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Identifying, selecting, and implementing rural development strategies for socio-economic development in the Jonglei Projects Area, Southern Region, Sudan

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IDENTIFYING, SELECTING, AND IMPLEMENTING RURAL DEVELOPMENT STRATEGIES FOR SOCIO-ECONOMIC DEVELOPMENT IN THE JONGLEI PROJECTS AREA, SOUTHERN REGION, SUDAN

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Identifying, selecting, and implementing rural development strategies for socio-economic development in the Jonglei Projects Area, Southern Region, Sudan

by

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CHAPTER I. INTRODUCTION

The bountiful agricultural potential of the Sudan has become established among policymakers in the Sudan, the Middle East and international organizations interested in world food problems. The Sudan has been described as the "Breadbasket of the Middle East," a "granary of the world," and a "land of tomorrow" (79:47). A visiting Canadian economic mission was so impressed with Sudan's potential that it reached the astounding conclusion that, if well organized, the Sudan can feed one-third of the world's population (79:47). Indeed, since mid-1970, shortly after the present government took office, the mood of the country with respect to organizing and tapping this potential has been bullish. Heretofore, the activity and interest in agricultural development has been concentrated in North-central and North-eastern Sudan, the traditional backbone of the country's economy, where are located the Gezira Scheme and its prototypes, the Kenana, Rahad, Guneid, Suki, Khashm el Girba and Gash agricultural projects.

Presently, however, the government is making efforts to distribute development more equitably throughout the country's many regions including the long-neglected rich agricultural potential in Sudan's Southern Autonomous Region. Within this region the Jonglei Canal is now under construction and is projected to be completed by 1985. This project will not only achieve its primary objective of providing additional irrigation water to Northern Sudan and Egypt;

it will also provide drainage to large areas that are often seasonally flooded in the canal area. It will also have considerable long term impact on the inhabitants of the canal area and, indeed, on socio-economic development in the Southern Region and its integration with the rest of the Sudan.

Responsibility for socio-economic development[1] in the Jonglei Canal area has been entrusted to the National Council for Development Projects in the Jonglei Canal area, hereafter referred to as the NC-JPA. Assisted by an Executive Organ, the NC-JPA was established in 1974 by Republican Order No. 284 and charged with three main objectives. These objectives are (22:5):

1. Planning and implementation of integrated economic and social development projects in the area.

2. Derivation of maximum benefit from the conditions created by the project for providing new living conditions to the inhabitants.

3. Promotion of studies related to effects resulting from establishment of the project (Jonglei Canal) and undertaking measures to mitigate any adverse effects therefrom.

The extent to which the Jonglei Canal will realize its full

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[1]The term "socio-economic development" is interpreted to mean not only sustained growth in per capita incomes, but to include other social, political and quality of life aspects relating to equity, widespread participation in development, political and social stability and environmental quality. The concept is further discussed in Chapter IV.

potential contributions to the Southern Region and its integrative role in the Sudan will depend largely on the rural development strategies to be adopted by the NC-JPA in its discharge of the above objectives. Two such strategies, the "improvement approach" and the "transformation approach," already in embryonic form, are somewhat divergent in nature and subject of considerable informal discussion among officials of the Executive Organ and their expatriate advisors and consultants. The improvement strategy emphasizes the modernization of the present traditional subsistence agriculture. The basic tenet of this strategy is provision of opportunities to small land holders and pastoralists. Within this strategy, agricultural development would proceed within existing traditional subsistence production units and institutions accompanied by provision of basic social services, distribution of improved seeds, fertilizers, pest and animal disease control measures, improved agricultural hand tools and tillage methods, adequate credit facilities and better policies applied to both inputs and outputs. There is no philosophical commitment in this strategy to bring about fundamental changes in the social and economic systems of the inhabitants of the Jonglei Projects Area (JPA). Economic development according to proponents of this strategy should ". . .affect as little as possible the existing social, economic and political structure of the people . . . because too rapid change may have detrimental repercussions" (53:576). It is argued that a sudden and disruptive change of the "Dinka way

of life" should be avoided (18:13).

The second budding strategy may be called the transformation of traditional subsistence agriculture through mechanized or semi-mechanized modern agricultural schemes comparable in scope to those of North-central and North-eastern Sudan. This strategy embraces from the onset commercial agricultural production with a large export potential. Proponents of this strategy argue that improvement in crop production within present institutions could be achieved very slowly and at high cost. According to this strategy, the best way that maximum benefit for the inhabitants would be obtained from the conditions created by the canal lies in the transformation of the simple subsistence and traditional economy into a modern and complex economic system (109:15). Furthermore, proponents assert that the "improvement approach" fritters away scarce resources and effort to widely scattered and unorganized production units, and hence in the long run the "transformation approach" is much less costly. Sudden and disruptive change in the "Dinka, Nuer or Shilluk way of life" is seen by advocates of this strategy as a necessary and inevitable aspect of socio-economic development and national integration of the area. The problem for the inhabitants of the JPA does not lie in the avoidance of sudden and disruptive change, but rather shaping and coping with such change.

The general objective of this study is to contribute to the debate on appropriate rural development strategies for the JPA by:

1) providing an analytical framework within which the various conflicting issues on the subject may be identified, debated and resolved; 2) applying the analytical framework to the JPA to suggest planning elements upon which an appropriate rural development strategy for the JPA could be based; and (3) provoking more discussion and review despite the fact that the strategy of integrated rural development, as recommended by international organizations, seems to be gaining ascendency in the area (see Chapter VII).

Study Approaches

The approaches in this study are based on five major results of explorative interviews conducted by the author with a wide cross-section of Southern Sudanese society including rural village communities in Bor and Kongor Districts of the JPA.[1] These five major results are:

1. The primary and initial objective of socio-economic development in the JPA is the eradication of hunger, disease and illiteracy, and the provision of basic social services including shelter, health care, nutrition, schools, transport and flood control.

2. Achievement of the preceding result, while necessary, is not sufficient; the JPA must also contribute to regional and

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[1] Procedures used and content of these interviews are discussed in Appendix A.

national socio-economic development and share in the national objective of the country to become the "Breadbasket of the Middle East."

3. There appears to be sufficient political commitment in the Southern Region to implement fundamental changes in the political, social and economic institutions should these changes be required for the achievement of the preceding two results. In the words of Sayed Abel Alier, President of the Autonomous Southern Region: "If we have to drive our people to paradise with sticks, we will do so for their own good and the good of those who come after us" (105:26).

4. The primary role of government is not only to maintain peace and security and to resolve conflicting interests, but also to participate actively in bringing socio-economic development and prosperity to the citizens.

5. The inhabitants of the JPA, although poor and illiterate, are nevertheless intelligent, creative and responsive, and will participate in change of whatever magnitude if they perceive such change to be in their interests and that of their posterity. Indeed, the people in the rural areas of the JPA appear to be more interested in change than some of their educated brethren who appear to be mission-bound to protect the Dinka, Nuer or Shilluk "way of life" which they themselves appear to have rejected.

Objectives of Study

The specific objectives of this study are:

1. To provide a framework for examining rural development strategies for socio-economic development of the JPA by focussing on: a) the goals of socio-economic development in the JPA as they relate to national goals; and b) the resource potential of the JPA in terms of the area's contribution to regional and national goals.

2. To ascertain the adequacy of the existing agrarian structure and rural development strategies in the JPA as means to realizing the resource potential and achieving the goals identified in the preceding objectives.

3. To evaluate alternative rural development strategies,[1] from within Sudan's experience, that may be adapted in the JPA.

4. To suggest planning elements upon which an appropriate rural development strategy for the JPA might be based.

Methods and Procedures Used in This Study

The general conceptual framework used in this study is the "means-ends continuum" model development in the literature on the

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[1]According to the 1973 census, 100 percent of the JPA was classified as rural and engaged in subsistence production. Rural development is interpreted to mean the process whereby the JPA progresses from subsistence production to sustained modern commercial production for the purpose of socio-economic development. Strategy is the general method by which society mobilizes resources to achieve the goals of rural development. These terms are further discussed in Chapter IV.

theory of inquiry (45; 15). This method has been used by Timmons (95), Adam (1), Lund (68) and Vigues-Roig (100) to investigate contributions of various aspects of land tenure institutions to agricultural development. It is hoped that application of the "means-ends continuum" model to the JPA will facilitate informed debate on choice of alternative rural development strategies for the area.

The "means-ends continuum" conceptual framework is used to develop an analytical framework for pursuing the objectives of this study. Within this analytical framework, linear programming is used in the diagnostic phase of the study to investigate the economics of resource allocation in a "composite farm" of the JPA. Variations of linear programming, including parametric programming and sensitivity analysis, are used to assist in ascertaining the possibilities and potential that can be offered by existing agrarian structure and institutions in the study area.

The units of weights and measurements used in this study are those prevalent in Sudan. Farmland is measured in hectares, acres or feddans whenever appropriate. One hectare is approximately 2.47 acres, and one feddan is 1.038 acres. Agricultural output is usually measured in kilograms and metric tons. The monetary unit is the Sudanese Pound, currently equivalent to $2.00, and hereafter designated by the symbol LS. A more complete table on weights and measures in included in Appendix B. A list of abbreviations used in this study is also provided in Appendix B for ease of reference.

Organization of the Study

Following this introductory chapter, Chapter II discusses agriculture's role in the national economy and identifies regions with "breadbasket" potential. One of these regions with breadbasket potential, the JPA, is the study area. Chapter III provides background information on the JPA and the Jonglei Canal Project, and discusses the physical and institutional environments which condition socio-economic development in the region. Chapter IV develops the "means-ends continuum" analytical framework and models used to pursue the objectives of this study. Chapters V, VI and VII consist of application of the "means-ends continuum" and models to the study area. The study concludes with Chapter VIII which includes the summary, conclusions and recommendations emanating from the study.

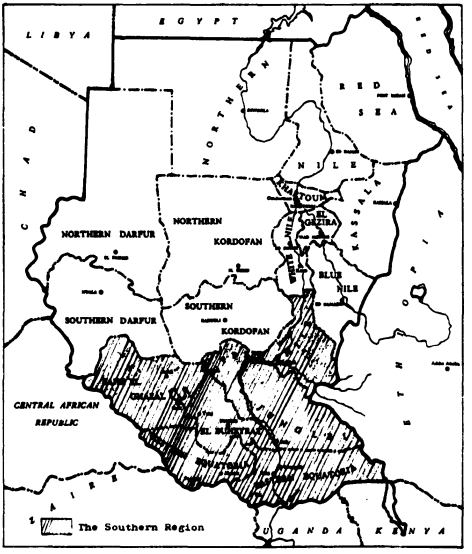
CHAPTER II. AGRICULTURE'S ROLE IN THE NATIONAL ECONOMY AND REGIONS WITH "BREADBASKET" POTENTIAL

The Democratic Republic of the Sudan was the first country in Africa to become politically independent from Anglo-Egyptian condominium rule. Located in North-east Africa and bordered by Egypt and Libya to the north; Chad, Central African Republic, and Zaire to the west; Uganda and Kenya to the south; Ethiopia to the east; and Red Sea to the north-east (Map 1), the Sudan is the largest country in Africa and ninth in the world in terms of area amounting to about two and one half million square kilometers. Sudan's population is estimated at 18 million and growing at an annual rate of 2.6 percent. For administrative purposes the country is divided into 18 provinces, 12 in the North and six in the South; the latter six provinces formed the Autonomous Southern Region in 1972 after waging an unsuccessful war of Secession for 17 years. The 12 Northern Provinces were also formed into 5 Autonomous Regions in 1981.

