in the markets. Their landholdings, however, are exposed to land-size fragmentation due to inheritance. Family-owned farms sometimes have less than one feddan of land.

Though most households have some livestock, animal husbandry is a secondary activity, with cropping being the most important activity. Some of the medium-scale private producers use modern sprinkler irrigation system for growing alfalfa fodder crops for export. Small to medium producers in the southern riverine grow sorghum for home consumption and fruits and vegetables for cash. The cash crop production consists mainly of banana, mango, lemon, and guava. The same is true for the northern riverine, where raising livestock is also considered a secondary activity. The small producers in Kassala State pursue crop and mixed crop-animal/pastoral production. The production of crops and livestock constitute the major source of livelihood for 75 percent of the population in this state. Small producers in eastern khors zone pursue agro-pastoral activities, growing sorghum and grazing sheep and goats on natural pastures in the khors of the eastern part of the Red Sea State and in certain parts of the River Nile State.

Traditional agriculture is practiced on areas of seasonal flood recession in Kordofan, on the clay plains of the Khor Abu Habil basin. However, a portion of the floodwaters is diverted to the Rahad stream (known locally as Rahad Turda) or, through regulators, to flood basin irrigation schemes, including the Rahad Scheme with 2 930 feddans (about 1231 ha); the Turda Vegetable Scheme 240 feddans (about 100 ha) and the El-Semeih Scheme, with8 500 feddans (about 3 570 ha). All these schemes are in poor condition and irrigation has been suspended for years except for a small area in El-Semeih. An irrigation potential of 60 000 feddans (about 25200 ha) has already been identified in the basin, particularly in the lower region. Production of horticultural

crops had been confined to the banks of *wadis*,' benefiting from shallow groundwater aquifers. The major horticultural farms extend along the banks of Khor El-Buteha, between Rashad and Abu Gubeiha, but smaller horticultural farms are also found all over South Kordofan State and the Khor Abu Habil area in North Kordofan State (IFAD, 2009).

Box 1.2: Livelihood zones in irrigated areas

Of the 19 national livelihood zones described in Chapter two, four correspond to small-scale irrigated farming zones. These are:

- Northern riverine small-scale cultivation (Northern, River Nile and Kassala States)
- Southern riverine small and medium-scale cultivation (Khartoum, Gezira, Gedaref, Sennar, Blue Nile, White Nile and Kassala States).
- Central irrigation schemes (Gezira and Gedaref States), and
- Eastern khors agro-pastoral (Red Sea State).

Livelihoods in these zones rely predominantly on irrigated agriculture. The poor small producers in the northern riverine cultivate wheat, sorghum, vegetables and fruits for home consumption, and sell their surplus in the market. Though most households have some livestock, this is a secondary activity, with cropping being the most important activity. The large private investment schemes, using modern sprinkler irrigation systems, grow alfalfa fodder crops for export.

Small and medium producers in the southern riverine grow sorghum for home consumption and fruits and vegetables for cash. The cash crop production consists mainly of banana, mango, lemon, and guava. The same is true in the northern riverine zone, where raising livestock is also a secondary activity.

Table I.18 **Livelihood of irrigated zones in Sudan**

Zones	Sources of income	Sources of food
Northern and River Nile states	Agriculture labour, horticultural products, selling fodder, labour migration, selling sorghum and wheat crops	Sorghum and wheat, mangoes, citrus fruits, buying millet and maize, onion, garlic, beef, mutton and goat meat
Along the White Nile and the Blue Nile, south of Khartoum	Selling vegetables, sorghum, millet, wheat, fodder, poultry and milk	Buying sorghum and wheat, own milk and poultry, vegetables products, buying fish and fruits
Red Sea , River Nile and Kassala States	Selling charcoal, firewood, wild fruits, livestock, labour as herders, in brick making and migration	Own milk and selling surplus to buy sorghum, and other foods

Source: Information collected from the states.

The small producers in Kassala state pursue crop and mixed crop-animal/pastoral production activities. The production of crops and livestock constitute the major source of livelihood for 75 percent of the population in this state. Small producers in the Eastern Khors pursue agro-pastoral activities, growing sorghum and grazing sheep and goats on natural pastures in the khors of the eastern part of the Red Sea state and in certain parts of the River Nile state. As indicated above, the small producers in the of the Gezira, Rahad, and New Halfa public agricultural schemes (in the Central Irrigated Schemes livelihood zone) have relatively stable water supply, which allows them to grow sorghum, wheat, groundnut, and cotton. In this livelihood zone, livestock production is relatively limited compared to the more intensive use of the land for crop production. Table I.17 summarizes the irrigated livelihood zones.

1.5.6 Characteristics of small-scale irrigated farming system

Production Technology: Most of the small-scale farmers in the Northern, River Nile and Sinnar states usually use traditional varieties of crops obtaining their seeds from the previous harvest. However, some of the farmers in various states use improved seeds (25 percent in schemes in the Northern, 47 percent in Sinnar, 54 percent in the River Nile and 70 percent in the White Nile state). Different levels of chemical inputs are often applied, chemical fertilizer (urea) and organic fertilizer (manure) are used as are pesticides and herbicides, in addition to manual weeding. Small producers lack collateral and cannot access formal credit, except in very limited cases. Therefore, self-finance is dominant in schemes of the Northern State (100 percent) and the River Nile State (83 percent). Near Merwe Dam, an administrative unit was responsible for the management and finance of the compensation schemes for people affected by the dam. The unit provided the people involved with 100 percent mechanization services in land preparation and harvesting. However, the unit is no longer providing services to the displaced population and, as such, their use of machinery has dropped considerably. In both of the River Nile and the Northern states, the marketing value chain system is undeveloped. Small producers lack the knowledge, experience and practice to access markets for inputs and outputs.

Table I.19 **Characteristics of production in the small-scale irrigated farming system in selected states of Sudan**

Item	Unit	Northern State	River Nile State	White Nile State
Land size	Feddans/household	1-20	1-15	5-150
Crops		Wheat, broad beans, spices, fruits and vegetables	Wheat, broad beans, spices, fruits and vegetables	Sorghum, wheat, fodder, rice, vegetables
YIELD				
Wheat	ton/feddan	1.0	0.9	0.6-0.8
Broad bean	ton/feddan	0.8	0.8	-
Fennel	kintar/feddan	0.6	3	-
Potato	ton/feddan	15		-
Dates	sacks/tree	1.0		-
Orange	ton/feddan	16	20	-
Onion	sacks/feddan		15	-
Sorghum	ton/feddan			0.8- 1.4
Rice				2.0
SEEDS				
Improved		25% (Devolution) 46% (Wheat resettlement) 50% (Suddud)	57% (Devolution) 50% (Wheat resettlement) 90% (Suddud)	70%

Item	Unit	Northern State	River Nile State	White Nile State
Traditional		75% (Devolution) 54% (Wheat resettlement) 50% (Suddud)	43% (Devolution) 50% (Wheat resettlement) 10% (Suddud)	30%
LAND PREPARATION				
Mechanized		38% (Devolution) (Wheat resettlement) (Suddud)	95%	80%
Manual		34% (Devolution) (Wheat resettlement) (Suddud)		20%
Other		28% (Devolution) (Wheat resettlement) (Suddud)		0%
PLANTIN				
Mechanized			5%	50%
Manual			95%	50%
Fertilizer application	%	85% urea,15% organic (Devolution) 75% urea,21% organic, 4% other (Wheat resettlement) 100% urea	100% urea,18% organic,14% other (Devolution) 100% urea,60% organic (Wheat resettlement) 100% urea, super phosphate (Suddud)	Urea (80%) Other (20)
Herbicides	%	75%(Devolution) 96% (Wheat resettlement) 25% (Suddud)	50% (Devolution) 40% (Wheat resettlement) 50% (Suddud)	20%
Manual	%	25% (Devolution) 4% (Wheat resettlement) 75% (Suddud)	50% (Devolution) 60% (Wheat resettlement) 50% (Suddud)	80%
HARVESTING				
Mechanized		20% (Devolution) 48% (Wheat resettlement) 100% (Suddud)	17% (Devolution) 20% (Wheat resettlement) 100% (Suddud)	40%(sorghum, wheat)
Manual		80% (Devolution) 52% (Wheat resettlement)	17% (Devolution) 20% (Wheat resettlement)	60%(vegetables, rice and fodder)
Both mechanized and manual			66% (Devolution) 48% (Wheat resettlement)	

Item	Unit	Northern State	River Nile State	White Nile State
CREDIT				
Agricultural Bank of Sudan Suddud unit		11% (Wheat resettlement) 100% (Suddud)	8% (Devolution) 40% (Wheat resettlement) 100% (Suddud)	20%
Self-finance		100% (Devolution) 81% (Wheat resettlement)	83% (Devolution) 40% (Wheat resettlement)	80%
Private companies		6% (Devolution) (Wheat resettlement)	9% (Devolution) 20%(Wheat resettlement)	

Source: collected from the State Ministries of Agriculture in the Northern, River Nile and White Nile States, Federal Ministry of Agriculture, Ministry of Finance (2015).

Cropping pattern: The small producers of the Northern and River Nile states have a comparative advantage in growing winter crops, aromatic and medicinal plants and horticultural crops. The most important crops are wheat, Egyptian beans, dates and green fodder. Horticultural crops cover a large share of the cropped area in Northern State (54 percent). The small producers of the White Nile, Blue Nile and Sinnar states have a comparative advantage in growing summer crops – sorghum, cotton, sesame and vegetables. White Nile producers also grow cotton and rice on their small farms. The small producers in Khartoum and Kassala have a comparative advantage in growing vegetables (onion, tomato, potato, eggplant, sweet pepper, green beans and okra), fodder (Abu70 and alfalfa) and fruits (citrus fruits and watermelon). These states (the Northern and River Nile states) witnessed a crucial change in their irrigation systems. The electricity generated by the Merowe Dam supplemented the electricity already generated on national grid, enabling the electrification of a large number of the previously diesel-operated irrigation pumps. Further, the introduction of modern irrigation systems (central pivot sprinklers and drip systems) using water pumped from ground aquifers are currently used to grow wheat, alfalfa, fruit trees, vegetables and field crops in some private and small farms in many states.

Production relations: Production relations are linked to the use of land, labour and water:

1. **Land renting:** In this system, farmland is rent in exchange for a certain percentage of production, ranging from one-twelfth of the crop output in poor lands to one-seventh in more fertile lands. In this case, the landlord does not share in the cost of agronomical practices, inputs or services. This type of relationship prevails in smallholder and inherited land known as *aradi, alkharaj* and *alushur* (sharing of tenth of the crop). The shares are determined according to traditions and norms, based on the fertility of the land and its distance from irrigation water sources. In Sinnar, the share is set one-seventh.
2. **Crop sharing:** This relationship is dominant in agricultural cooperatives where the cooperative provides different operating requirements (including salaries) and covers part of the cost of agricultural inputs (seeds, fertilizer, gasoline, oils). The cost of production and the returns are share equally by the cooperative and the farmers.

3. Water cost: Most of the independent small producers acquire their own pumping equipment. In most government agricultural projects, however, management provides to the tenants with the administrative, technological and financial packages of the operating unit. The managing body is responsible for the provision of irrigation and farm management services, while the small farmer is responsible for paying the cost of irrigation, supplying necessary inputs and carrying out the cultural operations.

1.5.7 Challenges to the irrigated sector

Small-scale irrigated farms suffer from limited use of agricultural technologies, irregular agricultural crop rotation, run-down irrigation infrastructure and inadequate maintenance of canals. Agricultural processing is limited and the marketing services and information are ineffective. There is also limited access to foreign markets, especially for vegetables and fruits, and an overall weakness in finance for the operational cost of agricultural production, processing and marketing.

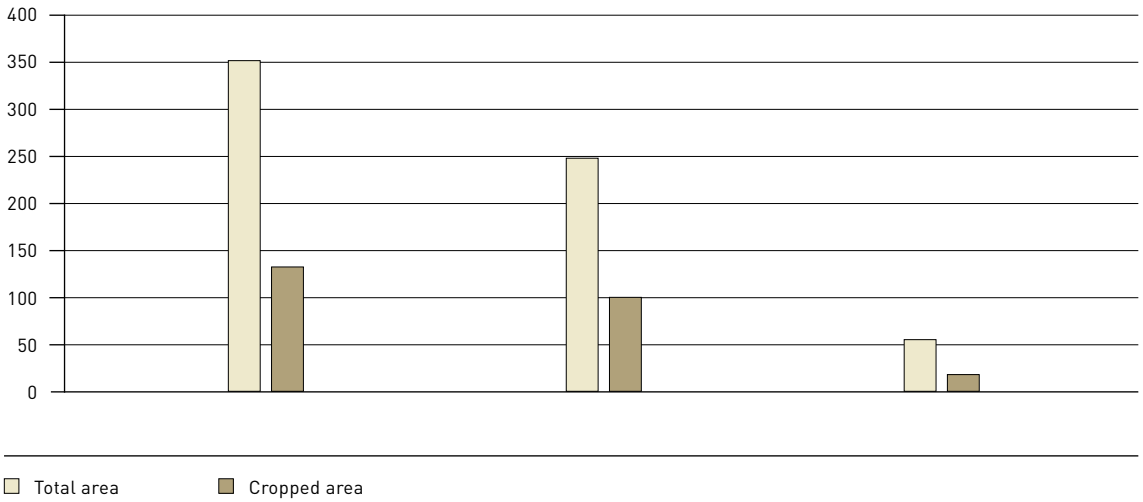
Table 1.20 **Cost and return for selected crops in River Nile State, 2013–14 (SDG/feddan)**

Cost item /crop	Wheat	Broad beans	Onion	Potato	Alfalfa
Land preparation	450	450	750	750	550
Seeds	250	300	600	400	2000
Labour	123	106	1 944	1 670	0
Irrigation	150	150	300	400	600
Fertilizers	500	0	750	900	50
Harvesting	189	179	1 403	1 953	0
Other	80	223	1 411	1 084	100
Total costs	1 742	1 408	7 158	8 757	3 300
Total revenue	3 600	4 800	13 500	18 000	16500
Zakat	180	240	675	900	825
Net revenue	1678	3 152	5 667	8 343	12 375

Source: Ministry of Agriculture and Irrigation (2015)

Constraints to production are not restricted to small-scale producers. The government-owned irrigated schemes also face numerous challenges. The government, with the support of international organizations, carried out programs to rehabilitate the deteriorated structures of the large irrigated schemes in Sudan. Two emergency programs were completed, the first in 1984 and the second in 1994. Despite considerable investment on their rehabilitation, the efficiency and cropping intensity of the land is still low. The area cultivated, for example, represented only 37, 40 and 32 percent, respectively, of the total available land in schemes in the Northern, River Nile and Sinnar states. The schemes suffer from poor management of the water supply, which further reduces cropping intensity and crop productivity. The lack of maintenance of the irrigated pumps and canals has led to the accumulation of silt in the canals, reducing their water carrying capacities and creating water supply scarcity problems.

Figure 1.10 **Cropped and total area of selected states (2014-2015)**



Source: Ministry of Agriculture and Irrigation and Ministry of Finance, 2015

There have been frequent administrative and organizational changes in these schemes as well as high staff turnover and a lack of qualified and trained professional and technical staff to operate and maintain the irrigation units and canals. The irrigation infrastructure is worn out. Tenants are frustrated by the pricing policies and incentives provided. There is little application of agricultural technologies and there are often delays in the provision of finance. No agricultural policies or marketing have been put in place to stimulate agricultural production and increase the value chain. Notably, the gap between potential yields in experimental research and average yields in farms has been high.

Table 1.21 **Comparison of average potential, research and farmer yield for cotton, wheat, groundnuts and sorghum in the Gezira Scheme (1986–2002)**

Type of Crop	Average Yield		
	Potential Yield	Research Yield	Farmer Yield
	(Kantar of seed cotton per feddan)		
Cotton:			
Extra Long Stable	16	12	4.5
Long Stable (Shambat)	18	14	5.0
Medium Stable (Acala)	22	18	5.5
	(Tons per feddan)		
Wheat	2.5	2.0	0.6
Sorghum	2.75	2.5	0.8
Groundnuts	2.8	2.0	1.2

Source: Agricultural Research Corporation (from World Bank Report, 2003).

1.6 Small-scale forestry production

1.6.1 Forest coverage

Forests and trees are grown in Sudan under two types of silvicultural systems. The most prevalent type, constituting 95 percent of the total forests endowments is rainfed. The other type is an irrigated system, practiced mostly within schemes and plantations. According to the Food and Agriculture Organization of the United Nations (2006), about 69 949 000 ha of land in Sudan are forested (defined as an area of vegetation dominated by trees of any size). A study conducted by the United Nations Environment Programme identified seven types of forests and related vegetation types in Sudan, prior to the secession of South Sudan.[26] These include (1) desert and semi-desert trees and shrubs, (2) riverine forests, (3) low rainfall woodland savannah, (4) high rainfall woodland savannah, (5) montane and gallery forests, (6) tropical forests and (7) plantations. In the northern desert area (Northern Kordofan, Kassala and Red Sea) drought resistant shrubs dominate. The Acacia nilotica species and, infrequently, Dom palm trees grow along the rivers. The low rainfall woodland savannah (with less than 900 mm annual rain) is dominated by vegetation composed of mixed grasses; bushes and thorny, short trees (predominantly acacia). The gum arabic belt, occupying an area of 520,000 km^2 lies in the wetter part of this zone, between latitudes 10° and 14° north. It accounts for one-fifth of the total area of the country, accommodates one-fifth of the population and two-thirds of the livestock. It acts as a barrier to protect the country from encroachment. There is intensive growth of trees in the mountains. Trees are also grown on plantations and around schemes.

1.6.2 Benefits and utilization of forests

Rainfed forests and trees constitute an important part of family farming in Sudan. The forestry subsector is an example of an agriculture system in which the ecosystem services provided by the agricultural resources go beyond the direct produce and economic benefits. They provide other ecological and recreational value. Forest products and services are diverse. Forests provide fuelwood and wood for charcoal production and raw materials for traditional construction and for the furniture industry. Forests also provide a variety of non-wood products, including gum arabic, *Acacia seyal* (gum talha), dom nuts,[27] honey, beeswax, *garad*,[28] fodder, edible oils, medicines, dyes and fibres. The ecological benefits of the forests include sand dune stabilization in fragile semi-desert environments, amelioration of soil through nitrogen fixation, the provision of natural ecosystems for wildlife and the conservation of biodiversity.

The different activities and methods through which forests products are obtained constitute a significant source of non-farming employment. Almost all the members of small farming families in the rural areas are involved in activities related to the gathering and sale of

[26] UNEP: Sudan Forest Resources

[27] a vegetable ivory, is obtained from hyphaene thebaica

[28] tanning pods obtained from Acacia nilotica

forest products. These activities constitute seasonal employment during off-season times of agricultural activities.

The most important forestry produce is gum arabic, which is collected by small-scale farmers as a supplementary job. Other forestry activities, such as charcoal production and timber cutting, are also largely undertaken by small-scale farmers. These forest products are sources of income and food for the farmers. The collection and marketing of gum arabic and non-timber forest products are in fact implemented in the post-harvest season. In addition, these activities support agriculture by enriching the soils, protect the environment and provide raw materials for cottage industry and eco-tourism.

1.6.3 Gum arabic production

The gum arabic production system is an example of a business model perfectly organized to complement crop cultivation. An important aspect of the gum arabic production system is that it extends the season of land production, following the end of the agricultural production season. It complements the agriculture model and supports the farming families during the dry season prior to rains. Family members also work in harvesting other forest products for sale or domestic use. Fuel wood collection, gathering of non-wood forest products and cottage industry activities are business functions in which family members are engaged almost all year round.

In almost all of Sudan, these business models related to forest products are based on the natural forests and trees controlled by government. In the case of forest reserves, access is illegal and families who enter the forest may face legal problems. In open forests, farmers' access is not strongly controlled, although wood gathering is not legal without permission.

Most forests are organized in management units and each unit follows an agro-forestry system organized sequentially according to the season of gathering forest products (the bush–fallow cycle) and season of cultivation (the agriculture cycle). The gum arabic bush–fallow system, widely practised in Kordofan and Darfur, follows the twenty-year cycle of the bush of the *Acacia senegal* tree species, followed by a 4 to 5 year cycle of cultivation of different crops.[29] Farmers abandon the farmland when crop production in the fourth or fifth year becomes uneconomic as a result of the decline of soil fertility. The bush (the wild plants growing in the fallow land) that follows cultivation enriches the soil during the twenty year cycle through nitrogen fixation by the gum trees or other acacias and through the addition of organic manure from the litter and animal waste.

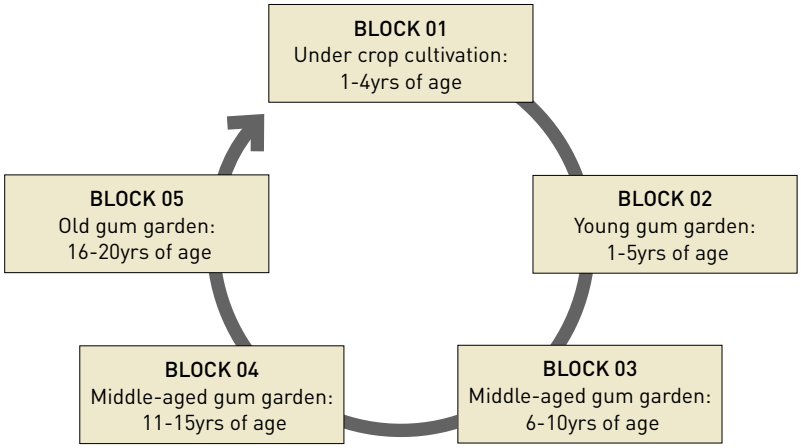
The bush-fallow system of production has been altered into many other types of agro-forestry cultivation systems, within the different agro-ecological zones, all based on the integration of trees and animals with agriculture in agrosilvipastoral systems. Windbreaks, shelterbelts and parklands, for instance, constitute production systems for wood and other forest products in many parts of Sudan. In these production systems, trees and crops co-exist on the same piece of land at the same time, resulting in a system which plays a significant economic

[29] However, the bush-fallow system involving other acacias is spontaneous and has never been organized in a systematic form.

role, including protecting crops and land and providing tree products. The parkland system is deeply rooted in the history of land management, particularly in west Sudan where the *Faidherbia albida*, *Ziziphus spina-christi* and *Cordia abbysinica* tree species are common (Elsiddig 2007). On the other hand, shelterbelts and windbreaks are common in north and central Sudan, where they are used to reduce wind speed and protect farms.

These production types are recognized to have a positive effect, increasing agricultural yield. By following the bush-fallow system, grain yield goes up to 1 500 kg per hectare in the first year (Elsiddig 2006, Luukkanen *et al.*, 2006) but declines to about 800 to 900 kg per hectare in the fifth year. Records and research also indicate that shelterbelts and windbreaks increase grain yield by 15 to 20 percent.

Figure 1.11 **Gum garden rotation system adopted by farmers in the gum belt in Sudan**



Forest organization for development of production on an annual basis is a mechanism for sustainable production (Elsiddig, 2001). Rural communities have a wealth of experience managing and organizing the production of resources by adopting of coping mechanisms which may facilitate their adaptation to and mitigation of drought and climate change. These mechanisms also help in conflict resolution.

However, various factors are at present negatively impacting the stability and sustainability of forest production. These are a result of conflicts between land users. The distribution of limited agricultural land among extended family members reduces the size of farmland available to each, thus reducing their annual agricultural production. The conflicts arising from land needs are exacerbated by the changing climatic conditions which further reduce yield and drive the expansion of agriculture into forests and range lands.

The decline in agricultural production, the reduction of forests and rangeland and the loss of land escalate the conflicts into serious confrontation between families and tribes and affect the situation of livelihood support from natural resources. Forests and range areas are shrinking and much time is spent by family members in search of wood for fuel.

Because of land hunger within the gum arabic belt, the bush-fallow cycle tends to be reduced from 20 years to around 12 to 15 years. The shorter period does not allow for the complete development of soil fertility as is the case when the bush-fallow cycle was 20 years. Under the new cycle, gum production will not be a sustainable system.

Natural forests reserves and unregistered lands are not subject to organization and so the production system is not planned. This leads to deforestation and forest degradation (Abdelaziz, 2015).

The poor conditions of families and vulnerability to uncertain climatic conditions affect small farmers and expose them to high risks. Knowledge about the protection and conservation of natural resources, particularly through vertical increase of yield and adoption of agro-forestry and other suitable modes of cultivation would improve the farming conditions. Improved agricultural technology, such as water harvesting and use of grain varieties that are high yielders and drought resistant, would improve agriculture yield. The business models designed and implemented by the American Forest Foundation (AFF) take various forms in relation to different production systems practiced with forest and tree resources.

Wood cutting results in the degradation of forests and, over time, depletes the resources and weakens the farmers' business. In both accessible and non-accessible forests, there may be a need to organize the production system in a way that enhances its sustainability. Partnerships and collaboration between the farming communities, the government and forest management organizations have been recognized to have successful results in improving the business models by conserving the forests while using them in a sustainable way.

There are other successful business models based on ownership of trees and forests by families and communities. Tree ownership has been promoted in community-owned forest reserves. The approach of tree ownership and community forest reservations solves the problem of community members' access to forest resources. However, the constraint is that the community forest areas are small and, thus, have limited capacity to provide for the needs of the small farmers and support the AFF business. Much better improvement of the AFF business model is successfully provided by the Gum Producers Association. Membership is open to owners of gum gardens and the Association provides services to its members in the gum arabic production and marketing chain.

1.6.4 Contribution to communities and the national economy

In the extreme dry years experienced in the country, tree leaves, fruits and tubers save many communities from a looming famine. The rural poor depend to varying extents on fruits of the *Ziziphus spp., Balanites spp., Adansonia digitata, Hyphaene thebaica* and various other tree species that provide edible products. Trees and forests provide protection to crop fields in form of shelterbelts, creating suitable agricultural environments, thus increasing agricultural productivity and enhancing sustainable production. Various studies indicate that tree shelters increase crop yield by 15 percent. Forest trees also contribute some 30 percent of the animal feed per annum and up to 70 percent in extremely dry years. Animal products constitute the major food source for sedentary and nomadic communities and generate a sizeable income for individuals and the country as a whole. Improvement of water regimes through reforestation

and conservation of forests in catchments areas greatly increases harvested surface water and increases groundwater recharge. The result has positive impacts on the development of small-scale family farming, which, in turn, affects food production and food security.

Forests and trees contribute substantially to the national economy. Forests play important roles providing services and livelihood support to the population. A large portion of the population (approximately two-thirds) is rural and considered forest-dependent for fuelwood as the main source of energy and for round timber for roofing and building thatched huts and brick houses. Rural people use the forests for grazing, hunting wildlife and obtaining food in the form of tree leaves, fruits, honey and tubers (FOSA, 2001, Elsiddig *et al.*, 2007). The role of forests in eco-tourism is limited and is largely dependent on the cottage industry. Village people are the main guides in the eco-tourism industry. However, there is a lack of necessary infrastructure to develop eco-tourism in forest areas.

Forestry activities also support the rural communities by providing employment in forestry operations (planting, thinning, guarding and harvesting tree crops). The supply of non-wood forest products such as edible parts, medicinal items and raw materials (like tannins), fibres and dry materials for cottage industry contributes significantly to the rural economy.

There are also areas inside forest reserves used for farming. The farmers raise crops on a part of the forest land, which they lease, and in return plant trees on the other part. This symbiotic relationship allows the farmers to produce needed crops and benefits the forester by reforesting bare areas and rehabilitating degraded forests – a mutually beneficial relationship defined as a partnership or collaborative management. The support given to village communities to establish village forests for fuelwood production, shelter and recreational purposes is a practical approach for improving the support that forests provide to rural communities. The forestry authorities support community forests by providing tree seeds and seedlings, irrigation installations and technical backstopping. Community forests contribute to rural development as a resource for generating income at the individual and communal level. The income generated improves livelihoods and rural services.

Forests represent an important resource for Sudan, contributing to the national economy and to livelihoods in the communities. In terms of the national economy, forests contribute 78 percent of the national energy balance and 33 percent of the livestock feed nationwide. (Beshir, 2001).

The recreational and amenity values and importance in eco-tourism of forests and trees in Sudan is increasing on farms, in villages, in landscapes and in urban forests. Still, there has been very little evaluation of the contribution of forests and the forestry sector to the national economy in terms of non-wood forest products, fuelwood, biodiversity, pharmaceutical and ecosystem services.

