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WESTERN SUDAN AGRICULTURAL RESEARCH PROJECT



DEVELOPMENT OF THE HORTICULTURAL
POTENTIAL OF KORDOFAN REGION OF SUDAN

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WASHINGTON STATE UNIVERSITY

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ABSTRACT:

Kordofan Region is a vast semi-arid area in central Western Sudan. Best known for its production of millet, groundnuts, sorghum, gum Arabic and livestock, it also contributes significant amounts of roselle, pumpkin, tomato, hot pepper, okra, watermelon, and fruits of citrus, mango and guava to Sudan's major marketing centers. Commercial horticultural gardens, 2-3 hectares in size, located on the sandy loam flood plains of the network of ephemeral streams, Khors, in Kordofan, take advantage of residual surface water and groundwater. Roselle, pumpkin and watermelon are often inter-cropped with cereals on lighter soils, while wild okra is harvested from sorghum and cotton fields on the extensive clay plains. Small gardens are found surrounding hillside homes in the Nuba Mountains and the more permanent nomadic settlements near waterholes through the area. Nuba Mountains home gardens, Jabreek planted at the onset of the rains, provide an important source of nutrients, particularly in the "hungry season," July-August. Vegetables in khor-based gardens planted in October or November, when the rains cease, are harvested by March. High temperatures and water storage curtail production during April-June, and periodic flooding prevents cultivation of adjacent to streams from July-September.

Most horticultural crops produced in Kordofan are derived from a few older introduced cultivars, well adapted to the local environment, but of low to medium market quality and productivity. Inadequate transportation linkages

constrain commercial production by limiting the availability of agricultural inputs (seeds, fertilizers, chemicals, etc.) are restricted access of perishable produce to major markets. Small to moderate size processing plants may prove feasible in growing areas, if they are designed to accept a wide range of produce to enable year-round operation and if they can be maintained, supplied and serviced locally.

However, full realization of Kordofan Region's horticultural potential requires strengthening of research and extension programs to provide growers with: improved cultivars, appropriate cultural practices, necessary agricultural inputs, access to tree seedling nurseries, more efficient irrigation methods and credit, especially for small landholders. A shift in the focus of agricultural production in Kordofan from extensive cereal, oil and fiber crop production on marginal rainfed lands toward horticultural crop production along water courses may help the rainfed lands recover their former fertility and ecological diversity.

INTRODUCTION

Kordofan Region is centrally located in Sudan between 9.5 - 16.5° north latitude and 27.5 - 32.0° east longitude, covering nearly 380,000 km² with a population of about 2.5 million. Annual rainfall ranges from less than 50mm on the northern border to more than 800 mm along the southern boundary. Rains occur between May and September. The length of the rainy season is proportional to the total amount of rainfall. Sandy and non-cracking clay soils predominate north of Khor Abu Habil, the major west to east flowing ephemeral stream. Extensive cracking clay soils occur south of Khor Abu Habil in the plains between the Nuba Mountains. Lighter alluvial soils surround the bases of the hills and mountains.

Khor Abu Habil and its tributaries comprise the largest drainage system in Kordofan Region. It has an estimated annual discharge of more than 100 million cubic meters. The Khor lies within the White Nile watershed, but its waters do not reach the river. Streams in the west and south of Kordofan are in the Bahr el Arab watershed. The western area is drained by Wadi el Ghalla, a detached former tributary to the Bahr el Arab. None of

the streams are perennial. There are a few permanent lakes (El Rahad, Abyad, Keilak, and Miri Bara) and several seasonally filled ponds (Abu Zabad, Aramal, Umm Badr etc.).

Livestock, horticultural crops and numerous small communities derive their water from shallow hand-dug wells along the banks of the ephemeral streams or from seasonally flowing springs. Most of these aquifers are shallow and of limited extent. More extensive groundwater resources have been reported in the Kheiran¹ area near Bara, in the vicinity of El Fula on Wadi el Ghalla, and along Khor Abu Habil.

The average daily temperature ranges between 35 - 19°C, with an annual variation of $\pm 5^\circ\text{C}$. April-June are the hottest months and December-February the coolest months.

The central Kordofan, between latitudes 12-14°N has been subject to increased settlement and exploitation of its marginal soil, water, range and forest resources. Large areas, formerly fertile, have lost their ground cover and top soil.