Agriculture in the National Economy

Structure of the national economy

Sudan's Gross Domestic Product (GDP) was estimated at 1,822 million Sudanese pounds in 1976/77, or about 100 Sudanese pounds per capita GDP. The structure of the national economy and projections to 1995 are shown in Table 2.1. Table 2.1 reveals that agriculture will continue to play the leading role in the



Map 1. The Autonomous Southern Region, International and Provincial boundaries of the Sudan and the JPA (80:5)

Table 2.1. Structure of the Sudanese economy. Sectoral contribution to gross domestic product (GDP) and expenditure on GDP: 1974-1977 and projections to 1995 (24:27)

Origin of GDP	1974/75 Sud. pounds (mil.)	As % of GDP	1976/77 Sud. pounds (mil.)	As % of GDP	1994/95 Sud. pounds (mil.)	As % of GDP	1976/77-1994/95 growth rate %
Agriculture	585	39	710	39	2,452	31	7.1
Manufacturing and mining	143	9	163	9	1,147	14.5	11.4
Electricity and water	21	1	23	1	158	2	11.3
Construction	65	4	79	4	554	7	11.4
Transportation	89	6	106	6	633	8	10.4
Commerce, finance and real estate	357	24	433	24	1,820	23	8.3
Government and other services	162	11	200	11	673	8.5	7.0
GDP at factor cost	1,422	94	1,714	94	7,337	94	8.5
Customs	89	6	108	6	475	6	8.5
GDP at market prices	1,511	100	1,822	100	7,912	100	8.5

economy well into the next century, contributing 39 percent of GDP in 1976, and projected to contribute 31 percent of GDP in 1995 at the end of the 18-year Perspective Plan (1976/77-1994/95).

In addition to its strategic importance as the chief export sector, accounting for over 90 percent of the country's foreign earnings, agriculture exerts important impacts on all sectors of the domestic economy. The agricultural sector provided employment for about 80 percent of the labor force in 1969/70 and almost 70 percent in 1976/77. Activities of all the other sectors of the economy, especially the transport and industrial sectors, are critically linked with agriculture. In all, about 80 percent of the Sudanese people derive their subsistence from agriculture and related primary activities. The pivotal role of agriculture in the Sudanese economy is well underlined in Sudan's current Six Year Plan of Economic and Social Development (1976/77-1982/83) which states in its "Highlights" that:

> Agricultural development, both in terms of plant and animal production, is considered the foundation of the national economy in its entirety, and the development of all other sectors is closely linked to agricultural expansion (19:44).

Indeed, according to the preceding statistics, agricultural development is virtually synonymous with national socio-economic development. The rurality of the Sudan is even more true of the Southern Region where more than 90 percent of the population live and subsist in rural areas.

Land use and potential

The Sudan is among a small number of countries in the world that still has vast agricultural production potential. In 1973, the Food and Agricultural Organization of the United Nations (F.A.O.) made an assessment of this potential and estimated the land area suitable for agriculture at nearly 292 million feddans (300 million acres). A breakdown of land use is shown in Table 2.2. Sudanese officials are more modest and have estimated their land potential at an even 200 million feddans suitable for agriculture (103:12), still a considerable amount. Out of F.A.O.'s estimate, 152,322,000 feddans (or 52%) of land suitable for agriculture are located in the Autonomous Southern Region.

It is on the basis of the land potential figures in Table 2.2 that Sudan has been described as the "Breadbasket of the Middle East." In April, 1974, before the United Nations General Assembly, the Sudanese Minister of Foreign Affairs stated the general framework within which Sudan hoped to achieve the objective of becoming the "Breadbasket of the Middle East" as follows:

> What we are trying to do in the Sudan is to proffer this wealth of land to our friends: those who have the money, and those who have the technological know-how, with a view to financing its utilization and cultivating it with the latest possible tools man has yet discovered. In other words, a tripartite venture between us who have the land and the water; the moneyed who are willing to invest in agriculture; and our friends whose technological abilities we lack (71a:33).

By 1976/77, only 15 million feddans (5% of F.A.O.'s estimated potential) were used for crop production. Sudanese officials

Table 2.2. Present and proposed land use in the Sudan (in 1,000 feddans) (101:178)

Distribution of surface	1970		1985	
	Feddans	% of total	Feddans	% of total
Total surface area of the Sudan	596,383	100		
Not suitable for agriculture	304,595	51		
Inland water area	30,895	5.2		
Swamps and desert	273,700	45.8		
Suitable for agriculture	291,788	49.0		
Forests	212,335	35.7	202,594	34.1
Permanent pasture	54,400	9.1	49,520	8.3
Arable land	25,053	4.2	39,674	6.6
Arable land breakdown				
Irrigated	3,218	0.54	4,438	0.7
Nonirrigated	21,835	3.66	35,236	5.9

estimate that the total land requirements will rise to 28.5 million feddans by 1982/83, of which 22.5 million feddans will be under crop and 6 million feddans will be left fallow (see Table 2.3). Most of the irrigated and rainfed agriculture in the above table will be in North-eastern and North-central Sudan where the modern sector of Sudan's agriculture is located.

Institutional Dualism in Sudan's Agriculture

The most important institutional aspects of Sudan's agriculture are directly related to the dual character of modern and traditional sectors. Land use, crop production, marketing, credit arrangements, technological and managerial systems, and other institutional relationships are best discussed in conjunction with the modern and traditional categories of Sudan's agriculture and the elimination of this dualism.

Traditional agriculture

This sector consists of unorganized and fragmented livestock herding and traditional cultivation characterized by settled, normadic, or transhumant modes of livelihood for the inhabitants. Prevalent in this sector are subsistence livestock and crop production, varying degrees of periodic production for the market, backward forms of irrigation and rainfed cultivation methods using simple hand tools and invariably, low cultivated area per family, low yields per unit of area and low labor effort and productivity.

Table 2.3. Land requirements for 1976/77 and projections to 1982/83 (in millions of feddans) (28:117)

	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83
Irrigated	2.8	3.0	3.2	3.4	3.6	3.9	4.1
Rainfed	12.2	13.0	14.0	15.0	16.0	17.1	18.4
Total	15.0	16.0	17.2	18.4	19.6	21.0	22.5

Livestock production is a major undertaking of the traditional sector. The country's animal wealth is quite plentiful and under-utilized as shown by low off-take (sales) rates and low annual growth rates (see Table 2.4). In general, livestock are kept for their numbers rather than their productivity. The primary objective of the herder is to maximize the number of animals in his herd, not to maximize their milk or meat yields or the number sold. That is, of course, rational behavior for several reasons. Large herd sizes are necessary partly as insurance against the many natural calamities, partly for status reasons, and partly because the animals are used in important social transactions such as marriages (76:268). The low off-take is consistent with the objective of maximizing the number of animals.

The principal form of land use practiced by traditional herders is unimproved grazing. There is no private ownership of grazing land; men and women graze their livestock by right as members of a community and most communities have well established and acknowledged patterns of seasonal grazing migrations (76:267).

Like livestock herding, traditional cultivation is also a precarious means of livelihood dependent on simple hand tools and the erratic whims of nature. Infrastructural resources such as credit and marketing arrangements, transport, education, health and water supply are nonexistent or abysmally inadequate in many areas of the traditional sector.

Except in the Northern Nile Desert regions where land is very

Table 2.4. Livestock numbers and off-take rates for 1976/77 and projections to 1982/83 (in thousands of animals) (28:25)

	1976/77 Numbers	Percent off-take	1982/83 Numbers	Percent off-take	Percent annual net increase in numbers
Cattle	15,832	6.9	18,905	9.5	3.0
Sheep	15,918	34.7	22,132	33.2	5.7
Goats	12,116	16.0	15,000	16.0	3.6
Camels	2,828	3.1	3,104	4.5	1.6

scarce, the principal form of land tenure is communal ownership and individual usufructuary cultivation of plots of land within communal lands.

Traditional cultivation and livestock herding are the dominant modes of livelihood in the whole of the Southern Region, in Western Sudan, and in other areas of the Sudan outside the modern agricultural sector.

Modern agriculture

The modern sector is characterized by modern irrigation methods, mechanization, cash cropping and heavy government involvement in all aspects of farming. Indeed, Sudan's agriculture was wholly traditional until the 1920s when the colonial regime built the Sennar Dam on the Blue Nile for cheap extraction of cotton. Irrigation, cash-cropping and the partnership of state and private interests in farming schemes have been the fundamental features of government plans for improvement and expansion of agricultural production. The modern agricultural sector now accounts for well over half of the total agricultural production of the country (see Table 2.5). The bulk of exports, except for gum arabic[1] and

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[1] A gum, obtained from several species of acacia, composed chiefly of the calcium, magnesium, and potassium salts of arabic acid. The best gum is nearly white or colorless and translucent and is obtained from A. Senegal and A. Arabica. Gum arabic is used in the manufacture of adhesives, inks, confectionery, etc., in textile printing and in pharmacy.

Table 2.5. Shares of different production sectors in area and production of major crops (in percent) (71a:20)

	3 years average 1966/67-1968/69		3 years average 1973/74-1975/76	
	Area	Production	Area	Production
Irrigated	22.4	53.8	18.5	50.3
Unirrigated	76.6	46.2	81.5	49.7
Public	27.6	54.9	22.3	51.6
Private	72.4	45.1	77.7	48.4
Mechanized	47.2	69.2	45.6	71.2
Traditional	52.8	30.8	54.4	28.8

livestock, which are produced by the traditional sector, comes from the modern sector.

Infrastructural resources in the modern sector are relatively well developed. Credit and marketing arrangements, as well as transport, education, health, water supply, etc., are handled by the corporations that manage and run the business of the modern sector.

The major corporations which constitute the bulk of the modern sector operate mainly in North-central and North-eastern Sudan (see Figure 2.1), and include: (1) the Gezira Board, which manages over 2 million feddans of irrigated cotton, dura, wheat and groundnuts; (2) the Agricultural Production Corporation (APC) which controls irrigated projects in Khashm el Girba, Suki, the White Nile Pumping Schemes, the Blue Nile Pumping Schemes, the Nile Pumping Schemes, the flood irrigated projects at Tokar and Gash Deltas, as well as unirrigated crop production in the Nuba Mountains; (3) the Mechanized Farming Corporation (MFC) which oversees crop production in more than 1,000 mechanized schemes in Gedaref and in several other provinces; and (4) the new Rahad Corporation.