The exact contribution of forest resources to the GDP, in values and figures, is very difficult to trace and evaluate at the national level because the greater part of the forest products and services provided to the rural economy, whether in the form of energy, wood or non-wood products and in eco-tourism, are spontaneous activities and are not subject to official registration. The formal National Accounts show a limited contribution of the forestry sector

to the GDP. According to these accounts, forestry contributes 1 to 2 percent of the GDP. This equals the value of wood produced from government forest reserves together with the value of timber royalties collected by the government. However, Elsiddig *et al.* (2007) state that because of lack of data on different forest products the economic contribution of the forests is not known. A recent energy consumption study (FAO, 1995) shows that the per capita consumption of fuelwood is 0.7m^3 per annum. The contribution of forests to the national energy supply is estimated to account for 71 percent of the total energy consumed in the country and when converted into tonnes of oil equivalent (TOE) it is valued at nearly USD 2.0 billion.

Gum arabic is the second largest important forest product in Sudan. Since the late 1980s, gum arabic has become the second largest export after cotton, amounting to 11 percent of total exports and constituting 80 percent of world production. Excluding gum arabic, most of the non-wood forests products are not accounted for. A huge volume of non-wood forests products enter into markets as raw material or as products of cottage industry which contribute a large percentage of rural family's livelihoods. Forests also contribute to eco-tourism, which has its share in the GDP.

Forests have multiple uses and benefits depending onto the characteristics of the different species of trees or shrubs they contain, in addition to the environment they provide for plant growth under and between forest trees. It is becoming possible to assess the quantitative impact of trees, shrubs and forests as a whole on the environment and to transform these quantities into figures by evaluating the negative impacts that arise as a result of the disappearance of trees. Phenomena like desertification, soil erosion and the effect of dust, air and water pollutants are among the negative impacts that have economic dimensions. Evaluation of the benefits of trees is absolutely vital and those benefits may exceed the tangible values of the targeted products.

Forests, trees and shrubs contribute to creating good weather conditions as well as providing shade, shelter and fertilization for the soil, together with the protection role they play in preserving water sources. These benefits are services provided by the trees that have no direct cost. It is expected that with the promotion of environmental awareness, more attention will be directed at the aspects of tree protection and forest management in efforts to approach a sustainable system.

The understatement of the contribution of the forestry sector to the national economy requires attention in order for the sector to be considered in budgetary allocations and investment initiatives. Support for small-farmers to invest in forestry development should be considered in budgetary allocation in the form of small credits loans. Initiatives in this direction have been taken by the Gum Arabic Association which also needs financial support.

Export earnings: Various products of forests and trees are included in the list of export commodities and becoming resources for foreign exchange. Gum arabic, which is obtained from the *Acacia Senegal* and the *Acacia seyal*, is the most important non-wood forest product in the Sudanese economy, as a cash earner for small farmers and a source of foreign exchange for the country. Gum arabic is one of the first export products of trees. It has been exported

since late 18th century and is still developing. With respect to foreign trade, gum arabic used to rank second among the country's exports until the early 1970s. Since then, it has dropped to the third place, but its earnings remain significant; USD 78.8 million in 1987 being the highest annual return. The world market, however, witnessed a decline in the consumption of gum arabic for various reasons, a situation that caused Sudan's exports of gum arabic to fall from an average of 45 to 50 thousand tons per year during mid-1950s to only 14 to 20 thousand tons in recent years. This affects the national economy but also is a devastating blow to rural small farmers who relied on gum arabic for centuries as a way to earn cash. Attempts are being made to improve the situation.

Other non-wood forest products of economic importance include resins, fibers, honey, beeswax, fruits, leaves, game and aromatic and medicinal plants (Mohamed, 2013). These products are either consumed by the households or sold in markets. There are some non-wood forest products, such as tannin from the *Acacia nilotica* tree and oil from the *Vitelaria paradoxica* tree, which are potential commodities for local markets and for export (Salih and Doma, 1997). Additionally, many fruits and seeds from trees are exported.

Poverty Reduction: The Central Bureau of Statistics (2009) stated that 45.5 percent of the population of Sudan lives below the poverty line of SDG 114 per month, around USD 2.00. Poverty in the rural areas is more severe than in urban areas. Poverty levels also vary by state, with the Red Sea, Darfur and Kordofan states being severely hit by poverty, followed by the Blue Nile, Kassala and White Nile states. The economy of the remaining states is average.

Trees and forests contribute to poverty reduction in many ways. Wood products, for example, including firewood, building poles and furniture, have high value when converted to monetary amounts. Non-timber forest products comprise a large number of commodities present in almost all markets in Sudan, as raw materials or items processed in cottage industry. Trees provide additional food, such as fruits and honey. The contribution of trees and forests to the supply of fodder has been evaluated at 30 to 40 percent of the total livestock food requirements of the country.

There are some communities where natural resource products, including tree products, constitute the main sources of food, building materials, fuelwood and income. These products are used for domestic use or in the families' businesses. The monetary contribution to poverty reduction, if calculated, would be high. The communities in the east Nuba Mountains and in the east Blue Nile State are examples of communities that have important ties to the trees, forests and other natural resources.

Charcoal production plays an important role in providing employment opportunities and reducing the poverty among the rural poor. Rural people freely collect the fuelwood from natural woodlands. This trade employs large numbers of itinerant, casual or semi-skilled workers among the rural poor. Dependence on fuelwood trade among the poor becomes greater during drought years, which recur frequently in the central and northern parts of the country.

The provision of ecosystem services: An ecosystem service is any positive benefit that ecosystems provide to people, be they direct or indirect, small or large. Ecosystem services

are grouped into four categories (Millennium Ecosystem Assessment, 2005): (1) provisioning services, such as provision of food and water; (2) regulating services, such as climate and disease regulation; (3) supporting services, such as in nutrient cycles and crop pollination, and (4) cultural services, such as spiritual and recreational services. These benefits have an economic value. The most dangerous threat to man's existence is the potential destruction, by man's own activities, of those ecological systems upon which their very existence depends. This indicates the degree of dependence of humans on the environment. It has long been understood that deforestation could lead to soil erosion and the drying up of springs. The concept of ecosystem services is complex and includes services such as insect pollination, climate regulation and flood control. The ecosystem services are strongly linked with disaster management.

As an ecosystem component, forests provide benefits such as wood and non-wood products, in addition to nutrients water regulation, climate control and mitigation and cultural services. Environmental protection is one of the important ecosystem services that mitigate problems like climate change. Deforestation and forest degradation contribute to climate change, the decline of agricultural yield and the increase in poverty levels and many other problems, such as conflict. Unplanned agricultural expansion has resulted in the loss of forests and rangeland and led to various problems related to the loss of ecosystem services. Numerous economic services are provided by forests by enhancing agricultural production, conserving the soil and maintaining hydrological cycles.

Healthy forest ecosystems are ecological life-support systems that provide a full collection of goods and services of natural assets that are vital to human health and livelihood. Many of these goods and services are traditionally viewed as free benefits to society, such as habitat diversity, watershed services, carbon storage and scenic landscapes. Lacking a formal market, these natural assets are traditionally absent from society's balance sheet; their critical contributions are often overlooked in public, corporate and individual decision-making.

When forests are undervalued they are increasingly susceptible to development pressures and conversion. Recognizing forest ecosystems as natural assets with economic and social value can help promote conservation and more responsible decision-making. The Forest Service is exploring national opportunities to advance markets and payments for ecosystem services. It also aims at collaboration that stimulate market-based conservation and stewardship.

The Environment: Since early 1900s the value of forests in providing products and services that combat desertification, reduce land degradation and improve the environment has been recognized at all levels of land use types. Gum arabic is mainly produced in the semi-desert zone, where the *Acacia Senegal* belt constitutes the frontline of defence against desert creep. Forests also play a significant role in soil conservation and protecting agricultural crops from erosion as well as serving to protect the environment in general, in addition to serving other purposes such as grazing and browsing and landscape development. Recently, the value of forests in carbon storage and climate change mitigation has been identified through the greenhouse gas inventories (Sudan National Communication Report 2001; 2009) and the use of carbon as a marketable product obtained from trees and forests at community and national levels.

Because of these important services, forest development has attracted the attention of public and private institutions and communities, as reflected in the process of creating forest reserves under government ownership, within agricultural schemes, on farms, as communal reservations, under private ownership and owned by investment companies. Forests are better managed within forest reserves and private ownership systems, which are assumed to be successful approaches for sustainable forest management as envisaged in the 1986 Forest Policy. Natural forests outside reserves are controlled by policy and rules such as tax collection, based on issuance of licenses for the extraction of dead wood by community members for market use. However, such management is not efficiently and sustainably conserving the natural forests nor is it protecting the environment. Although licenses are required to clear forests for agriculture, particularly for mechanized farming, the policy has not been effective in forest conservation and protection against the vast expansion of agriculture. The law calls for 10 percent of mechanized schemes and 5 percent of irrigated agricultural land to be set aside as reserved forest land. Implementation of the law requires institutional strengthening.

Women and youth: Women and youth are important elements in the forestry sector and much attention has been given to them, including supporting skills development and employment and promoting rural women's business, such as community forests for women. Sudan developed policy reforms to increase women's ownership of forests in order to develop forest-related cottage industry businesses. The Intermediate Technology organization enhanced business development from non-wood forests products. Many women and youth from west Sudan are members of this organization and are involved in processing non-wood products for soft drinks and in packing edible tree fruits. The objective is to make use of under-utilized fruit trees to contribute to food security, hunger relief, poverty reduction and income generation.

The contribution of women in environmental conservation through the use of efficient cook stoves shows an example of women's role in the mitigation of climate problems.

Natural resource management: The mode of farming and the ecology: The bush-fallow system, whether in association with *Acacia Senegal* or other acacias, constitutes an example of natural resource management in which the practices of agriculture follow the bush cycles. The bush-fallow cycles constitute a form of sustainable land management known to enrich the soils and provide suitable conditions for cultivation following the conversion of forests to agriculture (Lukkannen *et al.,* 2006). This system has been practiced for a long time, particularly during the native administration when the customary laws promoted the good governance of the bush and agriculture cycles. However, mono-culture cycles presently used may extend for long periods, as in the case of small-scale mechanized agriculture, which disturbs the sustainability of the system. On clay plains, when the land is abandoned, the bush grows and the soil improves, although the rotation is not complete and does not allow for good improvement.

1.7 Small-Scale Fisheries

1.7.1 Overview

Sudan is endowed with diverse surface and underground water resources and arable lands that are suitable to support a vigorous capture fisheries and aquaculture industry. Currently, capture fishery activities are centred around the River Nile and its tributaries, man-made lakes on the River Nile and its tributaries and the territorial waters of Sudan on the Red Sea. Apart from these conventional fishing areas, there are other water bodies, including several thousand kilometres of irrigation canals, non-Nilotic streams (*khors*) and over 1 800 natural or excavated large and small rainwater impoundments (*haffirs*), particularly in the savannah belt.

Capture fishery production was estimated to be about 34 000 tons in 2012, 29 000 tons from inland water catches and 5 000 from marine catches. The aquaculture sector is still incipient and annual production was estimated at 2 000 tons in 2012. The fisheries sector plays a major role in the food security and livelihoods of a portion of the Sudanese population and provides employment opportunities to 110 000 workers, 25 000 of whom are fishermen while the rest work in related jobs as fish traders or fishmongers, processors, boat builders and gear and craft suppliers.

Sudan's fisheries are multi-faceted and may be divided into three main sectors, namely, subsistence, artisanal and commercial.

- Subsistence fishing, using basic methods such as the spear, traps, cast-nets and hook and line, practiced either from river banks or from canoes and papyrus rafts, is practiced mainly in the inland waters of Sudan.
- Artisanal fisheries, where the fisher typically operates a traditionally-designed one-oar-propelled boat and which sometimes goes hand-in-hand with subsistence fishing, is undertaken mainly on the Jebel Aulia Reservoir as well as downstream the White Nile, before the confluence at Khartoum.
- Motorized boats are employed in the commercial marine fishery which, though still largely underdeveloped, is carried out by some relatively well-off fishers and fisher-folk associations, such as the cooperative societies.

1.7.2 Fish farming

The Sudanese artisanal fisheries and small-scale aquaculture are dominated by small-scale fishers and fish farmers. The majority of fishermen combine both agriculture and fishing as economic activities. They practice fishing by themselves, assisted by their family members, and use traditional boats and rudimentary fishing gear which they buy directly from the market, sometimes using loans from fish merchants for the purchase of their gear, with agreements to provide the merchants with fish at a certain price.

The fisher communities, including the full-time fishermen, their households and dependents, comprise a fabric of varied ethnicities, each with their cultural and social background and

endogenous knowledge and expertise in fishing. These fishers have low socio-economic status and are generally constrained by the lack of proper organization and by poverty. The sector as a whole receives insufficient support services and is poorly managed at the government level. However, there are some well-organized and efficient fisher societies and unions, particularly in White Nile and Khartoum States.

Full-time fishermen are predominant in Jebel Aulia but to less extent, in the other reservoirs. In Roseires, occasional fishermen form about two-thirds of the total. Fishermen settle either in fishing villages or in fishing camps. Around the inland fisheries the fishermen use fishing gear which includes passive and drifting gillnets, beach seines, trammel nets, baited and unbaited longlines, cast nets and fish traps. Regarding boats, two types of fishing boats are used on the reservoir fisheries. Sharook boats are small and simple wooden planked boats, which can be operated by one or two fishermen using one to two nets. Moorkakab boats are larger boats (four to five meters) made of locally available acacia wood, which can transport up to five fishermen (three on average) and five nets. Fiberglass and steel boats are also used. The level of motorization of the fishing fleet is low.

1.7.3 Distribution of fishery resources

Inland fishery resources: The man-made lakes on the River Nile and its tributaries are major focal points for finfish production potential in the country. These include Gebel Aulia in the White Nile, Lake Nubia along the Nile, Rosaries Reservoir and Sennar Reservoir in the Blue Nile, Khashm El Girba Reservoir in Atbara River and the recently constructed Merowe Reservoir along the Nile. The exploitation patterns and trends indicate a high degree of variability. Reservoirs on the Blue Nile (Rosaries and Sennar) and Atbara River (Khashm El Girba) are more or less in a state of equilibrium between the fish resources and the level of exploitation. Gebel Aulia Reservoir on the White Nile has shown signs of over-fishing, particularly in the northern sector. In contrast, Lake Nubia on the main River Nile is underfished and could be considered virtually untapped. Merowe is a newly constructed dam on the main River Nile. The dam complex of the Upper Atbara is a project that is currently under construction (Table 1). The man-made lakes on the River Nile and its tributaries play an important role in the economic life of Sudan and support a large number of people, including fishermen, fishmongers and traders of various kinds. All these require management actions based on the best scientific evidence.

Local inhabitants along the length of these water bodies and others who live inland exploit the fish resources of these inland reservoirs, benefiting from the open access management system prevailing in Sudan. Local fishing and marketing companies are also involved, particularly in the White Nile, Blue Nile, Merowe and Lake Nubia. Artisanal fishers of different ethnic groups are active in the inland waters. They are generally characterized by a low socio-economic profile and limited fishing capacity. Hence, stock assessment studies are needed to update the baseline information for rational utilization, conservation and management of fisheries in these water bodies. The majority of the fishing craft are poled dugout canoes. Arab tribes use rowing or motorized wooden and steel boats.

Table 1.22 **Physical characteristic of Sudan's major inland fisheries resources**

Reservoir Features	Gebel Aulia	Lake Nubia	Roseires	Sennar	Khashm El Girba	Merowe	Upper Atbara Complex
River basin	White Nile	River Nile	Blue Nile	Blue Nile	River Atbara	River Nile	River Atbara and Setit
Year opened	1 937	1 964	1966	1 925	1 964	2 009	Under construction
Surface area (km²)	600-1 500	830-1 144	290	140-160	125	800	240
Total length (km)	629	180	75	60	99	200	45 and 60
Max. depth (m)	12	25	68	26	10	57	45
Fish potential (t/y)	15 000	5 100	1 700-4 100 (after dam heightening	1 100	800	4 100	1 700
No. of fish species	56	43	22	22	15	32	21

Source: Data collected from the states.

1.7.4 Characteristics of Sudanese man-made lakes

Jebel Aulia Reservoir: The dam was constructed in 1937 across the White Nile. This lake has a surface area extending over 124 600 ha that stretches for some 650 km from the site of the dam (45 km south of Khartoum) to the town of Renk in South Sudan. The dam is located 45 km from Khartoum. There is a fish ladder along the eastern side of the dam which was reopened in 1996. The maximum depth of the reservoir is about 12 m, with mean depth of 2.6 to 6 m. Its width is about 6 to 7 km in the vicinity of the dam and about 1 km in the southern part. Studies have demonstrated that Jebel Aulia reservoir has 56 finfish genera from 13 families. However, a Russian expedition in 1964 reported 100 fish species. This reservoir is subject to considerable seasonal fluctuations of its water level depending on hydro-climatic conditions. It is generally at its full capacity in September-October with water receding from February until April-May.

Sennar reservoir: The Sennar Reservoir, which came into existence in 1925 in the Blue Nile about 260 km from Khartoum, was originally designed for irrigation purposes. In 1960, however, a small hydroelectric power station was installed. The 3 km length dam is equipped with a 300 m spillway to discharge the peak flood and 80 low-capacity sluices. There is neither a navigation lock nor a fish ladder. It has an area ranging between 140 km² and 160 km², with a mean depth of 6.5 m (maximum 26 m). The maximum flooded area is reported to occur in November-December and the minimum in July. The fish potential is estimated at 1 100 tonnes per year. The lake has 22 fish species.

Roseires Reservoir: The Roseries Dam, which was constructed in 1966 on the Blue Nile, was designed to produce electricity and to serve irrigation purposes during the dry season. The

dam was enlarged was completed in 2013 to a length of 25km, which increased the potential of the reservoir from 1 100 tonnes per year to 4 100 tonnes per year. An estimated 22 species are found in the Roseires Reservoir. There is no provision for a navigation lock or for a fish ladder. The peak of fishing activity is from May to August. During the peak period; about 42.5 percent of the annual catch is collected. About 10 percent is processed as *kajeke* or wet salted fish (*fasseikh*).

Lake Nubia: Lake Nubia constitutes the southern end of the Aswan High Dam Reservoir with a length of 180 km within Sudan. The lake, constructed in 1964, has a depth ranging between 3 m and 45 m. Fish potential is estimated at 5 100 tonnes per year, although annual fish harvest has never exceeded 2 000 tonnes. The active fishing season extends from March to October.

Merowe Reservoir: The reservoir (800 km^2) submerges natural resources in 164 km^2 of ecologically highly valuable riverine habitat which consists of a 200 km long stretch of the River Nile. The Merowe dam divides the main Nile River into three sections. The first extends from Khartoum to Abu Hamad (600 km). The second is the reservoir (200 km, 800 km^2) and the third is from the dam to Lake Nubia (700 km). There is no evidence of fish migration, other than local movements in the main Nile River. Therefore, the impact of the dam on fish fauna will be mainly limited to changes in the reservoir.

The population of fish which are especially adapted to water currents and riverine habitats will decrease, while those which can adapt to the lake environment will increase. A fish ladder would not make sense for two reasons: Firstly, there is no evidence of migrating fish and secondly, the ladder would be far too high and too long for the fish to be able to pass (a height of 20 to 30 m is commonly regarded as the maximum sustainable height for fish). The total fish population will increase with the formation of the lake (Table2), with 26 fish species and a fish potential 4 100 tonnes per year.

Table 1.23 **Fish production from Merowe**

Year	Camps	Boats	Fishermen	Fish production (tonnes)
2010	75	225	450	110 000
2011	110	330	660	165 000
2012	135	405	810	210 000
2013	145	425	780	342 014
2014	152	456	912	972 662

Source: Merowe fisheries research station (2015)

Khashm El Girba: Khashm El Girba's reservoir was formed in 1964. The reservoir has a surface area of 125 km^2, a length 80 km and a maximum depth of 5 0m. There are 15 fish species from 9 families in the reservoir. The main problem facing fisheries in this reservoir is the annual flushing of the lake in mid-August to get rid of silt which would otherwise reduce the carrying capacity of the basin. The Khashm El Girba Dam has a total storage capacity of 1 300 million m^3 and supplies water to the New Halfa irrigation scheme. The potential of fish stock is 800

tonnes per year. The artisanal fishing season in Khashm El Girba starts in mid-October with peak activity between January and July.

Complex of the Upper Atbara: Currently dams are being built at the Setit and upper Atbara Rivers, at a location 14 km upstream of their confluence, impounding 60 km of the Upper Atbara River and 45 km of the Setit River and creating a reservoir with two branches. The reservoir will have a surface area of 240 km^2 at full supply level and a total water storage capacity of 2 762 million m^3. Water from the Setit branch of the reservoir will be used for the future Upper Atbara irrigation project via a 150 km long canal. Water from the Upper Atbara branch will be used to feed the Khashm El Girba reservoir. Twenty-two fish species have been identified. Annual fishery productivity is projected at an average of 83.4 tonnes per hectare for Rumela (one of the two tributaries of the Upper Atbara dam project) and 83.4 tonnes per hectare for Burdana (the other tributary), which translate into a total fish yield of about 1 700 tonnes per year.

Marine capture fisheries: The Sudan Red Sea coast extends for about 853 km, protected by barrier reefs that form lagoons and natural harbours and fish landing sites. The territorial waters of the country consist of 91 600 km^2 of the Exclusive Economic Zone, inclusive of 22 300 km^2 of shelf area. Despite the high biodiversity of aquatic life, historically, exploitation has focused on harvesting wild molluscs and finfish. Both activities are largely of a traditional and subsistence nature.

Other high value resources are either untapped or only occasionally fished. Finfish fishing is carried out by the artisanal sector using traditional gear, craft and fishing techniques and is confined to near-shore areas. Currently, the harvest of artisanal fisheries is very low in comparison with the resources available. The sheltered waters and the areas of mangrove swamps contain a high level of biodiversity. The annual fish potential or the sustainable yield of fish in the sheltered coastal zone is said to be at least 10 000 metric tonnes of fish varieties. Investments in commercial fisheries have been limited, although they have been increasing in recent years. These fisheries use small- and medium-size trawlers and purse seiners.

There are 1 900 registered local fishermen operating 410 fishing craft, including 3 to 5 m dugout canoes (*houri*), 5 to 7 m wooden and steel boats (*felucca*) and 7 to 10 m launches (*sambouk*). The majority of the houris are propelled by wooden oars or bamboo poles, while the other fishing vessels are fitted with outboard or inboard engines, ranging from 10 to 100 horsepower. In addition, there are 30–50 medium-sized wooden boats and steel trawlers of 20–25 gross register tonnage, mostly operating on a seasonal basis.

The cultural practices of the Red Sea coast artisanal fishing activity are still at a primitive stage. Most of the coastal population is semi-nomadic and has taken to fishing as a major livelihood support as increasing desertification makes agriculture difficult and herding less profitable. Hardy small goats are grazed and camels and donkeys are used as a means of local transport. The fishing villages established around the more convenient fish landing sites are inhabited by subtribes of the Bija tribe, except in the southernmost area. The Bija people were originally small farmers and herders, but these livelihoods are being destroyed due to changes in the physical environment. They now live indigent lives in very poor conditions, sheltering in crude shacks and generally with no amenities such as electricity, water or motorized transport of their own.

The artisanal fishermen only fish within the lagoons created by the barrier reefs. At most, they may venture a little beyond the reef but refrain from going deep-sea fishing as their boats and engines are too small. However, there is general agreement among all fishery officials of the Red Sea State regarding the following: (1) the sustainable yield is very much higher than the current fish harvest in the lagoons; (2) the lagoons are generally unpolluted because of the simple fishing techniques employed by artisanal fishermen.

Fishing gear (marine fisheries): Fishing gear in use by local artisans includes pole-and-line, longlines trolling, cast nets, gillnets and beach seines. Trawling is practiced by a limited number of small-sized, commissioned or contracted trawlers in confined areas in the southern and northern parts of the Sudanese Red Sea, and generally operated seasonally, targeting shrimp, lizard fish, goat fish and threadfin bream. The irregular seabed limits trawling operations to an area of 71 000 ha in Delta Toker (29 500 ha), the Gulf of Agieg (6 500 ha), Mersa Mogadam (3 000 ha), Khor Nawarat (2 000 ha) and a few other small areas.

Finfish fishing activities are primarily artisanal, using traditional gear, craft and fishing techniques and operating close to shore. Investments in commercial fisheries are limited, though increasing, using small- and medium-size trawlers and purse seiners. Some firms are engaged in collecting and marketing fish through different forms of production arrangements with local fishermen.

Fish species: There are 49 species of cartilaginous fish in Sudanese waters, belonging to 11 families, of which sharks constitute 57 percent. The most popular species are the thresher shark (*Alopias vulpinus*), the rusty shark (*Ginglymostoma ferruginem* syn. *Nebrius ferrugineus*), the tawny nurse shark *(Nebrius ferrugineus)*, the tiger shark (*Galeocerda cuvier*), the smooth-hound or smooth dogfish (*Musttellus canis*) and the dog shark (S*coliodon palasorrah* syn. *Rhizoprionodon acutus*).

The reported bony fish fauna includes 280 species, but 60 to 70 percent of the finfish catch is *Epinephallus aerolatus, Lotijanus bohar, L. gibbus, Lethrinus* spp.*, Caranx* spp.*, Plectropomus maculatus, Aprion* spp.*, Scomberomorus commerson* and *Mugil* spp. Crustacean resources have not been adequately studied nor quantified. Crustaceans belonging to the families *Penaedae*, *Palinuridae* and *Potunidae* have been reported in coastal waters. Eight species of shrimps and prawns have been recorded in the catch, of which *Peneaus semisulcatus, P. latisulcatus* and *Metapeneaus monocerus* form the bulk of the harvest. Mother-of-pearl oysters (*Pinctada margaritifera, Trochus dentatus, Strombus* and *Lambia* spp.) are exported to Europe as raw material for button manufacture, cosmetics and inlay work.

The coral reef population is a unique and highly regarded national heritage that deserves utmost attention to preserve. There are three types of coral reefs: fringing reefs, barrier reefs and atolls. In these areas, the threatened dugong, sea turtles, sharks, manta ray and resident and migratory birds such as osprey, goliath, heron, white-eyed gull, sandpipers and crab plover have been reported. There are other living marine resources that are either untapped or sporadically fished. These are considered below.

Sea cucumber (*Echinoidea*) fishing has increased in recent years. Diving for sea cucumbers is practiced by local divers along the coast from April to October. The harvest is mainly for export to the Gulf countries. Although no proper export records are available, some indications of over-fishing have been observed. Mammals are represented by *Dugong dugong* and three species of dolphins, namely the common dolphin (*Dolphinus dolphin*), the bottlenose *(Turspis truncates*) and the humpback (*Sousa plumbea*).

Of the four species of sea turtles that had been reported in the Red Sea region, only the green turtle (*Chelonia mydas*) and the hawksbill (*Eretmochelys imbricates*) have been observed to roam and nest in Sudanese waters, particularly in the Sawakin Archipelago in the south and Makawar Island in the north. A population density of some 3 500 individuals was estimated in 1989. No current statistics are available.

Studies have documented that the mangrove plant (*Avicennia marina*) forms an important ecological system in bays and islands along the Sudanese coast, with well-established canopies, moderate aggregates, small aggregations or relic-thin populations. These ecosystems have suffered from heavy cutting, grazing and blocking of freshwater runoff routes. Seaweeds include eight species, of which *Halophila ovalis, H. stipulacea, Haloduleuninervis* and *Thalassia hemprichii* are frequent or common.

Marine fish potential: Estimates for finfish potential in the Sudanese marine waters vary, ranging from 6 000 to 35 000 tonnes per year. However, a conservative estimate of 10 000 tonnes per year has been adopted for this study.

1.7.5 Aquaculture

Aquaculture in Sudan dates from 1905, in the case of mariculture, and from 1953, in the case of freshwater culture. Mariculture has focused on culture of the mother-of-pearl oyster (*Pinctadamar garitifera*) and, more recently, on shrimp culture. The inland capture fisheries concentrate on tilapia, *Labeo sp.*, *Lates niloticus* and other native species. These inland fisheries include *haffirs*, reservoirs and irrigation canals with individual water capacities ranging from thousands to few million cubic meters and depths of 1 to 20 m. In the Gezira Scheme, the canal network consists of 5 649 km, with a depth range of 0.50 to 0.75 m. Similarly, there are other canal systems in the Managil Extension, the Guneid Sugar Estate and the Khashm El Girba Project.

