



PROBLEMS OF FLOOD IRRIGATED AGRICULTURE IN THE SUDAN: THE CASE OF KHOR ABU HABL SCHEME

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INTRODUCTION

Agriculture has been the backbone of the Sudanese economy since before the exploitation and export of oil in 1999 with more than 80% of the Sudanese labour force involved in agricultural production (Ahmed 2005; Ibrahim 2008). In 1999 the share of agriculture to GDP was almost half (49.8%) but dropped to 35.3% in 2007. However, since 1999 oil has contributed significantly to Sudanese exports and by 2007 reached 94.8% of total exports (Bank of Sudan 1999; 2007). Before oil extraction and exploitation, the Sudanese economy depended largely on modernization and development of irrigated schemes and mechanized rain-fed agriculture.

All major irrigated schemes in the Sudan, including the Khor Abu Habi Scheme, have been publicly administered through parastatal agencies in partnership with farmers. Besides administration, parastatal agencies such as Sudan Gezira Board (SGB), White Nile Corporation, Nuba Mountains Corporation and Gash Delta Corporation have been responsible for agricultural input and output services. However, for the last two decades Khor Abu Habi Scheme has been subjected to many problems that have adversely affected crop productivity, especially cotton, and decreased its area of cultivation.

The objective of the Khor Abu Habi flood irrigation Scheme has changed over the years. Similar to the objective of Gadaref mechanized rainfed agriculture that began in 1944 (Bascom 1990), the Condominium Government established the Khor Abu Habi Scheme in 1945 in order to make *dura* (*Sorghum vulgare*) available (Barbour 1961; March 1948). Later, besides *dura*, cotton was cultivated in the scheme to produce seeds for the cotton-growing areas of the Nuba Mountains (Barbour 1961).

Accordingly, farmers cultivated cotton as a cash crop and dura as a food crop.

Over the last two decades, besides dura, farmers have added the cultivation of additional food crops such as tomatoes, lubia adasi (*Cajanus zajan*) for subsistence and cash, as well. In recent years and with the improvement of transportation, tomatoes and other vegetables grown at Khor Abu Habl are sold at weekly village markets and town markets of East Kordofan District (*Mahaliyat* Um Ruwaba) (Ibrahim 2010). At the beginning of the millennium, the objective of the Scheme changed. The policy and objective of Khor Abu Habl Scheme is now directed to increasing food security and poverty eradication in rural areas of the Sudan. In response, in 2003 the area of cultivation was increased through rehabilitation of Er Rahad section which has been allocated completely to the growing of food crops.

FLOOD IRRIGATION AND ITS PROBLEMS

The need to increase food production and alleviate poverty in the semi-arid areas of developing countries has encouraged agricultural planners to harness seasonal rainwater to cultivate floodplains and beds of seasonal streams (Ghebremariam and van Steenberg 2007; Tesfai and Stroosnijder 2001). These types of cultivation are called flood irrigation (Barbour 1961; Kirkby 2001; van Steenberg 1997), spate irrigation (IFAD 2010; Tesfai 2002; Tesfai and Stroosnijder 2001) and flush irrigation (Barbour 1961, Kirkby 2001) and involve wetting arable land before cultivation (Teskai 2002). The importance of this type of cultivation has increased in recent years, especially with the challenges imposed by climate change on small farmers (Adger et al 2003; IFAD 2010; Leichenko and O'Brien 2002).

Flood or spate irrigation is practiced in many parts of developing countries. In Eritrea, the seasonal stream (*wadi*) water is diverted into large basins and left to soak up to two meters deep in the soil for the cultivation of sorghum (Teskai and Stroosnijder 2001). Ghebremariam and van Steenberg (2007) found the risk with spate irrigation is high, because the flood water is not equally distributed throughout the system.

In most cases farmers do not use fertilizers because of the nutrient rich sediments brought by the annual flood water (Tesfai and Sterk 2002). On the other hand, one of the main problems of spate irrigation is the accumulation of sediments in the fields that causes the rise of the field level which, in turn, does not allow the entrance of the flood water into the fields (Tesfai and Sterk 2002). Accumulation of sediment has forced some farmers of eastern Sudan to abandon their increasingly elevated fields (Niemeijer 1993)