The modern agricultural sector is modern or progressive solely because of government participation in farming, which makes it possible to undertake huge investments from external and internal sources as illustrated by the recent case of the Rahad Corporation. The Rahad is a $400 million agricultural scheme on the banks of the Rahad River that was opened in December, 1977. The scheme will

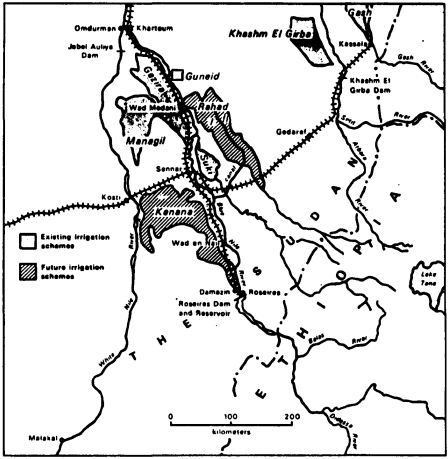


Figure 2.1. The North-central and North-eastern Growth Area of the Modern Sector of Sudan's Agriculture (101:196)

water 300,000 acres under the First Phase and provide modern homesteads for 16,000 tenant families. Each tenant farm will include about 22 acres. More than 66.7 percent of the production in the Rahad will be allocated to cotton and groundnuts, while the remaining area will be used by the tenants to grow their own subsistence food crops. The Rahad is the biggest agricultural scheme after the Gezira, differing from the latter in that it will be completely mechanized except for cotton picking. The scheme was financed by loans from the World Bank ($64 million), Kuawait's Fund for Arab Economic Development ($50 million), Saudi Development Fund ($28 million), and USAID ($11 million) (77:63). The land and people who are now tenants on the Rahad scheme were part of traditional agriculture until only a few years ago when the government intervened positively in the area. Similarly, the people of Old Half lived a nomadic desert way of life until they were displaced by the Aswan Dam when the government had to move them to New Half, a totally new non-desert environment.

The preceding summary of major aspects of traditional and modern agricultural sectors within the Sudanese economy reveals three important salient features of Sudan's agricultural development: (1) rural development strategies, agrarian structures and institutions are fundamental in transforming traditional agriculture; (2) changes in rural development strategies, agrarian structures and institutions are initiated through deliberate government policy and intervention in traditional agriculture; (3) the agricultural sector

is characterized by dualism as a result of deliberate government policies and interventions in traditional agriculture.

Major institutional problems that will likely continue to confront Sudan's agriculture arise from the aforementioned dualism. The traditional sector will continue to be bogged down in backwardness, inadequate yields, lack of infrastructure, relative government neglect, and fragmented and scattered efforts of millions of illiterate small scale herders and cultivators. The plight of the traditional sector will likely continue until government intervenes in a major way to transform and restructure traditional agriculture to a similar extent it has done so in areas that have become the modern sector. The modern sector, on the other hand, will confront qualitatively different problems such as fluctuation of world food and fibre prices, labor shortages as the reserve from the traditional sector gets exhausted as a result of the latter's own modernization, and rising managerial and energy costs on which this sector will increasingly depend.

Major Natural Resources Affecting Development of Sudan's Agricultural Potential

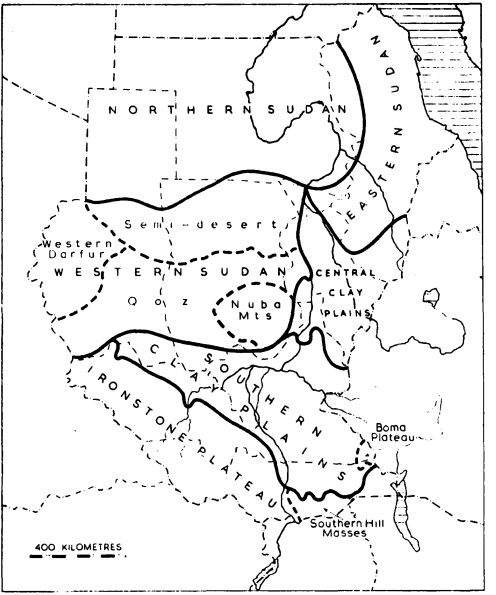
Besides the abundant land, other major resources affecting agricultural production in the Sudan include water, soil, sunlight and temperatures. It is on the basis of some of these physical conditions that several writers have divided the country into natural resource regions. Barbour (9) has divided the Sudan into

six regions on the basis of climate, geology, soils, vegetation and human types; while Gusten (44) has divided the country into nine regions according to "preponderant range of climate, vegetation and soils." Tothill (96) and Waterbury (101) have also studied the Sudanese economy and society along similar natural resource divisions.

Soil and water resources are two major factors that in future will condition development of Sudan's vast agricultural potential. Barbour most clearly delineates natural resource regions according to state of water and soil resources, and his "Economic Regions" are used in this section as a framework for discussing major natural resources affecting development of Sudan's agricultural potential. These regions, shown in Map 2 are: (1) Northern Sudan, (2) Eastern Sudan, (3) Western Sudan, (4) The Central Clay Plains, (5) The Southern Clay Plains, and (6) The Ironstone Plateau. The first four of these regions are in Northern Sudan, while the last two are in the Autonomous Southern Region. Sunlight and temperatures do not vary substantially across the regions and will not be discussed. However, water and soils vary widely and have important impacts on agricultural production.

Water resources

In most regions of the country the main factor limiting agricultural expansion is water, too little in some places and too much in others. The main sources of water are rainfall, river

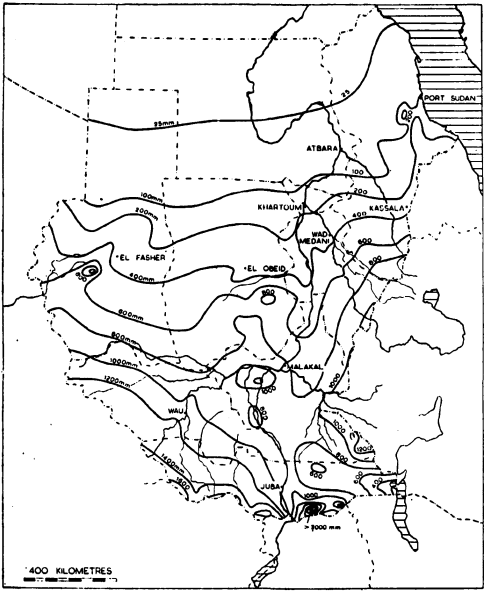


Map 2. Natural resource regions of the Sudan (9:129)

channels and groundwater.

Rainfall Precipitation in the Sudan comes mostly in the form of rainfall, and this increases from north to south (see Map 3). Rainfall is virtually nil in the northern frontier with Egypt, increases to about 250 mm (10 inches) in the Semi-desert and Eastern Sudan, and averages 600 mm (24 inches) in the Central Clay Plains and the Qoz region of Western Sudan. In Southern Sudan, the Southern Clay Plains average about 900 mm (36 inches) and the Ironstone Plateau about 1,200 mm (48 inches). In northern regions where rainfall is less than 16 inches, crop production from rainfall alone is at best highly risky. Rainfall for purposes of rainfed agriculture is adequate only in the southern parts of the Central Clay Plains and of the Qoz regions; while it is more than adequate in the Southern Clay Plains and the Ironstone Plateau of the southern region. In terms of rainfall alone, the southern parts of the Central Clay Plains and of the Qoz and the whole of the southern region are the areas in which Sudan's "bread-basket" objectives will likely be realized in future.

Groundwater Underground sources of water supply have not been adequately surveyed throughout Sudan and this could be an exploitable potential in areas that are running out of water. In the northern regions there are two sources of underground water. One is the permanent ground-water table of the Nubian and Umm Ruwaba Series, often at considerable depth varying from 400 to



Map 3. Rainfall map of the Sudan (101:7)

1,000 feet (53:56). The other is local concentrations of subsoil water along discharge lines, derived from local rainfall and particularly supported by seepage from floods (96:122). The latter source becomes more reliable in the Qoz region as the rains and floods increase in intensity and duration. Many areas of the Qoz frequently have shallow supplies of water underneath the sands; distribution and quantity depend on the buried topography and the amount of rainfall. In the Central Clay Plains, underground water sources are often poor and limited because of the imperviousness of the thick sheet of clay which forms the surface stratum in these plains. In some localities, water is found at depths of over 300 feet while at others, the thick accumulation of unconsolidated sands, gravel, and clays in the Umm Ruwaba and Muglad depressions east of Tendelti has water too saline for plant and animal use. The basalt country of Gedaref, east of the Blue Nile in the Central Clays, have water in cracks in the lava but the deeper levels have no open cracks and are dry. The volcanic areas of Jebel Mara are similar. In the Ironstone Plateau and the Southern Clays, water has been found at depths within 100 feet, especially east of the Bahr el Jebel, and salinity is low enough for the water to be consumed by both humans and animals without further treatment (96:123).

Underground water will likely continue to be important in many regions for humans and livestock, especially during the dry season. However, given the scanty knowledge about underground water resources

in the country and high energy costs, it is unlikely that underground water resources will contribute substantially to crop production in any of the regions.

River channels The majority of Sudan's river channels are concentrated in the southern region and North-central and North-eastern Sudan. The major river systems are the Bahr el Jebel, Bahr el Ghazal and Sobat all with numerous major and minor stream tributaries in Southern Sudan; and White Nile, Blue Nile, Main Nile and Atabara Rivers in North-central and North-eastern Sudan (see Map 5). All perennial flowing streams of significant size in the Sudan are part of the Nile system. There are also numerous wadis or intermittent streams, which flow only part of the year. Some drain into the Nile during the rainy season, others drain into swamps that have no outlet to a river or disappear into the sands of an inland basin during the dry season. Some of these intermittent streams carry huge discharges during the rainy season and support local areas of agriculture (the Gash and Tokar deltas, for example).

The White Nile (known as Bahr el Jebel in the South) receives much of its water from the Lake Plateau of East-central Africa (Kenya, Uganda and Tanzania are riparian states), while the Blue Nile rises at Lake Tana in the Ethiopian Highlands and makes its way through the mountains for about 500 miles before entering the Sudan. The other rivers in North-central and North-eastern Sudan (the Atbara, Rahad, Dinder, Gash and Baraka) all have their sources

in these highlands, and Ethiopia is a riparian state for all these rivers.