Fish farmer categories include:

- Local inhabitants in rural communities, such as oyster farmers, who are generally dependent on subsides and financial support from the state government, NGOs or donor funds. They mainly rely on family labour. Many of these farmers are also fishermen and may be enrolled in fisher organizations (for example in the Mohammed Goal area).
- Small-scale fish-farm owners in urban areas around Khartoum and other cities, who are generally comparatively well-off middle class citizens. Some of them self-finance their businesses, while others obtain bank loans to start or further develop their farms. There is no known association for this category except possibly personal membership in the Fisheries Trade Chamber or similar organization.

- Semi-industrial fish farming in freshwater (finfish) and marine waters (shrimp), practiced by capable investors.

Freshwater fish culture: Freshwater fish culture is carried out predominantly in earthen or concrete ponds. Pens and cages are rarely used. There are both public and private sector farms. Fish seed is either collected from the wild or through breeding facilities within the farm.

Freshwater fish culture consists mostly of pond culture of the indigenous species *Oreochromis niloticus* (the Nile tilapia). Other local species, such as *Lates niloticus, Labio spp.* and *Clarias lazira*, have been tried, but not yet released to farmers. Exotic species, such as the common carp, have been introduced for experimental culture in combination with *Oreochromis niloticus*, or for use as biological control agents (the grass carp, for example) to eradicate aquatic weeds infesting the irrigation canals of large agricultural schemes.

The culture systems are basically extensive and semi-intensive. As of yet, freshwater fish culture has not developed into a vertically integrated economic activity, despite the existence of favourable conditions. For freshwater fish culture, emphasis was placed on extensive and semi-intensive pond culture of the indigenous *Oreochromis niloticus* in monoculture or polyculture systems. Some trials of pen culture were conducted as were trials of seeding rainwater impoundments and dams with tilapia species as a form of rural fisheries-based aquaculture.

Marine-culture: Based on successful pioneer work, oyster cultivation started in the forms of both mass production and family farms, using bottom-culture techniques. The cultivation was aimed primarily at producing oyster shell for export, with some produced for local use in button manufacturing, inlay work and cosmetics. Considerable research has been devoted to developing oyster cultivation, which is meant to reduce the stress on the natural oyster population, boost consistent and steady production and improve the socio-economic status of the rural populations. The prolonged research has culminated in the verification and adoption of sound and viable alternative culture technologies, based on hanging methods. These methods paved the way for the economically viable expansion of family-run oyster farms along the coast and triggered the creation large investment enterprises in artificial pearl production as a pioneer intervention of the private sector.

Oyster culture is carried out by persons living in coastal areas of the northern zone of the Sudanese Red Sea. The culture operation consists of three stages: spat collection, nursery and rearing to market size. Spat collectors are hired during summer months and the catch is kept in multi-deck hatchery trays covered with galvanized wire mesh for protection, and finally transferred to trays suspended from long lines. It takes three years to produce market-accepted-size oyster shells.

Culture – base fisheries: In 2010, El Rahad Lake and Esounot Dam recruited with *Oreochromis niloticus*, *Lates niloticus* and *Bagrus bajad* and *Bagrus docmak*, *Clarias gariepinus* and *Labeo niloticus* fingerlings after studying the fisheries biology of the reservoirs. Stocking the El Rahad and Esounot Dam with fish seed has played an important role in the food security of fisher households and consumers of native fish. The stocked fish live and grow in Rahad Lake and Esounot Reservoir, consuming the naturally-produced food organisms in each.

The fisheries sector has successfully mobilized the rural communities by providing work opportunities in various activities related to fish production, processing and marketing. The organization of fishers into societies, unions and associations improved conditions in these communities and increased their solidarity and political influence. In 2011, fish were introduced to Miri Barah, and to Lake Keilak from Esounot. Specifically, in Lake Keilak, 30 000 specimens of *Oreochromis niloticus* and 1 000 specimens of *Oreochromis niloticus* (brood fish) were introduced from the Esounot Reservoir.

Recreational fisheries: Thus far, the development and management of recreational fisheries has been a low priority as a consequence of the very difficult food security situation. Despite this, some marine sport activities (scuba diving, underwater photography, hunting and seafaring) and inland water sport activities (such as angling), and some successful ornamental fish businesses have been developed by some citizens.

1.7.6 Fish marketing and post-harvest use

Finfish is marketed and consumed fresh (70 percent), sun dried (25 percent) or wet salted (5 percent). The fresh fish is transported from distant fishing grounds to consumption areas in the capital, Khartoum, and other cities, either chilled or refrigerated. Sun-dried fish is mostly marketed in rainfed and mechanized agricultural schemes to be used as food for the workers and labourers of the schemes. Wet salted fish (mainly *Hydrocyon* sp., *Alestes* sp. and *Mugil* sp.) is for local consumption or export. Insignificant amounts (mainly discards and offal) go into fish and poultry feed production. Some infrastructure for fish handling, preservation, processing and marketing is available.

Shells of the mother-of-pearl oyster and the gastropod *Trochus dentatus* are exported to some European countries. Other shells are harvested and sold locally as a source of calcium for poultry feed or as souvenirs. A portion of the catch supports local handicrafts and cosmetics cottage industry. Shrimps and prawns are sold locally as a high-value delicacy food, particularly in high-end hotels.

Fish marketing: There is a high demand for fish in Khartoum and fish is brought in from several fish-producing states. With the exception of some shrimp, all landings are of freshwater fish products. As for marine fisheries and mariculture, Port Sudan is the principal consumer. Some other towns in the Red Sea, Kassala and Gadarif States are also market destinations for marine products.

Companies and fish brokers transport fish to the market areas by means of insulated trucks or chilled in iceboxes. Fishes produced from freshwater fish farms are marketed fresh.

Fishing units located in authorized fishing camps whereby fishermen enter into agreement with fish traders in these camps, there is a real commercial affiliation of fishermen with the owner of a given camp resulting to monopolistic situation in the other types of camps, (*tayas*) commercial affiliations is less which results in a more classical oligopolistic situation with fishmongers.

Dry fishes (*kajeke*) are transported and sold to farmers in large irrigated schemes. Dry salted fishes are marketed to big cities and a portion is exported to Saudi Arabia and Egypt.

1.7.7 Contribution to the economy

The contribution of fisheries to the Sudanese GDP is marginal, though the exact value is not recorded because of the prevailing poor statistical data collection. However, the total value of fish exports in 2009 was USD 0.2 million and per capita fish consumption was 1.8 kg. Despite the fact that the contribution of fisheries to GDP is extremely low, fish and fish preparations contribute to the food security of a large sector of the rural and urban communities. Fisheries also provide secondary employment and a source of income that indirectly contributes to household food security.

The aquaculture industry is not developed as yet. Sudan's inland and marine capture fisheries are small-scale and semi-industrial. If properly managed, such fisheries could satisfy subsistence requirements and provide a good margin for large investments, particularly in the areas of freshwater fishing, mariculture and off-shore capture fisheries and related facilities and supplies. However, a number of constraints limit the magnitude and trend of fish resource utilization and the development of the fisheries sector.

1.7.8 Policy and institutional issues:

Constraints include the lack of or inadequate fishery policies and management, laws and regulations, monitoring and statistics, infrastructure and institutions, investments and financing, capacity and training and processing and marketing.

The major issues related to fisheries exploitation are the following:

- difficulties in monitoring and, therefore, controlling fishing capacity and efforts due to the geographic dispersion of fishing sites, the great size of water bodies, the multi-gear nature of fisheries and the migratory behaviour of some fishermen;
- presence of different fisher communities with different modes of exploitation;
- access to fishing grounds, sometimes by appropriation, sometimes legally, when referring to temporary fishing camps established by migrant fishermen or by the owners of the authorized camps;
- few management practices that could contribute to regulating existing fishing effort;
- lack of social cohesion and organization of fisher communities in general;
- market constraints at most fishing sites.

Institutional Support: The main central fisheries authority in the country is within the Ministry of Animal Resources and Fisheries. It is responsible for planning, formulating policy, providing training and extension services and overall supervision of the fisheries sector. This entity discharges its obligations from its headquarters and associated structures based in Khartoum, in close coordination with 13 state fishery departments and relevant public and private sector institutions and agencies.

The government has also established the Fisheries Research Centre under the umbrella of the Animal Resources Research Corporation, which is attached to the Ministry of Animal Resources and Fisheries. The Centre performs its functions through six specialized stations geographically positioned to cover the most important inland and marine waters. These are located in Khartoum (the headquarters), Port Sudan (the Red Sea Research Station), Kosti (the White Nile Research Station), Wadi Halfa (the Lake Nubia Research Station), El Damazin (the Roseires Research Station), Half El Gadieda (the Khashm El Girba Research Station), Khartoum (the Aquaculture Research Station) and Merowe (the Merowe Research Station).

The government also set up the Fisheries Training Institute as a specialized training facility within the Fisheries General Administration of the Ministry of Animal Resources and Fisheries. It provides short-term training courses targeting fisheries officers and fishers from the public and private sectors. Arrangements are underway to restructure and upgrade this institution to develop it into an effective managerial tool for capacity building.

In addition many of the over 100 universities and colleges distributed throughout Sudan are engaged in fisheries and related disciplines. The fisheries sector benefits from these facilities through education, training, research, participation in technical committees and community development.

Other institutions included in fisheries policymaking and research include the Fisheries Council, a coordinating structure within the Ministry of Animal Resources and Fisheries with representatives from interested public and private institutions and agencies; the Fisheries Technical Committee of the Sudanese Standards and Metrology Organization (SSMO), an advisory committee responsible for drafting fisheries standards and specifications and advising on other matters pertaining to the development of fish products, trade, quality control and consumer safety; the Advisory Council of the Ministry of Animal Resources, a high-ranking technical council representing all fields and activities of the Ministry of Animal Resources; and the Higher Council for Environment and Natural Resources, a coordination body within the Ministry of Environment and Physical Development and acting as a national focal point for issues, programs and conventions of environmental concern.

Fisheries management in Sudan takes into consideration issues outside the fishery sector, including the following:

1. Water policy: Priorities have been established for agriculture, generating electricity, navigation and other Nile river basin management purposes. It must be taken into account that fisheries in reservoirs are de facto a by-product of water policy objectives.
2. Environment policy: The Ministry of Environment has no legal power to implement environmental policy. The body responsible for this is the Higher Council for Environment and Natural Resources.
3. Animal resource policy: It is believed that even within the Ministry of Animal Resources, the fisheries subsector is not assigned great importance.

SECTION TWO

Trajectory and dynamics of structural change affecting the sector

As has become clear from the description of the different small-scale farming subsystems, the development of small-scale family farming in Sudan is being influenced by a host of drivers. These include changes in the country's demography, increased competition over natural resources, intense conflicts, the secession of South Sudan, migration and population movements, urbanization, environmental deterioration, climate change, a gold rush, governance and institutional changes, globalization and technological development. The purpose of this section is to analyse the implications of these changes on agriculture in general and small-scale farming in particular by reviewing these exogenous developments and analysing the concomitant domestic economic adjustments and some general social developments.

2.1 Exogenous Drivers

2.1.1 Demographic developments

In 2014, Sudan had a population of about 39 million, growing at 2.3 percent per year.[30] The country has yet to experience demographic transition. Settlements are concentrated along the water sources, many of which are clustered along the River Nile and its tributaries. Though the country is sparsely populated[31] and population density is low (22 persons per km^2), population pressure is being felt in areas with fertile land and/or abundant water. The population is relatively young (about 41 percent below 15 years and 61 percent below 25 years). Sixty-seven percent of the population resides in rural areas, living either a sedentary lifestyle (57 percent) or a nomadic lifestyle (10 percent). Thirty-three percent of the population lives in urban areas[32] with a high level of concentration in metropolitan Khartoum, partly because of the presence of 2 million displaced persons. According to World Population Prospects, if the

[30] Population growth rates in Sudan differ significantly from one source to another.

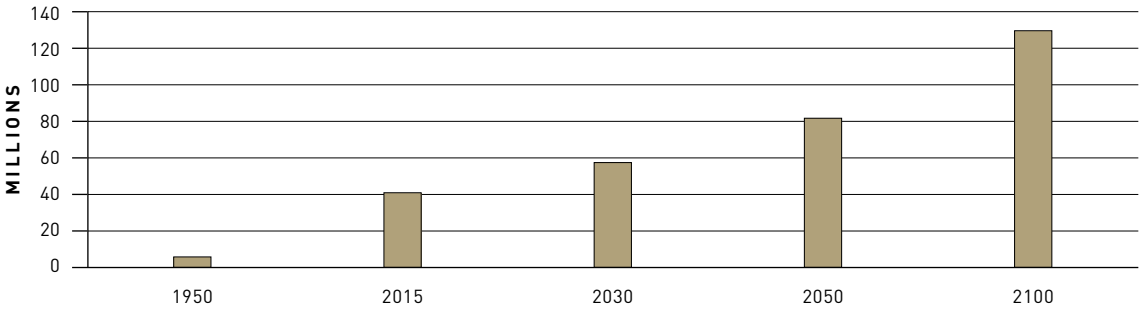
[31] This is mainly because of the arid conditions.

[32] The percent of urbanization increased from about 19% in 1975 to 24% in 1995 and to 34% in 2010. The early investment in large agricultural projects kept rural population... However, during the 1980s, drought and conflicts led to significant movements of population (lack of social services and employment opportunities).

current trends continue, the population of the country will reach 56.443 million in 2030 and 80.284 million by 2050.[33]

In addition to the large number of displaced population, the country has also been experiencing emigration to neighbouring and other countries, as well as receiving a significant inflow of immigrants. Migration is caused by disparities in employment and incomes between the different parts of the country as well by an increased frequency and duration of droughts. The major implication of the increase in population, especially among the rural population, is the pressure on land for food production.

Figure 2.1 **Projection of population growth (2015-2100) (in millions)**



Source: United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects (2015).

Additionally, in view of the increased commercialization of agricultural production, land was also sought for cash crops. Importantly, the increase in commercial production initiated a fundamental transformation of the small-scale family farmers. The pastoral communities were significantly affected by the competition over land. At the start, they were slower to adjust to the changing conditions. Until recently, it was noted that pastoral herders had downward sloping supply curves: the higher the prices of the cattle, the less they would sell. The individual objective function was to maximize the herds, which have been sources of status and measures of wealth. This cultural attribute, however, is undergoing change with the small-scale livestock sector, increasing its supply to both the domestic and external market. However, increased crop production and the rise in the number of livestock put heavy pressure on land.

2.1.2 Drought and climate change

About half of the land surface in Sudan is susceptible to periodic droughts. Large areas are ecologically sensitive and require careful management for sustained agriculture and pastoral production. Several incidences of drought in the one area of the country or another were reported during the last two centuries. A major drought affected the country during 1888-89, the famous *sanat sita,* during the Mahdiya rule. Also during the colonial era, between 1933 and 1939, the country was hit hard with a prolonged period of rain shortfalls and drought.

[33] United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects (2015).

Another drought hit the country from 1951 to 1953, another occurred in Darfur from 1969 to 1973 and another occurred from 1979 to 1983, leading to large-scale famine and migration. The country suffered another drought during the 1980s (1983-1985) and from 1990 to 1991.

Thus, in addition to population growth and the increase in the number of livestock, pressure on land and grazing was also exacerbated by soil degradation. The expansion of cultivation and animal husbandry reduced fallow lands and resulted in greater use of marginal lands. The increase in the frequency of droughts, the decline in rainfall since 1969,the drop in precipitation and creeping desertification in the northern part of the country have been considered by some scientists evidence of permanent climatic change. Continuing climate change is expected to further diminish rainfall.

Some experts maintain that since most land in Sudan is arid or desert, the country is highly vulnerable to climate change and rainfall variability. They note that, over the past fifty years or so, annual average rainfall in the country has declined. The wide fluctuations in rainfall and the periods of drought[34] and flooding which occur from time to time are also considered evidence of on-going climatic changes. Such change will significantly impact small-scale rainfed agriculture. While rainfall variability in terms of both quantity and timing, a characteristic of the savannah and semi-arid zones of Sudan, increases the risk of reduced food availability; drought poses the risk of complete crop losses. A pessimistic scenario predicts that the "humid agro-climate zone will shift southward, rendering Sudan increasingly unsuitable for agriculture, resulting in the decline of crop and food production. The area of arable land, including the gum arabic belt, would shrink. Droughts, floods, pests and pathogen outbreaks would increase. Climate change could affect the amount of crops produced, forage and feed, water availability and, indirectly, the spread of livestock diseases. Higher temperatures would lead to a decline in dairy production, reduce animal weight gain, cause heat stress affecting reproduction, increase production costs and lower food conversion efficiency in warm regions." These changes would have serious consequences on human settlements and conflicts.

2.1.3 Conflicts

For more than five decades, Sudan suffered from internal conflicts. The conflict in South Sudan was the longest. The first round of conflict began in 1955 and lasted until 1972 when the Addis Ababa Agreement was signed, giving South Sudan regional autonomy. Conflict erupted again in 1983 and continued until 2005, when international partners arbitrated a peace agreement between the Sudanese government and the Sudan People's Liberation Movement (SPLM). In accordance with the agreement, a referendum was carried out in 2011, which led to the secession of South Sudan from the north. Since then, two other major internal conflicts have erupted: one in eastern Sudan, between the Beja Congress Party and the Sudanese government, and the other in Darfur, between the government and various Darfuri movements. Although the first one was resolved in 2006 with the signing of the Eastern Sudan Peace Agreement, the Darfur conflict has dragged on and gained international publicity. Other conflicts have also erupted in the Blue Nile and Southern Kordofan states.

[34] Severe drought was experienced during 1980-84 and less severe droughts took place in 1989, 1990, 1991, 1993 and 2000. Floods also occurred in 1946, 1952, 1988, 1989, 1990, 1991, 1993, 2000 and 2001.

The Darfur region (consisting of five states) lies in the west of Sudan, next to Chad. Its population is currently about 8 million, constituting 25 percent of the total population of the country. The region is geographically and ethnically diverse. There are two main lifestyles in the region: sedentary agro-pastoralists and sedentary agriculturalists who grow millet, sorghum, groundnuts, okra and various fruits; and nomadic pastoralist herders who practice transhumance, migrating from the north to the south, reaching southern Sudan. The latter group include camel owners (abbala) and cattle owners (baggara). In addition to these nomads, new groups of migrant tribes from neighbouring countries arrived in the region over the last two decades.

The underlying causes of the conflicts in Darfur, as well as in other regions, are the struggle for control of natural resources and competition for political power. Some of the conflicts are intertribal, caused by competition over land, aggravated by the growth of the population and land degradation. Intertribal fighting existed in Darfur for decades, starting with tensions between the sedentary rural farmers and the nomadic pastoralists and triggered by competition over land and other natural resources.[35] The increase in the population of the region, which doubled over the last 25 years, the expansion in livestock and crop cultivation, lack of alterative livelihoods and work opportunities and environmental degradation all contributed to the conflicts that trouble the Darfur region.

Tensions escalated during the 1990s and exploded to a full-blown war between some Darfuri movements and the government in 2003. The fighting and hostilities led to the displacement of an estimated two million rural dwellers, approximately 1.7 million of whom moved to refugee's camps or urban centres in the region (Nyala, Fashir, Genina and Zalinga) or to other parts of the country. Two hundred eighty thousand took refuge in neighbouring Chad. Thus, the conflict had in serious socio-economic consequences: loss of lives, disruption of livelihoods, destruction of infrastructure and disruption of trade[36]. According to a report on Darfur, "the conflict and long term underdevelopment in Darfur either destroyed or severely impacted livelihoods for almost all Darfuris. The systematic destruction of assets and the displacement of rural communities was a common phenomenon of the conflict, as homes, markets and productive assets were destroyed or broken, along with the transport infrastructure that facilitated trade. Cattle and livestock were looted, crops were deliberately damaged, seeds stolen and irrigation and water systems rendered inoperative. Insecurity curtailed freedom of movement, impacting both traders and pastoralists. The majority of urban traders went bankrupt and crop production was radically reduced.[37](Darfur Joint Mission Report, 2013).

The rise in looting and lack of security led many small herd owners to sell their stock, which had become a liability. This situation necessitated humanitarian assistance on a large scale and the presence of peacekeeping forces (United Nations–African Union peacekeeping troops).

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[35] Peace Agreement included the establishment of Darfur Land Commission

[36] Gerald J. and Dorothy R. Friedman, "On the Hoof Livestock Trade in Darfur'; September 2012 prepared for the United Nations Environmental Program (UNEP). The authors are from School of Nutrition Science and Policy, Tufts University.

[37] Darfur Joint Assessment Mission, "2013 – 2019 Development Darfur: A Recovery & Reconstruction Strategy". A report prepared on behalf of the Darfur Regional Authority, 2013.

Rounds of peace negotiations were held in Ndjamena, Chad; Abuja, Nigeria and Doha, Qatar. A regional authority was established to oversee all of Darfur.

The land tenure system is a potential and actual source of social conflict: A UNDP study (2008) established a link between the land tenure regimes and current local conflicts in Sudan. A field study conducted by Abdelatif Ijami (2005) among respondents representing traditional farmers, pastoralists and the semi mechanized scheme farmers recognizes semi mechanized farming as a major factor fuelling conflict and perpetuating inequities and social grievances on the clay plains of central Sudan. A pastoral land tenure study (UNDP, 2002) attributes the proliferation of local conflict between pastoralists and farmers to a complex of factors. An IFAD study (2008) reports that the context of land tenure has been radically changed and transformed. This was why the peace agreements included the establishment of a land commission to provide a legitimate institutional structure to deal with the issue of land and land-related conflict.[38]

2.1.4 Impact of the secession of South Sudan

The evident result of the secession of South Sudan has been the loss to the country of an important and sizeable segment of the population of about 10 million, most of whom resided in Southern Sudan but, because of the prolonged conflict, a many were living in the north. In addition to the decrease in population, which had effect on the labour force, there was a significant loss of territory. The total area of Sudan shrank from 2.5 million km to 1.8 million km, with the southern, separated territory being richer in terms of forestry and having higher rainfall. The secession of South Sudan also reduced the revenues of the government of Sudan and provoked a serious macroeconomic shock. The government of Sudan was compelled to develop a diversification policy and reform the agriculture sector as an engine of growth. It also aggressively sought direct foreign investment, including in agriculture.

The border between South Sudan and Sudan is about 1 937 km long, running along the states of Blue Nile, White Nile, Sinnar, South Kordofan and South Darfur. These (north) Sudanese states have a total of over 47 million livestock, 17.5 million cattle, 16.4 million sheep, 12.8 million goats and 0.7 million camels. The northern part of South Sudan provided grazing lands for tribal groups from these states. The pastoral system was highly dependent on migration during the dry season. Frequent droughts in the semi-arid zone, the encroachment of semi-mechanized rainfed farms and the rise in the number of livestock made the southward movement extremely important. After the secession of South Sudan these nomadic groups, who used to migrate south searching for richer grazing lands and water, were restricted in their movement and now have to compete in areas that are already crowded and are relatively poorer in grazing land. Taor and Siddig (2012), who studied the impact of the secession on the nomadic groups of South Kordofan, noted that the secession added to the problems of

[38] According to a UN report: "Competition over land and natural resources, exacerbated by drought and desertification, population pressures and limited livelihood options particularly for nomadic population, are all components of protracted conflict and on-going environmental crisis. The struggle for political and ideological power, political and economic marginalization, ethnic tensions and the progressive weakening of local governance, coupled with increase resource scarcity, are all fundamental root causes of the Darfur crisis". "Sudan Country Analysis Nov 2007 prepared by the UN with the support of the Go National Unity and the Government of Southern Sudan.

insecurity and desertification, intensifying the competition over land and, therefore, setting the nomadic tribes against each other and against the farmers. Livestock has become vulnerable to lack of water and diminished grazing land.[39]

Taor and Siddig also mentioned that the secession of South Sudan reduced the availability of seasonal labourers. Southern Sudan used to provide a significant number of seasonal labourers to the agricultural schemes. The same study by Taor and Siddig (2012) also stated that the shortage of labour in Kordofan and Darfur happened after the signing of the Comprehensive Peace Agreement and the secession of South Sudan. The labour shortage led to a sharp increase of agricultural wages. The study maintained that this new development necessitated "urgent need to scale up improved seed technology, and animal-drawn implements". What was not mentioned is the possibility that rising urban and agricultural wages prompted more small-scale farmers to migrate seasonally or permanently in search of paid work.

The secession of South Sudan did not end all the hostilities between the governments of South Sudan and Sudan. Borders between the two countries have not been demarcated and one important region, Abyie, remains a disputed area. Consequently, large tracks of land and communities of small-scale farmers are affected by lack of insecurity and displacement. Trade in sorghum, the staple food for a significant number of South Sudanese, has been disrupted. Sudanese owners of semi-mechanized schemes in the Renk region of South Sudan are no longer allowed to cultivate these schemes.

2.1.5 Migration, urbanization and population movements

Though conflicts were responsible for the displacement of a large number of the population estimated at 2 million in 2010, population movement for the most of the time was a voluntary act of small-scale farmers responding to a changing environment. Sudan is no exception to the phenomenon of internal and external migration of the labour force. Economic theory describes immigration based on pull and push factors and as a process of surplus labour moving from rural economies to urban centres. In Sudan, there have been movements both from rural to rural areas and from rural to urban areas. The establishment of irrigation schemes in central Sudan and the need for seasonal agricultural labour, as mentioned earlier, resulted in large migration from the less fortunate areas. During the 1980s, population movements increased as a result of droughts, conflicts and the regional disparities in access to economic opportunities and basic health and education services. A field study undertaken in the Darfur region by Helen Young showed that labour migration and remittances constitute the second most important source of income, after agriculture. Farmers migrate to other areas in Darfur and to Omdurman, Libya or Saudi Arabia. Young estimates that the value of annual remittances totals between USD 78 and USD 350 per family, including money, clothes, sugar, flour, edible oil, biscuits, mats, radios and televisions.[40]

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[39] Taor and Siddig. 2012. "The impact of the secession of South Sudan on South Kordofan State. Khidab Magazine, No. 2(January-June and No. 3 (July-December), 2012 (in Arabic).

[40] Helen Young, "Livelihood, migration and remittance flows in times of crisis and conflicts: case study for Darfur, Sudan". Human Policy Group (HPG), Study researched and written by the Feinstein International Center. September 2006

The urbanization process in Sudan accelerated rapidly after independence. From 1960 to 2000, the urban population grew, at an average rate of about 6.3 percent per year. As a result, the urbanization rate increased from around 11 percent in 1960 to 33 percent in 2014. However, the growth in urban population, which slowed down for a period, has taken off again due to the war and the rise in income disparities brought about by the discovery of oil. Khartoum received a disproportionately large share of internal immigrants. Other urban centres also have also mushroomed as a result of both pull and push factors. One example is the case of Nyala city, in Darfur.[41] During the early 1970s and mid-1980s, Darfur was afflicted with severe droughts. Consequently, rural people from northern Darfur moved southward where rains were more plentiful. Most of them settled in the city of Nyala. The eruption of conflicts resulted in increase of people in its hinterland to Nyala in search for security and jobs.

According to the United Nations Population Fund (UNFPA), in 2007 about 3.7 million people in Sudan reported that they are new comers to the locations they currently lived in. The total urban population in the country is currently about 13 million. It is projected to continue increasing by about 3 percent per year to about 21 million by 2030, at which time almost 40 percent of the population will be in urban areas. As a general rule, initially, only a few members of rural households, mostly adult men or adolescents, migrate. These first migrants are normally deprived of the rural in-kind income, such as food produced on a subsistence basis, and their social networks are disrupted. Some of them constitute the urban poor. In theory, urbanization can drive growth in the surrounding rural areas. Urbanization is associated with higher income and productivity. Masimiliano Cali (World Bank, 2013) maintains that urbanization has a significant poverty-reducing effect on surrounding rural areas. However, urban-rural linkages explain this and it is not due to the relocation of the rural population to urban centres. The expanding urban population reflects the urban-rural linkage in an increase in demand for rural produce.

A second factor is the urban-rural remittances associated with urbanization. Urbanization is also credited with lower transaction costs, easier knowledge spillover, more efficient labour markets and easier access to markets and links with the global economy. However, in Sudan, urbanization has been accompanied by the creation of slums in urban centres. Urban centres are characterized by congestion, pollution and social tensions. Migrant families are separated and children are raised by the elderly and grandparents.

In Khartoum and other cities, the population has been polarized between those who benefited more from the oil boom during 2000–2011 and the migrants and refugees on the outskirts of the cities. The increase in incomes and urbanization resulted in a change in the patterns of expenditure and led to the expansion of the urban food market, especially in high value items such as vegetables, horticultural products, poultry, fish and dairy. This has given rise to increased commercial production in land adjacent to the cities. Some small-scale commercial farms sprang up. However, these commercial farms have to deal with a changed trading sector, with the emergence of large supermarkets that are directly linked with the small traders.

