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Africa's Development (NEPAD)

Comprehensive Africa Agriculture
Development Programme (CAADP)

Food and Agriculture Organization
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GOVERNMENT OF THE REPUBLIC OF THE SUDAN

SUPPORT TO NEPAD–CAADP IMPLEMENTATION

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Volume II of V

BANKABLE INVESTMENT PROJECT PROFILE

Smallholder Water Harvesting and Productivity Enhancement

January 2005

SUDAN: Support to NEPAD–CAADP Implementation

Volume I: National Medium–Term Investment Programme (NMTIP)

Bankable Investment Project Profiles (BIPPs)

Volume II: Smallholder Water–Harvesting & Productivity Enhancement

Volume III: Integrated Traditional Farming & Pastoralism

Volume IV: Agricultural Marketing & Rural Infrastructure Development

Volume V: Institutional Capacity Building

NEPAD–CAADP BANKABLE INVESTMENT PROJECT PROFILE

Country: Sudan

Sector of Activities: Agriculture

Proposed Project Name: **Smallholder Water Harvesting and Productivity Enhancement in the Eastern Region of Sudan**

Project Area: Eastern Region

Duration of Project: 5 years

Estimated Cost: Foreign Exchange .....US$37.5 million
Local Cost.....US$12.5 million
Total ..... US$50.0 million

Suggested Financing:

Source	***US$ million***	***% of total***
Government	7.5	15
Financing institution(s)	37.5	75
Beneficiaries	5.0	10
Total	***50.0***	***100***

SUDAN:

NEPAD–CAADP Bankable Investment Project Profile

"Smallholder Water Harvesting and Productivity Enhancement in the Eastern Region of Sudan"

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Abbreviations

ADS	Area Development Scheme
ARC	Agricultural Research Corporation
BEW	Block Extension Worker
BRC	Basement Rocks Complex
CAADP	Comprehensive Africa Agriculture Development Program
CBO	Community–based Organization
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FWUA	Farmers' Water User Association
GDP	Gross Domestic Product
GOS	Government of Sudan
HH	Household
MoAF	[Federal] Ministry of Agriculture and Forestry
MAAWI	State Ministry of Agriculture, Animal Wealth and Irrigation [in Kassala and Red Sea States]
M&E	Monitoring and Evaluation
NEPAD	New Partnership for Africa's Development
NGO	Non–governmental Organization
NPC	National Project Coordinator
NRBA	Nile River Basin Agreement
O&M	Operation and Management
SMOA	State Ministry of Agriculture
SNPM	Site National Project Manager
SPFS	Special Program for Food Security
TLU	Tropical Livestock Unit
UNICEF	United Nations Children Fund
VEW	Village–based Extension Worker
WFP	World Food Programme
WHO	World Health Organization
WUA	Water User Association

I. PROJECT BACKGROUND

A. Project Origin

I.1. Water control is one of four main components ascertained by both FAO and Government of Sudan (GOS) for improving the food security situation in the country through the *Special Program for Food Security* (SPFS) project which focuses on areas of concentration of rural poor, particularly in the traditional rain–fed sector in Kordofan (Abuhabil), Western Omdurman, Lower Atbara, Southern ErRahad Scheme and West of Gezira Scheme. The SPFS has been implemented and demonstrated as a pilot project at three locations in the country with recognized tangible success and impact in crop production. The SPFS constraints analysis identified limited agriculture water supply as one of the major factors that impede significant increases in agricultural productivity.

I.2. The principle origin of the project idea is thus the SPFS project, which recommends priority expansion of its modality in similar drought–affected areas. A more recent origin of the project idea was the national workshop on identification of bankable projects under the *New Partnership for Africa's Development* (NEPAD) and the *Comprehensive Africa Agriculture Development Program* (CAADP), held in Khartoum in October 2004, which recommended priority investment in agricultural water provision for enhancing productivity based on expansion of area under sustainable land management and reliable water control systems as top priority. The GOS has given priority to the food security projects within its *Comprehensive Long Term National Strategic Plan* and supports that by the establishment of a *Food Security Administration Unit* within the *Ministry of Agriculture and Forestry*.

B. General Information

I.3. Sudan is the largest country in Africa with a total area of about 2.5 million km^2. It has a high ecological diversity, ranging from desert in the north to high rainfall humid areas in the south. The Nile River and its tributaries traverse the country and constitute the main draining watercourse. Water resources in Sudan are substantial. Annual rainfall ranges between zero–50 mm in the extreme north to more than 1,000 mm in the extreme south (West Equatorial) and 350–800 mm in the central clay plains and savannah belt. Surface flow consists of many perennial rivers and numerous ephemeral streams and wades. According to the *Nile River Basin Agreement* (NRBA) between the basin 9 countries, the amount of water allocated to Sudan is 18.5 billion cubic meters (bcm) per year at Aswan Dam, which corresponds to 20.5 bcm further downstream in Sudan. The Sudan is currently using about 14.6 bcm of its share for irrigation. The non–Nile water seasonal streams supply about 7.0 bcm, while the underground water basins store some 9.0 bcm. At present only about 1.3 bcm of underground reserve are utilized mainly for domestic purposes and limited irrigation activities.

I.4. The population, growing at about 2.6 percent per year, is currently estimated at 34 million. Over 60 percent are rural. The average density of 14 inhabitants/km^2 masks the fact that about one half of the population live on just 15 percent of the land. With an average annual per caput income estimated at US$310 (2000), poverty is widespread.

I.5. Sudan is endowed with a vast potential of agricultural resources that could enable the country to become food secure. Wide regional and household deficiency in food security prevails across the country. The most vulnerable areas are the Southern region, North and West Darfur, the Red Sea and North Kordofan States. The food insecurity situation derives from poverty, and the vagary of low rainfall in many parts of the country, and aggravated by large population movements

and displacements that occurred due to the long civil unrest in the south, west and east and to drought in the north, which limit the output of rain–fed agriculture.