All the river water development projects, with the exception of the Jonglei Canal, are in North-central and North-eastern Sudan. The Sennar Dam was the first to be built in 1924 for irrigation development of the already famous Gezira Scheme and, now, its extensions. The Jebel Awulia Dam, built in 1937, was to regulate the water to Egypt; it is now redundant since completion of the Aswan High Dam in 1971. The Kashm el Girba Dam on the Atbara was completed in 1964 for development of irrigation schemes for resettlement of Wadi Halfa residents displaced by the Aswan High Dam. The Roseries Dam was completed in 1966 for hydroelectric generation and irrigation schemes between the Blue, Rahad and Dinder Rivers. Modern irrigation and mechanized agriculture are concentrated in these Central Clay Plains projects in the key provinces of Blue Nile, White Nile, Gezira, Khartoum and Kassala.

Use of the waters of the River Nile system is governed by the Nile Waters Agreement, which came into effect on December 12, 1959, between the Republic of the Sudan and the United Arab Republic (Egypt). This century's average annual yield of the Nile as measured at Aswan is 84 billion cubic meters (BM^3). 10 BM^3 of this is estimated to be lost by evaporation. The remaining 74 BM^3 is divided between Sudan (20.5 BM^3) and Egypt (53.5 BM^3). The text of the 1959 Nile Waters Agreement is included in Appendix D.

Sudan's current Six Year Plan of Economic and Social Development

assumes that the average water requirement in the Nile area is 4,800 M^3 per irrigated feddan. On the basis of this assumption and the land requirements of Table 2.3, the total annual water requirements for North-eastern and Northern-central growth areas are computed in Table 2.6. Table 2.6 reveals that further expansion of irrigated agriculture in this area by only 200,000 feddans in 1983/84 over that of 1982/83 would result in water deficits for the first time and bring to an end the historical water surplus enjoyed by the region.

Any increase in water supply from future water development projects as well as any decreases through natural fluctuations or claims by other riparian states shall be split equally between the two countries (see Nile Waters Agreement). Future increases (from the Jonglei Canal) and decreases (from claims by the other riparian states) in water supply are both likely. The 1959 Nile Waters Agreement assumed that none of Nile source countries would need the water for irrigation purposes. The fear, however, still remains that these countries would one day decide to harness the waters of the lakes and rivers located within their borders. Indeed, in 1974 at the height of the energy crisis, a member of the Kenyan Parliament suggested that the Nile be harnessed at Lake Victoria and the water sold for oil, barrel for barrel. Since neither Sudan nor Egypt produced oil at the time, the threat remained nothing more than a bad joke. With Ethiopia, however, the threat is real. Like Sudan, Ethiopia has abundant

Table 2.6. Water requirements, surpluses and deficits in Northcentral and Northeastern growth area of the Sudan: 1976/77-1983/84

	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84
Irrigated land (million feddans)	2.8	3.0	3.2	3.4	3.6	3.9	4.1	4.5
Water requirements (mill. M^3)	13.44	14.44	15.36	16.32	17.28	18.72	19.68	21.6
Water supply (constant)	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5
Water surplus (+) or deficit (-)	7.06	6.10	5.14	4.18	3.22	1.78	0.82	-1.1

land resources, over 200 million feddans of arable land of which only 11 percent is under cultivation; and 7.7 million feddans of land suitable for irrigation of which only 33 percent is being utilized (78:102).

In 1979, Ethiopia asked the Soviet Union to help in harnessing the same rivers that flow into North-eastern and North-central Sudan. Ethiopia and the Soviet Union are reported to have agreed to build dams for irrigation and hydroelectric purposes on the Takeze, Atbara, Dinder, Beles and Abbai Rivers as shown in Figure 2.2. A war of words ensued in the Press with Egypt charging "conspirators in the Horn (of Africa) who want to exploit events in the vicinity," and Ethiopia complaining that neither Egypt nor the Sudan "ever felt constrained to consult it before they made plans to dam the river, as they were required to do under international law." A commentary on Radio Addis Ababa is reported to have emphasized that Egypt should not be alarmed now that Ethiopia wants to dam the river up to the Sudanese border with "water actually belonging to Ethiopia" (78:104).

Saudi Arabia, without any rights to the waters of the Nile system, even had plans to build a pipeline (see Figure 2.2) from Atbara and across the Red Seas to divert an agreed (presumably with Sudan and Egypt) amount of the Nile waters.

It is clear that the peaceful and equitable utilization of the Nile waters in the future will require cooperation and agreement among all the riparian states. Whatever form such future agreement

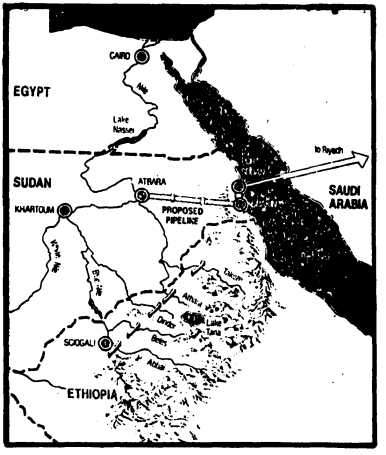


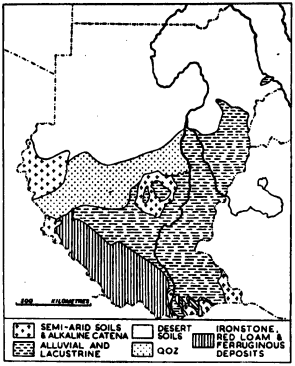
Figure 2.2. Possible crisis in the sharing of the Nile Waters (78:103)

and cooperation takes, both Egypt's and Sudan's share of water under the 1959 Nile Waters Agreement will have to decrease if any of these countries acquire any allotments in the Nile waters. The pressure to increase the yield of the Nile, especially from sources in Southern Sudan, can only increase, and the water development projects indicated in Map 5 will most likely be implemented early in the 21st Century.

The preceding discussion of Sudan's water resources shows that the potential for irrigated agriculture turning the country into a "breadbasket" is limited and will soon become fully exhausted. In future years, Sudan will have to turn to rainfed agriculture. The potential for this in terms of water availability is also great. Rainfed agriculture on a large scale is precarious in areas where rainfall is less than 400 mm (16 inches) and risky where rainfall is between 400 mm and 600 mm (see Map 3). In future years, Sudan's modern agriculture will have to move to areas where rainfall is 600 mm or greater, generally in the Southern parts of the Central Clay Plains, the southern parts of the Qoz region, and the whole of the Southern Clay Plains and the Ironstone Plateau of the southern region.

Soils resources

The soils of the Sudan, covering as they do an area of 2.5 million Km^2, are quite varied in character. Five broad soil types can be distinguished. These are: (1) desert, (2) Qoz, (3) semi-arid,



Map 4. Soils of the Sudan (52:53)

(4) alluvial, and (5) lateritic soils as shown in Map 4 (9:52).

Desert soils These soils, found in Northern Sudan, Eastern Sudan, and semi-desert regions, which are part of the Sahara Desert, are extremely thin and support very little plant life except for specialized vegetation. Their potential contribution to agricultural development is practically nil.

Qoz or aeolian soils The principal area of Qoz soils is a vast extent of now static billowy sand-dunes. The dunes are now stabilized partly by a shallow and slight surface cementation by iron oxide or clay and partly by vegetation (96:107; 9:60). The Qoz absorbs all rain that falls and stores it until exhausted by growing plants or escapes into underground channels. The Qoz is not a rich soil; nevertheless, some considerable areas of this soil are used for producing good crops of groundnuts, melons and millet. The agricultural potential of the Qoz for large scale agriculture is low as a result of the relatively low fertility of the soils, taken with the fact that they are too permeable for supplementary irrigation if there was water, which is not available in sufficient quantities. The Qoz and the northern parts of the Central Clay Plains are moreover the areas that are threatened by desertification, and this could be exacerbated by large scale mechanized agriculture. These considerations make it unlikely that the Qoz region will contribute significantly to Sudan's "breadbasket."

Semi-arid soils These are soils formed in situ under semi-arid conditions. They are not extensive, being confined to the

Jebel Mara in the extreme west of the country, the Nuba Mountains in the center, and the extreme southeast of Southern Sudan including the Boma Plateau. Rainfall is higher in these highlands than in the surrounding areas. The soils are fertile and well-drained, and provide good opportunities for specialized crops especially in the Jebel Mara Mountains.

Alluvial and lacustrine soils These are the most widely distributed soils in the Sudan. The more extensive and more important alluvial soils are the clays that have been deposited by streams from the uplands to the south and east of the country. In North-central and North-eastern Sudan, they form the Central Clay Plains, which consist of limited areas of alluvial terraces beside the Blue and White Niles and their tributaries, together with the Northern Gezira Plain, which is thought to be of lacustrine origin (9:57). In Central Sudan, the clays stretch from the Nuba Mountains to the Ethiopian foothills. In Southern Sudan, the clays are even more extensive, known as the Southern Clay Plains, they occupy a vast triangle between Lake Rudolf, Melut and Aweil (see Figure 3.3). The Southern Clay Plains consist of heavy, dark grey to dark chocolate clays that develop deep cracks in the dry season and expand in the wet season becoming quite impermeable. The clay content and the fertility of the clay plains in general increases from north to south.

All studies on the Southern Clay Plains agree that these soils are rich in fertility but characterized by drainage problems. In

1954, the Jonglei Investigation Team concluded that ". . .on the whole, provided the drainage problem can be solved, they (Southern Clay Plains) must be regarded as one of the better agricultural soils in the Sudan, in spite of their inferior tilth and comparatively narrow range of moisture content between saturation and wilting points" (53:108). A similar conclusion was reached more recently by the International Land Development Consultants (ILACO) about the soils of the Pengko and Eastern Plains that ". . .the real vertisols are most suited to agriculture provided that some protective measures against flooding from the Nile or against creeping flow from the east are taken" (64:50). The ILACO study continued to report that this soil group (the vertisols) is most widely distributed in these plains and that the main constraint of drainage could be improved by the construction of a surface drainage system, or possibly, as they say in another report, by deep ripping and ploughing (65:16).

Lateritic or ironstone soils This is the last group of the five soil types. The Ironstone Plateau of Southern Sudan is covered throughout almost the whole of its extent by hard red concretionary ironstone of lateritic type, at a depth of 15 to 30 centimeters (6 to 12 inches) below the surface. The ironstone itself is often 3 to 5 meters thick and goes much deeper in some areas (9:54). These soils are thus generally thin (less than one foot deep in most places), and their agricultural potential is variable depending on the different level of the cantenas. The exception in the Ironstone

Plateau region is the so-called "Green Belt" which consists of the area covering the extreme southwestern parts of Western Equatoria Province and a similar area around the Acholi Mountains in the Torit District of East Equatoria Province. The soils in the Green Belt are like the rest of the Ironstone Plateau, but they are deeper and better and agriculturally very important.

In terms of soil quality alone, the best soils are the limited volcanic soils of the Jebel Mara and Boma Plateau, followed by the extensive clays in Central and Southern Sudan, then the Ironstone Plateau, and finally, the Southern Qoz soils. These are the soils wherein Sudan's "breadbasket" potential lies.