In the Sudan, there are three types of flood irrigation: (1) diversion of flood water from a seasonal *khore* (stream) such as Khor Abu Habl through canals and then into basins that encompass the farms; (2) flush irrigation that occurs at deltas such as those formed by the Gash and Baraka seasonal streams in the northeastern parts of the country. The Gash flood water is controlled through canals that irrigate farms (Kirkby 2001). Since Baraka flow is irregular and has no permanent channel, it is difficult to build canals to control its water (Allan 1948). Therefore, Baraka's flush irrigation water is left to spread over land covered by flood water which is different from one year to another; and (3) in the northern part of the Sudan, the River Nile overflows its banks and fills depressions called *ahwad* (basins) through canals. These flood waters remain in these basins for 30 days, and then return to the river through drainage canals (Allan 1948). In general, flood irrigation constitutes 14% of irrigated agriculture in the Sudan (Mehari et al 2007:116).

Flood irrigation schemes in the Sudan, similar to other forms of irrigated agriculture, have experienced a number of problems and a decline of crop productivity since the early 1990s (Ibrahim 2008; Kirkby 2001; Narayanamurthy et al 1997). For example, the Gash Delta has seen a shrinking of the area of cultivation and degradation of the physical environment (IFAD 2010; Kirkby 2001). In eastern Sudan, Kirkby (2001) found that sedimentation of fields through flood water poses a great problem as it causes the rise of the field level and impairs the rate of infiltration. He mentions that the average accumulation of sediment is around 40mm per year. Accumulation of sediment in the Gash Delta around Kassala has forced some of the farmers to abandon fields raised

by the deposition of sediment (Niemeijer 1993). Khor floods are characterized by high spatial and temporal fluctuation. In some years flood waters fall short of plant needs (Barbour 1961; Wallach 1988) and in others it comes in excess to the extent that it overflows its banks and causes damage to nearby villages and infrastructure such as the flooding that took place at Khor Abu Hahl in 2007 and in the Gash Delta in 2003 (Ibrahim 2010, IFAD 2010).

KHOR ABU HABL

Khor Abu Hahl originates in the Nuba Mountains of Southern Kordofan and is one of the largest seasonal streams in the Sudan (Figure 1). Located between latitudes 12° 15' N and 13° 00' N and longitudes 30° 30' E and 31° 15' E it occupies an area of 26,792 m² (State of North Kordofan 2007). It flows eastward and drains into the sandy soil and dunes near the town of Tendelti. In exceptionally higher floods it flows beyond Tendelti and drains into the White Nile (Yam Consultancy & Development 2003). High floods in Khor Abu Hahl are associated with flood hazards to neighboring villages and the destruction of infrastructure and earth dams (IFAD 2010; State of North Kordofan 2007).

Heavy clay soil is the dominant soil type at the bed and flood plain of Khor Abu Hahl. Rains fall from June to October and averages near the source range from 500mm at Dilling town to 400mm downstream near Um Ruwaba and Tendelti. Floods of Khor Abu Hahl occur from July to October. High floods increase sediment transport rates that causes siltation of the khor bed, the canals and basins. This reduces the capacity of the fields to hold more moisture for irrigation which eventually reduces crop productivity.

The area is mainly inhabited by members of the Gawamma tribe. There are other groups of people living in the area namely members of the Bederia and the Falata tribes. They are distributed over a number of villages of the Khor Abu Hahl Scheme (mainly Semeih, Allah Kareem, Al Udayyat, Al Za'afaya, Al Tibna Hassan, Al Tibna Abdallateef and Qoz Shaw). The main occupation of the inhabitants is cultivation of the

flood irrigated lands supplemented by cultivation of the rainfed agriculture on the *qoz* (sandy soils). The *qoz* land adjacent to the Scheme is characterized by small plots and land fragmentation. Farmers cultivate millet (*dukhn*), dura, sesame and *karkadi*. In recent years, rainfed cultivation has suffered from increased rain variability and low productivity (State of North Kordofan 2007).

Material for this paper was collected as part of another study carried out in East Kordofan in January 2010. This study depends mainly on secondary sources and group interviews with a number of Khor Abu Habl farmers. In addition, the author personally interviewed the Director of Agriculture at Um Ruwaba Town.