[41] Margie Buchanan-Smith and Helen McElhinney, "City limits: urbanization and vulnerability in Sudan: Nyala case study". ODI January 2011

Furthermore, reportedly, pressure has been placed on the small-scale dairy producers with regard to prices and demands for hygiene and quality.

2.1.6 Decentralization and institutional changes

The conflicts discussed previously led to political instability. Since 1956, multi-party democratic regimes were replaced three times by military systems. These events, together with fear of the breakup of the country led to the adoption of a highly centralized system of government. Poor governance and mismanagement exacerbated regional inequalities and the marginalization of a large portion of the population. However, ethnic and regional tensions eventually led to negotiating a constitutional arrangement that leaned toward federalism. Following a reform in 1992, the country adopted a three-tier system of government, consisting of the federal authority, state administration and local governments. The goals of the federal system were to achieve fairness between the different regions, improve service delivery and decentralize the development process.

The country is currently divided into 18 states, each of which is divided into localities. The states are headed up by governors (*walis*). The governor is assisted by state ministers and district commissioners. The federal government is assigned the responsibilities of foreign relations, defence and defining macroeconomic policies, including monetary, fiscal and foreign exchange. It is also in charge of large-scale federally owned agricultural projects, water policy and the transport and procurement of goods for public use. The states are in charge of providing basic education, health services and water. The federal government's control of the oil revenue and most trade taxes gives it fiscal power. Since the country has significant regional inequalities, different regions have different bases for revenue generations. Khartoum State and other states in the central eastern part of the country are much better off than the rest of the states (Table 2.5). Though the government has established a system of revenue transfer to the states, it has not been possible to transfer sufficient resources to the states for them to be able to deliver on their responsibilities. Furthermore, they do not have the technical and institutional capacities to carry out their development mandate.

2.1.7 Gold mining

Since 2010, artisanal gold mining has significantly expanded in Sudan, driven by the high gold prices. By 2015, there were at least 110 gold mining sites spread over 10 of the 18 states in the country. These sites attracted a large number of individuals, estimated to be over half a million. A survey carried for a study sponsored by the African Development Bank showed that those who turn to mining or mining supporting businesses are normally young, mostly with a rural background and a low level of education. Nearly 50 percent of those working in the mines were originally farmers or herders. Most are from areas of traditional agriculture, and a sizeable number are from Gezira State.

Largely because of artisanal gold mining, the country's production of gold increased significantly from nearly 4 tons in 2009 to over 50 tons in 2014. Mining activity generated over USD two billion, more than the amount generated from the export of agriculture products. This expansion in the export earning capacity came at a time when the secession of South

Sudan led to loss of oil revenues. The earnings from gold exports reduced the pressure on the foreign trade balance, although the country continues to have an external imbalance. As such, the government was obliged to seek a diversification strategy, which, in effect, meant increasing non-traditional agricultural production.

The main impact of the expansion of gold mining on agriculture was the switch of thousands of farmers and agricultural workers to gold mining. As a result of the loss of agricultural labour, agricultural wages rose. Furthermore, gold mining is creating serious hazards for the natural environment and for the health of humans and animals.

2.1.8 Globalization

The increased interdependence of the world economy in trade and financial flows increased both the opportunities for local economies as well as their vulnerability of to changes in the global economy. It also changed the global environment in which smallholder farmers operate, affecting the demand for their produce and the supply of inputs. The rise in demand for energy has led to an upsurge in bio-fuels, which, in turn, caused spikes in the prices of food and other agricultural products. Fear of a permanent global food deficit generated interest in investment in Sudanese agriculture. Countries in the region, including North African and Middle Eastern countries, have also been concerned about the future food supply of their respective populations. This prompted renewed the interest in investment in Sudanese agriculture. Opportunities have thus been created for small-scale farmers to export their produce or engage in out-grower arrangements. On the other hand, competition over land increased.

Already, the smallholder farmers are been increasingly integrated into a regional market through the exports of livestock and horticultural products. Trade liberalization, in tandem with advances in international communications and logistics, have served to encourage global trade in agricultural products. However, there is a concern that increased global competition may not favour small-scale producers who lack access to the global market, assets, finance and market information. The emergence of supply chains in agricultural products operating at a larger scale may also be unfavourable to small farmers, unless they constitute producer associations.

2.1.9 Technological development

For decades, technological developments have been directly and indirectly affecting agriculture, including small-scale farming. The growth of knowledge, scientific developments and the advancement of modern technology have been influencing agricultural development in Sudan for more than a century. Pump schemes were introduced around 1910, tractors have been used since the 1940s and fertilizers have been widely used since the 1960s. A clear example of the impact of science on agriculture in Sudan was the introduction by the British colonial administration of a vaccination program targeting the rinderpest epidemic, which was a threat to the cattle. Consequently, the cattle population rose from 2 million in 1930 to 12 million in 1970. Another application of the fruits of technology was in the increased use of herbicides, insecticides and fungicides in large-scale schemes, though these were accompanied by great environmental hazards.

However, breakthroughs in genetic engineering, other fields of biology and chemistry and new emerging technologies, especially information technology and biotechnology, are creating great opportunities, as well as risks, for agricultural production, with far-reaching implications for small-scale farming. The application of biotechnology, such as the in-vitro acid, technique including the recombinant deoxyribonucleic acid (DNA) and direct injection of nucleic acids into cells or organelles, or the fusion of cells beyond the taxonomic family, is now widely used in such areas as vaccine technology, genomics, bioinformatics and molecular breeding. The use of genetically modified (GM) cotton led to heated debate in the country about the risks of introducing GM technology and using biotechnology.

These technologies can have a positive impact. They can help with climate change adaptation, providing better ways to fight pests and diseases. They can help produce more with less land and less labour input. They can improve food security and save the population from hunger and famine by discovering new high-yield varieties, as happened in the green revolution of rice and wheat in Asia. Yet, they do not go without risks. They may lead to the decline of family farms. In countries with less-developed technological capacities, like Sudan, local produce may lose competitiveness if the farmers do not take advantage of these discoveries. The countries may miss the opportunity to find ways to make crops tolerant to the high temperatures in the country. There is, therefore, the need to build an adequate regulatory and institutional framework and the scientific infrastructure to ensure the safety and proper use of these technologies. Furthermore, the lag between discovery, application and productivity should be reduced.

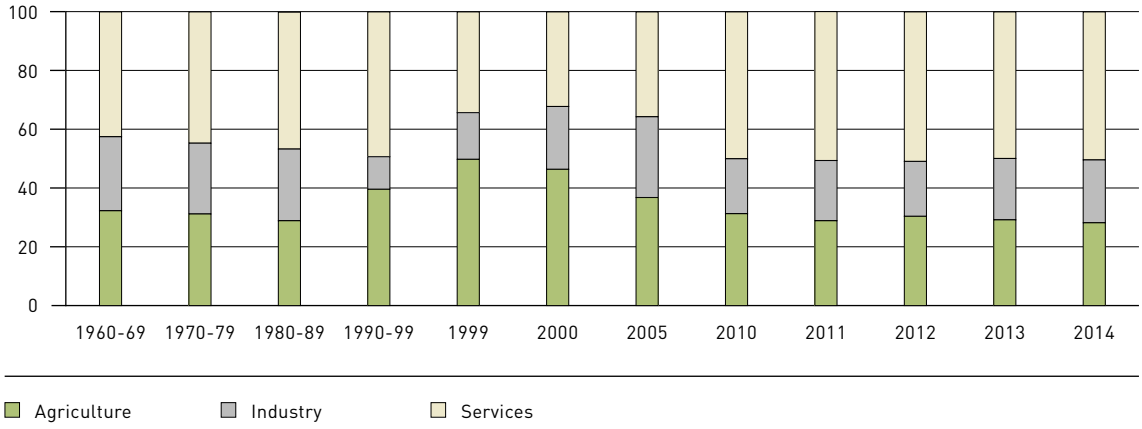
2.2 Economic Adjustment

2.2.1 GDP growth and composition over time

On the eve of Sudan's independence, agriculture provided livelihood for the majority of the population, accounting for 61 percent of GDP, whereas industry contributed little over 1 percent of GDP. However, as is evident in Figure 2.1 and Table 2.1, in the post-colonial era, significant changes took place in the composition of the GDP, with the rise in share of industry and services. By the end of the 1960s, the contribution of the agriculture sector had declined to just over 30 percent. Though it rose in the 1990s and reached a high point in 1999 and 2000, after that it declined to 30.4 percent in 2012. The contribution of industry fluctuated, falling to just over 20 percent in 2014, while the share of services reached half of GDP.

Recent growth of aggregate GDP and agriculture GDP: Although virtually throughout the period since independence agriculture was the main engine of growth; during the last 15 years, since the discovery of oil, the growth of aggregate GDP exceeded that of agriculture in 10 out of 15 years. The exceptions were 2002 (with an excellent harvest), 2009 (with the drop in oil prices) and 2011, 2012 and 2014 (after the secession of South Sudan and the loss of most of the oil revenue). (See Figure 2.2 and Table 2.1).

Figure 2.2 **Share of agriculture in GDP (1960-2014)**



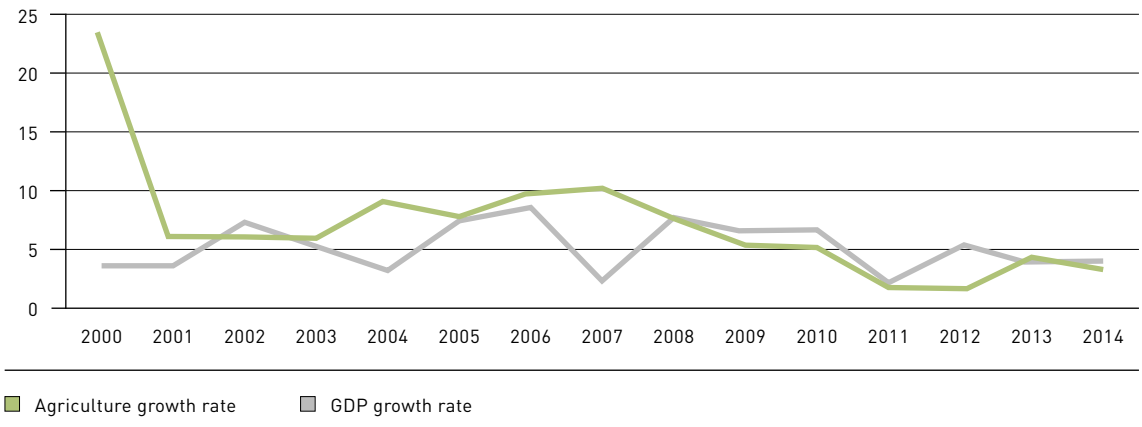
Source: Bank of Sudan: Annual Report, several years.

Table 2.1 **GDP composition during 1960-2014**

	Pre-Oil Era				Oil Era					Post secession of South Sudan		
	1960-69	1970-79	1980-89	1990-99	1999	2000	2005	2010	2011	2012	2013	2014
Growth real GDP (%)	-1.1	1.7	0.2	4.6	6.0	8.4	8.1	5.2	1.9	1.6	4.4	3.6
Sector/ GDP (%)	1960-69	1970-79	1980-89	1990-99	1999	2000	2005	2010	2011	2012	2013	2014
Agriculture	32.3	31.2	28.9	39.6	49.8	46.4	36.8	31.3	28.9	30.4	29.2	28.2
Industry	25.3	24.1	24.4	11.1	15.9	21.4	27.5	18.7	20.4	18.7	20.9	21.4
Services	42.6	44.7	46.6	49.3	34.4	32.2	35.7	50.0	50.7	50.9	49.9	50.4

Source: Bank of Sudan: Annual Report, several years.

Figure 2.3 **Aggregate GDP and agriculture sector growth rates (2000-2014)**



Source: Bank of Sudan: Annual Report, several years.

Table 2.2 **Aggregate GDP and agriculture GDP growth rates (2000-2014)**

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Agr growth rate (% change)	3.7	4.0	7.3	5.2	3.5	7.2	8.4	2.4	7.7	6.7	6.7	2.6	5.7	4.0	4.1
GDP growth rate (% change)	23.64	6.1	6.5	6.0	9.1	8.1	10.0	10.2	7.8	5.9	5.2	1.9	1.6	4.4	3.6
GDP per capita (US$ current)	394	413	452	525	622	751	989	1235	1430	1365	1655	2048	1806	1726	1876

Source: Bank of Sudan: Annual Report, several years.

Important landmarks in the country's economic history after independence include the expansion of irrigated schemes in central Sudan, the crisis in the cotton industry and the drive to diversify the economy. Another important economic event was the expansion of the private sector in rainfed mechanized farming, producing cereals and oil seeds. It also led the process of import substitution industrialization, focusing on basic consumer goods and agro-processing. There has also been an increase in non-tradable services, such as construction, finance, real estate and government services. The discovery of oil in 1999–2002 fuelled rapid economic growth. However, the boom came to a halt after the loss of oil revenue with the secession of South Sudan. The increase in gold mining discussed earlier is the most recent economic development with important implications for the structure of the economy.

2.2.2 Yields and productivity in the agriculture sector

Yield volatility: Although the contribution of agriculture to GDP has remained, for the most part, stable, there is a high degree of volatility in the aggregate produce and average land productivity of the various crops, as shown in Figure 2.3 and Table 2.3. According to El-Gilany *et al.* (2012),[42] less volatility and higher yields of various corps are realized under irrigated agriculture because of the higher certainty of soil moisture and the use of better technology.[43] This implies that small-scale farmers face a high level of uncertainty and food insecurity, as they are largely dependent on rainfed agriculture.

Table 2.3 **Yields of food crops: selected years (kg/feddan)**

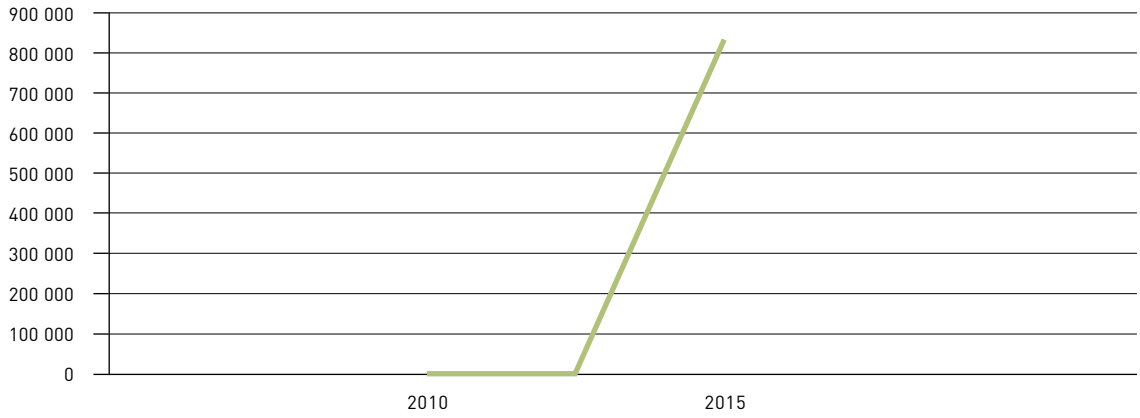
	Sorghum	Millet	Sesame	Groundnuts	Wheat
1961–62	408	269	238	314	683

[42] El-Gilany, A., Jamalludin, S. and Saidatulakmal, M. Mechanism of Poverty Incident in Agriculture Sector of Sudan. *Journal of Development and Agricultural Research Economics.* 4(14):371-383. December 2012.

[43] According to El-Gilany *et al.* (2012), there is evidence of gaps between the yield of on-farm trials and actual average farmers' yields in the trials made.

	Sorghum	Millet	Sesame	Groundnuts	Wheat
1970–71	314	253	169	371	562
2000–01	249	92	63	272	1094
2005–06	274	124	92	389	976
2010–11	267	98	103	289	668

Figure 2.4 **Crops production (2010-2015)**



Total Factor Productivity Growth: Two researchers, Antonio Flavio Dias Avila and Robert E. Evenson computed total factor productivity (TFP) rates for Sudan in a comparative study of developing countries.[44] While the calculation of TFP rates by itself was useful for understanding the performance of the sector, the authors' objective was to investigate the role of technological development in productivity growth. The study, which primarily used FAO data, supplemented in some cases by national statistics, calculated the production growth rates for both crops and livestock and weighted-average growth rates of such inputs as quality-adjusted cropland, pastureland, agricultural labour, synthetic fertilizers, animal feed, seeds, tractors and combine harvesters for the two periods 1961–1980 and 1981–2001. The study showed that the growth rates of TFP in Sudan were below the averages for African countries, Asian countries and Latin American and Caribbean countries.[45] The average growth rate of TFP for Sudanese agriculture during the entire period of 1961–2001 was 1.22, combining the crop (1.38 TFP growth rate) and livestock (1.07 TFP growth rate) subsectors. As shown in Table 2.2, the annual average TFP growth rate declined sharply between the first period 1961-1980 and the second period for crops, livestock and the aggregates. The combined average TFP growth rate declined between the two periods from 1.38 to 1.07.

[44] Dias Avila, A., and Evenson, R. 2010.Total Factor Productivity Growth in Agriculture and the Role of Technology Capital. In *Handbook of Agricultural Economics*. Vol. 4, Chapter 72: 3769-3899. Burlington, Academic Press.

[45] The data used for Sudan was gathered prior to the secession of South Sudan.

Table 2.4 **Crop, livestock, and aggregate total factor productivity growth in developing countries for the periods 1961-80 and 1981-2001**

	Crops		Livestock		Aggregate		Average 1961-2001
	1961-1980	1981-2001	1961-1980	1981-2001	1961-1980	1981-2001	
Sudan	1.47	0.75	1.31	1.24	1.38	1.07	1.22
Africa	1.03	1.74	1.49	1.09	1.20	1.68	1.44
Asia	1.71	2.02	2.20	3.45	1.92	2.50	2.21
L. America/ Caribbean	1.46	2.40	1.42	2.21	1.39	2.31	1.85

Source: Dias Avisa, A. and Evenson, R. 2010. Total Factor Productivity Growth in Agriculture and the role of Technology capital

2.2.3 The diversification drive

Crisis in the cotton industry: While the government continued investing in cotton schemes, the use of cotton in the global textile industry was challenged by the increased use of polyesters and other synthetic fibers. The international prices of cotton dropped from 135 cents per pound of cotton in 1951 to 36 cents in 1962–63. This affected both private schemes and the state-owned schemes.

The private schemes were affected by conflicts between the tenants and the scheme owners. With the rising cost of production and decreasing yields, cotton production had become less and less viable. The tenants were no longer motivated to spend their labour cultivating it. Mounting debt on the part of the tenants and the schemes and unrest led the owners to request government intervention. Thus, in 1967, the government took over all schemes with expired licenses and offered generous compensations. In 1970, the then military government in power nationalized all private schemes of more than 60 feddans. A public corporation, the Agricultural Reform Corporation, was established to manage these projects. This meant the continuation of the schemes under the management of a parastatal. The challenges faced by the Corporation were to rehabilitate the infrastructure of the schemes, reduce the costs of production and improve the marketing of cotton.

State-owned irrigated agriculture, which did not fare better, was, however, more able to initially absorb the price shock. However, as with the private schemes, low returns on cotton discouraged the tenants and led to rising tensions and confrontations. The newly established domestic textile industry absorbed only a small fraction of the cotton produced by rainfed schemes. The government's main response was to diversify crop production. The signing of the 1959 Nile Water Agreement made possible the expansion of the area under irrigated schemes at a rate of 100 000 feddans per year during the next decade. It also made possible vertical expansion in the existing schemes through crop intensification. The production of sorghum, groundnuts, vegetables and wheat were introduced as part of crop rotation in the new schemes as well as in the old ones.

The intensification drive came with a heavy cost to the schemes: average crop yields per feddan declined. Two of the explanations for the diminishing productivity of the schemes were, first that the efficiency of irrigated schemes declined because intensification brought

production to the limits of the physical and human potential of the schemes and, second, as noted in a World Bank report in 1979, "the expansion was at the expense of neglected maintenance of existing infrastructure". Consequently, the water delivery system was strained and crops were sometimes left without adequate watering. Intensification also affected crop sharing arrangements. Initiating and operating irrigated agriculture involved the construction of irrigation infrastructure (dams or pumps, irrigation networks, levelling and equipment), recurrent operational and maintenance costs, use of land, marketing costs, etc. Compared with rainfed agriculture, the costs of capital and recurrent costs of irrigated schemes were high. The approach of recovering costs from the tenants' produce had been a contentious issue. Initially, crop sharing was based on cotton production, and the use of water for other crops was related to cotton. Eventually, water charges on wheat, groundnuts and vegetables were introduced, while sharing was confined to cotton production.

Growth limits to semi-mechanizing farming: Semi-mechanizing farming provided an opportunity for increasing food production and further diversification with the production of oil seeds. Thus, starting in the 1960s, investment in this sector expanded to 6 130 000 feddans in the Gedaref region, Damazin, South Kordofan and Darfur. However, there were two major issues associated with semi-mechanized farming. First, semi-mechanized farming restricted the access of pastoralists to traditional grazing lands and stock routes, especially in the Blue Nile, Kordofan and Darfur. Several researchers documented this impact. Abusin (1989)[46] noted that the expansion of mechanized farms in the Habila area (of the Nuba Mountains) resulted in diminishing pastures, deterioration in grazing lands and the emergence of new types of grass, such as sheleni (*zorria glochidiate*), which are harmful to the livestock. The expansion of mechanized farms also reduced the access of traditional sedentary farmers to their land. Conflicts resulted from this competition over land. Secondly, the exploitative management of natural resources reduced land productivity. Semi-mechanized scheme owners would start farming intensively in one area for a short period and then move on to more attractive virgin land when yields declined, a practice likened to shifting cultivation. This practice led to soil erosion and even to desertification in some areas. According to Bello (2006), this model of development in the Nuba Mountains failed to promote regional development. An alternative, more superior model, according to him, could be "attainable through adaptation of sound integrated rural development plans aiming at introducing development projects based on appropriate technology suitable to the environment of the localities in the region"[47] (Bello, 1998).

Agro-based industrialization: Parallel to the diversification drive within the modern agricultural sector, the government pushed for an import substitution and agro-based industrialization. Interest in industrialization began early in the post-colonial era. As early as 1956, the first national government introduced "The Enterprise Concession Act" with the objective of promoting industrial development. It offered protection from foreign competition, tax exemptions and subsidies. Duties on imported raw materials, machineries and spare parts were reduced. Land and energy were provided at discounted rates. These measures redirected

[46] Cited by Bello, A. (2006). Development as a Historical Process in the Nuba Mountains Region in Sudan. Unpublished paper.

[47] Bello, A. 1998. op. cit.

a significant number of private investors to invest in the industrial sectors. Thus, from 1956 to1966, some 185 new industrial enterprises were established, compared to only six only from 1945 to 1955. In 1967, the government initiated more measures intended to redirect investment towards industry. The government also established the Ministry of Industry and Mining in 1966 and adopted the Organization of Industrial Investment Act in 1967, which offered favourable terms for local and foreign investors in resource-based activities and agro-based industry.

The main characteristics of these industries are that they require simple skills, they are labour intensive and they are largely small or medium sized. Most of them are agro-based, including food, beverages, textiles and footwear. The textile industry was based on short–staple cotton, produced in rainfed schemes in South Kordofan. By the early 1970s, the textile subsector consisted of two large factories (the Sudan Textile Industry and Khartoum Spinning and Weaving, employing, between them, 5 000 workers) and 18 small textile companies, employing at total of 2 000 workers. Leather-based industries produced shoes, bags and suitcases while food industries included oil processing and flour milling. The vegetable oil industry also fed into other industries, such as soaps and pharmaceuticals.

In his assessment of that early industrialization drive, El-Bushra (1971)[48] noted that the labourers "who originally come from the rural areas seem to retain interest in village life. Several immigrants take a job in town simply to enable them to save money which is usually invested in agriculture and livestock". Interestingly, out of 33 000 industrial workers only 1 000 were females. Females stayed behind in the rural areas while men remit money or bring it back to invest in the rural economy. El Bushra also argued that, "Bearing in mind the agriculture nature of the economy, the authorities are well advised to give the priority to these industries which use agricultural and animal products for their raw materials. Industries such as textiles, leatherwork, flour milling and oil crushing should be greatly encouraged." (El-Bushra, 1971).

While the early drive towards industrialization was aimed at import substitution, agricultural accumulation was aimed at producing exportable primary commodities. The explanation for this was that the comparative advantage of the country in these agricultural commodities was already demonstrated, while there was pessimism regarding the export of manufactured goods.

2.2.4 The sedentarization of the nomads

Livestock development or the development of well-being: Since independence, the implicit and explicit official thinking was that public policy should push for the sedentarization of the nomads. Several reasons probably explain the fixation with the settlement of the pastoralists. There was a concern, since the colonial time, that the pastoralists assigned higher value to building herds than to the flow of earnings. They were viewed as less market and commercially-oriented than the others and have a downward sloping supply curve. Other reasons given were

[48] El-Sayed and El-Bushra. 1971. Development of industry in Greater Khartoum, Sudan. East African Geography Review. No. 10.

that the nomads were less receptive to change and modernization than the cultivators and that it was difficult to provide public services for the ever-moving nomads. The bias against the nomads apparently lingered from the colonial era. In 1944, the Soil Conservation Committee issued a report in which it explicitly stated that, "in the event of conflicts of interest arising between nomads and settled communities, it is in the interest of the permanent well-being and development of the Sudan that the right of the settled communities should prevail and nomads should be excluded from all areas to be settled."[49] The statement demonstrates that the Committee considered cultivation to be superior to nomadism in terms of contribution to the national economy. As such, the Committee felt that there were higher returns for the economy from crop production than from animal husbandry. The cultivators' interests were seen as paramount, because their crops were seen to yield bigger returns per unit area.

Thus, both the colonial administration and the national governments used the land policy as a major tool for tilting the balance in favour of the cultivators. However, grazing areas were regulated by the colonial administration by delineating homelands to large ethnic confederations while intra-ethnic allocation of land was carried out by the tribal leaders, who were empowered by the system of Native Administration. The national governments also largely disregarded the interests of the nomads when promoting the establishment of semi-mechanized farms and irrigated schemes. Shazali and Ahmed (1999) cited the example of the nomadic group in eastern Sudan (whose use of land was challenged by the semi-mechanized farms in the Gedaref areas) and the Rufa'a Al-Hoiin the Blue Nile state and Sinnar states. Ahmed noted that the commercialization of agricultural production, in addition to civil conflicts, led to the settlement of the nomadic pastoralists, who eventually adopted an advanced form of transhumance.

Pastoralists had to cope with a changing environment. Because of the drought, they had to diversify their production and engage in crop production and gum arabic gathering. Many of them settled and started to buy crop residues from the mechanized farms and to transport water for their animals. Gradually, they were drawn into market relations. According to Ahmed, at the same time (since the early 1970s) policy makers, started to show interest in the role of the livestock sector in both export earnings and local food supplies. Hence, the government started to provide more public services to the nomads. Mobile animal health services were introduced. This led to an increase in the number of animals in the herds of the nomads at the same time that semi-mechanized farms were expanding, triggering conflicts over land and the migratory routes of the nomads. According to Salih, policymakers were more interested in livestock development than in the development of the communities. The focus was on maintaining steady off-take and providing low-priced livestock products. The welfare of the nomads was not directly targeted, although the two purposes could be served.

The history of concern regarding meeting the demand for livestock products for both urban food consumption and for export extends back to the colonial era, when the government showed interest in providing services to nomadic groups while addressing part of the land

[49] Cited by Shazali and Ahmed (1999. from Galal El-Din El-Tyeb (1985).

issues. In 1938, the colonial administration established the College of Veterinary Science, aimed at training in veterinary sciences and at conducting research on the production characteristics of Sudanese livestock. After independence, and as part of the Ten Year Plan (1960–61 through 1970–71), three research stations were established. The first was established in Nesheishiba, near Medani. The program at that station encourages the production of dairy products in Medani, targeting the Kenana and Butana cattle breeds, and promotes mixed farming in Gezira. The second research station to be established was the Ghazala Gawazat station, which serves South Darfur and South Kordofan and aims to introduce new breeds of cattle and assist the pastoralists to improve their cattle raising practices and management. The third one was the Um Benein station, which also aims at improving the milk quality of Kenana dairy cattle, teaching herd owners better systems of dairy cattle husbandry and promoting the integration of livestock into the agricultural system. In addition, five centres have been established for improving dairy production in large cities. Veterinary services were also enhanced by increasing the production of vaccines and by creating 130 animal dispensaries and 20 veterinary hospitals.