I.6. The agricultural sector, comprising five sub–sectors (irrigated crop production, rain–fed crop production (mechanized and traditional), livestock, fisheries and forestry, generates close to 40 percent of GDP and employs some 60 percent of the total labour force. From the total area of Sudan (250 million hectares) about 84 million ha are arable land of which only 17–20 million ha are annually cultivated. The irrigated crop production is mainly composed of four large government– owned irrigation schemes plus a number of small–irrigated schemes along the Blue and White Nile Rivers (2 million ha). The traditional rain–fed agriculture is practiced on 90 percent of the total cultivated area and is mostly smallholder farming and agro–pastoral (15 million ha) production. Mechanized large–scale rain–fed farming is practiced in the central clay plains.

I.7. Sudan's livestock population of about 120 million heads is managed under nomadic (pastoral), transhumance (agro–pastoral) and sedentary (village–based) systems. Major constraints are low input and output, inadequate water and feed supply and feeding regime, low quality of local breeds and poor institutional services. Fisheries is a relatively minor activity. The forestry sub–sector produces gum Arabic and provides fuel–wood, charcoal, fodder and timber. The vegetation cover accounts for 12 percent of the Sudan area of which forest and woodland areas constitute 24 million ha, while permanent pastures occupy 47 million ha.

I.8. The agricultural productivity is extremely low because there has been major disruption in the productive base and infrastructure in parts of the agriculture sector being devastated. Thus, food production and security dropped drastically. Erratic rainfall patterns (volume and distribution) cause catastrophic famines in years of drought, and torrential damaging floods in other years. Irrational use of natural resources (water, soil and range) engenders resource erosion and degradation. The majority of the water harvesting techniques being practiced in Sudan are concerned with harnessing surface runoff for provision of domestic and stock drinking water.

II. PROJECT AREA

II.1. The proposed area for this project is the Eastern Region which geographically occupies the north–eastern corner of Sudan, and which consists of the Red Sea State and the northern part of Kassala State (see map in Appendix). The Eastern Region is among the most vulnerable drought–prone areas in the country and received emergency assistance over many years. Agricultural activities in the Eastern Region, basically traditional and subsistence in nature form the main source of livelihood for the majority of population.

II.2. The land use pattern in the Eastern Region evolves around animal herding, small–scale traditional cultivation, limited drinking and irrigated ground water holdings and flood basin irrigation. However, traditional dryland farming and animal herding represent the two major land uses in the region. The two activities form the economic basis for survival and adaptation to the prevailing harsh environmental conditions to large group sectors of population. With exception of Tokar and El Gash deltas, where agriculture is more reliable, crop production in the region is practiced under conditions of high risks and uncertainties. The average cultivated area is very small (0.5–4.0 ha per farm), and crops are subjected to surface runoff water limitation and rainfall uncertainty. Thus, cereal production usually falls short of the total household consumption needs, the farmer depends primarily on food aids and on grains purchased from local market.

II.3. The target population lives in rural sedentary and nomadic areas. They were chosen because they are particularly drought–prone and severely affected by the political instability/civil unrest, all primarily dependent upon crop cultivation and livestock herding and densely populated with either population or increased number of livestock which have placed increasing pressure on arable land and pasture resources. Irrational natural resource management is one of the major reasons of the decline in productivity in this region.

II.4. Water resources are the region's most precious resource. There is no perennial river. Rainfall is limited with an annual average of less than 200 mm and drought is a common occurrence. Groundwater is fundamentally scarce and highly localized. Although the region has limited water resources and large water deficit, it does not make effective use of what available. This situation makes the region highly vulnerable to drought and unstable farming environment, that results in undermined economic growth and caused declining food production.

II.5. ***Water Resources.*** In the project area perennial watercourses are absent, while surface drainage of ephemeral streams and wades are numerous. It is mainly shaped by the undulating and elevated surfaces, seasonality and variability of rainfall, which are prone and conducive to some favourable runoff in the lieu of steep slope, rocky surface and sparse vegetation cover. The Red Sea Hills that run parallel to the Red Sea coast serve as a water divide between watersheds of the Red Sea to the east and the Nile to the west. Based on these hydrological and morphological features, five major catchments can be identified in the region, namely; Khor Baraka, Arab, Arbaat–Odrus, Gowb and Diib catchments.

II.6. These *khors* play an important role in the livelihood of the Red Sea Region people. The region depends entirely upon them as a source of both domestic and agricultural water supply, for production of millet and sorghum crops as rain–fed in the flood receding moisture, and irrigated vegetables and forage production where shallow ground water exists.

II.7. ***Topography and Soils.*** The Red Sea and North Kassala Regions consist of three distinct morphological zones: (i) Coastal, (ii) Mountainous range and (iii) Inland zone. The topography is composed of rocky hills, mountains, outcrop rocks and a network of seasonal watercourses and streams. Most of the soils in the region are sandy, sandy clay and khors and wadis such as khor Arab, Sinkat, Diib, Gowb and Arbaat. Wadi Tokar provides its delta with the best loamy soil in the region. The inland flat lands are filtered with running valleys and isolated pockets of mountains and rocky hills. Loamy and alluvial deposits, confined to numerous natural depressions areas, offer good grazing ground for the livestock and rainfed farming on flood residual moisture during the rainy season.