HORTICULTURAL PRODUCTION

Kordofan is best known, agriculturally, for its production of livestock, roselle (kerkadeh), gum Arabic and agronomic crops (Table 1). However, the Kordofan Region produces large quantities of vegetables and fruits (Table 2). Most produce entering commercial marketing channels comes from the several thousand gardens and orchards in the flood plains of the seasonal streams (Khor-based gardens). Individual holdings range from less than 1 to more than 30 hectares, with an average size of 2-3 ha. or about the maximum area that can be irrigated from a single hand-dug well.

¹ Kheiran is the plural of Khor. It refers to the occurrence of more than one Khor i.e. ephemeral streams.

Khor-based gardens are found in more than 50 locations in Kordofan, covering from a few hectares to more than several thousand hectares. For example, the Bara, Banjadeed, El Rahad, Dilling and Kadugli production areas are each 200-400 ha., while those in Khor El Delaib, Umm Berembeita, Abu Kharshola and El Fula cover 800-1200 ha. The largest single production area is in Khor el Butha between Rashad and Abu Gubeiha. It extends over 12,000 ha.

Mango trees outnumber citrus and guava trees in most Kordofan orchards by a ratio of 3:1. However, citrus is more important in Abu Kharshola and Bara. Vegetables are usually grown separately from fruit trees, but in Abu Gebeiha, pumpkin is planted between the trees. Otherwise, vegetables are relatively unimportant in Abu Gubeiha. Vegetables account for about 30 percent of the cropped area in Banjadeed; 70 percent in Bara and nearly 100 percent in Abu Habil.

Small gardens are an important source of nutrients for families in communities with limited access to markets. Small home gardens, Jabreek surround hillside settlements in the Nuba Mountains. However, almost every camp of transhumant pastoralists has a small garden, where the site is occupied for a sufficiently long period to permit their establishment. The number and range of nutrients contributed to diets by vegetables from small or home gardens is greater than those derived from vegetables produced in Khor-based gardens or rainfed fields (Table 3). Chili peppers, leafy greens, vegetable cowpea and okra are the sole plant sources of several essential nutrients. The produce from Nuba Mountain home gardens help fill a nutritional gap in the so called "hungry season," when stored cereal grain supplies run low or are exhausted, prior to the harvest of the earliest maturing field crops. Consequently, they are planted immediately at the onset of the rains, normally before field crops are seeded and harvested from July through the end of the rainy season.

TABLE 1: AVERAGE ANNUAL AGRONOMIC CROP PRODUCTION
KORDOFAN REGION, SUDAN, 1977/78 - 1981/82

CROP		ANNUAL PRODUCTION		RELATIVE PRODUCTION
COMMON NAME		KORDOFAN	NATIONAL	----- KORDOFAN/NATIONAL
<u>ENGLISH</u>	<u>ARABIC</u>	__ (000)	MT. - -	%
Millet	Dukhun	173	482	35.7
Sesame	Simsim	80	242	32.8
Groundnuts	Fuul Sudani	220	821	26.8
Sorghum	Dura	274	2,301	11.9

SOURCES: PLANNING STATISTICS AND AGRICULTURAL ECONOMICS SECTION
MINISTRY OF AGRICULTURE AND IRRIGATION
KHARTOUM, SUDAN
Reeves and Frankenberger, 1982

TABLE 2: ANNUAL PRODUCTION OF HORTICULTURAL CROPS
KORDOFAN REGION, SUDAN 1980/81

CROP	COMMON NAME		PRODUCTION	PROPORTION OF TOTAL
	ENGLISH	ARABIC	M TONS	FRUITS OR VEGETABLES %
<u>FRUITS</u>				
Mango	Mango		32,141	74.3
Lime	Laymoon		4,466	10.3
Guava	Guava		4,291	9.9
Grapefruit	Grapefruit		1,335	3.1
Orange	Burtogal		1,028	2.4
TOTAL FRUITS			43,261	100.0
<u>VEGETABLES</u>				
Pumpkin	Qara		12,174	39.1
Tomato	Banadora		8,226	26.4
Watermelon	Battikh		5,000*	16.1
Okra				
(Cultivated)	Bamia		2,035	6.5
Onion	Basal		1,570	5.0
Chili Pepper	Shatta		1,320	4.2
Eggplant	Bazingan		707	2.3
Sweet Pepper	Filfil		97	0.3
Squash	Qara Kosa		30	0.1
TOTAL VEGETABLES			31,146	100.0

* Includes only seeds

SOURCE: STATISTICAL DATA
HORTICULTURAL DEPARTMENT
KORDOFAN REGIONAL GOVERNMENT
HORTICULTURAL RESOURCES OF THE KORDOFAN
WSARP PUBLICATION No. 6, 1982