The Five Year Plan (1971–1975) established seven major settlements in Kordofan through the provision of water points and corridors for migrating animals. The purpose was to get the nomads to settle around Babanousa Milk Factory. Unfortunately, the settlement was limited by the 1972–1975 drought in the area, which forced the Baggara to change their migratory pattern. By 1978, the factory closed down. In 1974–75, the government also established the Animal Production Corporation to promote private and public dairy production, livestock fattening and poultry production. The Corporation set up ten state-owned dairy farms near principal towns and 37 fattening and dairy farms in Gezira. It is to be noted, however, that these services were developed in response to a rising demand for milk and milk products, which prompted the establishment of private dairy farms and two feed factories. However, the 1970s witnessed an increase in food aid, which flooded the market with powdered milk.

Failed attempts to settle the nomads and assist traditional agriculture: In the early 1980s, there were some attempts to develop a more sustainable forms of agriculture to replace the traditional shifting cultivation and livestock herding systems in Darfur. A group of development agencies funded the Western Savannah Development Project, which was also expected to arrest land degradation and promote more intensive forms of agriculture. The project included measures to supply farmers with improved crop varieties, encourage the use of fertilizers, introduce tractor cultivation of heavy soils, improve animal health and rangeland and pasture management, facilitate the utilization of the idle fertile land through the development and rehabilitation of stock watering points and the develop planned settlements.

However, the project was not as successful as it should have been. Farmers did not show interest in the improved seeds, fertilizers and mechanical cultivation. They did not find these financially attractive. There was no recovery of the costs of preparing the water points. Pastoralists could settle down and farmers, who valued labour more than land, continued to use extensive, rather than intensive, production methods. Little success was achieved, for example, introducing the use of animal-drawn implements, especially donkey-drawn ploughs, and the project encouraged the partial privatization of veterinary services and the increase in drug supplies.

While the project had design problems and did not undertake thorough socio-economic assessment of the context, the major reason for its failure was weak implementation capacity on the part of the government. However, perhaps more important was the lack of overall vision to address the problems of traditional agriculture.

The Four Year Salvation, Recovery and Development Program (1988–89 through 1991–92) included the objectives of developing the traditional agriculture sector and promoting small-scale holders, together with the objective of rehabilitating irrigated agriculture. Of eight measures adopted by the program to support agricultural production and achieve food security, three were specifically directed towards rainfed agriculture. These were: (1) making credit available through the Agricultural Bank and commercial banks, (2) improving the infrastructure, especially roads and railways and (3) supporting the use of new technologies and the development of the Agricultural Research Council and extension services.

2.2.5 Economic policies and the agriculture sector

Serious macroeconomic imbalance and heavy indebtedness afflicted the economy through the 1980s and the 1990s, reflected in high inflation rates, depreciating exchange rates, the drop in foreign exchange reserves and the inability to service its foreign debt. The government needed external financing to rehabilitate and reform irrigated agriculture. State-owned irrigated schemes suffered from deteriorated infrastructure. The World Bank provided a reform package during the 1980s, which included the rehabilitation of the irrigation infrastructure. Although the program included assistance in support of smallholder development, livestock marketing and agricultural credit; attention and resources were largely diverted to the large-scale schemes. The argument, then, was that there was a need to rehabilitate the existing irrigation infrastructure and revitalize production in big schemes. Reforms were also instituted in macroeconomic policies and crop sharing arrangements at the schemes level. An individual account system was introduced replacing the Joint Account System. The latter had been under strong criticism because it imposed fixed percentage sharing of the costs and benefits and late payments to the tenants for the purchase of cotton. Since the tenants had little incentive to work in cotton production, it was difficult to recover the production costs.

The traditional crop and livestock subsectors, fortunately, benefited from price liberalization, which was part of the reform packages. During the 1990s, after experimenting with administrative prices, the government adopted the Three Year National Economic Salvation Program (1990–91 through 1992–93) which included a stabilization and price liberalization program. The improved price incentive together with favourable weather conditions led to a rise in agricultural production. The increase in agricultural production during the 1990s (by 10.8 percent per annum) as compared with the 1980s (a mere 0.6 percent) was attributed in no small way to the improvement in the price incentives, which stimulated production by small-scale agriculture.[50] Adjusting and floating the exchange rate lessened the degree of overvaluation of the local currency. Bias against exports was reduced after the government

[50] Elamin, D. and El Naam, N.2000. *Pricing Policies and Agricultural exports in Sudan, lessons from the 1980s through the 1990s*. El Obied Research Station. Also see World Bank, Supply Prospects for the Agricultural sector. Oct. 1995

cancelled the export tax on agricultural products and dismantled the monopolistic position of the marketing boards. The production in both rainfed agricultural farms and livestock operations was stimulated by the improved price system. However, though the elasticity of supply with respect to prices can be high, the responsiveness of farmers and investors is often dampened by the lack of adequate infrastructure. The poor infrastructure, especially in transport and energy (with frequent power interruptions), resulted in high production costs of that drove business out of some activities.

Concerns regarding sustaining the external balance have prompted efforts to boost the domestic production of wheat, the imports of which constitute a heavy burden on the economy. The objective of self-sufficiency in wheat has been at the centre of policy attention for decades in view of the persistent shift in urban areas from sorghum and millet to wheat. The process of shifting from sorghum (and eating the staple *kisra* meal) to wheat (bread) began with food aid during the 1970s and continued with urbanization and the changes in the relative cost of the subsidized bread, compared to cost of the kisra. During the three decades following the coup d'état of 1989 (which brought the current regime to power), self-sufficiency in wheat has become a strategic objective that overlooked the opportunity cost, soil and climatic unsuitability and the issue of competitiveness. The National Economic Salvation Program set a target to achieve 90 percent self-sufficiency in wheat percent by the end of the program period. In order to achieve that, the program intended to expand the irrigated area under wheat production and earmark resources for that purpose. In the meanwhile, the government provided significant subsidies for imported wheat.

By 2000, however, policymakers were advised by the World Bank "to shift to promoting the participation of the poor in economic growth, by refocusing rural development strategy towards the needs of traditional rainfed areas and orient the regulatory framework in the private sector to support small and medium scale enterprises" (World Bank, 2003). The shift of attention to poverty reduction and food security has led to increased focus on traditional rainfed and small-scale family farming. The Five-Year Plan (2004-2008) set among its objectives to focus on small-scale farmers in rainfed farming areas. The six other objectives targeted were also linked to that overall objective, namely, public investment in infrastructure such as rural roads and electronic communications; crop insurance programs; research; institutional reforms such as land policy; increased role of the private sector in areas such as marketing, and participation of producers in policymaking. The medium term strategy (2004-2006) clearly reflected the emphasis in favour of traditional agriculture. The strategy aimed at land tenure reform, a technological package (research and extension), access to rural credit, provision of basic social services (including basic education), primary health care, water and sanitation, improving access to markets through investment in basic infrastructure) particularly feeder roads) and abolishing marketing monopolies.

During the oil boom, which lasted from 2000 to 2011, there was little public investment in agriculture, but the government continued to set agricultural targets. In 2006, the government introduced the Green Mobilization Plan (GMP). It also adopted the Executive Agricultural Revival Plan (ARP), Phase I (2008-2011) and Phase II (2012-2016). The overall theme for agriculture development was set forth in the vision for the "Strategic Quarter-Centennial Plan"

(25-Year Plan) prepared by the government to achieve faster rural development. It makes a commitment "to trigger rural development so as to give rise to rural communities in which all services are provided: fresh water, technical education, health care, electricity, fossil fuel and renewable sources of energy and other development projects with fair and just distribution between all regions, cultures and ethnic groups" (The Quarter Centennial Strategy, 2007-2032).

The plan also aims at addressing five constraints facing the sector in the medium term, namely (a) low and declining productivity; (b) recurrent droughts; (c) inadequate infrastructure; (d) trade constraints; (e) weak institutional capacity; and (f) weak private investment. It also suggested that the main policy for resolving these constraints should be through a broad framework for growth in the agriculture sector, based on the following actions (a) a new land law that provides for, among other things, long term leases with land use conditions, tradability of leases and a reduction in the number and size of very large farms in the semi-mechanized areas; (b) more relevant and effective agricultural research and extension; (c) improved financial services in rural areas; (d) programs to improve marketing of agricultural and livestock products such as wheat, oilseeds and milk; (e) maintenance of a strategic reserve to enhance national food security; (f) investments to improve domestic water supplies in rural areas; (g) programs to improve the welfare of families in the traditional rainfed farming areas; (h) efficient use of water for irrigation; and (i) combating desertification by rehabilitating vegetation cover through upgrading of pastures, rehabilitation of forests, reforestation and the promotion of agro-forestry.

However, the implementation of the program was weak and the strategic direction of the government's policies was not clear. Following the secession of South Sudan and the loss of oil revenue, the government intensified efforts to attract regional capital, repeating the earlier marketing strategies portraying Sudan as a breadbasket. The country is marketed as rich in land and water resources. Concessions were promised and vast areas of land were allotted to private foreign investors from the Middle East. Local entrepreneurs also showed great interest in investment in agriculture. Consequently, land conflicts have continued, while the macroeconomic imbalances, the lack of stability in policies and weak infrastructure have continued to discourage investors. The government is still struggling to set policies and programs that can help revive the existing irrigated schemes. Reviving the Gezira scheme has been a difficult task, especially in view of the conflict between the tenants and landowners in the project. The resources needed for rehabilitation of the Gezira scheme could not be ensured and the implementation mechanism is weak.

2.3 Social Conditions and Policies

2.3.1 The poverty profile

In comparison with other developing countries, Sudan has poor social conditions and a high incidence of poverty. The 2014 World Development Report ranked Sudan 166th in the Human Development Index out of 187 countries. The Index developed by UNDP measures "average achievement in three basic dimensions of human development – a long healthy life,

knowledge and a decent standard of living" (HDR 2014). The report also shows that there is gender inequality in Sudan. The gender equality coefficient, defined as "a composite measure reflecting inequality between women and men in three dimensions: reproductive health, empowerment and labour participation ratio" is 0.628, which, on a scale ranging from zero to one, is relatively high.

The 2009 National Baseline Households Survey estimated that 46.5 percent of the population lived below the poverty line (USD1 per day).[51] The survey also estimated a poverty gap (defined as the shortfalls of the income of those below the poverty line relative to the poverty line) as 16.2 percent and the severe poverty incidence as 7 percent.

However, national averages regarding social conditions and poverty incidence mask significant disparities between rural and urban areas and between the various regions. Traditional crop farmers and pastoralists have a higher incidence of poverty. Rural poverty has a higher incidence, much more depth and is more severe in than urban poverty. The same is true of the incidence, depth and severity of poverty in western Sudan (both Darfur and Kordofan) and in Eastern Sudan, which are significantly worse than in the rest of the country. Poverty has also been found to be positively correlated with education. The higher the education level, the higher the income. Poverty is also gender sensitive – higher among female-headed households than male-headed households.

Table 2.5 **Poverty profile (2009)**

Region	Poverty			Poverty Gap Among Poor
	Incidence	Gap	Severity	
National Level	46.5	16.2	7.8	34.8
Rural	57.6	21.3	10.6	36.9
Urban	26.5	7.1	2.7	26.6
Darfur	62.7	24.6	12.6	39.3
Kordofan	58.7	23.1	11.7	39.3
Eastern	46.3	17.7	9.0	38.2
Central	45.4	13.8	6.1	30.4
Northern	33.7	9.4	3.8	28.0
Khartoum	26.0	6.4	2.4	24.7

Source: Central Bureau of Statistics, 2009 National Baseline Household Survey, Khartoum

The high incidence of poverty is a result of poor growth performance and prolonged conflicts. Poor health and education indicators are the result, in part, of low levels of public spending on health and education. During the 1980s and 1990s, the country experienced a significant decline in the provision of public services.[52] This was attributed to cuts in public

[51] The poverty line is not estimated in accordance with the global definition of one dollar per day. It is based on National Survey estimates.

[52] See World Bank, Restructuring and Structural Adjustment, Vol. 1.

expenditure on these services as the government was forced to adjust its expenditure to achieve stabilization objectives and to cover the cost of military fighting.

Another category of people experiencing high levels of poverty and poor social indicators are the displaced population who have been affected by the armed conflicts in various regions. Despite efforts to provide assistance to those in refugee camps, the camps do not provide adequate social services and food assistance. The refugees in camps are also more vulnerable to diseases.

Among the total population, 31.3 percent consumes less than the minimum dietary consumption requirements. Differences are sharp between regions: 44 percent of the population in the Red Sea State do not consume the minimum dietary requirements, while only 15 percent of those in Gezira and the River Nile do not meet the minimum requirements. There is widespread malnutrition and high levels of underweight among children in the country. The maternal mortality rate is 2 054 per 10 000 live births. Only about 77 percent of the children are fully immunized. Access to safe water is available to about 62 percent of the total population. This proportion is higher in urban areas (75 percent) than in rural areas. Nationwide, only 42 percent of the population has access to improved sanitation (means of excreta disposal), but this breaks down to 65 percent in urban areas and 25 percent in rural areas. The rural population suffers from poor sanitation, inadequate hygiene and frequent outbreaks of diarrhoea and cholera.

2.3.2 Poverty reduction strategies

Efforts to fight poverty and improve social conditions have been pursued within the framework the Millennium Development Goals (MDGs) and the recently formulated Interim Poverty Reduction Strategy (I-PRSP). According to the 2011 MDGs Progress Report, the country made some progress but much still needed to be done. In 2011, an Interim Poverty Reduction Strategy was prepared. Although funding was not assured, the strategy was based on four pillars, namely, to strengthen governance and institutional capacity, reintegrate internally displaced persons and refugees, develop human resources, and promote economic growth and employment creation. The last pillar focuses on creating an enabling environment for growth in general and for growth led by the private sector, promoting the growth of the agricultural sector, developing infrastructure and protecting natural resources.

SECTION THREE

Support policy targetting small scale-family farming

3.1 Constraints and Policy Responses

3.1.1 Analytical framework

The preceding sections demonstrate the importance of small-scale farming as a source of livelihood for the majority of the rural population, a critical means for poverty reduction and a major contributor to food security, with significant contributions to value added and great potential for maintaining ecological balance and environmental protection. In theory, what smallholders can produce is determined by comparative advantages, which are related to inherent factor, endowments such as agronomical conditions, land and labour. However, beyond these endowments, there are a variety of factors that can enhance productivity and improve competitiveness. These factors are amenable to interventions in terms of further investment, the regulatory and institutional framework and price incentives.

Policy neglect and bias against small-scale family farming, together with a variety of production constraints and market failures, explained and described below have undermined the potential of small-scale farming and caused low and declining productivity of some of its major produce. To realize the potential of this subsector, reach the production possibility frontier of small-scale farms and expand on that frontier, require a focus on removing these constraints, overcoming the market failures, ending the policy bias and increasing public investment in rural infrastructure.

Designing the policy responses to these constraints would require a thorough knowledge of the effectiveness of the different policy tools to be used. However, awareness by itself does not guarantee the adoption of these policies. Two factors are important: the economic consideration of costs and benefits and the political economy at work. The former would require evaluation of alternative choices and opportunity costs while taking account of the budgetary constraints. The issue of the political economy of decision-making necessitates that the voices of the small-scale farmers be heard. Though, in general, this would require a governance structure more susceptible to group pressures, the existence of small-scale producer organizations is one of the factors that can partially contribute to seeing their agenda served.

This section highlights the various constraints and the policy responses to address them. The section starts by describing where the objective of promoting small-scale family farming stands within the overall strategic and policy context. The section then considers issues of

macroeconomic stability, the incentive structure, access to natural productive assets (land and water), to inputs (seeds, fertilizers, weedicides) and to credit. It also takes up issues of human capital development, the functioning of markets, adequacy of physical infrastructure, the capacity for applied research, technology transfer and the provision of extension services.

3.1.2 Strategic refocus on small-scale family farming, but not far enough

The current strategic development thinking reflects an increased focus on small-scale family farming, which still does not go far enough in removing the biases against it. Prompted by the loss of oil revenue after the secession of South Sudan, the government turned to revitalizing the agriculture sector as an avenue for restoring growth, generating employment and addressing the ensuing problem of the macroeconomic imbalance. The Quarter Centennial Strategy (QCS) (2007–2032) had already incorporated a long-term development plan for the agriculture sector aimed at diversifying the economic structure and exports and achieving food security. But the increased interest in small-scale family farming is largely motivated by the objective of reducing poverty, especially within the context of the Interim Poverty Reduction Strategy (I-PRSP), which focused specifically on enhancing the livelihoods of the small producers, strengthening their technical and institutional structures and capacities, halting environmental degradation, reducing rural-urban migration, removing regional disparities and enhancing gender equality.

In 2006, the government adopted the Green Mobilization Plan (GMP), one of the objectives of which was to further the progress of small-scale producers in the agriculture sector. The plan proposed applying the concept of making **"the village the centre of development"** in the rural areas. The instruments for achieving this objective, specified in the plan, include the transfer of appropriate agricultural technologies, providing credit, control of animal and crop pests and diseases, conservation of natural resources and the diversification of the export earnings of the agriculture sector. The plan aimed to shift traditional producers into more commercial production, while the creation of the public private partnership was geared towards the introduction of new sources of finance, advanced technology and innovative management capacities of foreign private sector investors.

The Executive Agricultural Revival Plan (ARP), Phase I (2008-2011) and Phase II (2012-2016), are programs for the implementation of the GMP. The ARP Phase II continues to support the role of the small-scale traditional agricultural producers and the strengthening of the capacities of community based organizations (CBOs) in food security, poverty alleviation and increasing export earnings. The program attempts to develop the role of the village as a centre for development in the provision of agricultural services and advice, increase employment opportunities, and to perform as marketing inlets for input supplies and outlets for output products. The program aims to create effective farmer and pastoralist organizations that support the governance of policy formulation, and participate in establishing a safe, friendly environment for agricultural development and management in the rural areas.

The first and second National Five–Year Strategic Development Plans (2007-2012and 2012-2016) continued along the same lines of promoting the development of small-scale producers,

an aspect considered necessary to achieve the targets of the Millennium Development Goals (MDGs) for reducing poverty and food insecurity in Sudan.

3.1.3 Refocus requires removing policy bias and neglect

Government expenditure on the agriculture sector is still below expectation though the government is committed, within the context of the Comprehensive Africa Agriculture Development Program (CAAD), to increase the share of public expenditure going to the sector. Historically, the policy bias against small-scale family farming has been reflected at two levels. At a higher level, the strategic focus of public investment has tilted towards large-scale irrigated schemes and semi-mechanized farms. Thus, the proportion of investment going to large-scale farming has been more than the investment benefiting small-scale farming. Though statistics about the breakdown of public expenditure by subsector do not exist, there is no reason to think that small-scale family farming is receiving adequate support. Moreover, the loss of oil revenue has reduced the fiscal space, which is needed to ensure smooth functioning of federal and state government units. The loss of oil revenue also starved the government of the surpluses to be spent on development, which explains the pressure on the government to attract foreign direct investment in agriculture.

At a second level, the incentive structure has not favoured small-scale family farming and crops production in general. Price disincentives held down investment and production in three ways. First, the overvalued currency has been disadvantageous to exports and traded goods and reduced the competitiveness of Sudanese goods. Second, by fixing the prices of commodities, the then operating marketing boards denied the producers an incentive to expand production and discouraged investors from investing in agriculture. Thirdly, taxes on agriculture are still significantly high, burdening small-scale family farming without providing a satisfactory level of services in return.

Strong evidence exists that price incentives are critical for sustaining growth. Gum arabic production was adversely affected by low prices offered to the farmers. The Gum Arabic Council monopolized the marketing and export of gum arabic, fixing lower prices than the prevailing international prices. Other government bodies at various levels imposed taxes on gum arabic resulting in a reported 18 types of taxes on the product at one time. Smuggling to neighbouring countries increased, and production, which was already affected by insecurity, decreased significantly. Similarly, policies that imposed price ceilings for sorghum and policies meant to induce wheat production in irrigated agriculture have had a negative impact on the production of sorghum and distorted the incentive structures.

The increase in agricultural production during the 1990s (by 10.8 percent per annum) as compared with the 1980s (a mere 0.6 percent) was attributed in no small way to the improvement of price incentives. According to a World Bank Report (1993), though the improvement in agricultural production in the 1990s was partly a result of favourable weather conditions, a more important explanation for the difference in the growth performance between the two periods was the government's success in reducing macroeconomic instability and prices

disincentives.[53] Adjusting and floating the exchange rate lessened the degree of local currency overvaluation. The bias against exports was reduced after the government cancelled the export tax on agricultural products and dismantled the monopolistic position of the marketing boards. The production of both rainfed agricultural farms and livestock farms was stimulated by the improved price system alluded to earlier. As a result, their outputs rose sharply from -9.1 percent and 2 percent, respectively, to 24.5 percent and 15.9 percent. Production in irrigated agriculture also rose from 1.5 percent to 6.6 percent between the two periods.

The increase in small farmer production demonstrates that farmers are responsive to price incentives. Despite what appears as optimism regarding the elasticity of supply of smallholders with respect to the price incentives, it is evident that production and productivity of small-scale family farming could be much enhanced if the price disincentives and other non-price incentives are removed. Increased access to productive assets, finance, input, markets and technology will certainly lead to increase in production.

3.1.4 Improving access to natural productive resources

Land: Land, together with water, constitutes the foundation of agricultural production. Both small-scale crop and animal producers have been much affected by the current system of land ownership and the competition for land use, and they will continue to be influenced by these systems if current trends and problems in this regard persist.

Historically, customary rules over land were based on communal ownership of land. The tribal leaders allocated land on the basis of use and lineage. These leaders also arbitrated between the members of the tribe and settled disputes with other groups. Since land was readily available at the time, the system worked well except for occasional disputes. The arrangement also suited the nomadic groups, which used the land and its resources seasonally and shared them with sedentary farmers. They did not have to be concerned about migration routes.

The first challenge to the customary rules came from the land grab which spread throughout the country immediately after its colonization, under British–Egyptian condominium rule. The country's reputation for excellent agro–climatic conditions for growing cotton led to the inflow of several adventurers of various nationalities seeking to grab the then cheap and abundant land. The colonial system had previously issued the "Title to Land Act" of 1899 and, having developed its own design of promoting cotton production, in 1925 it adopted the "Land Settlement and Registration Ordinance" providing the legal framework for land ownership and setting the stage for regulating the utilization of land in the Gezira and other irrigated schemes by foreigners and local entrepreneurs.

Although the ordinance provided for land registration, it left most of the land unregistered under customary rules. After independence, it was found necessary to regulate the allocation of land for commercial agricultural production. Thus, in 1970, the military government at the time adopted the "Unregistered Land Act", which transferred the full ownership of

[53] Elamin, E., Dirdiri, H. & Nasser, A.2000. Pricing Policies and Agricultural Exports in Sudan, lessons from the 1980s through the 1990s. El Obied Research Station. Also see: World Bank. Supply Prospects for the Agricultural Sector. Oct. 1995.

all unregistered land to the government. This act together with an act abolishing "Native Administration" weakened the authority of the tribal leaders to allocate land to the tribal population. The new group of administrators were assigned the role of land allocation. Most of the land used by small-scale farmers lies within the boundaries of the unregistered land, representing 80 – 85 percent of the land which was placed under government control upon the issuance of the Unregistered Land Act in 1970. Although the government had the formal ownership of the unregistered land, it was not able to exercise effective control over land allocation and utilization except at the level of mechanized farming. At the same time, the land allocation and judicial powers were taken from the native administration and vested in the hands of local government officers, and later in the state government. This created a vacuum in the administration of land which negatively affected the natural resources.

Current land policy fails to provide most farmers with long-term leases and, hence, leaves them without formal land tenure security. Customary law provides farmers with long-term user rights if they continue to cultivate the land, but in practice this has led to serious land degradation. The policy has also came under criticism on grounds that it gives the perception that land is free and abundant, whereas the majority of the population was using the unregistered land. A World Bank study (1979) recommended the registration of user rights and the start of a land market so as to "reinforce the perception of land as a scarce and valuable resource and set the stage for intermediate financing and shifting the forces to increase productivity". The land used by the smallholders has been coming under pressure as a result of the population growth, the expansion of mechanized farms and the increase in livestock. Most of the land used by the traditional farmers and herders have remained unregistered. FAO's voluntary guidelines on land use, however, maintain that property rights need not be the primary objectives.[54] The most important objective is to secure access to land under whatever conditions, be it through property rights or land use rights.

The expansion of agriculture, especially mechanized farms, disrupted pastoral movements. Environmental degradation, drought and insecurity contributed to the problems the pastoralists face. Conflicts and competition increased between individuals, communities and production subsystems. In Darfur, some nomadic groups occupied the land used by sedentary groups. Some speculative traders, opportunistically and in league with local authorities, grabbed land. Legislation did not adequately address these various issues and the institutions dealing with land were not functioning properly. There was no law enforcement capacity, no supporting services and no mechanism for resolving conflicts. Long–term land leases for community land were issued to privileged citizens and foreigners without local consultations and without the genuine consent of the customary landowners. Issues of governance and administration at the local and national levels often precipitated conflicts. As a result, the Comprehensive Peace Agreement signed in 2005 between the government and the South Sudan-based Sudan People's Liberation Movement stipulated the establishment of the National Land Commission and regional commissions. Land is the most contested asset in the country and a cause of conflicts and instability.

[54] FAO, "Voluntary Guidelines on the Responsible Governance Tenure of Land, Fisheries ad Forests in the Context of National Food Security". The Committee on Food Security, Rome, 2012.

Competition over land led to the use of marginal lands, to reducing fallow duration and to overgrazing. In addition to exacerbating the problem of soil fertility, these land use practices also led to desertification. Thus, the challenges of improving the agricultural resource base require reforming the land system and improving land use practices, including use of fertilizers.

On the basis of the above analysis, it is evident that there is a need to reform the land tenure system such that the rights of individuals and private or public entities to hold land or resources are recognized through laws. Furthermore, the capacity for land management and for enforcing land laws, both at the national and state levels, should be strengthened. Finally, special provisions should be made to identify and enforce the migratory routes of the nomads.

Water: Water is evidently a critical factor for agricultural production. Access to water is an important determinant of land productivity. Water sources in Sudan consist of rainfall, surface run-off, mostly water from the Nile and its tributaries and underground run-off. According to a report from the Ministry of Irrigation and Water Resources (Background paper on rainfed agriculture, (2014), the annual available water from the Nile is 20.5 billion cubic meters (bcm), *wadis* (seasonal water courses) provide 5 to 7 bcm and renewable groundwater provides 6.0 bcm. The total is approximately 30.0 bcm. Six bcm of water is expected to be provided through water reclamation, raising the total water available to 36.0 bcm.

Currently the country's water resources are underutilized and poorly utilized. The country may face water shortages as the demand is expected to increase to 52.0 bcm by 2027.The surface runoff water in the Nile Basin, which is largely used for irrigating the large schemes, is regulated by agreement with Egypt. According to the agreement, which was signed in 1959, Sudan's share (annual abstraction) equals 18.5 bcm. Presently, Sudan's average annual use of Nile water ranges between 14 and 15 bcm. About 95 percent of it is used for irrigation purposes, 4 to 5 percent is used for domestic water supply and less than 1 percent is used for industrial and other purposes.

The building of dams and reservoirs in Sinnar (1925), Rosieres (1966), Merwe (2009) and Jebel Awliya (1937), to control the use of water during the high flood seasons, succeeded in enhancing the capacity of the country to produce cash crops and food crops and in reducing poverty in the irrigated area of central Sudan.[55] Small-scale pump schemes were established in between the big schemes. Fruit and vegetable production in small pump irrigated schemes spread along the Blue Nile, the White Nile and the main Nile.

While Sudan has not used its share of the Nile water under the agreement with Egypt, some tension has arisen with other Nile Basin countries on the utilization its water. The ongoing construction of dam in Ethiopia will have far-reaching impact, which is yet to be fully studied. Small-scale production will not escape positive and negative impacts of the dam under construction, though the balance is undetermined.

[55] There were also some negative effects. Among these is the increase in the incidences of bilharzia and malaria. They have also interrupted the migration of cattle.

Non-Nilotic runoff includes the Gash River and that Baraka River, both originating from the Ethiopian Plateau and disappearing in deltas without reaching the Nile. Additionally, there are other seasonal water resources in the form of about 300 streams and wadis which provide sizable amounts of water in east, south and west Sudan and could be developed to support agriculture. An example is Wadi Azum, originating from Jebel Mara and flowing to Chad. The total annual yield of water of these streams is in the range of 2 to 3 bcm. Their use for irrigation purposes is very limited due to their seasonality and to neglecting their development (Mohammed, 1998). However, water use from wadis, using on small dams, is developing and could support integrated small-scale farming systems in the dry lands.