II.8. ***Climate.*** The climate is characterised by desert, semi–desert and semi–dry climatic conditions. The annual rainfall in the region is very low, for the period 1950–1980 the record is in the range of 36 mm at Halayib in the north to 164 mm at Suakin in the central coast of Red Sea State and to 70 mm in the border between the Red Sea and Kassala states. The rainfall generally decreases from south to north. In the southern coastal areas such as Tokar, rainfall is relatively higher (100–170 mm) than at inland. Long–term rainfall averages for inland stations such, as Sinkat, Haiya, Musmar, Gabeit and Tohamiyam are 112, 90, 58, 51 and 75 mm, respectively. It is mainly this part of the inland zone which enjoys both summer and winter rains. Generally, the coastal areas receive the bulk of their rainfall in winter, while the areas in the interior receive theirs in summer. In all the interior areas (Haiya, Durdeib and Musmar), and including parts of Kassala state, rainy months are July, August and September. The Coastal (Port Sudan, Suakin, Agig and Tokar) receive their winter rains in November–January and summer rains in July–August. The rainy season is short and the rainfall is very low all over the region, and it is highly variable as well and variability increases from south to north.

III. PROJECT RATIONALE

III.1. The successive exposure of the region to repeated droughts requires more than just emergency relief. They require targeted intervention measures to enable those people to survive the surrounding persistent harsh conditions. The proposed project would enable the settled and nomadic vulnerable people in the region to restore their lost productive capacities and endowments to become self–reliant in food production through an integrated assistance approach of better and enhanced management of their meagre living resources and environment. With more than two thirds of the population in the region depending primarily on agriculture for their livelihood, sustaining agricultural productivity is one major avenue to alleviate poverty and improve food security.

III.2. A good potential for improvement in agriculture in this region lies in the development and supply of water. In fact, settlement and nomadism in the region are commonly influenced by the availability of water supplies and land capacity for crop and animal production. Some amounts of water (rain, surface and ground water) currently lost or not efficiently used can be harnessed, conserved and used. Direct efficient utilization of rainfall through rainwater harvesting and conservation means and development of surface/ground water resources for spate/supplementary irrigation is necessary to improve reliable supply and management of water for agriculture to meet the growing demand for food, alleviate poverty and sustain economic growth.

III.3. Improved technologies of water harvesting, small–scale irrigation, improved early maturing and drought–resistant crop varieties and cultural practices and extension services for crop productivity and range development that have been tested, demonstrated and proved in Sudan by an FAO, UNDP, *Agricultural Research Corporation* (ARC) and *State Ministry of Agriculture* (SMOA) and other countries of West and East Africa regions could successfully be transferred, scaled up and adapted. The project intervention would consolidate and promote these previous activities to a larger group of beneficiaries. The present very low yield levels (0.4 t/ha for sorghum, 0.3 t/ha for millet and 0.2 t/ha for sesame) of crops can be potentially doubled beyond the increase level set by the country national strategic plan (25–50 percent)

IV. PROJECT OBJECTIVES

IV.1. ***Overall Objectives:*** The overall objective of this project is to enhance food and water security situation of the rural population in the Eastern Region of Sudan by restoring their production capacity through the use of technologies related to water management.

IV.2. ***Specific Objectives:*** The project would have several specific objectives:

- Runoff water harvesting to improve irrigation potential of wades of intermittent flow and appropriate utilization and conservation of over land runoff to increase crop productivity.
- To rehabilitate the highly degraded grazing land areas through soil and water conservation to improve their productivity.
- Increasing access to potable water through construction/rehabilitation of dug– out reservoirs, retention dams and drilling/installation of boreholes where feasible.
- To demonstrate/promote sinking shaft open wells in the shallow aquifers for utilization of ground water resource combined with improved surface irrigation to save irrigation water

for supplementary irrigation, provision of inputs and improving farmers' agronomic skills so that cultivated area can potentially be increased.

- To train and build the capacity of extension staff, community–based organizations (CBO) and farmers on the operation and management of irrigation activities and drinking water facilities.
- To raise farmers' awareness about the need for sustainable land use through improved agronomic and conservation practices and farmlands shelterbelt protection.

V. PROJECT DESCRIPTION

V.1. The project, to be implemented over a period of ***five years***, would consist of the following ***five components***:

Component 1: Water Harvesting

V.2. This component would promote the use of simple, sustainable, community–driven, least costly targeted interventions, benefiting as large numbers of beneficiaries as possible, utilizing potential natural resources. Available water resources in the area, liable to water harvesting harnessing, comprise rainfall/overland water flow, seasonal watercourses flow and water bodies (lakes and ponds).

(i) Modifying of Indigenous Terrace Water Harvesting Techniques

V.3. The proposed modification is to enhance rainfed crop production for 15,800 households in an area of 13,000 ha (Table 1) presently under traditional terrace cultivation aimed at increasing soil moisture to alleviate the effect of most common long dry spells (3–4 weeks) during the cropping season for improving and stabilizing crop yield. The farmers traditionally build up terraces to harvest water for crop production purposes in limited scale. However, these terraces are improperly designed and thus either washed away or proved to be inefficient in harvesting adequate water to be retained for sufficient time duration to sustain plant growth for successful cropping season.

V.4. The proposed intervention is to modify these terraces using simple contour alignment instrument (Water Tube–Level) and build them according to the standard design procedure and compactness to ensure uniform water distribution, moisture retention and durability of terrace structures. The terrace system would be built up of earth/stone bunds on its three sides to collect water from its fourth upslope open side with inner arms to provide control of water between the cultivated plots and draining ditch to discharge excess water out of cropped land at its lower end. The terraces are raised manually by hand or animal drawn implements. Each farmer household is expected to treat about 0.5–1.0 ha with either earth or stone terraces, depending on the availability/ suitability of building material and suitability and size of his holding. The participating farmers would need training assistance to upgrade their technical skills on structure layout and building technique and improved agronomic practices, establishing water users associations, provision of improved drought tolerant seeds and hand tools for cultivation process.