KHOR ABU HABL AGRICULTURAL SCHEME

The scheme was established in 1945 by the government of Sudan to make use of the seasonal flood of Khor Abu Habl to cultivate dura by the local inhabitants of the *qoz* north of the scheme. At the beginning it covered an area of 8,000 to 10,000 feddans (Barbour 1960:161; March 1948). The scheme followed the tenant and partnership system that applied at the Gezira scheme between farmers and the government (Barbour 1960). Traditionally, similar to other irrigated schemes, the Khor Abu Habl Scheme was administered by the government which is represented by the scheme administration located at Semeih village. It was responsible for financing agricultural operations (only cotton cultivation) at the Semeih section. These operations included the costs of weeding, opening of canal gates and distribution of seeds (*tagawi*). With the adoption of the liberalization policy by the government in the early 1990s, the administration no longer provides these services. Instead, farmers must depend on themselves to borrow money from local banks through the recently established institutions of the Association of Water Users. Banks will give loans only for the growing of cotton. The Khor Abu Habl scheme is divided into sections, the Semeih and the Er Rahad. The first one was established near Semeih village, and the other near Er Rahad town (Figure 1).

Semeih Section

Semeih Section covers an area of 13,000 feddans. The length of the main canal that drains from Khor Abu Habil is 14 kilometres long and is connected to 13 subsidiary canals that irrigate the basins. The area of the basin ranges between 30 and 60 feddans, and there are five to 12 farms (*hawashat*) in each basin. Each basin is separated from other basins by an earth bank one metre high. Since Er Rahad section has not functioned since 1949, therefore when reference is made to “the scheme” it is only the Semeih section (State of North Kordofan 2007).

Usually, irrigation of the scheme starts in July until August when flood waters enter the basins. The basins have banks one metre high that allow irrigation water to rise to a depth of 70 to 80 centimetres. The water will be kept for two weeks and then passed to the neighboring basin. The basin, which comprises many *hawashat* (farms), will be left to dry before cultivation of cotton, dura, tomatoes, lubia adasi (*Cajanus zajan*) and other vegetables begins (State of North Kordofan 2007).

Both closed and open crop rotations are practiced at Khor Abu Habil Scheme. Closed crop rotation is only practiced at the Semeih section, while the other was dominant in the Er Rahad section. Semeih section (closed crop rotation) is divided in two parts. One part involves the growing of cotton and farmers can cultivate crops of their choice on the other. They usually grow dura, tomatoes, lubia adasi. On the other hand, in the open crop rotation system, farmers are given the choice to cultivate their farms with crops other than cotton and many cultivate the same crops as their neighbors who practice closed crop rotation.

Before the beginning of the flood season, farmers of the Semeih section and the scheme administration agree on the area allotted for cultivation of cotton and the one which will be cultivated with other crops. Prior to 2008, the two parties agreed that 8,000 feddans of the Semeih scheme should be cultivated with cotton and the remaining 5,000 feddans could be cultivated with farmers' choice which is usually dura, tomatoes, lubia adasi. Since 2008, both parties have agreed that the land of the Semeih scheme should be divided into two halves; one half must be cultivated

with cotton and the other with crops of the farmers' choice. Based on this agreement, the newly-established Association of Water Users (farmers) will borrow money from banks, namely Sudan Agricultural Bank, to finance all operations of cotton cultivation only. All costs of cotton cultivation will be deducted from the sale of cotton. The remaining profit will be enjoyed by the farmers.

As can be seen (Table 1), a remarkable increase in cotton production took place in the years 2004 through 2006. This was the period when a national rehabilitation programme was initiated to enhance agricultural production. This programme primarily financed the production of cotton, cleared the silt deposition in the canals, and paid for the cost of weeding and pesticides. The programme continued until 2007, however, productivity of cotton decreased in that year because the high flood caused significant damage to the canals and the basins of the Scheme. In the last two seasons, with the lack of credit, farmers cultivated more than 90% of the Scheme with tomatoes which has a favorable sale price in the cities between El-Obeid and Kosti as well as in all east Kordofan villages.

Er Rahad Section

The Er Rahad section has the same system of canalization as the Semeih section. The main canal that drains from Khor Abu Habl extends for six kilometres. The scheme covers an area of 6,000 feddans. For unknown reasons, production of crops at the Er Rahad section ceased in the year 1949. As part of the national rehabilitation programme, the Er Rahad section started again in 2004 with a reduced area of only 200 feddans (State of North Kordofan 2007). The area increased the following year and has become 1,728 feddans divided into 864 *hawashat*. Each *hawasha* is two feddans, which is approximately one third of that of the Semeih section (State of North Kordofan 2007).