The pattern and quantity of rains pose risk to rainfed agriculture. Dependence on the timing and amount of rainfall increases vulnerability to weather shocks and limits the ability to use known yield-enhancing technologies. The annual amount of rain has been decreasing steadily since the middle of the 1970s. Drought is becoming more frequent, resulting in noticeable deterioration of the natural resources and causing disturbances in the farming system. Adapting to the quantity and pattern of rain by adopting appropriate agricultural practices and techniques is one way to make the best use of available rainfall. There is also room to obtain more water through water harvesting.

Another source of water is groundwater recharged from rainfall, independent of the Nile waters. This groundwater is found in the Nubian sandstones, Umruwaba and others in the alluvial deposits and lava flows elsewhere. Thus far, only limited amount of water from these sources is utilized. Various attempts were undertaken to exploit the underground water in Darfur and Kordofan by drilling boreholes or digging wells; but so far there has been little success. But, these remain a great potential source for addressing the water shortage in many parts of the country. Underground water is distributed throughout the country and could be used flexibly and conveniently with proper management. According to a World Bank report, these are being substantially under-exploited but "could be tapped to balance out, in some instance, seasonal fluctuations of surface waters". (World Bank, 1979, p.11, Vol. 2).

Small-scale farmers could be much assisted through the development of these underground water resources. Nomads and animal breeders also stand to benefit. Small-scale producers could also be encouraged and assisted to invest in irrigation from surface water. Productivity of irrigated agriculture is more than double that of rainfed farms. This is a matter of increasing agricultural yields during the main harvest season and improving the possibility of year-round cultivation as well as opening up previously barren lands for cultivation. Access to irrigation reduces the risk of crop failure, encouraging the adoption of higher yielding varieties of food crops, diversification into higher value cash crops, application of fertilizers and pest management and intensification of farm labour practices.

In sum, with regard to the water resources, there is a need to facilitate more involvement of small-scale family farming in irrigation from known main surface water flows, assist small-scale farmers to use efficient methods of irrigation, encourage water harvesting, increase the exploitation of underground water, promote agricultural methods and techniques that suit rainfall patterns and invest in irrigation infrastructure to increase the efficient use of water

in coordination with power generation and other stakeholders in the shared water. Producers' organizations can certainly play a role in this regard.

3.1.5 Enhancing human capital

In addition to access to natural resources, another main asset of small-scale producers is their labour, which is sustained by good health and nutrition and complemented by knowledge and skills acquired from the traditional culture, by learning from experience and through training. An adequate labour supply is needed to utilize the natural resources. This includes the employment of the family members, especially youth and women.

Human capital, as embodied in education, knowledge and experience, is an important factor in agricultural production. In addition, the health and nutritional status of people engaged in agriculture make a difference in terms of productivity. Farmers need knowledge to acquire the skills which make possible effective use of inputs and to access technology and information. The smallholder farmers need, at least, to be literate and numerate. Educated and skilled labourers are more likely to learn. Related to human capital is social capital, defined as the communal relationship within and amongst households and societies, based on trust and a chance for mutual benefit.

To conclude, policy should focus on improving the social services in the rural area, fighting illiteracy, introducing vocational training and capacity building measures for small producers, encouraging the youth to become involved in agriculture and empowering women. Value addition and the creation of employment opportunities are also needed to meet the rising work force.

3.1.6 Increasing access to finance

Since small-scale farmers have limited cash surpluses and a resource base they need access to finance as means for buying inputs, investing in productivity, conducting harvesting operations improving their access to markets. However, most small-farmers have difficulties in accessing finance.

While the share of the agriculture sector in the country's total finance is relatively small (16.7 percent in 2014) compared with its contribution to GDP (31 percent in 2014), the share in finance of small-scale family farming within the agriculture sector must even be less than its GDP contribution, which exceeded 50 percent. In comparison to small-scale family farming, access to finance in large-scale schemes has been much higher and has a longer history, beginning during the 1930s and prompted by the plan to expand cotton production by bringing in large, private investors. One year after independence, in 1957, the government established the Agricultural Bank of Sudan (ABS), which since then has been an important player in agricultural credit. However, throughout its history the bank focused mostly on irrigated schemes and semi-mechanized farms. Commercial banks were also involved in financing government-owned irrigated schemes with government guarantees.

By contrast, small-scale producers receive little or no finance from the financial sector. A World Bank report prepared in 2003, indicates that "one of the most serious deficiencies of the credit system is the high skewed allocation against small-scale farmers, who account

for the bulk of agricultural GDP". Surveys also show that nearly two-thirds of finance of small-scale farmers originates from their own savings, 10 percent is obtained from family friends and the rest is obtained through the informal *shail* system or by purchasing inputs from agricultural companies and traders with deferred payment, normally at a high prices. Smallholders identified access to finance as one of the most important constraint to their activities. Livestock producers in general have no access to capital, finance or rural credit, let alone smallholders. They usually start up their herds with their own financial resources, often building their herds from income generated from crop farming, herding labour (cash or in-kind), off-farm activities, migrant work or remittances.

The reluctance of the financial institutions, especially banks, to lend to smallholders is attributed to their perception that agricultural risk is high because of rainfall variability, vulnerability to drought and fluctuations of commodity prices. Farmers also have limited collateral to secure loans as it is difficult to verify land titles and property rights in rural areas. They also lack the formal educational needed to present well-prepared documents and financial statements to loan officers. Furthermore, the remoteness of small-scale farms from urban centres and the dispersed demand due to low population density in those areas considerably increases transaction costs for the service providers. Information and administrative costs associated with providing a larger number of relatively small credit transactions in order to finance small-scale farmers are high.

One of the first attempts to promote finance to smallholders was begun in 1992, when the Agricultural Bank introduced *el-salm* which was presented as an Islamic product aimed at replacing the traditional shail system. *El-salm* is basically a purchase with deferred delivery. The buyer pays the seller the full negotiated price of a specific product, which the seller promises to deliver at specified time. The experience was not fully successful as the farmers saw the product as *shail* in a new disguise.

In addition to *el-salm*, the authorities decided to promote microfinancing to address poverty in general. Loans were secured from the Donors Credit Fund, which is operated by the World Bank, and the Islamic Development Bank, (which supplied USD 15 million) to setup a microfinance program to provide credit to the small producers within the Bank of Sudan. The UNDP supported a value chain analysis and the training of 30 staff working in different commercial and development banks and community development associations to handle microfinancing operations.

The Bank of Sudan established policies requesting all national and commercial banks to allocate 12 percent of their lending ceiling to the microfinance program. It also encouraged the establishment of microfinance companies at the national or state levels to cover urban-rural development efforts and provide credit to the small-scale producers in those states, with a capital requirement of USD 5 million at the national level and USD 2.5 million at the state level.

Some successes: Some limited successes were reported in the Kassala and Blue Nile States during the period 2007 to 2014. In Kassala, a micro-finance project was funded and run by the Agricultural Bank, the Farmers Bank and the Kassala Microfinance Corporation. The project reached 14 201 smallholders, of whom 87 percent were males and 13 percent were

females. The project also supported a women's development project with an amount of SGP 1 million. An estimated one thousand women in the rural areas of the state benefited from the project. In 2015, microfinance operations succeeded in extending support to a total of 62 625 clients, including small agricultural and animal-raising producers, with a total of SDG 76.72 million in loans. A similar project extended to the Blue Nile State resulted in a cumulative amount of SDG 66 million in loans by 2014, of which agriculture received 30 percent (about SDG 20 million). Microfinance-related insurance companies covered clients who did not have guarantees.

In 2012, another microfinance operation was earmarked to fund a project aimed at linking small farmers with markets. A total of SDG 11 million was allocated to eight states in the country, including Kassala and Blue Nile. In Kassala, micro projects were approved for a total of SDG 1.8 million, of the SDG 2 million allocated to the state. Twenty-three thousand small farmers benefitted from the micro projects in Kassala, out of the 100 thousand beneficiary farmers in all of Sudan. The project provided SDG 688 200, about 83 percent of the total credit to the small farmers. The benefiting farmers in Kassala reached were 1 700 farmers including 300 women. The credit provided to the small livestock producers was about SDG 141 500, about 13 percent of the total credit. About 26 animal producers benefited from the Project. The average repayment rate was 72.5 percent, with 77 percent repayment rate in animal production and 68 percent in crop production activities.

The project targeted traditional small-scale agricultural producers with landholdings ranging between 5 and 10 feddans and practicing rainfed farming. It assisted in establishing community associations to link the crop and livestock producers to the insurance market, credit, extension services and input and output inlets and outlets. The Ministry of Agriculture, the Bank of Sudan represented by the Sudanese Company for Microfinance and the World Food Program were involved in supervising and managing the project. The Ministry provided technical assistance and extension services, and training to increase crop productivity, while the World Food Program also provided training as well as food to farmers to bridge the food gap during the August to October production season. The Cooperative Islamic Company provided insurance to small producers against risks associated with rainfed agriculture. About 22 thousand small farmers benefited from the provision of insurance services. The project supported capacity building of 298 small farmers in microfinance, agricultural extension, agricultural marketing and agricultural insurance. The training component was carried out using farmer field schools which provided training to 24 agriculturalists and veterinarians. The project also supported the establishment of small cottage industries in activities such as vegetable and fruit processing, production of edible oils, milk production, production of mesquite charcoal cubes, bread making and tomato paste; thus, creating employment opportunities for small producers.

Risk management: Small-scale family farming faces much more risk than many other businesses due to the variability of rainfall in Sudan and unpredictable climatic conditions. Further risks arise from fluctuating prices due either to shifts in supply and demand or policy changes. The government often intervenes in food marketing, sometimes banning exports or transportation of food products from one state to another. The government can also change the foreign exchange

rates or the tax rates. In horticulture and vegetable production, the perishable nature of the products and lack of adequate storage and transport facilities often threaten products. Livestock sales also face risks of other countries instituting import bans in case of health hazards.

The small-scale farmers address these risks by diversifying their products or seeking other employment opportunities. They avoid borrowing and revert to their own savings if they can. But by avoiding borrowing they miss opportunities. The local financial system has not yet developed services that can help the farmers avoid these risks. For example, markets elsewhere have weather insurance. Tools to manage the risk of price fluctuations include forward, future and options markets, guarantee schemes and insurance and credit packages. In Sudan, the government addresses the problem with price stabilization programs.

There is yet a need to search for innovative ways of expanding smallholders' access to finance. There are many problems in lending to farmers. Risks and transaction costs are high and the farmers lack the collateral for their loans. However, the experience so far has shown that these problems are surmountable. Some of the measures that can facilitate rural financing include: involving communities and producer groups which can facilitate group financing, guaranteeing, training and capacity building; expanding crop insurance against agricultural risks and instituting land use rights. Addressing the issue of collateral would also be of great help.

3.1.7 Delivering inputs

Sustained productivity growth in small-scale family farming will depend on the farmers' access to and capacity to combine improved land, crop and animal husbandry practices with cost–effective use of modern inputs, including fertilizers and improved crop varieties. Access to and use of improved inputs such as high yield seeds, pesticides and fertilizers, have an important impact on yield and production potential. Good agricultural practices are the result of accumulated local and scientific knowledge and can be enhanced through agricultural extensions services.

Seeds: The timely delivery of seeds to farmers and the improvement of high quality seeds is critical for their production and productivity. Small-scale farmers have historically stocked their own seeds. However, the seeds system has undergone changes and they have become dependent on sources outside their communities. In their endeavour to produce improved quality seeds, agricultural research centres have seized most of the share of seed production. Research stations work to improve the quality and the multiplication of seeds. The seeds are distributed to the farmers either directly or through small traders. Few extension services accompany the distribution of the seeds. The Agricultural Bank has also been purchasing and distributing seeds. Recently, private sector enterprises have taken on a greater role in seed importation, distribution and development.

The government has instituted policies, regulations and standards for seed production and use. The National Seed Administration (NSA) was established, with support from FAO. FAO also trained the staff, built and equipped the laboratory and the seed processing plant and set up the seed production farms. FAO also assisted the government in preparing the seed legislation.

These capacity-building measures supported by FAO, enabled the country to produce 100 percent of their sorghum seeds and 89 percent of their millet seeds. Following the privatization of the seed industry, the role of the NSA has been confined to legislative and quality control matters. Seed production activities are largely left to the private sector, while research stations focus on improving varieties.

The Ministry of Agriculture supported the establishment of agricultural production service centres in the irrigated Northern and River Nile States and in the rainfed states of Gedaref, Sinnar and the Blue Nile. These centres help the small farmers with the supply of seeds, fertilizers and herbicides, but are still unable to satisfy the demand for production services. Accordingly, a number of large private companies have begun to respond to this growing demand by establishing agricultural service centres in important agricultural areas in the Northern and Gedaref States.

The widespread distribution of free good-quality seeds by the government, FAO, IFAD, UNDP, UNICEF and NGOs to the traditional farmers has been crucial in raising the crop yields. However, despite a substantial amount of money spent on improving the national supply chain of seeds, small-scale producers still face shortages in accessing seeds. There have been several incidences of delays in providing seeds or even shortages of seeds. Several small-scale producers identified the timely availability and good quality of seeds as one of their main constraints (Osman, 2007).[56] In drought affected areas, farmers often deplete their seed stock. Some communities in the semi-arid zones have realized that the traditional seeds they are using are not suitable for the now shorter duration of the rainy season. Farmers also complain of the quality of the seeds they receive. Some complain that the varieties purchased actually reduced their productivity.

Success story: One success story was a seed production and distribution experience undertaken by the El Obied Research Station, supported by Care International. The experiment involved enhancing the availability of improved seeds through the distribution of high quality varieties to about 65,000 farmers in the areas of Sheikan and Enhoud in North Kordofan. The improved varieties were developed by the Research Centre. The purpose was to develop varieties that adapt to short rainy seasons. Farmers have understood that the traditional seeds they have been using are unsuitable for the changed pattern of rainfall. The Centre developed varieties of groundnuts, millet, sorghum, sesame and cowpeas better adapted to the changed climate and with higher yields.

According to Abdelrahman,[57] the station first undertook diagnostic surveys and worked closely with the farmers to identify their constraints. The station then managed to improve the varieties of these crops and helped increasing the availability of the new seeds and the farmers' access to them. The seeds were distributed in coordination with the government offices and through local community organizations. The station also ensured the continued provision quality seeds at household and community levels. Farmers were trained in cultural

[56] Osman, A. Community based seed Supply in Sudan. *LEISA Magazine*. (23) 2 June 2007.

[57] Osman, A. Community based seed supply in Sudan. *LEISA Magazine*. (23) 2 June 2007.

practices and in technical aspects of seeds and seed production (such as genetic and physical purity, germination rates, absence of weed seeds and diseases). Farmers were also encouraged to undertake seed multiplication in accordance with regulations and standards. The Seed Management Administration of the Ministry of Agriculture inspected and guaranteed the quality of the seeds. The experiment has contributed to addressing the issue of seed availability and resulted in the communities becoming self-reliant in terms of seed production. It is also creating an income generating activity for those who are engaged in the multiplication and distribution of seeds. Above all, the farmers' crop productivity has increased significantly.

Fertilizers: A study conducted by FAO in 2006 reported that fertilizers are rarely used in rainfed agriculture.[58] By international standards, the use of fertilizers in small-scale irrigated agriculture is low. This low use of fertilizers thought to be one of the factors that explains the lagging productivity growth of small-scale family farming in Sudan. In the case of smallholdings in Sudan, where soil is poor and has been deteriorating due to overgrazing and overuse, the need for fertilizers is evident. From an agronomical perspective, since the use of fertilizers will help replenish the nutrients in the soil, it may be advisable to expand the use of the organic fertilizers if productivity is to be increased, production to be expanded and environmental sustainability to be achieved.

From another point of view, not using fertilizers in traditional farming might have been a rational choice, based on the risks linked to high climatic variability and the volatility of output prices. The decision of small-scale producers to not use fertilizers is sometimes explained by profitability and risk considerations. As such, the incentives to use fertilizers depend on crop prices and fertilizer prices. The cost of fertilizer has been fluctuating with the changes in petroleum prices. Moreover, farmers face the risk of rainfall variability, which introduces a high level of uncertainty. As such, there is a need to assess whether the farmers' decisions are due to the unavailability of the inputs, to their affordability or to the farmers' knowledge of their potential for increasing production and profits and the level of risks involved.

Several research programs on the use of fertilizers were implemented from 1975 to 2000. These included the FAO Fertilizer Program (1977-1991), the European Economic Community Fertilizer Program and the GTZ German Program. The FAO Program covered almost all of Northern Sudan. Trials were carried on smallholder-produced vegetables, onions, tomatoes and other horticultural products. The results revealed high crop responses. Though some smallholders started using fertilizers on their farms, consumption is still limited.

Weak extension services and poor research might have been a factor in the limited results of the research programs. These could help in "tailoring the dosage, composition, and timing of application to specific field and seasonal conditions" and advising on what worked and what didn't worked. Possible remedies include better extension services, on-farm demonstrations, participatory research, improved business environment and the involvement of farmers' organizations.

[58] FAO. 2006. *Fertilizer use by crop in the Sudan*. Rome, FAO.

Access to tools and mechanization: The use of mechanization and modern tools by small farmers is limited. Animal-drawn implements (ploughs) have been introduced in some areas, but their use is still very limited as the cost of the draught animals (usually oxen) is high and some expertise is required to train the animals. Also, there are shortages in the skills needed to manufacture and repair these tools. Innovative ways can be sought to encourage cooperatives and producers organizations to take on a greater role in promoting mechanization.

3.1.8 The provision of physical infrastructure

Poor physical infrastructure reduces the productivity of the small-scale farmers, lowers competitiveness and discourages investment. The inadequacy of trunk and feeder roads raises the costs of production and marketing, which may constitute one-third of the farm prices for exports. Paved highways in Sudan are limited to the central eastern belt – the area of irrigated agriculture and the export route. Major towns located along the Nile and its tributaries are linked by paved roads. The roads are also extended connecting Medani, Gedaref, Kassala and Port Sudan and also Sinnar, Kosti and El Obeid. These paved roads constitute networks between main towns. Links to the towns' hinterlands and villages consists of dirt roads, which can only be used during the off-rain season.

As indicated, the rural roads are usually open and accessible to farmers and families for easy transportation in times other than the rainy season. The difficulties in using the rural roads arise during the rainy season, particularly in areas characterized by clay soils. The constraints faced by farmers in transporting their products to markets result in losses of their fresh products. Because of this, farmers who are close to the paved network are privileged as they can reach the markets easily. Still, the difficulties associated with transporting agricultural products to the markets lead to pricing problems. High prices are expected during the rainy season.

By improving the quality of the roads, both vehicle operating costs and travel time can be reduced. It is also likely that the volume of traffic will increase and create a more competitive transport sector. Subsequently, access to labour markets, input markets and social services will become easier and cheaper. This will lead to increased productivity and incomes.

Energy shortages also restrict agricultural production, processing and marketing and prevent the expansion of the areas under cultivation, irrigation, storage refrigeration capacity and processing services. However, the current generating capacity of the country falls very short of demand. Some of the pump schemes still use diesel, which is expensive and often in short supply.

3.1.9 Linking with markets

While the focus of the preceding discussion has been on supply side measures, it is widely acknowledged that the ability of small farmers to access markets for their produce is critical to improving their income and wellbeing. Several factors may frustrate the farmers in their efforts to get the best prices for their produce, some of which are the variability of the agricultural produce from one year to another, the resulting price fluctuations, the perishable nature of some of their products and the absence of storage or transport infrastructure. Additional difficulties arise because of the dispersed nature of small-scale farms, the distance of some of

rural areas from urban centres, the price elasticity of food and other crops, the structure of the market, the regulatory framework, pricing policies, the role of the state in marketing and in price stabilization and the level of development of the agro-processing industry.

Virtually none of the farmers in Sudan produce for subsistence alone. Small farmers produce for markets as well as for subsistence. However, they often face unfavourable market conditions. Poor marketing conditions lower the prices of their produce and weaken their incentives to engage in production. This is true for those who produce for the domestic food market, those who produce for export and those who produce for the agro-food processing industry.

Lack of access to marketing information and information asymmetry between producers and sellers is one challenge undermining small-scale family farming. Farmers need information on prices which they can use as market signals to inform them regarding what they should produce and how. They also need the price information and the status of supply and demand to help them negotiate with the traders and intermediaries. However, the channels for disseminating market information in areas such as Darfur, Kordofan and Blue Nile, not to mention some areas of small-scale family farming, are weak. Farmers also lack knowledge about how the price mechanism works, who the players in the market are and how markets function.

For many of the producers scattered in remote villages throughout the country, transport is an important factor. This is especially true for perishable products. Many small-scale producers in areas with great potential in the production of products such as fish, meat, dairy, fruits and vegetables fail to transport their products to the urban markets or for export. Lack of cold storage facilities in areas such as Jebel Marra and the Blue Nile result in the produce rotting or simply in the production of such products being unviable. For storing grains, farmers use traditional methods. Additionally, the government has established silos and warehouses for strategic reserves. But the warehouses are not distributed evenly throughout the country and there is inadequate storage capacity in many parts of the country. Post-harvest losses are substantial and may reach up to 50 percent of the harvest in some cases.

However, linking the farmers to markets is not simply a question of roads. At harvest time, farmers need money to finance some of the activities. Since they do not have easy access to finance, they sell their products at lower prices than if they were to sell them later. Thus, farmers need access to credit or short term capital to enable them to smooth out their cash flow and avoid having to sell under pressure.

Building marketing infrastructure (institutional as well as physical) and increasing access to the means of processing add value and assist in increasing farmers' earnings. For instance, surveys have shown that average price of cattle in Omdurman is 110 percent higher than that of Nyala, and that of sheep is 97 percent higher in Omdurman than in Nyala. Meat processing and direct export from Nyala saves the producers considerable amounts of money.

In the past, the government's involvement in formulating agricultural prices had a negative effect. Marketing boards set prices below international prices. One example of this was the Gum Arabic Corporation, which took advantage of its monopoly to lower the prices paid to the producers, leading some of them to smuggle their product to neighbouring countries and discouraging others from continuing to produce gum arabic. The prices of other products are

sometimes depressed intentionally by the government in order to keep food prices down. In other more justifiable instances, price stabilization was used to overcome wide fluctuations. A stabilization fund was set up and at times when prices were low, they were raised. In the case of wheat, the state fixes the price before the season.

However, since the adoption of market liberalization, the government has abstained from any forms of intervention in price fixing. The private sector is taking on a greater role in the marketing agricultural products. Supermarkets also have become more dominant in domestic retail sales. New marketing arrangements are emerging, such as contract farming. Some commercial enterprises or commercial farmers are also facilitating the access of small-scale farmers to loans, seeds and advisory services in return for the right to market their crops. One example is DAL, an enterprise which has its own dairy farms but entered into arrangements with small producers to buy and distribute their dairy products under its name. Although these may be positive developments, farmers are better off establishing cooperatives, which can strengthen their bargaining power, facilitate large-scale transport and purchases and enable value addition for their produce. Economies of scale will help to reduce the marketing costs. Producer groups and associations can help reduce the layers of market intermediaries and increase access to processing facilities.

In 2005, the Government of Sudan proposed to seven projects in the area of agricultural marketing and rural infrastructure development to the Comprehensive Africa Agriculture Development Programme.[59] These included support for market information system; support for transport facilities and feeder roads; development of processing, packaging and quality control systems for perishable products, development of livestock holding grounds; promoting the creation of producer marketing associations and cooperatives and building capacity in the area of SPS/TBT (sanitary and phytosanitary measures and technical barriers to trade), a measure that will facilitate international market access for Sudan's agricultural products.

To conclude, there are several areas in agricultural marketing which need to be addressed. These include developing marketing information, use of ICTs, building market infrastructure, upgrading farmers' technical capacity, introducing risk management instruments, encouraging collective action through producer organizations, offering farmers training in organizational management skills, promoting exports and international market diversification and addressing the stringent sanitary and phytosanitary standards in global markets.

3.1.10 Advancing research, innovations and extension services

The main role of science in agriculture is to help produce more on less land and with less effort. Agricultural research plays a key role in raising farm yields. Studies consistently show high returns on investment in agricultural research which leads to improved seeds varieties. The green revolutions of rice and wheat in Asia and Latin America are strong evidence of the importance of applying science and technology to agricultural production.

[59] GoS, NEPAD, FAO: Support to NEPAD – CAADP Implementation, Vol. IV. Bankable Investment Project Profile: Agricultural Marketing and Rural Infrastructure Development January 2005

The prospects for higher returns from agricultural research have since increased as a result of recent technological developments in chemistry, biology and genetics. Expectations are even higher that science and such technological developments as genetic engineering will help achieve sustainable agricultural production and climatic change adaptation.

Agricultural research in Sudan dates back to the colonial days. Several research stations and training institutions have been established. However, with the macroeconomic crisis that afflicted the country during the 1980s and 1990s, public spending on agricultural research declined, and after increasing again from 2000 to 2010, it dropped again in real terms from 2010 through 2014.[60,61] According to Stads and El Siddig (2010), Sudan has one of the lowest per capita expenditure on research in Africa. Although at one point the country had the fourth largest pool of researchers in Africa, the number of qualified and experienced researchers has dropped. From 2004 to 2009, around 60 PhD-qualified researchers retired or died. These have been replaced by young, locally trained researchers.

The main research institution in Sudan is the Agricultural Research Corporation (ARC). Established in 1967, the ARC focuses on crop and forestry production, soil and water management, agricultural engineering, plant biotechnology, food technology and genetic resources. The ARC headquarters is in Wad Medani, in the Gezira state, and 35 ARC units are spread throughout the rest of the country.

The other important research institution in Sudan is the Animal Resources Research Corporation, established in 1995, which focuses on animal production, fisheries and wildlife. The corporation has a network of 22 regional veterinary laboratories and animal production research stations. The other two research institutions dealing with agriculture are the National Centre for Research, which among other areas deals with the environment, natural resources, biotechnology, genetic engineering and arid and dry lands, and the Hydrology Research Centre Station, which deals with irrigation conveyance systems, weed control and siltation. About 31 educational institutions also deal with training and research in agriculture.

A study by El Siddig in 2010 noted that about half the agricultural researchers were involved in crop and livestock research, around one-tenth were focusing on forestry and another tenth were focusing on natural resource management. The rest of the researchers concentrated on postharvest issues, socio-economic issues, fisheries, water and irrigation and other areas. The study also indicated that horticulture crops are the most researched crops in Sudan. It noted that Sudan's research on rainfed crops is relatively understaffed, compared with research on irrigated crops; that researchers are permanently posted in the western region and that the quality of the research conducted by the ARC, which constitutes the majority of agricultural research, was deteriorating. Limited investment in agricultural research as a share of agricultural GDP, under-funding of research centres and poor remuneration of researchers all have an effect on the country's agricultural research efforts.

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[60] Stads, G. and El Siddig, K.2010. *Sudan recent developments in agriculture research*. Country Note. Rome, IFRI.

[61] According to Stads and El-Siddig (2010), it increased from 26 million purchasing power parity dollars in 2001 to 52 million purchasing power parity dollars in 2008.

In summary, building the capacity of the research institutions in the country requires sustained investment to train a new generation of scientists and improve the currently degraded research facilities. Research staff also need to be provided with incentives and their interaction with partners in research, education, agri-business and other relevant areas needs to be facilitated. Finally, the necessary support should be provided in order for them to access global knowledge and technology.

Extension services also have an important role to play in promoting knowledge-based approaches to maximizing efficiency, increasing productivity and improving the quality of produce. Equipping small-scale farmers with the necessary knowledge, management and business skills and improving their access to markets will enhance the quantity and quality of their produce and, thus, help to ensure profitable sales, improve their food security and strengthen their livelihoods. However, the country's extension services are poor and inadequate and have been continuously eroded. Extension units are short of operational funds and physical resources. Many of the competent staff have left. Links with external research centres are limited and the extension services has not kept up with ongoing globalization nor with scientific developments.

In a nutshell, what is required is to expand the extension services and the linkages between the research centres and farmers.

3.1.11 Producer organizations

While the tenant unions for farmers involved in the irrigated agriculture schemes and associations for farmers practicing large-scale semi-mechanized agriculture have been organized and, to some extent, able to defend their interests, small-scale farmers, pastoralists and animal breeders have not had effective representation and have not had a political voice. This has been mainly due to the fact that they are geographically scattered and differentiated by various livelihoods and systems of production. The fact that the system of political representation has not been well-established in the country also makes it difficult for a group as less educated as the small-scale producers to capture any significant political influence.