Table 1: Target areas and beneficiaries for the terrace water harvesting techniques		
Site	Covered area (ha)	Beneficiary households
Hoshiri	1,500	1,500
Gwob	1,000	1,300
Paraseed	1,000	1,600
Durdaib	1,000	1,500
Khor Arab	2,500	2,500
Aroma	1,600	1,600
North Elgash	1,000	1,000
Hamashkoreep	2,000	2,000
Qoz Rajab	1,400	2,800
Total	13,000	15,800

(ii) Contour Dikes on Wades Flood Plains

V.5. With the majority of areas in the Eastern Region receiving less than 100 mm of annual rain, rain–fed cultivation is at greater risk. However, a better potential for improvement is available if wades concentrated flood flow is retained for increased water supply. Surface runoff water is immediately collected during and shortly after rainstorms due to the rocky nature of the Red Sea Hills and carried in ephemeral streams. In fact, along the seasonal wades flood plains farmers tend to cultivate crops following the receding or retreating of floodwaters. In many wades, crop production is not possible throughout the arable areas of the flood plains especially during drought years as there is no control over the floodwaters. Thus, the irrigated and cultivated area is rather small in order of less than 0.5 ha. Therefore, flood water obstruction; retention and conservation are crucial for successful cropping and runoff farming. The cultivated area can potentially be increased to 30–50 percent with the capture and spreading of streams runoff.

V.6. About 4,900 farmers' households, covering an irrigable area of some 9,800 ha, would benefit at 2 ha per household. The project intervention would include technical assistance in the form of surveying of proposed sites, design of retention dams/dikes and water spreading bunds and training of farmers on implementation of activities, improved cropping practices and operation, management and maintenance of water harvesting schemes. Table 2 presents target areas and beneficiaries for contour dikes on wades flood plains.

Table 2: Target areas and beneficiaries for contour dikes on wades flood plains			
Wadi	Typical represented site(s)	Area (ha)	Beneficiary households
Khor Arab	Tahamiyam, Haiya, Musmar, Er Rogel	3,200	1,600
Wadi Diib	Um Riit, Khashim Gabeit, Oko–Gramait,	2,000	1,000
Wadi Gwob	Arkoweit, Orheep, Dalie	900	450
Khor Salateb	Shediab	500	250
Arbaat	Odrus, Sinkat, Arbaat	3,200	1,600
Total		9,800	4,900

(iii) Overland Runoff Harvesting for Regeneration of Vegetation Cover of Grazing Land

V.7. The passing nomadic tribes throughout the Eastern Region utilize the rangeland resources seasonally, while it is utilized year long by the sedentary village livestock. The movements of the nomads were towards Arkweit and the northern borders of Kassala State in the summer and to the Red

Sea State in winter, where relatively richer grazing land and water sources were ensured. A large number of livestock from Kassala State also concentrate on its northern borders at the Gash die area (a water drainage/spreading area in the further down stream reach end of Gash river), where the water and grazing grasses are available. The river Gash is an ephemeral stream that flows normally in the period from July to September. This constitutes heavy animal pressure and consequently the rangeland resources are severely overgrazed and deteriorated at these particular areas and at many other places. Reseeding with appropriate vegetation cover species and conservation of indigenous species under suitable water harvesting practices and communal rangeland management would likely to improve and restore the rangeland productivity and sustainability.

V.8. The project would support:

- *Surface runoff rainwater harvesting activities* comprising microcatchment (MIC) techniques such as semi–circular and V–shape earth bunds (for the rain–fed area in–situ moisture conservation) on flat to gentle slopes land, and macrocatchment (MAC) techniques such as contour embankments and contour ridges (for collection of rainfall overland/rill flow and interception and control of drainage water flow) in mild slope areas. Microcatchment and macrocatchment techniques, to retain and impound localized runoff and intercepting/spreading overland flow, respectively to improve moisture conservation for immediate crop water use, have been successful in drought–prone Kordofan, Darfur, Butana and Kassala states for adequate establishment and growth of rangeland grasses and crops. These water harvesting techniques are simple to layout, construct and to replicate by farmers. The trees are planted in the small shallow pits, while grass seeds are scattered/collected in the closed catchments between the structures, where the water would spread after filling of the pits;

- *Provision of good quality grazing native grasses and trees species* adapted to the particular area. Grass species recommended are *Ipomoea cardiospala, I. cordofana, Clitoria ternata, Panicum turgidum,* and *Blepharis linarifolia.* Recommended tree species include *Acacia tortilis, Acacia seyal, Acacia ehrenbergiana, Ziziphus spina–christi, Grewia tenax* and *Balanites aegyptiaca.* Some of these trees, in addition to their browsing and environment benefits, provide edible fruits with a high economic value that can be sold in the local market as a source of income generation activity.

V.9. Local contractors would be required to construct the larger MAC structures with full participation of beneficiaries in the topographical surveying for simple contour identification and layout and shaping of structures. The benefiting communities would be required solely to provide construction and planting labour force for the smaller structures MIC activities and to foresee the general (O&M) and organization of utilizing grazing resources issues. Therefore, capacity building of beneficiaries would be an essential component of the project intervention for orientation and sensitization about the benefits and impacts, implementation, operation and management of recommended technologies. It is expected that about 125,000 ha of rangeland would be treated with rainwater harvesting techniques, to produce about 125,000 tonnes of dry matter at the yield of one tonne per hectare benefiting about 41,667 Tropical Livestock Unit (TLU) at carrying capacity of 3 tonnes/year for each TLU (Table 3).[1]

V.10. The nomadic pastoralists, although primarily livestock herders also cultivate sorghum for food in the wades depression, the fringes of Gash die area and other areas outside the villages controlled territory and their animals reach. These activities of crop cultivation could be coupled and

[1] The TLU consists of 5 sheep, 5 goats, 1 camel, 1.43 cows and 1 equine.

associated with range land regeneration so as to provide protection for these particular areas, which is most important aspect affecting the communal and open access grazing. In this respect, the right of range land treatments, conservation and rotational use could be administered by the nomads' traditional leaders, sheikhs and prominent society leaders. For sedentary village livestock farmers the targeted land for range land regeneration could be placed in fallow areas of the command crop cultivated areas in the vicinity of the villages as these areas are basically restricted for grazing until the crops are harvested. Moreover, the villagers are well abiding by the traditional rules that organize the land use.