Regions with "Breadbasket" Potential and Future Directions in Sudan's Agricultural Development

The preceding discussion of agriculture's role in the national economy, and of the institutional and natural resource aspects of Sudan's agriculture, indicates that modern agricultural development must move southward from its traditional center in North-central and North-eastern Sudan. Institutionalization of dualistic development in agriculture, with government and private investments concentrated in modern schemes in North-central and North-eastern Sudan while the rest of the country engages in "improving" traditional agriculture, is apt to have serious political implications relating to instability and regional tensions.

Sudan has just emerged from 17 years of civil war, which was a

result of differential development between Northern and Southern Sudan, and the country cannot afford to foster further inequitable development among the regions. Regional equity in development is particularly relevant inasmuch as the transition from traditional subsistence production to modern commercial production is made possible in the Sudan through deliberate government policy and interventions in traditional agriculture.

Furthermore, as shown in this chapter, Sudan's "breadbasket" potential lies mostly in the Southern Clay Plains. The northeastern and northcentral growth areas are running out of irrigation water; while agriculture is not viable in other regions in Northern Sudan because of lack of water. The Qoz Region in Western Sudan similarly lacks sufficient water, and it has soils which cannot sustain large scale agricultural development for long periods. The Ironstone Plateau Region, although it has adequate water, has soils that are poor for most of the region.

If the Sudan plans to realize the objective of becoming the "Breadbasket of the Middle East," then clearly modern agricultural development must be introduced into the Southern Clay Plains. The Southern Clay Plains Region is identified and discussed in the next chapter as the Jonglei Projects Area (JPA) and the area of study. The Jonglei Canal, currently under construction and also discussed in the next chapter, falls within the JPA and provides necessary conditions for drainage and irrigation without which modern commercial agriculture cannot be viable in the area.

CHAPTER III. AREA OF STUDY

The first of four sections of Chapter II provide background information on the Jonglei Canal within the study area, Jonglei Projects Area (JPA), as depicted in Figure 3.3. The purpose of this section is to present two main implications of the Jonglei Canal to the inhabitants of the JPA. One feature is that the canal is an alien and sudden intrusion into the physical, economic and institutional interrelationships within the traditional economies of the JPA. The other implication is that the canal opens up hitherto dormant opportunities for economic development in the JPA. It is, therefore, incumbent upon policymakers and inhabitants of the area to take (1) necessary remedial measures against adverse effects of the canal and (2) maximum advantage of the new opportunities. Section two discusses delineation of the Jonglei Projects Area; while the last two sections discuss the physical and institutional environments of socio-economic development in the JPA. The discussion in the last two sections of this chapter is used later in the diagnostic phase in identifying physical and institutional failure and success elements that impede or promote achievement of the goals developed in the delimiting phase.

Background on the Jonglei Canal Within the Jonglei Projects Area

The Jonglei Canal Project is an immediate consequence of Egypt's growing demands for water. The River Nile is virtually the sole

supplier of water to the Egyptian economy. During the first sixty years of this century, the average annual discharge as measured at Aswan, Egypt, was about 84 BM^3 with a standard deviation of 20 BM^3. During this period, Egypt's water demands had been growing rapidly. By the end of the 1940's, these demands were estimated at between 55 and 63 BM^3 per annum, mostly for agricultural uses (103:3). Demand was thus last catching up with supply.

The Egyptians have always been keenly aware of the fact that population growth and sustained economic growth could not be supported by unpredictable natural discharges from the Nile. As far back as the beginning of this century, the Egyptian Irrigation Department appreciated the necessity of controlling supply through a system of "over-year" storage facilities throughout the Nile Valley. The suggestions and plans for this over-year storage came to be known as the "Century Water Storage Scheme." The argument for the storage scheme is straightforward. The unpredictable element from the natural Nile discharge could only be removed by storing successive annual floods, that is, storing the difference between total discharge and total demand.

The storage scheme contemplated over-year storage facilities at Lake Victoria, the source of the Bahr el Jebel in Central Africa, and at Lake Tana, the source of the Blue Nile in the Ethiopian Highlands. Lakes Edward, Kioga and Albert were to be used to regulate the discharge from Lake Victoria into the Victoria Nile and the Bahr el Jebel Rivers. Figure 2.1 shows a schematic diagram

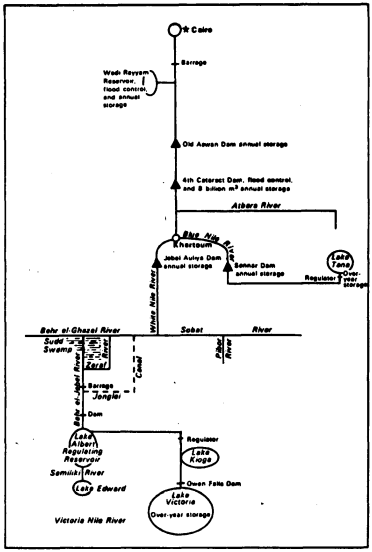


Figure 3.1. Diagram of the Century Water Scheme as conceived around 1950 (101:282)

of the Century Water Storage Scheme as conceived in 1950.

Assuming the necessary diplomatic and technical problems could be solved at the southern over-year storage stage, the Scheme's major problem still lay downstream. North of Juba, in Southern Sudan, the Bahr el Jebel enters the Sudd Swamps. Here the river reaches the flat bottom of its drainage basin and spills over its banks to form a swamp which varies from 5,000 to 8,000 square kilometers in surface area. Between Juba and Bor the river drops by 33 meters over a distance of 168 kilometers, but between Bor and Malakal the river drops only by 37 meters over a distance of 773 kilometers as shown in Figure 2.2. It is estimated that one-half of the Bahr el Jebel annual discharge of 28 BM^3 in an average year is lost annually through evapotranspiration in the Sudd Region. Clearly, the over-year storage scheme would come to naught if the additional stored water in Central Africa could not be passed through the Sudd Swamps.

The natural solution for the Century Water Storage Scheme was to cut a channel through or around the Sudd Swamps. This canal, which came to be known as the Jonglei Canal, was first proposed by Egypt as early as 1904; while Egypt sought its approval as early as 1938 (109:5). The canal was to begin 80 miles north of Bor near Jonglei Village, from which the canal got its name, and divert the waters of the Bahr el Jebel eastwards to join the Sobat and White Nile Rivers at their junction, just south of Malakal (Figure 3.3).

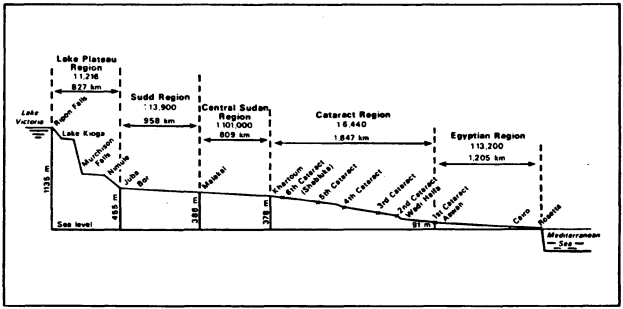


Figure 3.2. Slope of the Nile from Lake Victoria to the Mediterranean (101:15)

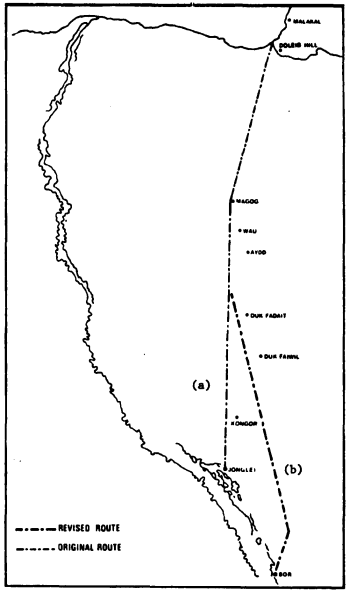


Figure 3.3. The Jonglei Canal, Old (a) and Final (b) Versions (22:37)

The Jonglei Canal Project, however, could not be implemented. Among other things, the Second World War intervened and the Sudanese were not very enthusiastic with the plan as it called for major ecological changes in the region. The effects would particularly be great on the inhabitants of the canal area whose transhumant economies have for centuries evolved from and depended on the regime of the Nile (53:193). After the War, the situation was further complicated by the imminent emergence of Uganda, Kenya and Tanzania (all riparian states) as independent nations whose agreement would have to be sought by any over-year storage scheme that planned to use the lakes located in these countries as storage facilities for Egypt's water needs.

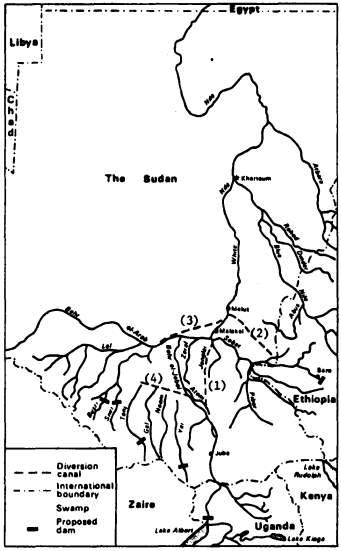
Meanwhile, Egypt's water demands, fueled by the pressures of continued economic growth and the pressures of the Middle East Wars, continued to grow. The Egyptians, therefore, started to consider alternative over-year storage sites, and concluded with only one over-year water storage facility that was to be located in Egypt itself. For this purpose construction of the giant Aswan High Dam was begun in 1961 and completed in 1971. The resulting storage facility, known as Lake Nasser in Egypt and Lake Nubia in the Sudan, has a storage capacity of 157 BM^3.

Construction of the Aswan High Dam, although alleviating Egypt's water shortage, at least temporarily, could not solve the problem of water losses in the Sudd Swamps. With over-year storage

achieved at Lake Nasser and the 1955-1972 war in Southern Sudan ended, the Egyptians revived plans to tap the water losses in the Sudd. Four proposals (see Map 5) to increase the annual discharge into Lake Nasser were considered: (1) the old Jonglei Canal proposals; (2) a canal to redirect the Barro tributary of the Sobat around the Mashar Swamps into the White Nile; (3) another canal to channel the waters of the Bahr el Ghazal system north of the Sudd Swamp into the White Nile; and (4) a canal to collect the waters of several rivers and streams, now completely lost in the Sudd, and redirect them into the Bahr el Jebel east of Bor.

It is on the first of the above proposals, the Jonglei Canal, that agreement has been reached. It is estimated that digging of the canal, in its first phase, will be completed by 1985 at a cost of about $350 million. The project will increase the Nile discharge at Aswan by an estimated 4 BM^3 in its first phase; and on the basis of the 1959 fifty-fifty costs/benefits Nile Waters Agreement between Egypt and Sudan, each nation will get 2 BM^3 (105:26).

The new Jonglei Canal proposal is a modified version of the old proposals (see Figure 3.3 which shows the old and final versions of the canal). When completed, the canal will be 360 kilometers long; longer than the Suez and Panama Canals put together and the longest canal in the world. The canal will be 38 meters wide for the first 40 kilometers downstream from Bor, 50 meters wide for the last 50 kilometers upstream from the junction of the Sobat and the Bahr el Jebel, and 30 meters wide in the intermediate 270 kilometers.