Decentralization and the system of representation and political contestation in the states provide better opportunities for the small farmers to make their voices heard. Recently, small-scale farmers have understood the benefits of cooperatives and producer organizations for marketing, finance and production purposes. These organizations will likely lead to strengthening the political collective power of the small farmers. As an example, through a gum arabic donor-funded project, it was possible to set up 130 producer associations who organized networking meetings and awareness campaigns to increase their member's knowledge in production and marketing issues.

More generally, the formation and strengthening of institutions such as producer associations and village development committees is critical to empowering small-scale producers to fully exploit the advantages of working as groups to market their products, purchase inputs, facilitate access to markets, mobilize and/or attract funds or investment for their communities, manage common infrastructure facilities and engaging in income-generating activities. It will also help them build political clout if more participatory democratic governance takes hold in the country.

3.1.12 Strengthening institutional capacity

While the above account maintains that there is a growing focus on small-scale family farming, the translation of these strategies into programs and the implementation of these programs hinge on institutional capacity and arrangement in the agriculture sector. There are at present an array of institutions that are directly or indirectly related to agriculture in general and to small-scale family farming in particular. Above these are the ministries, directly overseeing agriculture as a whole. These include the Ministry of Agriculture, Irrigation and Forestry and the Ministry of Animal Resources and Fisheries. Other related government agencies deal with the environment, natural resource management, land and social and physical infrastructure. There are also the knowledge supporting institutions, which are responsible for generating and disseminating knowledge, science and innovations and providing extension services.

It could safely be stated that Sudan has trained large numbers of experts in the area of crop production, irrigation, animal husbandry, marketing, fisheries and forestry and agricultural economics. Considerable research has been done on the various aspects of agriculture.

However, as mentioned in the preceding section, despite all the achievements of the past, there are worrying signs of weakening institutional capacity. This is partly due to high turnover among the staff of the ministries, research institutions and universities. It is also because government decentralization led to an increase in the need for experts at the state level. Thirdly, lack of funding at the federal and state levels left government officials unable to carry their tasks effectively. Another limiting factor is that capacity in statistics and data collection is weak. No animal census has been undertaken since 1975. Weak institutional capacity at the state level particularly affects small-scale family farming. Also, since issues of small-scale family farming arise among various, different sectors, poor coordination will lead to ineffective policy implementation.

On the basis of the above, it could be concluded that unless the institutional capacity is strengthened, not much can be expected from government in improving the delivery of services to small-scale family farming and the design of appropriate instruments to address the various problems and constraints facing the subsector. This would require strengthening the institution capacity of ministries dealing with small-scale family farming at the federal level, training staff and improving the institutional capacity at the state level, improving public service delivery and increasing the involvement of the communities.

It is also important to tap the expertise of specialized agencies, strengthen partnerships with all donor agencies and improve coordination among interventions in the sector. Several agencies, including United Nations organizations, bilateral donors and NGOS, have contributed to addressing capacity–building needs. FAO, IFAD, WFP, UNEP and UNDP have provided support for capacity building and conducted studies that have proved valuable to policymaking and the management of the agriculture sector in general and small-scale family farming in particular. The United Nations Development Assistance Framework (UNDAF), the IFAD Country Strategic Opportunities Paper (COSOP) and the Sudan Country Programming Framework (CPF) of the FAO have been guiding the UN organizations in their interventions in agriculture and in the rural areas of the Sudan.

The UNDAF (2013-2016) addressed peace-building, governance and rule of law, supply of basic services for better education, health, nutrition, water and sanitation services. The IFAD-COSOP supported the rural poor in the traditional rainfed agriculture. It increased the capacities of the rural producers. IFAD assisted in the establishment of farmer and pastoralist unions, including women's associations. It provided improved extension services to poor farmers and supplied microfinance, built feeder roads and introduced agro-processing activities. IFAD also supported the establishment of storage facilities and the access of the poor producers to finance and to input and output markets. The FAO-CPF (2012–2016) designed four priority areas for building capacity in planning and policy formulation, agricultural research and technology transfer, natural resource development and conservation, and disaster risk management (DRM) in agriculture. In addition, several NGOs contributed significantly in supporting localized and pilot projects, which contributed to understanding the impact of various policy instruments on farming.

3.2 Conclusion and Recommended Policy Actions

3.2.1 The challenges of small-scale family farming

The term small-scale farmers is defined for the purpose of this paper as those who, while fully or partially engaged in any of the six agricultural activities mentioned above, have limited endowments with productive assets though they are in full control of their own production, managerial and marketing choices. This definition includes family farmers but is not restricted to them, and though traditional farmers represent the largest, most predominant segment of the category of small-scale farmers, the definition adopted here includes non-traditional small-scale farmers as well. The term also comprises those involved in crop production, animal production, forestry and fisheries. It excludes, however, tenants who operate farms in large agricultural schemes and seasonal labourers who do not do farming activities on their own.

With this definition, it is clear that there are a large number of small-scale farmers, mostly dependent on rainfed agriculture and animal husbandry, supporting an even bigger population spread throughout the country. Small-scale farmers, as a whole, are in a state of flux. Some of farmers or their direct members move permanently to other non-farm jobs. Few grow and move on to medium or large-scale commercial farming.

Small-scale farmers are faced with continuously changing local and global contexts, induced by demographic, economic, ecological, political and technological factors. The rising population, the commercialization of production and the increase in livestock have put pressure on natural resources. The competition over natural resources, which is exacerbated by the frequent occurrence of droughts and by climate change, led to intense conflicts in Western Sudan and other regions. The conflicts resulted in serious socio-economic consequences, resulting in the disruption of livelihoods, the displacement of population and the migration to urban centres. The secession of South Sudan after decades of war, which reduced the population, territory and natural resources base of Sudan, affected the livelihoods of transhumant groups in South Darfur and South Kordofan and reduced the supply of agricultural labour.

The global spike of food and agricultural prices, consequent to the increase in oil prices, led to heightened interest in bio-fuels and of a fear of a permanent global food shortage. These fears generated interest in investment in Sudanese agriculture, which the government quickly welcomed. Meanwhile, ongoing globalization was accompanied by rapid technological developments and scientific breakthroughs.

These changes in the domestic and global contexts are having far-reaching implications for small-scale family farming. Globalization and technological developments changed agricultural production, trade and finance. They also brought opportunities and risks for small-scale family farming.

While small-scale family farming has to adapt to all these domestic and global changes, it has also continued to face a variety of production constraints, market failures and policy biases. Government response to the secession of South Sudan was to shift focus to the agriculture sector, as an avenue for economic growth and diversification. There has also been an increasing recognition of the role of small-scale family farming in the generation of export earnings and in the fight against poverty and regional inequalities.

3.2.2 Why should they be assisted?

The hesitant shift of attention to small-scale family farming in the country has come at a time of increased international support to poverty reduction and to furthering the achievement of the millennium development goals. It has also coincided with the emergence of a new development paradigm that discovered the value of developing small-scale family farming. The United Nations Organization declared 2014 the International Year of Family Farming.

Multiple arguments have been advanced in support of the viability of small-scale family farming. An important role is seen for small-scale family farming in food security. The improvement of the productivity of the subsector enhances food availability and accessibility. Increased food production reduces the price of food in urban centres and improves diets and the quality of nutrition. The increase in agricultural output boosts the incomes and raises the standards of living of a majority of the rural population, thus contributing to poverty reduction and rural development, which is characterized by widespread incidences of absolute and relative poverty. Small-scale agricultural-based growth in general has greater poverty reducing impact than large scale agriculture-based growth.

The improvement in the rural economy expands its capacity to retain and absorb workers, at a time when the urban formal market is not generating sufficient job opportunities. By helping to reduce poverty and disparities in economic opportunities, the improvement of productivity in small-scale family farming also helps to reduce social tensions and internal regional conflicts. It also improves gender equality, as agriculture is the largest source of employment for women. Moreover, if assisted, small-scale family farming could help to avoid environmental deterioration and conserve and enhance soil fertility and biodiversity while providing decent livelihoods for farmers.

The above arguments are not intended to romanticize small-scale family farming and family or traditional farming. It is not to be forgotten that some agricultural practices in small-scale farming have been harmful to the environment. They have led to deforestation, expansion

of farming into new marginal lands and loss of soil fertility. However, all these undesirable results have been consequences of the pressures farmers faced and the institutional and legal framework under which they have been operating.

The apparent lower productivity and efficiency of small-scale family farming, when compared to large-scale schemes, can be explained in part by the negligence of policymakers with regard to small-scale family farming and the unlevel playing field between the two subsectors. Large schemes have been supported by public investments, subsidies and preferential treatment. The advantage of scale economies is important but can be offset in the small-scale subsector through producer associations and cooperatives. Small-scale farmers have also shown that they are economically rational and have been responding to economic market opportunities. Their decisions on crop mix and integration with animal production are taken in accordance with strategies in which risk aversion is an important factor. There is no reason to think that the supply response of small-scale farmers will not be elastic if constraints are removed and market information is made available.

Even with its lower productivity, compared with large-scale schemes, small-scale family farming contributed significantly to the national economy. It generated half of the agricultural GDP, provided employment for over 70 percent of the population and was the source of 70 percent of foreign exchange earnings in 2015. Where it prevailed, small-scale farming stabilized rural communities and injected more incomes into the rural economies than what large scale farming normally provides.

3.2.3 How should they be assisted? Broad areas for interventions

The preceding sections present the case for the importance of increasing the productivity of the small-scale family farming. They also showed the ongoing domestic and global changes affecting the subsector and the constraints holding it back. To respond to the changing contexts and the constraints small-scale family farming is currently facing, it is critical that the government target the following strategic actions:

- **First: increasing the focus on smallholders and levelling the playing field**

The efficient evolution of the subsector cannot be left to chance or to markets alone. There is a need for substantial, systematic and multidimensional public interventions to level the playing field with large-scale farmers and non-agricultural economic activities, doing more to address the biases of the past. A separate, strategic plan targeting small-scale family farming that facilitates systematic, prioritized and costed interventions is needed. (While further work has to be done to provide a more operational definition of who constitutes the group of small-scale farmers, in this study this includes all family-based farmers with asset endowments such as land, livestock and agricultural machineries, who make their own production and management decisions).

- **Second: resolving the issues of access to natural productive assets**

Addressing the land issue is critical for revitalizing the rural economy. The lack of property rights has led to conflicts, overuse and underinvestment of land and also deprived the farmers of collateral against which they can get access to credit. One option is to lease the land to its current user, begin a system of land registration and enforce property and land use rights. To

avoid further conflicts, land disputes should be resolved together with the communities and on the basis of general consensus. Regarding the livestock subsector, in addition to providing animal producers with the legally-supported right to land use, similar to cultivators, it is important to demarcate and map the livestock routes and enforce the use of these routes if conflicts are to be avoided.

The second major issue is access to water, which is an important determinant of land productivity. The challenges and the responses needed differ from one area of the country to another. Water availability is one of the most binding constraints to both crop and animal production in rainfed agriculture. Water harvesting is a proven effective means of overcoming the problem. It includes the full utilization of rainfall and seasonal streams outside the Nile Basin. Also, more underground water should be put into use. Given the low and variable level of rainfall, in certain cases drought-resistant varieties can be used. More generally (for the whole agriculture sector), water should be treated as scarce resource and the efficiency of its use should be enhanced. The opportunity cost of the use of water should be one of the criteria for crop selection and rotation. In irrigated agriculture, the strategic issue is to let more of Sudan's share of water go to smallholders irrigation. Eventually, with Sudan approaching the maximum of its water share in the Nile, the issue of increasing the efficiency of water use in irrigated agriculture will capture attention. Furthermore, the impact on small-scale family farming of the dam being built on the Blue Nile in Ethiopia should be studied more carefully. The fisheries resources should also be protected and their utilization should be rationalized.

- **Third, addressing supply-side constraints**

The supply side constraints which should be addressed include price incentives, physical infrastructure and access to inputs and farm technology. Factors of production can be put into use only if the environment is made to be conducive to doing so. Farmers produce in response to price incentives and their response is stronger if there is adequate physical infrastructure, such as road networks, telecommunications and power. Enhancing accessibility to improved seeds, fertilizers and other inputs will also lead to more production. Additionally, agricultural practices such as crop patterns and rotation, tillage and harvesting will increase production. Animal production, on the other hand, will be enhanced much by the provision of veterinary health services and water points, in addition to advisory extension services for nomadic herding and off-takes.

- **Fourth, boosting access to finance**

Expanding small-scale farmers' access to finance is a great challenge. While it could help farmers to increase productivity by increasing their capacity to invest, purchase inputs and finance some production and marketing operations, the financial system has yet to overcome issues of the high risk involved in agricultural production (especially in rainfed agriculture) and the transaction cost of doing business with sparsely distributed farming population. The production level of small-scale farmers in rainfed agriculture is highly variable and this variability is often translated into wide price swings, due to poor marketing infrastructure and low elasticity of demand for food. Many farmers lack collateral to guarantee their loans. Measures to be taken include strengthening the capacity of micro-finance operators,

introducing various insurance products, reliance on group financing and, above all, instituting a better system of property rights and entitlements of land ownership.

- **Fifth, building human and social capital**

Knowledge-intensive agriculture requires variety of specific skills. Investment in human capital will expand the capacity of the rural population and small-scale family farming to utilize new technologies, introduce better agricultural practices and improve their marketing skills. Long term objectives can be achieved through improved schooling, health facilities, food security and nutrition. Farmers can also be directly targeted for business and vocational training. The interest of young people in agriculture should be simulated and women should be empowered through access to finance and land. Farmers and communities can be encouraged to set-up their own organizations and groups, which can assist in acquiring inputs, marketing output, bargaining collectively and transmitting and sharing market information.

- **Sixth, facilitating the marketing of agricultural products**

Well-functioning markets signal scarcities, strengthen value chains and enable farmers to manage risks, access credit and exchange information. Hence, marketing institutions and infrastructure should be built and regulated. Post-harvest losses can be reduced through the construction of warehouses and cold storage facilities, especially for perishable agricultural products. Producer groups and cooperatives can help to strengthen the bargaining power of the small farmers and help them in information sharing. Efforts are also needed to encourage penetration of foreign markets and diversification of these markets.

- **Seventh: Improve the policy and institutional framework**

It is evident that the overall state of governance in the country, the political and administrative structure, is important for all economic activities. A genuine representational political system leads to inclusiveness, accountability and a participatory process in decision-making. These will influence such national policy choices as the allocation of public investment, the burden sharing arrangement of extracting government revenues for current or development expenditure, the regulatory and legal enabling framework and the enforcement and implementation capacity of the state. While the larger issues of political governance lie outside the scope of this paper, it is to be noted that conflicts have very much harmed the small-scale producers, destabilized their communities and disrupted production. Political will, therefore, is needed to address the thorny issues of access to assets, particularly that of land, and to undertake measures which reduce regional inequalities. It is the contention of this paper that a focus on small-scale family farming contributes to the reduction of regional inequalities and hence conflicts.

If the strategic development focus shifts to small-scale family farming, the budgetary process will have to ensure public expenditure tilting toward the rural economy. Additionally, the effective tax rate on agriculture (including a degree of protection to industry, direct and indirect taxation on agriculture and over-valuation of currency) should not overburden small-scale family farming. However, what sustains the bias against the small-scale producer is governance that discourages civil engagement and collective decision-making and in which urban dwellers capture more influence than the scattered, largely voiceless rural population.

Producer organizations can give voice to smallholders and hold policymakers and the implementing agencies accountable by participating in agricultural policymaking, monitoring budget execution and engaging in policy implementation.

3.2.4 Recommended policy actions

I. Strengthen the strategic, policy and institutional framework			
1.1 Refocus the development strategy			
Issue		Recommended action	
	Reorient the development strategy by focusing on the objective of promoting small-scale family farming		Rethink the strategy and build consensus
	Need for substantial, systematic and multi-dimensional public interventions.	1.	Prepare a comprehensive small-scale family farming development strategy.
	Increase public expenditure on small-scale development	2.	Increase the percent of public expenditure earmarked to the subsector. (Determine the current percentage in the states and at the federal government level and use as a benchmark).
1.2 Improve macroeconomic management			
	Maintain stable macroeconomic environment	3.	Target internal and external balances, low inflation rate, stable and unified exchange rate and large fiscal space.
1.3 Reform the incentive structure			
8k	Avoid price disincentives to small-scale family farming and remove subsidies and exemptions from other sectors which lead to distortions in relative prices or give preferential concessions to investors in the other sectors.	4.	Avoid overvaluation of the exchange rate, over taxing small-scale family farming and setting prices administratively. Remove multi taxes on agriculture and stop road tax collections.
1.4 Enhance institutional support to the subsector			
	Address weakness in the vertical and horizontal coordination between the agencies involved.		Clearly define the coordination arrangement.
	Enhance the capacity for policy making and program implementation and monitoring at the federal level.		Train and motivate staff.
	Enhance the capacity for policymaking and program implementation and monitoring at the state and local levels.		Recruit competent staff and train and motivate staff.
1.5 Address the problems in decentralization			
	Define responsibilities within each level of government and between the states and the federal government.		Address issues of defining mandates and authorities and improve the inter-governmental fiscal relations
1.6 Strengthen knowledge generation.			
			Strengthen capacity for research and studies. Strengthen state bureaus of statistics and the ministries dealing with the agricultural subsectors.

II. Addressing the issues of access to and management of natural productive assets			
2.1 Land			
	Propose and adopt land system reforms so as to ensure long-term land use and property rights.		Revise the land tenure system so as to ensure secure ownership, and recognized rights and official registration. This should encourage investment and allow use of land title as collateral to facilitate access to adequate and timely formal credit.
	Build consensus on the reformed land policy.		Organize national and state level consultations.
	Avoid encroaching of large-scale farmers and foreign investors on land which small-scale producers and herders use.		
	Strengthen the Land Commissions both at the federal and state levels.		
	Strengthen the capacity for land administration, land registration and enforcing property rights.		Clear and transparent mandate.
	Improve land use and soil protection.		Large-scale farms should be held accountable for good land use and management so as to avoid soil mining.
			Assist herders to rationalize the building of stocks and apply more sustainable systems of animal husbandry and land use.
	A new land law that provides for, among other measures, long-term leases with land-use conditions, tradability of leases and a reduction in the number and size of very large farms in the semi-mechanized areas		
	Study the idea of allocating land to interested herders from the migratory group for use as ranches, applying good management practices		
	To strengthen livestock production, securing the conditions for mobility is essential. Since nomads move to get access to remote pasture, mapping, regulating and demarcating stock routes are needed.	4.	Demarcate and map the livestock routes
	Development of appropriately distributed water sources to prevent overuse of rangeland while allowing access to lands currently not used due to lack of water		
2.2 Water			
	Promote water harvesting		
	Simple, local innovations for water storage facilities, such as rubber water bags, earth pits lined with plastic sheets and cemented earth tanks		
	Take advantages of seasonal streams outside the Nile Basin		
	Utilize underground water		
	Increase the efficiency of water use		
	Fully use Sudan's share of water, especially for smallholder irrigation		

	Drought-resistant varieties can be used in irrigated agriculture		
	Assess water requirements in the selection of crops and in crop rotation		
2.3 Natural resource management			
	Address root causes of conflicts and poverty		Especially, improve governance, equality and inclusiveness
	Improve the regulatory and legal framework for land use		
	Improve the capacity of the states in natural resources management		
	Increase afforestation		
	Involve communities in managing natural resources		
	Establish forestry nurseries		
	Monitor climate change		
	Develop and manage pastures		

III. Addressing the supply-side constraints			
3.1 Access to seeds			
	Timely delivery, improved varieties, affordability		
	Encourage the private sector to expand seed production		
	Government should strengthen the capacity of the National Seed Administration to regulate and monitor seed production, distribution and certification.		
	Conduct research in order to supply improved seeds		
	Develop a sustained seed marketing outlets.		
	Expand and build capacity for extension services		
	Improve sowing techniques		
3.2 Access to fertilizer			
	Timely delivery, improved varieties, affordability.		
	Encourage the private sector to expand fertilizer marketing and manufacturing		
	Strengthen government capacity to regulate and monitor the use, the certification and distribution of fertilizers.		
	Research agencies should conduct research on the appropriate doses of fertilizers to be used and farmers should be assisted in the application of fertilizers.		
	Develop fertilizers marketing outlets		
	Expand extension services and build capacity for delivering extension services.		
3.3 Access to tools, implements and mechanization			
	Introduce animal-drawn technology		
	Introducing zero tillage		

3.4 Overcoming the problem of labour shortages			
	Use animal traction		
3.5 Cultural practices			
	Adopt and encourage, but monitor, the adoption of improved methods of cultivation such as early maturing, stable and drought-tolerant varieties, better cultural practices and water harvesting technologies.		
3.6 Animal Feed			
	Forage is a limiting factor for increasing production and reliable data on forage is lacking		Carry out a survey to estimate volume of forage and establish community enclosures for its propagation.
	Encourage harvesting, processing and conservation of surplus green forages for use in the dry season		
	Sheep fattening is increasing as an off-farm activity among the youths, particularly small and sedentary producers. This needs to be assessed, encouraged and supported		
3.7 Support to poultry production			
	Backyard poultry production in rural areas is the province of women. The activity suffers great losses due to parasitic and Newcastle infections. An extension program needs to be developed to build awareness among producers on improved methods of husbandry, management and feeding.		
3.8 Animal health support			
	Animal health is a constraint for small-scale production, as is access to markets.		Provide support for controlling animal diseases through research and vaccine development.
3.9 Animal breeds			
	Breed improvement is an important factor for increasing yield. The local practice of cross-breeding with local types is on the rise and the new cross-breed is adapted to the local ecology and preferred in the market. This approach needs be assessed and encouraged.		
3.10 Preparation of studies			
	There is variety of small-scale livestock producers. A study should be conducted to characterize them. This is of primary importance for any planned intervention.		

IV. Increasing access to finance			
4.1 Improved financial services in rural areas, adopting the village revolving fund approach.			
	Restructure, capitalize and strengthen the capacity of the Agriculture Bank of Sudan (ABS) in order for it to expand its reach to small-scale family farming.		
4.2 Encourage the development of producers' development banks.			
	The Zakat Chamber should provide guarantees and collateral		

4.3 Ease the conditions and cost of borrowing by the small scale farmers, for example through exemption from down payment and improving the terms of finance.			
	Restructure, capitalize and strengthen the capacity of the Agriculture Bank of Sudan (ABS) in order for it to expand its reach to small-scale family farming.		
4.4 Expand mobile banking			
	Restructure, capitalize and strengthen the capacity of the Agriculture Bank of Sudan (ABS) in order for it to expand its reach to small-scale family farming.		
4.5 Expand microfinance institutions			

V. Building human and social capitals			
5.1	**Strengthen research in all agricultural areas**		
5.2	**Strengthening extension services**		
5.3	**Investment in domestic water supply in rural areas**		
5.4	**Programs to provide education and health services in rural areas**		
5.5	**Increase the number of farmer field schools.**		1. Organize farmers field schools 2. Develop a manual for the schools 3. Train farmer field school trainers

VI. Linking to market and enhancing the supply chain			
6.1 Market liberalization			
	Well-functioning markets signalling scarcities.		Anti-monopolistic policies Abolish marketing boards
6.2 Enable farmers to access and manage risks, access credit and exchange information.			
6.3 Value Addition			
	Encourage innovations among commercial small-scale producers who are able to generate value added in response to evolving market needs along the market chains.		
	Improving the quality of products is key to meeting the market demand for quality agriculture commodities that draw premium prices.		
6.4 Opening new markets			
	Opening new markets entails promoting market-oriented producers who respond to evolving consumer demands		
	Farms' profitability and sustainability cab enhanced through facilitating accessing to lucrative growing domestic and international markets.		
6.5	**Building the managerial, financial and technical competences of the small producers will help them to compete regionally and internationally.**		

6.6 Strengthening the value chains			
	Encourage processing and marketing of animal products including slaughtering in the producing states and transporting the product from there to foreign markets		
	The government should help build marketing institutions and infrastructure and regulate them		
6.7 Public-Private Partnership			
	Create public-private partnerships that create favourable circumstances small-scale farmer production.		This could be done through: Incentive policies: announcing purchase prices, reducing of unjustified fees Supply of agricultural inputs Provision of marketing services (storage, transportation and grading) Provision of processing facilities (cottage industry, packing material)
6.8	**Penetration of foreign markets and diversification of these markets**		Undertake export promotion measures
	Programs to improve the marketing of agricultural and livestock products, via the value chain approach		
6.9 Warehouses and cold storage facilities			
	Abattoir Small-scale animal producers in remote areas lack access to slaughter facilities. Moving animals long distances increases costs, reduces weight, is detrimental to animal health and can result in losses.		Slaughter facilities Encourage processing and marketing of animal products, including slaughter facilities and transport
6.10	**Establish local stores supported by social solidarity credit to increase opportunities for income-generation by small-scale producers**		
	Empower small-scale producers by organizing them into specialized associations such as sheep producer associations, goat producer associations, domestic poultry producer associations, etc.		

VII. Promote technological development, technological transfer and innovation			
7.1	**Provide support to research centres (especially the Agricultural Research Council) and universities**		
7.2	**Build partnerships with regional and international research centres.**		
7.3	**Focus on high-yield crop varieties, drought-tolerant and pests and disease resistant varieties, use of inputs including seeds and fertilizers**		
7.4	**Link research to drought, soils and climate change.**		

ANNEX A

Working with communities: successful development initiatives

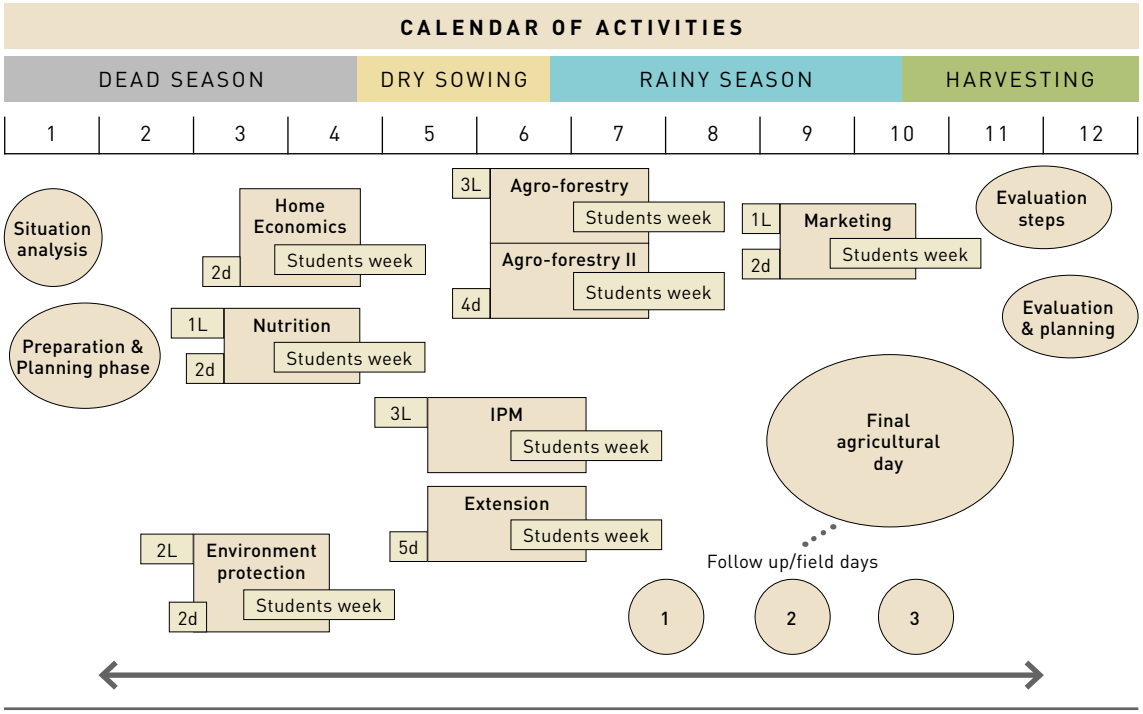
Case 1

The Development of the Village Um Sidir

Um Sidir is a small village inhabited by about 807 persons belonging to the transhumant Kenana tribe. It lies 60 km southwest of El Obeid, Abu Haraz and Sheikan administrative units in North Kordofan. A project was sponsored in the project by the German Development Service in collaboration with Kordofan University and several non-governmental organizations. The program included training in the management of natural resources, measures to improve food security and the nutritional status of the population, support for tree planting, vegetable gardening and the construction of latrines.

As an outcome of the project, some vanished tree species have been restored. The members of the community have shown much appreciation for the efforts made in afforestation and the protection of the environment. The capacity building activities assisted in upgrading the skills of the members of two community-based organizations and in upgrading skills in project implementation, lobbying and public relations, organizing, community mobilizing, reporting and planning. The program succeeded in sensitizing the community to the importance of communal work in redressing the factors disrupting its livelihood.