Table 3: Water harvesting rangeland improvement intervention

Region	Site	Water harvesting treated area (ha)		No. benefiting TLU
		MIC	MAC	
Red Sea	Hayia	5,000	–	1,667
	Sinkat	6,000	–	2,000
	Khor Arab	–	10,000	3,333
	Hoshiri	4,000	8,000	4,000
	Arkweit	5,000	–	1,667
	Durdeib	7,000	–	2,333
	Musmar	–	9,000	3,000
Kassala	Hamishkoreep	8,000	15,000	7,667
	Aroma	4,000	–	1,333
	Gash Die	–	20,000	6,667
	Malwia	6,000	8,000	4,667
	Khor Abualga	–	10,000	3,333
Total		45,000	80,000	41,667

<u>Component 2:</u> Promotion of Small–scale Well Irrigated Plots

V.11. The objectives of this project component are to improve agricultural productivity through provision of sustainable source of under ground irrigation water, use of irrigation water saving techniques in potentially fertile soils in the wades basins and diversification of seasonal cultivation (summer: cereals and winter: vegetables and forages).

V.12. In this intervention, farmers would be assisted to dig a large open shaft wells and acquire, on credit terms as individual or as groups water lifting units and irrigation equipments. These would include construction materials for wells; small–motorized pumps (diesel driven turbine pumps) and improved surface irrigation using PVC/flexible hose water conveyance pipes and drip irrigation equipments and provision of planting cereal and vegetable crops. The target beneficiaries would be trained in the building of wells, installation of irrigation systems, operation and maintenance of equipments and irrigated agriculture management and establishment of *Farmers' Water User Associations* (FWUAs). About 4,935 farmer households would benefit from cultivation of 1,974 ha with 0.4 ha each. Depending on the potential yield of well, it is anticipated that each well would provide irrigation water for at least 6 ha command irrigable area to be shared by a total of 15 households. Table 4 presents the small–scale irrigation technology development with potential irrigable areas and crops. Because of favourable temperature in the high land of the mountain range in Gabeit, Sinkat and Arkweit, warm weather horticultural crops such as grapes, citruses and off–season vegetables were proposed for these areas. This would diversify the cropping pattern and would enable participating farmers to profitably grow high–value crops for home consumption and for the local market in neighbouring big towns.

V.13. The increased production of fruit and vegetables would require immediate action for marketing. Thus, grouping of FWUAs into bigger cooperative societies for promotion and facilitation of crop marketing would be essential for improving the economic returns of farmers. Strengthening the marketing capability of these societies would call for a credit line to facilitate the purchase of small trucks, improve storage facilities and enhance capacity building.

Table 4: Proposed small–scale irrigation technology intervention

Site	Well Construction		Pumping Unit	Irrigation Unit	Area (ha)	No. beneficiary HH	Crops
	Rehabilitation	New					
Gabeit	15	50	60	40	390	975	Sorghum, grapes, tomato, cucumber
Sinkat	12	35	45	35	282	705	Sorghum, grapes, tomato, leafy vegetables
Hooseit	12	30	40	30	252	630	Sorghum, forages, vegetables
Tokar	25	60	75	75	510	1,275	Sorghum, watermelon, okra, potatoes
Arkweit	15	40	50	50	330	825	Sorghum, grapes, citrus, vegetables
Halayib	10	25	35	40	210	525	Millet, vegetables, forages
Total	89	240	305	270	1,974	4,935	

<u>Component 3:</u> Potable Water Facility Rehabilitation/Construction

V.14. In the Eastern Region, rural water supply ranks as one of the top priorities both from social and economic welfare. The region was subjected to severe adverse natural conditions i.e. climate changes, mainly low rainfall, land degradation, declined agricultural production together with loss of livestock. The majority of the population has potable water sources over 10 km away. The average per caput consumption rates of 4–16 litres/day is only 20–80 percent of WHO recommended minimum requirements.

V.15. There are about six types of water supply systems commonly used in the project area. These include the traditional water system (natural water pools and depressions), deep bore–holes equipped with motorized pumps (water yards), hand–dug open shaft wells, slim bore–holes fitted with hand–pumps, privates cisterns (*khazanat*) in towns and surface water structures (*hafirs* and dams). Each of these systems has a role to play in the overall solution to the region's water supply problems, but each also involves a different set of problems and impact.

V.16. The project would address the problem of water shortage in selected areas of relatively high population and livestock demands. The basic objective for these areas would be to improve drinking water supply through: (i) construction of new hafirs/dams and rehabilitation and modification of existing traditional hafirs into enhanced ones by constructing inlet/outlet systems, filtering mechanism, providing controlled water abstraction/pumping means and removal of sediment loads in the reservoirs and dams and rehabilitation of dams' structures and modification of intake weir to increase the storage capacity; (ii) drilling and installation of new water yards (open shaft wells & deep boreholes) and rehabilitation of existing water yards boreholes and pumping units.

V.17. The rehabilitation and improvement of drinking water facilities would be expected to affect the livelihood of about 60,000 people of settled, nomads and thousands of livestock in the region (Table 5). By the end of the project those people would get access to at least 20 litres of safe water per person per day. Communities would be expected to participate in the excavation and rehabilitation of hafirs and after construction to operate and satisfactory maintain them, thus building their technical

capacity for sustainability of the watering facilities. Local contractors would be used to design and construct the water yards and dams. Water use charges are important to establish a revolving fund for operation and maintenance (O&M) of water provision infrastructures to be shouldered by the WUAs.