Map 5. Major river channels of the Sudan, and proposed diversionary canals and dams in Southern Sudan (101:217)

The major benefits which Sudan stands to gain from the canal project are: (1) the share of the 2 BM^3 for irrigation use in Central Sudan; (2) there is considerable potential for irrigating millions of feddans on a supplementary basis in the canal area; (3) the canal and the proposed parallel all-weather road will greatly improve transport within the region and with the rest of the country; and (4) the drainage effect of the canal may be beneficial to the inhabitants of the area in nonagricultural respects as well, such as tropical disease control. On the other hand, the adverse effects on the flood plain pastures may be considerable. It is estimated that at least 19 percent of these plains might be lost as a result (105:26). It is too early, however, to assess the full range of ecological effects of the canal project at the present. Fears by ecologists and environmentalists are highly conjectural.

However, the canal project is pregnant with serious political implications. When agreement on digging the canal was reached in February 1974, rumors started to circulate in Southern Sudan that some two million Egyptian peasants would be resettled in the canal area to farm the potential irrigated area that would be opened up by the canal. Heavy rioting broke out in Juba, Capital of the Autonomous Southern Sudan, in October 1974 leaving 3 people dead and about 200 arrested, including members of the Regional Assembly of Parliament (105:26). Several sources tend to give substance to Southern Sudanese suspicions. A recent article in the Arabic

Newspaper "Asharq al-Awsat" (The Middle East), for example, reported that:

> The plan to utilize 3 million Egyptian peasants in the Jonglei Canal area has been postponed because only 15 percent of the land suitable for agriculture in Southern Sudan will be opened up by the Project during its first phase (7:5).

Resettlement of surplus Egyptian peasants is a recurring problem in the Arab World. Resettlement of Egyptian peasants in the Sudan would likely arouse widespread opposition not only in Southern Sudan but in other parts of the country as well; and it is unlikely that Egyptian peasants will be resettled in the JPA within the foreseeable future.

The people who will bear the primary ecological and political effects of the canal are the present inhabitants of the canal area (JPA), principally the Dinka, Nuer and Shilluk people. Although the preceding background information on the Jonglei Canal Project indicates that the canal was initially conceived and designed to cater primarily to interests external to the JPA; nevertheless the canal presents opportunities for large-scale development in the JPA. It also presents real problems and challenges to the capacity of the inhabitants of the JPA to cope with and to shape the process of change that will inevitably ensue from the possibilities opened up by the canal project. It hardly needs emphasizing that correct assessment of these possibilities and selection of adequate and appropriate rural development strategies for the JPA from the onset are central to this process of change.

Delineation of the Jonglei Projects Area (JPA)

The JPA is defined for the purposes of this study to coincide with the administrative boundaries of Jonglei Province in Southern Sudan, Sudan (see Map 1). This area lies approximately between 6° 30' and 9° 30' North Latitude and between 30° 10' and 34° East Longitude. It is the area bounded by the Sobat, White Nile, and Bahr el Jebel Rivers in the North and West (Map 5), by the administrative boundary between Jonglei and East Equatoria Provinces in the South; and by the Sudan-Ethiopia border in the East (Map 1). The JPA includes the Bor, Kongor, Pibor, Akobo, Waat and Fanjak Rural Councils, and has a total area of approximately 120,000 square kilometers (30 million acres) presently in swamp, pasture and cropland.

The area designated as the JPA in this study is somewhat different from that described by the (1954) report of the Jonglei Investigation Team, hereafter term JIT, and also from that described as the Jonglei Development Projects Area by the Executive Organ of the National Council for Jonglei Development Projects.

According to the Executive Organ, the JPA lies between approximately 6° 30' and 9° 30' North Latitude, and between approximately 30° 10' and 31° 45' East Longitude (5:7). This area covers about 3 million feddans on both sides of the canal channel. It is the area said to be "directly" affected by the canal. This definition of the JPA, the Executive Organ admits, is tentative as the extent of the "direct effects" of the canal cannot be known

with reasonable precision until after completion and operation of the canal. The definition was adopted only for "practical purposes".[1]

The 1954 JIT definition of the Jonglei Area is much broader than that of the Executive Organ as it includes areas inhabited by people who would be "directly" as well as those who would be "indirectly" affected had the canal version of that time (see Figure 3.3) been implemented. The JIT distinguishes between those people who would be "directly" affected and those who would be "indirectly" affected in these words:

> By 'indirectly' we mean those people who will have to face definite losses in pasture or other existing economic assets as a result of changed physical conditions and also a reduction in potential assets not at present exploited. By 'indirectly' we mean those who, through economic and social contacts, will obviously feel the effects; what may be called the general repercussions (53:193).

According to the JIT definition, the JPA would extend from as far south as Nimule and to as far north as Kosti (Map 1), a distance of 1,625 kilometers. It would include the areas inhabited by: 1) the Madi, Bari and Mandari people in East Equatoria Province; 2) the Dinka and Nuer people in Jonglei Province; 3) the Aliab and Chiech Dinka people in Lakes Province; 4) the Dinka, Nuer and Shilluk people in Upper Nile Province; and 4) the Baggara people in Kordofan and White Nile Provinces in Northern Sudan (53:193-253).

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[1] As reported in interviews with officials of the Executive Organ for development projects in the JPA.

The total area of the JIT definition of the JPA was estimated at 512,000 square kilometers (123 million feddans).

The JIT version of the JPA was designed to delineate areas where inhabitants would be compensated for losses suffered as a result of the Equatorial Nile Project (the Jonglei Canal was officially known by this name). Although the Executive Organ definition of the JPA has to date not been precise, the various versions, such as the one above, are based on the JIT compensation definition.

As stated earlier, this study views the Jonglei Canal as an infrastructural facility designed not only to increase water yields for irrigation further north; it is also a means to bringing socio-economic development to the JPA. Compensation per se is relevant where damages to individual interests are involved as a result of excavating in the area. The view expressed here is that the inhabitants of the JPA are not people to be merely compensated, but permanent participants in the benefits of the canal project including the water that will flow in the canal channel in all its uses. For this reason, socio-economic development in the JPA is discussed in this study within the national context of goals, and not as an isolated case of compensation. This view of the canal's role and of the national context of socio-economic development in the JPA is supported by the Mandate (Republican Order No. 284) of the NC-JPA which calls for ". . .the endeavor to derive the maximum benefit from the conditions created by the Project (canal)."

Two possible definitions of the JPA that would be consistent with a developmental as contrasted to a compensational delineation are considered and recommended. One definition is to delineate the JPA as the whole of the Southern Clay Plains (Figure 3.4). This definition is based on similarity of the physical and social bases for economic development. According to Barbour:

> Throughout the Region (Southern Clay Plains) the sources of livelihood of the population are cattle-raising, agriculture and fishing. These vary in their relative importance according to the areas of grazing and cultivable land available, but since among the Luo people (chiefly Nuer, Dinka, Shilluk and Anyuak) the types of crops grown, the types of cattle kept, and the prevailing attitudes towards them are fairly consistent, it will be convenient to study the way of life of all these people as a unity (9:238).

The Southern Clay Plains would thus be the most desirable definition of the JPA from the point of view of both the natural and cultural resources. However, since the Southern Clay Plains are so extensive, covering areas within five of the six Southern Provinces, this definition would be too broad in terms of development administration.

Another definition, the one suggested and used in this study, is to delineate the JPA to coincide with the administrative boundaries of Jonglei Province (Map 1). The advantage of this definition is that Jonglei Province is a large portion of the Southern Clay Plains (see Figure 3.4 for the area bounded by the Baro and Bahr el Jebel Rivers, the Ethiopian border and the provincial border running from the Boma Plateau). Development experience can thus be easily transferred to other areas of the Southern Clay Plains. The definition takes into consideration

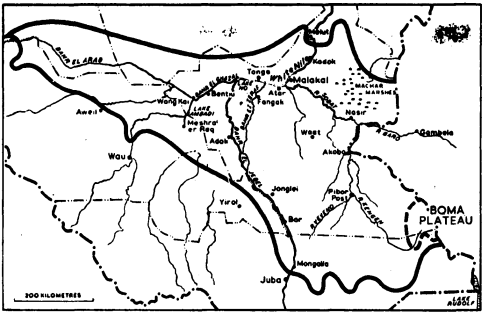

Figure 3.4. The Southern Clay Plains (9:235)

administrative boundaries within which socio-economic development objectives would be pursued.

For the purposes of this study it is not significant whether the JPA is defined as the narrow strip of land along both sides of the canal channel, or more broadly as the Jonglei Province, or most broadly as the Southern Clay Plains since the primary interest is on identification and selection of appropriate rural development strategies for the JPA. In this study, therefore, the JPA in its broad usage refers to the whole of the Southern Clay Plains; while for the purpose of initiation and implementation of rural development programs the JPA is used to refer to Jonglei Province.

Within Jonglei Province, field work for this study was conducted only in Bor and Kongor Districts. These districts were selected because they are where most of the pilot and other research and development studies are concentrated. These districts were the most accessible areas during the rainy season when field work for this study was conducted. The next two sections, which discuss the physical and social environment of socio-economic development in the JPA, refer mainly to these two districts. However, given the physical and social homogeneity of the region, the discussion applies to the whole of the Southern Clay Plains.

The Physical Environment of the JPA For Socio-Economic Development

The role of the physical environment in the process of economic development is increasingly being appreciated in economic literature.

Georgescu-Roegen, for example, observes that ". . .the entire economic history of mankind proves beyond question that nature, too, plays an important role in the economic process as well as in the formation of economic value" (38:13). This role is clearly discernible at both extremes of the process of economic development. In technologically very backward societies survival critically depends on the often erratic whims of nature. On the other hand, in technologically very advanced societies the mounting problem of industrial pollution has reawakened scientific and social interest in the role of the physical environment in the process of economic development.

A detailed description of the physical environment of the JPA is available in Volume 1 of the report of the Jonglei Investigation Team (1954). Apart from the effects of the 1960's floods on the ecology, it is unlikely that there have been major changes since the report was published. This section is therefore confined to discussion of the physical environment insofar as it impacts on identification and selection of rural development strategies for socio-economic development of the JPA.

Land types

The whole of the JPA is subject to varying levels of flooding during the rainy season (May to October). The floods are caused by heavy rains and the Nile's habit of overflowing its banks with heavy discharges that it brings from the Central African plateau

during the same season. The excess water problem is compounded by the extreme flatness of the land and the heavy impermeability of the soils. Small differences in relief, however, have tremendous effect on the ecology and livelihood of the inhabitants of the area.