TABLE 3: VEGETABLE CROPS TYPICALLY GROWN IN HOME GARDENS (H), KHOR-BASED PLOTS (K) AND RAINFED FIELDS (R) AND THEIR RESPECTIVE RELATIVE CONTENT OF VITAMINS, MINERALS AND PROTEINS. KORDOFAN REGION, SUDAN

PRODUCTION			RICH NUTRIENT: (CONTENT OF)						
SITE (S)		CROP							
H	K	Chili Peppers	B ₁	B ₂	C	Nc			
H	K	Leafy Greens	A	B ₂	C	Fe	Pr		
H		Veg. Cowpea	B ₁	B ₂	C	Nc	Ca	Pr	
H		Okra	Ca						
H	K	Tomato	C						
H	K	R	Pumpkin	A					
H	K		Eggplant						
H	K		Cucumber						
H	K	R	Watermelon						
	K		Green onions	C		Fe			
	K		Sweet Peppers	A		C			
	K		Squash						
	K		Bulb Onions						
	K		Radish						
		R	Wild Okra	Ca					
		R	Roselle	B ₂	C		Nc	Ca	Fe

ENTRIES IN TABLE	NUTRIENTS	AMOUNT	NUTRIENT	AMOUNT
Equal or Exceed	A	500 I.U.	Niacin (Nc)	1.0 mg
Tabulated Amount	B ₁	0.14 mg	Ca	94 mg
Given per 100 g Of	B ₂	0.14 mg	Fe	2.5 mg
Edible Portion	C	20 mg	Protein(Pr)	25% (dry weight)

SOURCES: PHILIPPINES FOOD COMPOSITION TABLES, 1974
 RILEY AND MOOMAW, 1979
 WSARP REPORT NO. 6, 1982

Roselle, watermelon and pumpkin are frequently intercropped with groundnuts, sesame or millet on lighter rainfed soils. Several thousand metric tons of roselle calyces are harvested annually in Kordofan. About half are consumed in beverages and jams in Sudan. The remainder are exported to Europe. The watermelon cultivar(s) grown under rainfed condition in Kordofan is particularly seedy. The seeds, rich in protein and unsaturated fats, are a popular snack food. Some of the Kordofan-grown watermelon seeds are exported to Egypt. The melons are valued as a source of water for man and livestock in the dry season. Pumpkin brings a good market price, is rich in Beta-carotene (Vitamin A), and can be shipped long distances with little damage. Most pumpkin consumed in Sudan is grown in Kordofan.

Wild okra is harvested from cotton and sorghum fields on cracking-clay soils. It is usually sliced and dried before marketing. The calcium provided by okra and roselle is particularly important for young children who consume small amounts of milk or milk products.

Constraints and Solutions

The prevailing older cultivars, some well adapted, give inferior yield or quality. This factor, coupled with the nearly complete absence of good cultural management, offers the most obvious indicator of the neglect of horticultural research and extension in the Kordofan Region. Introduction of new cultivars is further limited by the lack of tree nurseries and low availability, poor selection and improper storage of vegetable seeds.

Insect pests and pathogens on vegetable and fruit crops go largely unchecked. Orobanche, a parasitic weed, and leaf curl virus seriously constrain tomato production. Selection and breeding research are needed to develop superior cultivars with higher yield potentials and resistance to major pests and diseases.

Orchards are not pruned, weeds grow profusely, and many trees show signs of mineral deficiencies. Vegetables are usually planted in flat beds surrounded by bunds. The plots are periodically flooded, which damages fruits and is conducive to disease infection and insect pest infestation. Appropriate soil, water and crop management techniques need to be developed and disseminated to growers.

Inadequate transportation linkages constrain commercial production of all crops, including horticultural crops by limiting the availability of agricultural inputs (seeds, fertilizers, chemicals, etc.) and restricting access to major markets. The latter is a more serious constraint for perishable fruits and vegetables. Much of the produce arrives at markets in damaged or ruined condition. Improved means of harvesting, handling and transport of produce are needed to raise effective productivity and returns to growers.

The response of fruits and vegetables to several levels of fertilizers, seed dressing, pesticides, herbicides, etc. needs to be ascertained in order to prepare a spectrum of recommendations to match the resources of small and large growers, as the products become more available in Kordofan markets.

Credit facilities are generally available only to larger producers. The formation of cooperative production/marketing societies by growers may permit the extension of credit to small landholders and increase their marketing leverage, as well.