Table 5: Potable water facility development

Site					Water yard (OSW/DBH)		No. Benef. HH
	Rehab.	New	Rehab.	New	Rehab.	New	
Orheep	2	2	1	1	0	0	2,000
Paraseed	2	2	0	1	0	0	1,500
Gwob	2	2	1	1	0	0	4,000
Sinkat	3	2	0	0	3	2	10,000
Hyaia	0	0	0	0	2	2	4,000
Tokar	0	0	0	0	5	6	10,000
Dalie	2	1	0	1	0	0	1,000
Durdeib	2	2	2	1	3	4	6,000
Hoshiri	2	2	2	1	0	0	2,000
Telugwreib	0	0	0	1	2	–	3,500
Tohamiyam	0	0	0	0	2	1	3,000
Qoz Rajab	0	2	0	2	0	2	3,000
N. Gash	2	2	0	1	0	0	4,000
Hemishkoreep	2	2	0	2	0	2	6,000
Total	19	18	6	12	17	19	60,000

VI. INDICATIVE COSTS

VI.1. A five–year cost estimate for the project components is summarized in Table 6. The project total cost is estimated at US$50.0 million. The small–scale irrigation intervention would represent the largest capital investment (27.6 percent) followed by grazing land development (25 percent). The potable water facilities development would generate 15 percent of the total costs. Other forms of water harvesting, such as terrace cultivation and contour dikes, would represent about 10.4 percent and 11.8 percent of the total investment cost, respectively. Their costs would be much lower compared to small–scale irrigation intervention, despite of their large treated area, because their investment cost per hectare is substantially low.

VI.2. The unit investment cost per hectare for water harvesting is taken at US$100, US$400, and US$600 for the grazing land development, cropland terrace cultivation and contour dikes, respectively, while for small–scale irrigation scheme it is about US$7,000. Variable investment costs have been used for the rehabilitation and installation of potable water facilities (hafirs, dams and water yards), depending on the amount of information available for similar project in the country. Rehabilitation and new installation/construction costs are at US$30,000–80,000, US$150,000–500,000 and US$80,000–100,000 for hafirs, dams and water yards, respectively. Water harvesting and irrigation training at US$600,000 and US$500,000, respectively; institutional building at US$400,000; project management at US$1,000,000; physical items at US$800,000; M&E at US$200,000 and in–depth study and design work at US$100,000.

Table 6: Project estimated cost by component						
Component	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Terrace water harvesting	2.00	2.00	0.50	0.50	0.20	5.20
Contour dikes water harvesting	2.00	2.00	0.70	0.70	0.50	5.90
Grazing land development	2.50	2.50	2.50	2.50	2.50	12.50
Small–scale well irrigation	4.00	4.00	4.00	1.00	0.80	13.80
Drinking water facility development	3.00	2.00	1.00	1.00	0.50	7.50
Water harvesting capacity building (officers/farmers)	0.20	0.20	0.10	0.10		0.60
Irrigation/drinking capacity building (officers/farmers)	0.10	0.20	0.10	0.10		0.50
Institutional building (extension/FWUAs)	0.10	0.10	0.10	0.10		0.40
Detail study & design of WH/irrigation schemes	0.10					0.10
Project management& coordination	0.20	0.20	0.20	0.20	0.20	1.00
Monitoring & evaluation		0.04	0.06	0.04	0.06	0.20
Physical (Vehicles, equipments)	0.40	0.30	0.10			0.80
Price contingencies	0.50	0.40	0.30	0.20	0.10	1.50
Total (US$ million)	15.1	13.94	9.66	6.44	4.86	50.00

VII. PROPOSED SOURCES OF FINANCING

VII.1. Development partners, Government of Sudan, NGOs and beneficiaries would be the main expected financiers. There is a good will among the European Union (EU), the USA, the international lending institutions such as World Bank and UN agencies (FAO, UNICEF, etc.) to contribute to rural development in Sudan after the peace settlement. Support to water development projects, such as drinking and small–scale irrigation schemes in particular, have become attractive activities to many donors and NGOs. The small water schemes can be effectively installed and managed and maintained by poor–resource farmers once resource mobilization is facilitated for them, while big schemes investment may remain a government and donor full responsibility and are typically beyond the technical and financial capability of the beneficiaries.

VII.2. The construction of simple water harvesting techniques, digging of shallow wells, rehabilitation of hafirs and dams and trench excavation and installation of irrigation water distribution system would be carried by the benefiting farmers as their contributions towards the project cost. Farmers can also be empowered to maintain and properly operate the irrigation/water harvesting schemes, the drinking water facilities by themselves through building and establishing of local responsible body (FWUAs). The beneficiaries' kind and manpower contribution would amount to 10 percent of the total project financing. Procurement and supply of materials, equipments and capacity building and management interventions could be of a donor funding responsibility at 75 percent of the total project investments. The government can supply staff, offices/buildings and tax–custom exemption at 15 percent of the total project investments.

VIII. PROJECT BENEFITS

VIII.1. The main benefits of the project would go to the small–scale traditional farmers, settlers and nomad's herders and the environment in general. The main benefits anticipated from the project would be:

- Increased average productivity per hectare and stabilizing yields of the main crops and hence improving food security.
- Increasing access to potable clean water for both human and livestock.
- An improvement in the grazing land productivity and conservation and resulting increase in livestock production.
- Sustained land use and improved cropping practices and hence reliability and sustainability of productivity.
- Strengthening the capacity and skills of community–based organization (CBO) such as water users/development associations, farmers and extension workers for O&M of irrigation, watering facilities and land resources.
- An improvement in the general environmental, social and economic welfare of population in the project area.