The Jonglei Investigation Team have divided land into five main types according to differences in relief and water regime. These land types, shown in Figure 3.5 are: (1) permanent water surfaces, consist of the River Nile, its tributaries and the many lakes that dot the swamps; (2) permanent swamps, along the Nile and tributaries, remain flooded all the year and are covered with heavy growth of papyrus and kindred vegetation; (3) flood plains, locally known as Toich, are areas inundated from the rivers for periods of four to six months every year; (4) intermediate lands, areas where flooding from the rivers is not likely, but which become flooded every year because of the heavy summer rains, the impermeability of the soils and lack of drainage; and (5) high lands, distinctly higher areas, some two meters above the other land types, within or beyond the flood plains. The high lands escape flooding from the rivers and have sufficiently permeable soils to drain quickly after the rains. The small differences in relief, together with the flood conditions, determine the type of natural vegetation and the utility of the land for grazing, agricultural, transportation and residential uses.

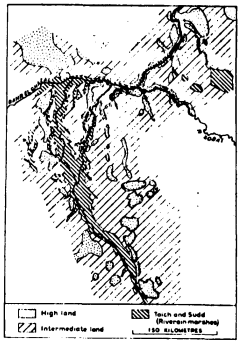

Figure 3.5. Land classification in the JPA (53: Map E1)

Soils

Generally, the soils are alluvial clay and are considered to be among the best soils in the Sudan in terms of fertility (see Chapter II). They are, however, quite impermeable in much of the area and have the characteristics of contracting and cracking when dry becoming very hardened. On the other hand, when wet, they expand and become very lumpy and difficult to work.

Where the exchangeable bases in the structure of the clay are mainly composed of calcium, the soils generally possess a good tilth and are fertile. But where sodium takes the place of calcium, as may occur in the flood plains where river water has been evaporated from the soil, the soil becomes exceptionally impermeable and infertile (9:235).

The above soil characteristics delineate suitable land for agriculture and limit it to the high lands and parts of intermediate lands in exceptionally dry years. However, after construction of the Jonglei Canal, much of the intermediate lands west of the canal will become drained and arable.

Climate

Generally, temperature and rainfall have more effect on climate than any other factors. In the JPA, temperature variation is small, ranging from a mean of 81° F for the coolest month (January) to a mean of 91° F for the warmest month (May). On the other hand, rainfall is very erratic and is characterized by an equatorial double maximum intensity (53:6). Table 3.1 shows the erratic nature

Table 3.1. Rainfall statistics for Bor Town in the Jonglei Projects Area (53:54)

Month	Average rainfall	Standard deviation mm	Standard deviation percent	Extremes (mm) Maximum	Extremes (mm) Minimum
January	2	Not examined		18 (1950)	Nil 28 years
February	8	Not examined		60 (1906)	Nil 11 years
March	27	Not examined		107 (1915)	Nil 3 years
April	84	56	67	209 (1907)	Nil (1911)
May	125	60	48	269 (1918)	11 (1924)
June	120	53	44	249 (1918)	33 (1907)
July	142	60	42	320 (1932)	37 (1935)
August	135	63	47	310 (1914)	39 (1925)
September	131	92	70	515 (1917)	22 (1903, 13, 27)
October	97	57	59	265 (1917)	17 (1927)
November	24	Not examined		76 (1931)	Nil 11 years
December	7	Not examined		99 (1918)	Nil 17 years
Year	903	237	26	1,663 (1917)	448 (1910)

of rainfall, as measured by the monthly standard deviation for Bor in the JPA. More recent illustrations of the erratic nature of rainfall are contained in ILACO's Annual Reports, published since 1976. In 1980, for example, 365 millimeters (mm) of rainfall was recorded at Kongor for July, of which 185 mm was in one single rainstorm. In Bor, 75 miles south of Kongor, only 105 mm was recorded for that July.

The great annual variations in rainfall, and the even greater monthly variations, constitute the most important single environmental factor affecting the economy of the JPA. The climatic conditions have a very important implication for agricultural development in the JPA. The heavy impermeability of the soils coupled with periods of intense heat and isolation, alternating in the rainy season with spells of severe rainfall, produce in the soil a rapid transition between a hard dry condition difficult to work and providing little moisture for plants, and a saturated state when plants suffer from water-logging. Drainage during rains and supplementary irrigation between rains are thus two fundamental physical problems for JPA agriculture.

Vegetation in relation to animal husbandry

Except for Cyperus papyrus and related vegetation in the permanent swamps, the whole of the JPA is dominated by annual and perennial grasses. Tree growth is limited by the effects of excessive water and poor drainage during the rains, and is limited to high land areas, where its growth is further limited by human

demands for construction and fuel.

The various grass species and the conditions under which they grow are important to livestock and wildlife movements in the area. On the high lands, where drainage is good, most of the grasses are annuals. Setaria pallidfusca and Pennisetum ramosum are dominant on the heavy clay soils; and Dactyloctenium aegyptium, Cyndon dactylon and Eragrostic spp are dominant on the more sandy clays. These grasses constitute a serious weed problem for crop production. They also provide excellent grazing during the rains, and although they later become woody and unpalatable, they are quickly grazed down by the heavy concentrations of livestock in the high lands when the rest of the region is flooded.

On the intermediate lands the dominant grasses are two annuals, Setaria incressata in the northern sector and Hyparrhenia rufa in the south. These grasses are flooded much of the time when they might provide valuable fodder. The latter, rufa, has the important property that if its dry growth is burnt off in the early part of the dry season while the ground still retains some moisture, the plant produces a valuable green regrowth that can be used by cattle for as long as water is available in the intermediate lands.

In the flood plains, the dominant grasses are Echinochloa pyramidalis, Oryza barthii and O. punctata, which are dominant in the shallower areas. These grasses are inaccessible as fodder during their periods of growth because of river floods, and only

Echinochloa provides a valuable regrowth when burnt in the dry season.

In the deep flooded areas, Enchinochloa stagnina and Vossia cuspidata are the dominant grasses. The former is palatable to cattle even when it is fully mature after seeding, and is eaten unburnt when the water recedes from it. The latter is less palatable when dry and is of little use as fodder.

The above grasses and the conditions of their growth are important in the transhumance of the inhabitants of the JPA. The transhumance in turn affects the amount of labor available for agricultural activities.

The Social and Institutional Environment of Socio-Economic Development in the JPA

The social life and institutions of the inhabitants of the JPA revolve around agriculture, animal husbandry and fishing, their chief means of subsistence. The many natural hazards connected with the physical environment of the JPA have provided a wealth of statistical information over many centuries, from which the inhabitants of the area have learned to spread the risk of disastrous famines among the three occupations. Evans-Pritchard writing about the Nuer Tribe, emphasizes the dependence of their modes of livelihood on environmental conditions, and the necessity to engage in diversified productive activities.

According to Evans-Pritchard:

> The necessity of a mixed economy follows from the ecological equilibrium. Rinderpest prevents complete dependence upon milk foods; climate prevents complete dependence on grain; and hydrological variations prevent complete dependence on fish. These three elements together enable Nuer to live, and their seasonal distribution determines Nuer modes of life at different periods of the year (32:92).

Like the productive activities, the institutions within which these activities and other social and political activities are conducted are also influenced by the physical environment. These institutions and socio-political relations are discussed in this section as they relate to failure and success elements that constrain or promote increasing the cultivated area and agricultural output in the JPA.

Agriculture

The physical conditions of the region and the low technological level make agriculture a very laborious and demanding occupation. Agriculture therefore plays a less important role in the lives of the people than does animal husbandry. According to Evans-Pritchard, the ecology gives a bias in favor of cattle husbandry (32:92). The heavy clay soils are not easy to work by muscle power, both when they are wet and when they are dry. Weeds grow very rapidly. Pests, diseases, droughts and floods can wipe out an entire season's work. Under these physical and technological conditions and with more palatable means of subsistence available in animal husbandry and fishing, agriculture has traditionally not been popular in the JPA, especially among the Dinka and Nuer people.

Indeed, until very recently, agriculture was viewed as an occupation for those who had no cattle.

It is, however, important to note in the context of social constraints on agriculture that the social bias in favor of cattle husbandry, itself a result of the environmental bias, will tend to work against agricultural development even if the physical environment should be changed. Social practices often lag behind changes in technology and physical environment. Furthermore, policymakers, like the inhabitants of the JPA, are overwhelmed by the difficult physical conditions of agriculture in the JPA.[1]

Cropping practices The principal staple all over the JPA is sorghum (Dura) in its many varieties. Risk is also spread among dura varieties and among plots in different locations. Family plots are often located both in the high lands and in the intermediate lands. If the year turns out to be exceptionally dry, the plot in the intermediate lands can not be a complete failure, as there will be sufficient moisture for some sorghum varieties. If it is a year of excessive flooding, the plot on the high lands will not be a total failure, as some varieties will resist the drought conditions.

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[1]ILACO consultants in the area, as indicated in personal interviews conducted by the author, appear to favor the "improvement approach" to rural development because of their own failures in pilot studies for the planned large scale Pengkou Plain Development Project. In turn, ILACO's findings and recommendations appear to be influencing officials of the Executive Organ to opt for the "improvement approach." This approach, as shown later in this study, offers very little socio-economic development to the JPA, and merely manages poverty and misery.

Family plots are therefore scattered over long distances, a practice that is necessary for survival, but consumes a great deal of labor. Mottin, on the plight of the African woman illustrates the problem of scattered fields when she writes:

> We saw one woman who had walked a total of 640 kilometers to bring back the harvest from one acre of land, thirty kilometers each trip, 40 trips of 16 kilometers each way, the field being 8 kilometers away from the village! (74:42).

Other crops grown in the JPA include maize, groundnuts, sesame, various beans, pumpkins, and marrows. Some tobacco is grown near the homestead in the summer and in the intermediate lands during the winter. Wild rice (Oryza barthii), a gourmet food in Europe and America, grows in the intermediate lands and flood plains, and during famines women go out to cut it for food.

Settlement patterns Settlement patterns of villages in the JPA affect agricultural development directly. The present settlement patterns are dictated by the hydrological conditions and lack of slope. Permanent settlements and crop plots are concentrated on the few pieces of land in the high lands and intermediate lands. The settlements are in the form of independent households. The whole of the JPA, except for Shillukland, is dotted with widely scattered household units and fields. A "village" is sometimes as long as 30 kilometers. This settlement pattern makes provision of infrastructural services (schools, health, security, markets, extension, tractor pools, etc.) extremely difficult and expensive. The traditional settlement pattern will become obsolete once

construction of the canal is completed, but if the countryside is not restructured, the traditional settlement patterns will certainly be a major constraint to agricultural development.

Land tenure A major aspect of the agrarian structure in the JPA is communal land tenure. Communal tenure is a form of land holding in which control over land is exercised through a social group. In the JPA land is held on a tribal, village, or family basis, and individuals have rights in this land by virtue of their membership in the relevant social unit. Hence, title to land has a communal character and it is usufructuary, rather than absolute. The custodians of the land are the chiefs, the gods, and the ancestors. Legally, however, all land in the JPA is considered by the government as unsettled and unregistered. Since land is abundant and labor is scarce, and there has been no pressure from modern commercial agriculture in the past, the conflict between tribal and state ownership of land has hitherto not been a serious issue.