High temperatures and shortage of irrigation water limit vegetable production during April-June. Water shortage can be caused by low water levels in wells or the lack of fuel (or electricity) to operate well pumps. Breeding for heat tolerance can help overcome the constraints imposed by high temperatures. Improved water management and fuel transport are needed to solve irrigation problems.

Labor demand by field crops and uncontrolled flooding of the Khors curtails commercial vegetable production in the Khor-based gardens in July-September. Vegetables are planted along the banks of the receding streams in October and November to take advantage of residual soil moisture. Their produce is harvested mainly during January-March. Cultivation of the higher slopes near the streams, use of cultivars better suited to rainfed production and more efficient use of labor on field and vegetable crops would help smooth out seasonality of vegetable crop production.

Development Potentials and Projects

Kheiran Project

The extensive groundwater aquifer in the vicinity of Bara will be tapped for irrigation of horticultural crops, animal production and dune stabilization. A wide range of native and introduced trees will be planted surrounding crop production areas to halt desertification and serve as windbreaks for the cultivated fields.

Vegetable crops will be planted in separate plots as well as between young fruit trees. A limited number of goats, dairy cattle and chickens will be integrated into the project to utilize waste vegetative material and to provide organic fertilizer. It is envisioned that once the concept proves successful, similar production areas could be established to serve as nuclei for rebuilding the deteriorated ecological environment, while increasing the regional productivity.

Rehabilitation of Khor Abu Habil

A pre-feasibility study is being made to determine the practicality of rebuilding the diversion gate and canal system originally constructed in the forties and expanding the capacity of Rahad Lake from 50 to 100 million cubic meters. It is proposed that the additional stored water be used to irrigate 800 ha. of vegetable and fruit crops.

Establishment of a Food Processing Plant in Abu Gubeiha

Establishment of a food canning and dehydration plant in Abu Gubeiha to process the seasonal surplus of fruits and vegetables has been proposed. A preliminary study indicates that it may be economically feasible, provided that: 1) it is of simple design with equipment purchased and repairable locally (in Kordofan); 2) it is capable of processing a wide range of vegetables and fruits into a number of products to assure year-round operation; 3) it has sufficient storage of fuel to enable operations to continue during interruptions in fuel supply; 4) the plant is designed for easy management and operations within the capability of locally available manpower; and 5) that good relations are established with growers, including consultation on purchase prices and transport of produce to and from the factory.

Rehabilitation of Government Fruit Nurseries

The need to provide good planting stock of fruit trees and horticultural services in Kordofan has already been noted. Work has already begun to reactivate old nurseries and establish new ones. A program of selection and breeding of improved cultivars will be initiated in order to provide growers with superior fruit trees.

Establishment of Banana Plantations

Consideration is being given to conducting a feasibility study of developing banana plantations along the Wadis el Ghalla, Abu Seiba and Shalengo. Groundwater and surface water resources appear adequate to support several large production areas. Proximity to the railroad or an all-weather road to the rail line should facilitate good access to major markets throughout Sudan.

Other Planned or Pending Developments

Potato trials conducted in El Rahad and Bara in 1982 produced promising yields, equivalent to 14t/ha. Additional trials are planned, including evaluation of cultivars propagated by "true seeds," developed by the International Potato Center.

Project proposals are being drafted to study decortication of watermelon seeds and control of watermelon insect pests and diseases.

Private sector investment in the provision of agricultural inputs is being encouraged as an alternative to further investment in rainfed mechanized farming schemes.

Concluding Remarks

There is a growing appreciation of horticultural crops among urban consumers, who are becoming better able to purchase these products. Thus, the demand for fruit and vegetables in Sudan can be expected to rise. With the improvement of roads, it will become increasingly easier for Kordofan produce to find its way to major urban markets in Sudan and into export channels. Even now, an appreciable quantity of mango from Kordofan is being exported to neighboring countries.

Kordofan Region is already making a significant contribution of fruits and vegetables to the major markets of Sudan. A considerable number of plantings have been made by growers on their own initiative on the basis of little or no technical information. Kordofan has a comparative advantage over other regions in Sudan for producing a number of species of fruits and vegetables. Horticultural crops are being grown with a minimum of inputs and costs. Inexpensive land costs coupled with the low level of required inputs has enabled many subsistence producers to buy their own gardens or orchards. This has resulted in a wide base of participation among the

populace in this type of agricultural production. The productivity of Kordofan Region should be increased greatly with the initiation of appropriate research and extension services.

Stimulation of the horticultural industry in Kordofan may not only increase the agricultural productivity of the Region, but also it has the potential of reducing the pressure on rainfed lands, enabling them to recover their fertility and ecological diversity.

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