Figure A.1 **Calendar of activities**



The training was provided by Kordofan University lecturers. University students from different disciplines spent three to five days in the village after every training session to reinforce the understanding of the concepts learned and issues discussed. The training also targeted women, who were educated about home economics, environmental protection, nutrition, marketing and pest management and extension services. Specific training topics included food processing and preservation, management of household resources, time management (cooking, fetching water, collecting wood) and gas cooking. Other training topics included village planning (streets, yards, garbage pits, dangers, sanitation, hygiene and construction of latrines, water micro catchments, tree-based income generation, desertification and sand dunes, crop rotation, conservation of soil fertility, market oriented cropping, parasites (types and habitat), integrated pest management, improved seeds, farming techniques, safe agricultural tools and storage and transport.

The activities of the one-year program were scheduled around to the agricultural season, giving the farmers time to absorb and take various actions in each step (Fig. A.1). The same 35 persons in each village were expected to take part continuously and to peer train further community members.

Case 2

Introducing Technical Packages in Sinnar State

The federal and Sinnar State Ministries of Agriculture, in collaboration with the Agricultural Research Council, initiated a project to support the small-scale, traditional, rainfed producers in Sinnar State. The project was implemented in response to the alarming levels of land degradation in the state. The purpose was to introduce environment-friendly and productivity-enhancing technical packages. It also aimed to formulate a regulatory framework for the development of both smallholder and large-scale farming in a way that conserved the environment. One of the main expected outcomes was that at least 60 percent of the participating households would adopt minimum tillage, soil and water conservation and livestock nutrition packages.

The three activities envisaged were: (1) demonstration of minimum tillage, soil and water conservation and animal nutrition packages; (ii) scaling up the successful packages and (iii) collaborating with the Agriculture Research Corporation on applied research for adapting zero tillage techniques to agro-ecological and livelihood contexts in the project area and for the production of quality drought-resistant seeds. The collaboration also included developing the capacity of extension agents working in the State's Ministry of Agriculture, Animal Wealth and Irrigation.

The project also addressed issues of market access and post-harvest management, including physical market accessibility and post-harvest handling techniques. The target was that access to markets would improve for at least 80 percent of the participating households. Four main activities were planned towards improving marketing and post-harvest management. These included the construction of 35 multipurpose crossings, improving traditional grain storage facilities and introducing solar drying techniques for vegetables and fruits and improvement of local oil seed presses.

In terms of post-harvest storage facilities, farmers use a rudimentary, traditional storage facility known as *siwaibas*, a hut-type construction made mainly of straw. Some farmers practice underground storage as well (*matmooras*). While post-harvest losses associated with these types of storage facilities are undocumented, according to the beneficiaries, the percentage is significant due to lack of cleaning or fumigation.

A technical cooperation program between the Agricultural Research Corporation, and an IFAD-Government of Sudan project made possible the transfer of technologies to small-scale rainfed farmers in Sinnar. The technologies transferred included the use of the chisel plough for in situ water conservation and sowing of improved, released cultivars of sorghum, sesame, groundnut, millet, cowpea and forage legumes in a three course rotation (2012-2014). Data obtained revealed that the use of chisel plough resulted in deeper water penetration in the soil than with the use of a wide level disc (WLD) and, together with sowing of improved cultivars, substantially boosted sorghum and sesame yields.

The two initiatives, in Um Sidir village in North Kordofan and in Sinnar, demonstrate that working with communities can lead to capacity building and technological transfers that can be replicated elsewhere, increasing the benefits to small-scale family farming.

Case 3

Improving livestock Production and Marketing

The project Improving Livestock Production and Marketing (ILPM), a pilot project, was a successful story. It addressed the natural resource issue (water and pasture), livestock routes, livestock markets, provision of veterinary services by the private sector and the empowerment of local communities. The project involved the stakeholders at all levels in decision-making regarding project activities.

ILPM was a USD 20 million pilot project, financed jointly by a multi-donor trust fund, which contributed USD8 million, and the Government of Sudan, which contributed USD 12 million, under the administration of the World Bank. The fund was a grant to the Government of National Unity, tagged as MDTF-N, as there was similar project for South Sudan. The development objective of the project was to support livestock production and marketing in two poor, conflict areas, identified as eastern Sudan (Blue Nile, Sinnar and White Nile states) and western Sudan (North Kordofan). The intention was to improve the livelihoods of livestock dependent communities in these areas as a means to ensure sustainable peace, mitigate natural resource-based conflict and enhance food security. The project was designed and structured around pilot activities to address pastoralists' priority needs and livestock production and marketing through:

- community-led projects to support improved livestock production;
- privatization of veterinary services;
- improvement of livestock markets and marketing; and
- mapping exercise in support of approaches to mitigate natural resource-based conflicts.

Once the interventions proved successful, they could be replicated in other traditional, rainfed areas of Sudan.

The key performance indicators of the project were:

- number of subprojects supporting livestock-dependant livelihoods;
- number of vaccinations delivered by private veterinarians;
- increase in animals traded in selected markets;
- completion of study on constraints to natural resource-based conflict mitigation.

The localities selected for the implementation of the project were: Damazin (Blue Nile), Abuhujar (Sinnar), Jebelain (White Nile) and Abuzabd/Elkhiwey, Ennihood and Gibaish (North Kordofan). The implementing agency was the Ministry of Animal Resources and Fisheries (MARF) and the implementation period was 2007-2012.The project had three components:

- Livestock Development Investment Fund;
- privatization of animal health services and markets;
- support for project implementation and studies

The project was managed by a project coordination unit based in Khartoum and two project implementation units, one in Sinnar (eastern sector) and the other in Elobeid (western sector). At the local level, there were local implementation units and at the grass-roots level there were village development committees chosen by the beneficiaries and registered with the state authority for social affairs (and thus officially recognized).

At each level of management there was a steering committee including representatives of stakeholders. The one in Khartoum was headed by the Undersecretary of the MARF, while those in the states (each state had its own steering committee) were chaired by the state minister responsible for livestock. At the local level, the committee was chaired by the locality commissioner. The intention of these arrangements was to ensure the involvement of and harmony among all decision-makers in the process.

For the provision of veterinary services, the North Kordofan Government issued an act allowing private veterinarians to deliver services that are vested in official authorities only. It was a courageous decision and the first practical step ever towards the privatization of veterinary services in Sudan.

The cost of rehabilitating the livestock markets was shared by the project and the participating localities as markets are an important source of revenue for the local government. A market board was established with representation from all stakeholders to run the market, with an agreed portion of the revenues going to the board for rehabilitation and improvement of the market.

The subprojects were community-driven. They were submitted by the community to the locality steering committee for validation, then to the state steering committee for approval and finally to the project steering committee for endorsement. The cost of any subproject was

shared by the project (80 percent) and the community (20 percent). Water points were run by the community and the revenues were deposited in a bank run by the village development committee. The net revenues were divided between the community, the locality and the State Water Cooperation through a tripartite agreement or by the community and the State Water Corporation through a bilateral agreement. The community revenues were used by village development committees to assist poor households to rebuild their animal assets and rehabilitate the schools and health centres.

Case 4

Blue Nile State Farmers Field Schools

To overcome some of the challenges facing the farmers, the Blue Nile State Ministry of Agriculture, Animal Resources and Fisheries, in collaboration with FAO and the Sudan Productive Capacity Recovery Program of the European Union (2007-2012), supported the establishment of farmer field schools (FFS) in the Blue Nile State. The objective was to improve the capacity of small-scale producers to adopt appropriate technologies on their own farms and to share the results with neighbouring farmers. Training was also intended to improve farm cultural practices and develop integrated pest management practices adapted to the local conditions.

The program succeeded in recruiting 33 extension workers, conducting 129 field school sessions and organizing 910 extension sessions. The training provided focused on the importance of improved seeds and germination tests, the significance of adopting crop rotations, measures for pest management and for the storage of chemicals, safety information regarding the use of pesticides and guidance on best post-harvest practices. In general, the program managed to upgrade the skills of the farmers in cultural practices. It was hoped that, even without the extension staff, the community would continue to work collectively to address the problems facing them and to share information and experience.

The implementation of the program, in accordance with the Planning Administration of the Ministry of Agriculture in Blue Nile State, was assessed as successful. It was much appreciated and positively received by the farmers. The program assisted in the training of the extension staff, the formation of a group of qualified trainers and in strengthening the relationship (through coordinators and facilitators) between the Ministry and the Agricultural Research Council in applied research and in FFS demonstration farms.

Case 5

The Village as a Center of Development

Within the context of the Agricultural Revival Program (ARP) and on the basis of the concept of the village as the focus of development, the Federal Government supported the establishment of agricultural development centres in the Blue Nile State. Seven such centres were found in the localities of Kurmuk (Daim Mansour and Al Kaily), Rosieres (Um Darfa, Khor Al Douom and Badous), Bau (Sda, Khor Al Douom) and of Geisan (Abu Gumai, Abu Shenanina, and Bakuri). These centres were staffed with agricultural engineers, extension

specialists, veterinary officers, fisheries experts and rural development practitioners. The targeted group were from among the small producers engaged in the production of food and cash crops, horticultural crops, animal production, veterinary services, fisheries, forestry and range and pasture protection and development.

The centres provided extension services and assisted farmers in accessing inputs, including improved seeds and agricultural implements. They also trained farmers in resource management, bookkeeping and conducting surveying and controlling crop and animal pests. They also assisted in introducing greenhouses and modern techniques that increased production and contributed to the process of building food security. Women were also trained in production and home-management affairs. Additionally, the centres encouraged and supported the establishment of a number of farmer and producer associations.

The staff of the centres gained good experience in dealing with small-scale producers. The program provided a great opportunity for building capacity through the training of 134 trainers, for the staff at the Ministry of Agriculture and Fisheries Wealth to gain experience and for the Ministry to establish and develop a database on a systematic approach to marketing, rainfall and food security. The Ministry also gained experience in project implementation and, as part of the project, it established a monitoring and evaluation (M&E) unit. The program helped to introduce and implement a participatory approach to project management and enhanced collaboration in implementing projects between the state and national levels. However, the sustainability of the activities hinges on the availability of funding. Though the state Ministry of Agriculture has so far managed to cover about 30 percent of the expenses related to extension workers in those centres, support for other services is not assured.

Case 6

On-Going Small Producer Development Project, Gedaref State

A similar program for supporting small-scale producers has been started in the Gedaref State in 2013. The project is jointly prepared and financed by the Ministry of Agriculture and Irrigation, the Agricultural Research Corporation, the Agricultural Bank of Sudan, agricultural services companies and agricultural insurance companies. The objectives of the project are to increase productivity and production of crops; reduce production costs; improve agronomical operations and train farmers in the application of agricultural technologies and mechanization. The project covers the localities of Rahad, Fashaga, East Galabat, West Galabat, Gala Al Nahal and central Gedaref, covering a total area of 2.2 million feddans.

Gedaref State has a population of 1.336 million people with a high annual growth rate of 4.7 percent (census, 2008). The state is endowed with rainfall ranging between under 200 mm per annum in the northern part to more than 700 mm per annum in the south-eastern part. Rainfed agriculture contributes more than 90 percent of the state's GDP and accommodates more than 65 percent of the economically active population. Two types of agricultural activity exist, rainfed mechanized agriculture and rainfed traditional production systems. Crops grown include sorghum, sesame, groundnuts, millet, sunflower, cotton and guar. Gedaref State is considered the main centre for the production of sorghum in Sudan. It contributes more than 50 percent of the total production of sorghum in the country.

The State is divided into two parts in terms of land-use. The area north of latitude 14°45'N is endowed with range pastures on which no crop production is allowed, except on a limited area. The area is used for animal grazing (camels, sheep and goats). The area south of the 14°45N latitude is assigned for crop production mainly. The agricultural ecologies of Gedaref are divided into northern, central and southern regions. The northern ecology has rainfall below 500 mm per annum and the crop season begins late. The suitable crops for this region are the early maturing sorghum and sesame crop varieties and millet and guar. The central ecology has rainfall ranging between 500 and 600 mm per annum and the crop season starts relatively earlier. Suitable crops are the early and medium maturity crops of sorghum and sesame as well as cotton, sunflower, groundnuts, guar and millet. This region is close to Gedaref town and is therefore privileged by existence of main transportation roads, marketing and agricultural services. The southern ecology has rainfall above 600 mm per annum, and an early crop season. Suitable crops for this area are the late maturing crop varieties of sorghum and sesame, as well as cotton, sunflower and millet.

The 154 000 small producers practice a mix of semi-mechanized and traditional crop production systems over an area of 2.2 million feddans. They have landholdings ranging between 5 and 500 feddans. Generally, they suffer from low productivity and production due to institutional constraints and problems related to the natural environment. They are unable to buy agricultural machinery and implements, lack knowledge on how to use agricultural inputs and receive weak agricultural extension services.

The project is intended to assist the small-scale producers through research, technologies and extension services, to introduce high yielding varieties, to encourage the adoption appropriate crop rotation, improve the planting techniques, intensify the use of fertilizers, pest and weed control, utilize mechanized harvesting and improve postharvest operations. To enhance water harvesting, the project is encouraging the farmers to rely on closed ridges on both or one sides, open ridges on the two sides, semi-circular frames, L-shaped frames and terraces.

The project, which started in 2013, is scheduled to last through 2016. The project is well designed to address some of the capacity inadequacies facing small producers. However, the outcomes of the project are not yet known. Major issues which needed close attention are: the importance of monitoring and evaluation and the sustainability of the project. On both counts, there are serious problems given the low capacity and the fiscal constraints in the state.

Case 7

Al Shamil Agricultural Company

Al Shamil Agricultural Company is a private company specialized in the provision of agricultural services such as the provision of finance, the production and marketing of improved seeds and transferring agricultural and animal production technologies. It is concentrated in the Northern State. The company supported the diversification and intensification of cropping, especially through the introduction of improved varieties of date palm and mangoes in many states, including Northern, River Nile, Khartoum, Gezira, North Darfur and Red Sea states. The company operates in close cooperation with the Agricultural Bank and federal and local units in the Northern and River Nile states. It contributes to the

management and operation of four schemes in River Nile, with a total area of 21 565 feddans (5 037 farmers) and 10 schemes in the Northern State, covering an area of 92 265 feddans. The States reports indicated that the company has been successful in supporting small-scale farms in these states and contributed to create stability in these schemes through rehabilitation, management and sustainability of agricultural activities. It has contributed to increasing production in Guendto and to a food security program in Atbara and Damer (Ministry of Agriculture and Irrigation & Ministry of Finance, 2015).

Case 8

Kadar Kol Company (Alkamir Taiba Project)

This company fully financed the purchase of inputs and some agricultural services. The company undertook the management responsibility in collaboration with different departments dealing with extension, technology transfer and crop protection activities in the Nile State's Ministry of Agriculture. It assisted in rehabilitating Alkamir Taiba leading to the addition of 1 049 feddans in the Alkamir Taiba project extension. The company provided a pilot farm (for research) and irrigated 1 500 feddans of private projects affected by the receding of the Nile and clearing 160 km in the main and other canals. The company also collaborated with the Agricultural Research Station in Shandi and provided support to the marketing of crops, especially onions produced on small-scale farms. It also financed and implemented maintenance and clearance of irrigation canals (Ministry of Agriculture and Irrigation & Ministry of Finance, 2015).

Case 9

Farmer Field Schools and Water Management

Missions from the World Bank and FAO visited the Gezira Scheme and reported that a key element in making any improvement in the productivity of the scheme is the restoring of water flows and the devolution of more responsibilities in land and water management to the tenants, coupled with a participative approach in training and extension. With this objective in mind, from 2000 to 2002, FAO initiated and funded a pilot project aimed at raising productivity by broadening farmers' choices, which was intended to improve the farming system and enhance water management. The project was executed through joint collaboration between FAO, the Sudan Gezira Board (SGB) and the Agricultural Research Corporation (ARC) in one of the Gezira administrative areas (Abdel Hakum Block1). The pilot site was an area of 500 hectares, with a 50 km total length of minor canals. A total of 671 tenants participated. The farmer field school (FFS) system was adopted for participative training and extension in the project. A training curriculum based on the needs of the farmers was developed with emphasis on water management issues and the formation of water user associations.

About 350 farmers were enrolled in twelve FFSs to improve their knowledge, attitudes and practices in irrigation water management and consequently increase their yields and improve their farm incomes. Training concentrated on water requirements for crops, environmental hazards associated with irrigation water, maintenance and operation of irrigation canals, the impact of water stress and excessive irrigation on crop productivity, the impact of

agricultural inputs and cultural practices on irrigation and calculation of water requirements for summer season crops according to sowing dates and areas. It also dealt with the impacts of sedimentation and 18 types of weeds on the carrying capacity of small canals, water management along small canals and Abu XX, measuring water discharge in small canals and Abu XX, estimating quantities of irrigation water for holdings, options and constraints in crop choice with respect to water requirements and canal maintenance.

As an outcome of the project, the cropping intensity in one block in Gezira (Abdel Hakum Block) was increased to 67 percent from 33 percent and crop productivities were also increased. Cotton and sorghum yields reached about 2.45 ton/ha and 3.3 tons/ha, respectively, compared with pre-project yields of 0.952 ton/ha and 1.4 ton/ha, respectively. The changes in Abdel Hakam Block contributed significantly to increasing crop yield by 98 percent, 56 percent, 105 percent and 350 percent for cotton, groundnuts, sorghum and wheat respectively, while it increased the average cost by only 31 percent, 21 percent, 30 percent and 8.6 percent respectively. This led to the enhancement of the net return for all crops in the block (Mirgani *et al.*, 2001).

Case 10

Rawashda Forest

Success stories regarding natural forest reserves management, as in the management of the Rawashda Forest Reserve, gives an example of integrated agriculture and bush-fallow based on collaborative management between family farmers and the government. Farmers are moved to different pieces of land used for agriculture with nearby forests. The system creates forests in age-gradation as every year a portion of the agricultural land (25 percent) is demarcated and assigned to the farmers to be planted with trees. The system creates a sustainable forest structure and maintains agriculture development inside the forest reserve (Elsiddig, 2003).

The land is maintained fertile and the grain yield per unit area is much higher than under the traditional mono-culture system. In addition to the forest, the range resources and water are maintained for livestock and local people living around the forest reserve. Overall, the pilot has been successful and can be up-scaled within other forest reserves.

Farmers and village people developed rich knowledge about the bush-fallow system and they know that after the complete cycle of the bush the soil is very rich and provides high grain yield. Because of their experience in this context they were willing to collaborate in the management of the integrated agriculture and tree growing inside Rawashda forest reserve.

The bush-fallow system constitutes an integration of agriculture and natural resource management in which forests and agricultural crops are managed in sequential existence over time. Other forms of integration exist in which agriculture, trees and range plants are maintained and co-existence at the same time on the same land. These forms of integration include management of trees in the form of windbreaks, shelterbelts and scattered trees with plants grown on selected sites. The existence of trees in the different forms fulfils the purpose of creating a suitable environment for agriculture. The trees protect the crops and maintain soil fertility. The natural resources are managed for multiple purposes to support livelihoods and improve the environment.

ANNEX B

Organizations supporting small-scale family farming in Sudan

International Fund for Agricultural Development (Sudan)

http://operations.ifad.org/web/ifad/operations/country/home/tags/sudan

The International Fund for Agricultural Development (IFAD), a specialized agency of the United Nations, was established as an international financial institution in 1977 as one of the major outcomes of the 1974 World Food Conference. The conference was organized in response to the food crises of the early 1970s that primarily affected the Sahelian countries of Africa. It resolved that "an International Fund for Agricultural Development should be established immediately to finance agricultural development projects primarily for food production in the developing countries." One of the most important insights emerging from the conference was that the causes of food insecurity and famine were not so much failures in food production but structural problems relating to poverty, and to the fact that the majority of the developing world's poor populations were concentrated in rural areas.

United Nations Food and Agriculture Organization (FAO), Sudan

http://www.fao.org/sudan/en/

FAO Priorities in Sudan 2012 - 2016

The Sudan Country Programming Framework (CPF) (2012-2016) is co-owned by FAO and the Government of Sudan. It presents the broad commitment of FAO, subject to the availability of the required funding, to assist the Federal and State Governments in their efforts to achieving their own national and state development objectives that are specific to:

- Agriculture
- Food and nutrition security
- Natural resource management

International Center for Agricultural Research in Dry Areas (ICARDA)

http://www.icarda.org/

The International Center for Agricultural Research in the Dry Areas (ICARDA) was established in 1977. It is one of 15 such centres supported by the CGIAR. ICARDA's founding mandate to promote agricultural development in the dry areas of developing countries remains highly relevant today.

ICARDA works with a tight focus on the problem-solving needs of resource-poor farmers, achieving this through the in-field delivery of its research outputs. Although global food production has increased by 20 percent in the past decade, food insecurity and poverty remain widespread, while the natural resource base continues to decline.

International research centres such as ICARDA, which have helped drive previous improvements, continue to deliver new technologies to support sustainable growth in agriculture, and crucially, to work with a wide range of partners to accelerate the dissemination of these technologies.

Arab Organization for Agricultural Development (AOAD)

http://www.aoad.org/eng/about.htm

The Arab Organization for Agricultural Development (AOAD) was established in 1970, upon the desire of the Arab countries. Realizing the vital role of agriculture within the region's economy, the Arab countries recognized the need for coordination between their different policies in agriculture, natural and human resources as well as economic development, in order to achieve the ultimate goal of a fully integrated Arab economies.

AOAD started operating in 1972. Due to the abundance of Sudan's natural resources, in particular in agriculture, Khartoum was selected to host the organization's headquarters.

AOAD is one of the specialized Arab organizations, functioning under the umbrella of the League of Arab States. As such, its members are all the member states of the Arab League. The organization's goals, stated upon its establishment, are defined on two dimensions: nationally as well as regionally. At the national level, AOAD is to assist member countries in developing and enhancing their respective agricultural sectors. At the regional level, AOAD is to facilitate coordination amongst member states in the agricultural sector, with the aim of achieving a fully integrated Arab economy union, and food self-sufficiency.

Arab Authority for Agricultural Investment and Development (AAAID)

http://www.aaaid.org/english/

The Arab Authority for Agricultural Investment and Development (AAAID) was established in 1976.The agreement of establishment and the statute came into force in March 1977. The leaders of the Arab countries agreed upon the importance of achieving food security for the Arab Nations. The studies carried out by the Arab Fund for Economic and Social Development demonstrated that Sudan, with its potential agricultural resources, could provide a huge quantity of food. Thus, Sudan was chosen to be the starting point for Joint Arab Action to provide the largest amount of food products for the Arab countries. The AAAID's main office is in Khartoum, in the Republic of Sudan, and the regional office is in Dubai, United Arab Emirates. Areas of agricultural activity include: plant production, animal production, agricultural processing, related activities (services and inputs), support activities (research, developmental programs, technology transfer and training), marketing and inter-Arab trade. Areas of investment activities include: investment in companies in the form of shareholdings and loans as well as investment of excess liquid assets in financial markets.

African Development Bank (AfDB)

http://www.afdb.org/en/countries/east-africa/sudan/

The African Development Bank was founded in 1964. Its constituent institutions are: The African Development Bank; The African Development Fund and The Nigeria Trust Fund. Its shareholders are 54 African countries (regional member countries), and 27 non-African countries (non-regional member countries). The AfDB mission is to promote sustainable economic growth and reduce poverty in Africa. The overarching objective of the AfDB Group is to spur sustainable economic development and social progress in its regional member countries (RMCs), thus contributing to poverty reduction.

The Bank Group achieves this objective by mobilizing and allocating resources for investment in RMCs; and providing policy advice and technical assistance to support development efforts.

It has financed several research studies to improve agriculture in Sudan.

Agricultural Research Corporation (ARC) (Sudan)

http://www.arcsudan.sd/English.html

The ARC is the principle research arm of the government on agriculture. The ARC is entrusted with conducting applied agricultural research on food and industrial crops, forestry, livestock and food technology, and with ecological and regional responsibilities to develop sustainable production systems in Sudan. Overall, the main goal is high, sustainable productivity and quality of crops for an economically viable and progressing agricultural sector.

The ARC works in cooperation with other national institutions towards achieving food security, alleviation of poverty, income generation, promotion of agricultural exports and conservation of natural resources.

Farmers Commercial Bank

http://www.fcbsudan.com/

The bank seeks to achieve the purposes of the country's strategy in terms of upgrading the agricultural, industrial and commercial sectors in general, and furthering the development of rural Sudan, in particular, in addition to offering superior financial services for all other economic activities.

Animals Resources Bank

http://ar-bank.sd/ar/

The strategic objectives of the bank are to contribute to the improvement of the national economy following the general policies of the country. The bank undertakes investment banking activities and general banking and commercial operations at the national and international levels. It provides credit facilities to fund large, medium and small projects to develop animal resources. It also supports the traditional agriculture sector and the small-scale producers.

Central Trading Company (CTC) – Agro chemicals

http://www.ctcgroupltd.com/

CTC Group is a leading multi-faceted conglomerate with over 50 years of experience operating in Sudan across eight different sectors driven by a progressive thinking and ambitious entrepreneurial spirit. CTC Agrochemicals is a pioneer company in the field of weed control, providing the market with high quality herbicides. CTC Engineering imports and markets agricultural machinery.

Ministry of Agriculture and Forestry (federal)

http://www.sudagric.gov.sd/

The Federal Ministry of Agriculture & Forestry is responsible for defining the overall strategies of the agriculture sector in Sudan and drawing up the plans to realize the strategies. It is also responsible for coordinating of all the efforts of the main actors, both national and international, who work on developing and improving the sector. The Ministry is also responsible for oversight of all the organizations and agencies and other stakeholders involved in the sector, ensuring that the government's policies are adhered to. The Ministry contains the following administrations that directly support agriculture in the country:

- Seeds Propagation Administration
- Agricultural Extension Administration
- Crop Protection Administration
- Agricultural Planning and Economics Administration

There are state ministries of agriculture in each state. They are responsible for planning and oversight at the state level, but coordinate with the federal Ministry to achieve the national targets.

Agricultural Bank of Sudan (ABS)

www.alziraai.com

The Agriculture Bank of Sudan (ABS) was established in 1957 as the sole specialised agricultural credit institution in the country fully owned by the government. Its objectives are to provide facilities for the promotion and development of the agricultural sector. The bank provides all banking operations including current accounts, saving bonds, foreign exchange facilities, commercial transactions and partnership agricultural investments. The ABS gives loans to three different types of farmers: small, medium and large.

Mamoun Beheiry Center for Economic and Social Studies and Research in Africa (MBC)

http://mabecentre.net/index_e.html

MBC is an African, independent, non-governmental and non-profit research and training institution that aims to be a centre of excellence to encourage, promote and sponsor in-depth

research and studies in the disciplines and fields that Mamoun Beheiry loved and excelled in, namely those related to economic and social development in Africa. The centre has carried out many studies on agriculture in Sudan with the aim of improving the performance of the sector and benefitting from experience within the region.

Ministry of Livestock, Fisheries and Rangelands

http://www.marf.gov.sd/home.php

The primary mandate of the Ministry of Livestock, Fisheries and Rangeland is to preserve the renewable livestock resources in Sudan and to improve the quality of the resources with the aim of reaching self-sufficiency and food security and providing excess production for export to support the national economy.

The ministry is responsible for drawing up the policies and plans that help develop the livestock sector in the country and for developing and implementing veterinary extension programs to improve veterinary services and animal health. It is also responsible for the oversight and control of specifications for slaughterhouses and for imported animal products and vaccines. Finally, it is responsible for oversight and coordination with national and international organizations involved in the sector in Sudan.

Animals Resources Research Corporation (ARRC)

http://www.agriprofiles.net/organization/animal-resources-research-corporation-khartoum

The ARRC is responsible for doing research on animal health, production and breeds. It aims at improving the health and quality of the livestock in Sudan to help market livestock nationally and internationally. It also carries out research on wildlife.

Vet-Care Organization (VCO)

http://vetcare-sd.org/

The Vet-Care Organization (VCO) is an independent Sudanese non-governmental organization; legally established in accordance with the Humanitarian and Voluntary Work Act. VCO was founded in 2003 by a group of Sudanese professionals who worked in rural development projects (Sudan Village Concept projects I and II) while they were university students. VCO aims to empower rural communities to achieve food security, improved livelihoods and peace by helping them develop their organizational and technical capabilities, supporting them with technical inputs and linking them with relevant resources and markets.

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SMALL-SCALE FAMILY FARMING IN THE NEAR EAST AND NORTH AFRICA REGION

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