Unlike the Semeih section, the system of cultivation in Er Rahad was based on open crop rotation where farmers were given the option of cultivating crops of their choice. Therefore, dura, tomatoes, lubia adasi were cultivated by almost all farmers. Dura was cultivated annually as

their staple food and lubia adasi as an important component of their meals during the month of Ramadan. Tomatoes and the surplus of dura and lubia adasi were sold in the market as a source of income. However, the rehabilitation programme lasted for three years and, because of the lack of finance and environmental problems, Er Rahad section ceased producing crops once again.

Besides the old system of agricultural production, a new system of rainwater harvesting has emerged as a result of the construction of 13 earth dams across the Khor in the period 2000-2004. Storage of water behind the dams has increased farmers' income through cultivation of vegetables, making water available for nomadic groups through most of the summer period and increased ground water levels (Ibrahim 2010).

PROBLEMS OF KHOR ABU HABL SCHEME

Khor Abu Hahl Scheme is rife with financial, administrative and environmental problems which have adversely affected productivity and hampered its main objective since the early 1990s to the present. This has resulted in low crop productivity. A study carried out by the State of North Kordofan in 2007 mentioned that average dura productivity for the period 1970-1980 was 12 sacks per feddan and now has been reduced to 3 sacks per feddan. For the same period cotton productivity was reduced from three kantars/feddan to one kantar/feddan (one kantar equals 100 lb). As a result, many farmers have either abandoned cultivation or rented their lands to agricultural laborers.

One of the biggest problems that face farmers of Khor Abu Hahl Scheme is financial support and a lack of credit. The Nuba Mountains Agricultural Corporation was established in 1968 to provide administrative and agricultural services to the farmers of the Khor Abu Hahl Scheme. In 1992, with the adoption of the free market and privatization policy by the Sudan government the partnership system was changed (Elamin and El-Mak 1997; Elhiraika and Ahmed 1998) and the parastatal agencies abolished. In turn, the cost of agricultural operations became the responsibility of farmers. However, the new

system gave the farmers more freedom to choose the crops they want to cultivate.

Accordingly, farmers of Khor Abu Habil have formed a union called the Association of Water Users in order to borrow money from financial institutions. The Association was able to secure loans from lending institutions such as Sudan Agricultural Bank under the grantee of the District (*Mahalyiat*) of Um Ruwaba Farmers' Union primarily to finance cotton. However, due mainly to siltation of the canals, high rainfall variability and weeds, farmers suffer from low productivity.

On many occasions the return on the sale of cotton is far less than the cost of production. For this reason, many farmers were unable to repay their debt and consequently, they either abandoned their farms or rented them to sharecroppers (*tugondi*). In some cases, these farmers end up in prison. *E'sar* (hardship) is becoming increasingly common in the Sudan and applies to farmers in all kinds of agriculture who borrow money from banks and are unable to repay their debts. For this reason, the Sudan Agricultural Bank and other lending institutions refused to finance cotton cultivation at Khor Abu Habil Scheme for the seasons 2008 and 2009 and when cotton cultivation ceased cultivable land of Semeih section dropped 23% from 13, 000 feddans to 10,000 feddans.

Another problem pertaining to cotton production has arisen from the marketing procedures for Khor Abu Habil cotton. Before the introduction of liberalization and privatization in the early 1990s, the government owned General Corporation for Sudanese Cotton was responsible for the financing and marketing of the cotton of Khor Abu Habil Scheme. Since the application of privatization farmers must market their cotton through intermediaries from the Gezira Scheme, who buy unginced cotton at reduced prices. These intermediaries constitute a functional monopoly whose low prices keep some of Khor Abu Habil farmers in permanent debt. Farmers would avoid *E'sar* if they had direct access to local and international markets and could sell their cotton at favorable prices.

Khor Abu Habil Scheme suffers from a number of environmental problems. These include high siltation, weed infestation and fluctuation

of the Khor flood. Usually, the annual flood of Khor Abu Habl is accompanied by heavy silt and sediments. When it enters into the basins and is left for 15 days, the silt and sediments settle in these basins and canals. In the past the Nuba Mountains Corporation was responsible for desiltation and clearance of the main and subsidiary canals. After the abolishment of the Corporation, and because of the lack of financial support and equipment, the Scheme administration was unable to do the job. Therefore, for years silt has accumulated in the basins and canals to the extent that in some places the water storage capacity has been reduced significantly and in others, low flood water cannot enter into the *hawashat*. In turn, infiltration and retention of flood water in the soil cannot support full growth of crops. On the other hand, insufficient soil moisture has significantly reduced crop production. For this reason, the Scheme authority is thinking seriously of introducing supplementary irrigation through the pumping of the *chor* water into the fields.