IX. IMPLEMENTATION ARRANGEMENTS

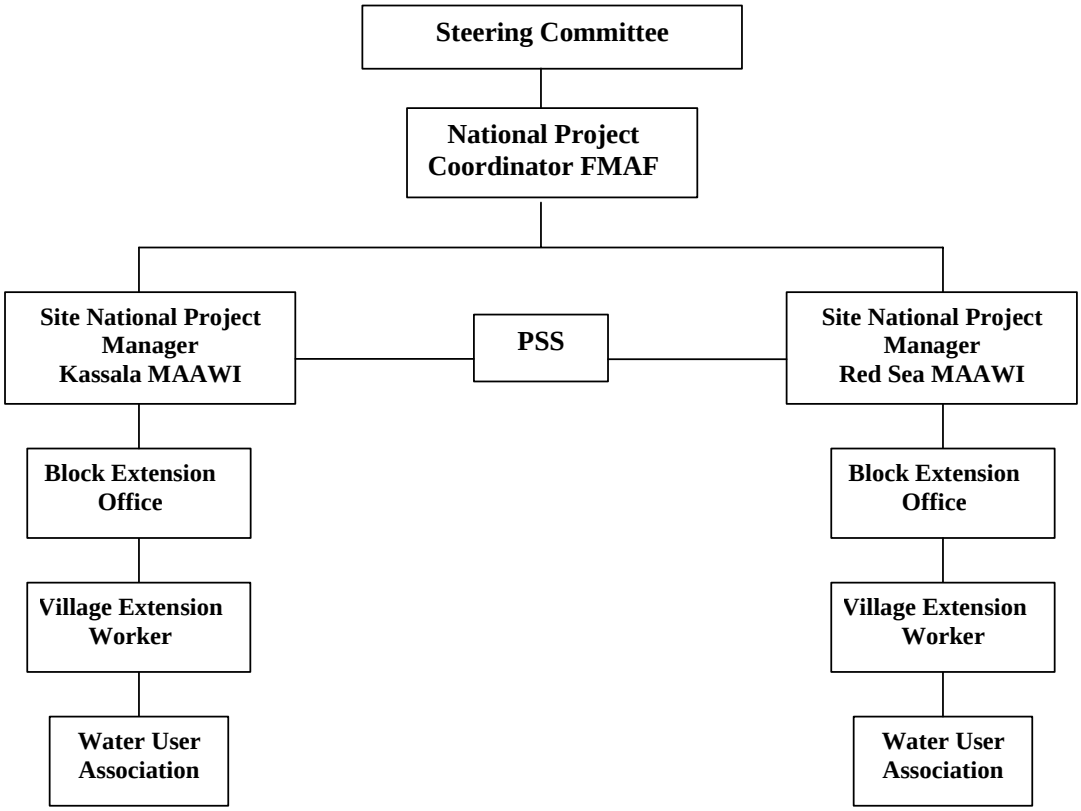
IX.1. The Federal *Ministry of Agriculture and Forestry* (MoAF) would have the overall responsibility and coordination of the project activities, in collaboration with the State *Ministries of Agriculture, Animal Wealth and Irrigation* (MAAWI) in Kassala and Red Sea States. The two state ministries would be assigned the implementation and management of the project. The project would establish a central coordinating unit at the MoAF responsible for the general planning, procurement and M&E, and two executing units in Kassala and Red Sea States in charge of the project implementation and day–to–day management. An international technical support body, such as FAO, could be requested to provide guidance in design, implementation and technical back stopping, mid–term review and reporting to donor agencies.

IX.2. The institutional framework of the project would include: (i) A *Steering Committee* (SC), multi–sectoral in its composition to include the Under Secretary, Director of Planning, Director of Technology Transfer and Extension and Director of Food Security in the MoAF, State MAAWI and representative of FWUAs. The SC would guide and assist in planning and facilitate execution of the project and approval of annual work plan and would have oversight responsibility for the project; (ii) A *National Project Coordinator* (NPC) to coordinate inputs procurement with the international technical support body, donor agency(s) and the federal government and monitor the implementation of the project; (iii) *Site National Project Managers* (SNPM) are national specialists in irrigation agronomy/water conservation engineering positioned at the executing sites and in charge of running the project and management of day–to–day activities and to report to SC, state ministers and NPC; (iv) *Block Extension Officers* (BEO) are national technicians to undertake activities at the site level with primary focus to encourage participation in the farming activities, such as implementation/ rehabilitation of infrastructure and cultural practices, shouldering O&M, credit delivery and collection with CBOs and supply of requisites to beneficiaries under supervision of the SNPM; (v) *Village Extension workers* (VEW) are village–based extension workers, with one VEW at one or cluster of

participating villages strongly connected to the BEWs and CBOs for dissemination of information, farmers' motivation, training and promotion community based–self operation and management; (vi) *Water User Associations* (WUAs) are CBOs that would be equally responsible as the project staff for implementation of activities and O&M of fully operated and maintained schemes; and (vii) *Project support staff* (PSS) to foresee the office administration duties at the executing units, which include administration and accountant officers, secretary, drivers and guard/workers.

IX.3. The private sector would provide contract services in terms of construction and installation of water supply infrastructures, supply of irrigation equipments and other farm inputs.

Project Management Arrangement



X. TECHNICAL ASSISTANCE REQUIREMENTS

X.1. Based on the project components and scope of activities, technical assistance would be required at the short–term and long–term levels. The technical input requirements for the short–term would be in the following areas:

- Detailed studies in the design of water harvesting and irrigation schemes by water conservation/irrigation engineer.