The Scheme is also suffering from high infestation of weeds, namely seida (*Cyperus spp*). It has become a problem to the extent that weeding represents the highest single cost of farming at Khor Abu Habl Scheme. Therefore, it has become more profitable for farmers to hand over their overgrown seida infested fields to sharecroppers (*tugondi*) than to cultivate them themselves.

One of the main goals of the Scheme when established in the mid-1940s was to raise the standard of living of the farmers in the area. Besides low crop productivity and environmental problems, the villages of the Scheme suffer from the lack of social services. Safe drinking water represents a major challenge to the inhabitants of the Scheme (State of North Kordofan 2007). Education and health services at these villages have never shown signs of improvement. However, in other irrigated agricultural schemes in the Sudan such as the Gezira, Sudan Gezira Board during the golden era of the Gezira Scheme in the 1950s and 1960s, contributed significantly to the improvement of social services to tenants and their families (Ibrahim 2008).

CONCLUSION

The rich soil and seasonal flood of Khor Abu Habil in the southern part of North Kordofan State encouraged both the Condominium and National Governments to establish an agricultural scheme to improve the standard of living of the local people. The scheme somehow fulfilled its objectives for the period 1945-1992 when the partnership system between the farmers and Sudan Government was implemented in a satisfactory manner. With the application of liberalization, free market policy and privatization by the government in 1992, the parastatal agencies that were responsible for finance and administration of all kinds of agricultural schemes were abolished and Khor Abu Habil Scheme was no exception. Hence, the Scheme has suffered from financial and environmental problems that hinder cultivation and reduce crop productivity.

As a result of the unsuccessful experience of the Khor Abu Habil Scheme, a new comprehensive plan of development is required to fulfill the objective of food security, eradication of poverty and increasing standard of living of the inhabitants of the Scheme. The experience of the rehabilitation programme in 2004 -2006 increased production substantially (Table 1). The new plan should consider intervention by the government to provide finance and agricultural inputs and outputs.

In addition, the plan should also consider making use of the whole area of Khor Abu Habil. As suggested by previous studies, the cultivable area could be increased up to 60,000 feddans. This could be done by the use of flood water during the rainy season and ground water in the dry period (Ibrahim 2010). This will keep farmers busy the year round and will eventually increase their income and standard of living.

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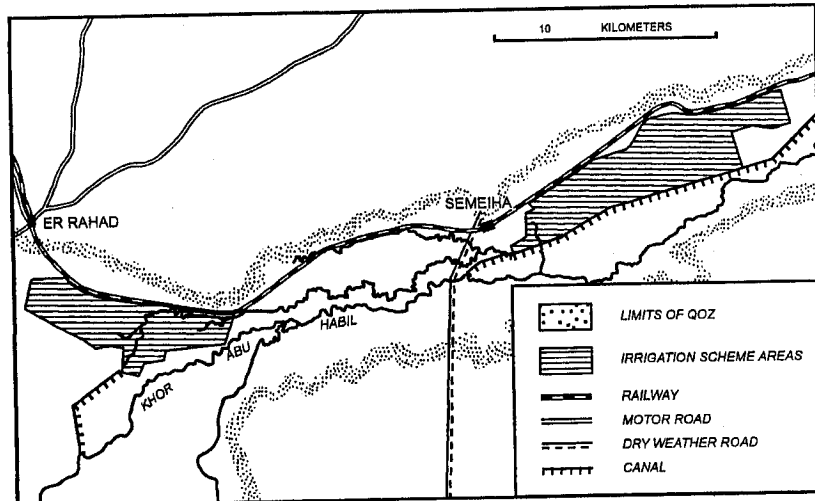
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Table 1: Production of Cotton at Khor Abu Habl Scheme 2001-2009 in Kantars

Year	Total Production/kantar	Average Prod. /feddan/kantar
2001	5,000	3.0
2002	3,000	3.5
2003	No cotton cultivation because high flood caused great damage to canals	
2004	3,500	4.0
2005	7,000	4.7
2006	12,000	6.0
2007	2,500	4.0
2008	No cotton cultivation because there was no credit	
2009	No cotton cultivation because there was no credit	

Source: State Ministry of Agriculture, Um Ruwaba June 2010

Figure 1: Khor Abu Habi Scheme



Source: Barbour (1961)