- Detailed topographic surveys of command target dry land and irrigated land that may be brought under water harvesting treatment and irrigation.
- Detailed hydro–geological studies in the target areas for quantification and evaluation of surface and groundwater supply envisaged for the design of water harvesting and irrigation schemes.
- Socio–economic studies for assessment of land tenure pattern, policy and strategy for development.
- Training in irrigation agronomy and water harvesting techniques for technical staff.
- Capacity building for community–based organization (WUA establishment, credit and O&M issues).
- Mid–term review and final project evaluation for the project activities.
- Socio–economic evaluation for the project impact and success.
- Environmental impact assessment for the project implementation.

X.2. The long–term technical assistance would be in the following specialized fields:

- Water engineering.
- Irrigation agronomy/water harvesting.
- National Project Coordination.

XI. ISSUES AND PROPOSED ACTIONS

XI.1. There are several main important issues and actions key to the project implementation and its success in the future, which include:

XI.2. ***Water Harvesting Technology.*** Although water harvesting is an indigenous technique in some of the project areas, the use of improved techniques is much more recent and less widespread. Therefore, careful assessment of each technique requirements and improvement is prerequisite to its implementation and sustenance. Under this project, special attention and care should be given to training of extension staff and beneficiaries in planning, layout, implementation and maintenance of structures. The self–based water harvesting treatment for individual farmers' field and communal treatment of grazing land area and construction of surface drinking water structures should be employed. The communal methods of treatment and construction could be performed using *food–for–work* rations with the help of WFP to obtain the full value of community land treatment for the common used facilities and employment generation. For the large water harvesting schemes and potable water facility construction and installation, local private contractors could be contracted.

XI.3. ***Participation.*** Participation of beneficiaries in the water harvesting and irrigation water management activities is clearly inevitable to success of implementation and operation and maintenance of these small–scale schemes. However, farmers in the project area are not yet empowered to take full scheme (O&M) responsibilities and to become self–reliant. Lack of self–determination and beneficiary involvement is usually exacerbated by lack of initial sensitization and

beneficiary participation in the planning, design, construction and actual implementation of activities. In order to achieve that, empowerment approaches to raise the sense of ownership, to contribute financially or in kind (labour) towards establishment and operation of facilities, reduce the degree of government involvement and to take on more of a supervisory role and provide technical advice and support when needed are necessary. It is also crucial to promote organization of farmers into associations such as water user associations (WUAs) that will jointly own the communal enterprises, provide farm inputs and supply of requisites to individual farmers, collect water fees and perform O&M for the watering and irrigation facilities at cost using an appropriate financial mechanism such as revolving fund system or credit.

XI.4. ***Land Act and Water Policy.*** In Sudan, both written codes and customary law govern land tenure. Officially, the existing land tenure arrangements are governed by the *"unregistered Land Act of 1970"*, which affirmed that all unregistered land is to be regarded as government property. In the Eastern Region most of the land falls under the definition of the above Act. However, customary right and inheritance forms of ownership continued to be authoritative rules for allocation of rights over land for centuries. The traditional law (*al urf*) also governs the land tenure system. One basic function of this system is to provide people with access to productive resources. For rangelands, they are communally owned by tribal groups, with each having rights over specific locality. However, it is important to note that land rights play an important role in restricting the expansion of digging wells in a particular area owned by an individual or group of inhabitants. This is because of traditional believe that digging of a well can result in land right claims and can bring more livestock, which would ultimately lead to weakening the land rights of the owners. Therefore, involvement and consultation with local leaders (*sheikhs*) and elderly people and community in deciding on investment sites, allocation of land use rights is of paramount importance.

XI.5. Provision and use of drinking and irrigation water require a number of policy initiatives. The concept of water as a *"free commodity"* must be modified/changed in favour of a water pricing policy to reflect the relative scarcity of water. In addition, regulations are required to control the use of ground and surface water for the non–Nile waters to reduce conflict and to ensure adequate supply and provision for O&M by system beneficiaries and where appropriate the recovery of investment costs.

XII. POSSIBLE RISKS

XII.1. The major risks, which could be identified at this stage, are the following:

- ***Land tenure*** Improper land distribution system may result in irrigated land to be owned only by a restricted number of the traditional claimers. However, involvement of local leaders and state authorities should help to mitigate this risk.

- ***Communal grazing.*** This component of the project activities might be constrained by land treatment, nomadic nature of the inhabitants, lack of protection and improper grazing organization (rotational). Grazing land water harvesting treatment might be faced by group determination to perform this activity collectively. The intensive empowerment and training of beneficiaries and management structure proposed by the project could help to reduce such risk.

- ***Limited capacity in irrigation agronomy.*** This factor may result in poor uptake and application of proposed improved packages. However, demonstration packages of improved irrigation and agronomic practices coupled with intensive training should help to strengthening the capacity of beneficiaries.

- ***Operation and maintenance of potable water and irrigation facilities.*** Many drinking and irrigation water facilities in the past have deteriorated due to lack of proper and adequate O&M, either by the local community or the government responsibility for repair and maintenance is jeopardized by the lack of funds, which accounts for delays in maintenance or its absence. Nevertheless, in this project proposal, once these facilities are rehabilitated or constructed, a larger potential irrigable area could be commanded, which would envisage an increased income to farmers to cover the cost of irrigation water and O&M requirements. Additionally, the pricing and sale of drinking water by the trained CBO could bring substantial income to community, provided that the government would not interfere in the revenue.

- ***Reliability of rainfall.*** Desert to semi–dry climate is prevailing over the Eastern Region in which the rainy season is highly erratic and short. Uncertainty of rain could limit the impact of the rainwater harvesting technologies for the rainfed farming. Of course, in a year of severe drought there may be no runoff to collect, but an efficient water harvesting system will improve plant growth in the majority of years. The alternative, ground water irrigated agriculture proposed simultaneously with the water harvesting intervention, could serve as safeguard against complete crop failure.

Appendix: Map of Sudan Showing the Project Area