At present, under tribal tenure, individual ownership as such has not been institutionalized. Each tribe has exclusive right in its area. The structures of the various tribes under their respective Court Centers, are given in Appendix A in conjunction with procedures of explorative interviews conducted in the area for this study. Each tribe, sub-tribe, or clan is an economic unit with its own land, pastures and waters, and each has well defined areas over which it has grazing, cultivating and fishing

rights. Boundaries exist between the areas of two adjoining tribes. Thus, there is no individual ownership of land, and the individual is regarded as a member of his tribe or community which owns the land. An individual's right to any piece of arable land is normally established through his own prior legitimate use of it, with acknowledgement of the community, or by inheritance of some established prior legitimate use.

Communal ownership of land has implications for production, distribution and consumption. Evans-Pritchard argues that, seen from the outside, each Nuer community may be said to be consuming a common stock of food, and that from the same angle the whole community may be said to create that stock of food (32:92). Evans-Pritchard thus argues that the economic unit extends far beyond the simple family:

> In a narrow sense the simple family might be called the economic unit, but . . . it is not self-sufficient and the active participation of a wider group is often necessary, e.g., in building, fishing, and hunting. It is also clear that a single family can not herd its cattle in distant pastures and at the same time, herd the calves elsewhere, attend to the tiny calves in the Kraal, milk, churn, clean the Kraal, prepare dung for fuel, cook the food, and so on by itself. Cooperation is found among neighbors who are also kinsmen. There is also much mutual assistance when cooperation is not essential to the performance of a task, e.g., in weeding and harvesting, for it is conventional to ask people for help, the obligation to assist being part of a general kinship relationship (32:91).

The implication of traditional African communal land tenure structures for socio-economic development has been subject of considerable controversy. Jacoby, for example, in calling for

institutional adjustments, observed that:

> Throughout Africa, the neglect of land under communal tenure arrangements has become an important problem, due to population increases and the introduction of a money economy and cash crops. There is no doubt that this neglect, particularly in pastoral areas, has blocked agricultural progress and that traditional tenure systems have not been able to provide the necessary incentives for increased production. There is an urgent need for institutional adjustments to pave the way for progress (51:2).

With respect to the JPA, Adam has enumerated several drawbacks of communal land tenure, including tenure uncertainty and incentives which he says are aggravated by lack of modern inputs (1:81-87). Adam, therefore, calls for land reform as one of the means to economic development in the area. On the other hand, it has been argued that there is not sufficient evidence indicating that traditional communal systems of land tenure in Africa have in themselves proved to be so inflexible as to prevent adaptation to new conditions (98:28).

Where land is abundant, such as in the JPA, problems of tenure have often included abuse of land by mining it without taking adequate conservation measures and cultural disruption of the indigenous communities. In East and West Africa, the pressures that have confronted communal farming have been introduction of cash crops, shortage of land in the face of a growing population, introduction of new crops and new methods of cultivation, absence of male workers as a result of expansion of industrial and urban employment, and land alienation either in the form of large-scale concessions granted to nonindigenous persons for purposes of

commercial development (Gedaref in Sudan) or in the form of land acquired by permanent immigrant settlers. These forces have tended to disrupt traditional tenure systems. The increasing commercial value of land resulting from the cultivation of cash crops provides land holders with the incentive to turn their right over land to commercial advantage. In some places, families of tribal chiefs have tried to change communal land into private holdings, and often this has led to establishment of large private estates. Commercial speculators have been known to engage in land-grabbing operations in areas undergoing change from communal tenure. Individualization of tenure, rack-renting of land, and absentee landlordism frequently result in areas where there is a transition from subsistence communal tenure to commercial agriculture, unless there are specific counter policies guiding the reorganization of agriculture.

The relevant issue of land tenure in the JPA is then not whether communal tenure is per se an obstacle to agricultural development, but rather whether introduction of cash cropping, new crops and new methods of cultivation will not lead in the long run to abuses detrimental to land quality and the social and economic welfare of the indigenous tribal communities of the JPA.

Although individualization of tenure, rack-renting of land and absentee landlordism, features that are now subjects of land reform in Asia and Latin America, are possible outcomes of the transition from subsistence to commercial agriculture in the JPA, the foundations for cooperative development also already exist in

the institutions of communal land tenure, mutual aid, communal production, distribution and consumption. Each tribe in the charts of Appendix A is already a cooperative or corporation that owns land and produces and consumes together. Only the contexts of subsistence and commercial agriculture differ. A relevant question for rural development strategy in the JPA is whether old forms of cooperation in subsistence production can be successfully adapted to new forms of production in a commercial environment.

Animal husbandry

The animals kept are mainly cattle. The Jonglei Investigation Team has estimated that in 1954 the Southern Dinka (Bor and Kongor Districts) had 200,500 cattle, and 29,400 sheep and goats. Payne used official AFSED (Arab Fund for Social and Economic Development) livestock growth rates to upgrade these figures to 427,367 and 130,254, respectively, for 1976. Other estimates put the figure for cattle at almost half the 1976 Payne's update (84:14). Clearly, although cattle husbandry is the major economic activity in the JPA, there has never been a reliable livestock census in the area.

The physical conditions of the JPA dictate a transhumant mode of life. During the dry season water and pastures become scarce and people, and livestock first move to the intermediate lands, and then to the flood plains, following the receding water and pastures. In the rainy season, the flood plains become flooded, the people and livestock move first to the intermediate lands, and when these too

become flooded they move to the high lands. As noted by Payne et al.:

> The annual transhumant migration of some of the people together with their livestock is a rational response to the existing ecological situation. When asked why they remove their livestock from the village during the dry season, 83 percent of respondents stated that it was on account of the lack of feed and water (84:26).

The annual cycle of transhumance of the Southern Dinka, including livestock and agricultural activities, is shown in Figure 4.3. The transhumance has been repeated in the same form for centuries, and it has become an important part of the cultures of the inhabitants of the JPA.

The high insurance value placed on livestock is probably responsible for what has been called "cattle psychology" among the people of the JPA. To the Dinka and Nuer, cattle are everything: Cattle provide milk and milk products for subsistence; their hides provide cover against cold and rain when the people are away in the cattle camps; the horns are made into spoons and dance trumpets; and the meat is eaten occasionally. Most of the social activities concern cattle. Cattle provide the traditional medium of exchange; with cattle a young man acquires his bride, with cattle the people make offerings to their gods and ancestors. Wealthy people show off their wealth, pride and generosity by spearing a fat cow, bull or ox at random from among other people's herd as a feast-gift to the community. The necessary compensation is usually made on the spot.

The inhabitants of the JPA do not slaughter their cattle for meat, except in very severe famines and in religious ceremonies, or

in cases of pride-slaughter such as the one just related. Nor do they willingly sell their cattle for cash except in situations where there are no other alternatives such as for paying court fines, buying sorghum grain during famines, or paying the poll tax (recently branded as a colonial legacy and abolished; but reinstituted as the so-called "combined cow and hut tax").

It is clear from the above account that, although cattle wealth is considerable in the JPA, cultural constraints prevent their use for agricultural development, either as draught animals, or as capital that can be converted into money to buy new inputs.

Allocation of labor

The allocation of labor is accomplished within the transhumant mode of life (Figure 4.3). The household's time is allocated to eight major activities as discussed below.

Cattle care related tasks These activities consist of grazing of the cattle during the day, releasing the cattle in the mornings from pegs to which they are individually tethered over night, tethering them again in the evening after grazing, milking in the mornings and evenings, manufacture and maintenance of the ropes for tethering, and the general body and health care of the animals.

Agriculture As discussed in the linear programming section of Chapter VI, agricultural activities consume considerable amounts of labor. In the past, work was done by women, with the men

supervising and helping during the critical periods of land clearing, sowing and weeding, or whenever it became clear that the women could not complete the task in good time. This has almost totally changed now for married men who have become increasingly interested in agriculture. Unmarried young men still engage more in cattle than in cropping activities (62:62).

Fishing and hunting Fishing is organized at several levels, and depends on the period of the year. There are individual, men, boys and women fishing parties. Wildlife hunting is organized by boys for small game and by men for large game. These two activities are done only occasionally and when there is need and natural conditions are favorable.

Home construction and maintenance The necessary tasks here are cutting and transporting wood (sometimes from as far away as 75 miles) and grass (rufa) from the intermediate lands. The former task is done by the men, and the latter by women and girls who also have the additional responsibility of plastering the walls with mud. Thatching of the roof normally is left to a hired expert. These activities are usually completed during the dry season when there is no agricultural work, and are therefore not competitive with agriculture.

Home crafts The women make rope for construction from wild grasses and fibres, while the men make ropes for tethering the cattle. Other home crafts include making dishes from gourds, spoons from horns and shells, pots and smoking pipes from anthills, and

other household items.

Wage labor During the dry season, some men may decide to visit relatives in urban areas to solicit for cash and consumer goods on the basis of kinship, or, failing, look for wage labor. Some women also may go to urban centers during this period to brew "Marisa," a local beer, for cash. Often these men and women do not return to the village in good time to start land clearing and sowing in April and May. This type of seasonal wage labor clearly competes with subsistence agriculture.

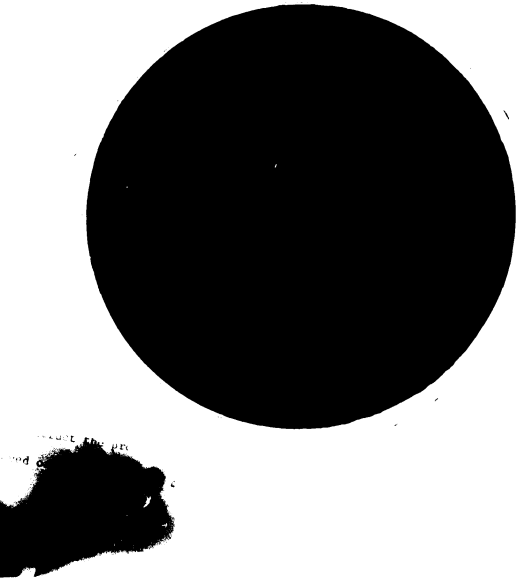
Court cases During the dry season and sometimes during the agricultural season, those who have court cases spend a great deal of their time at the tribal court centers (see Appendix A). Sometimes a household member or members spend months in litigation just to gain or prevent the loss of one cow. Court cases in consequence compete with agricultural activities, and there has been efforts recently to close the courts between May and October, the months of agricultural production.

Leisure The residual time is spent in "leisure," or rather in redundancy as there may be nothing to do. Leisure may take a great portion of the household's total annual available time particularly during the dry season when people and livestock are in the intermediate lands and flood plains. Here, herdsmen are selected each day to graze the cattle, sometimes as far away from the cattle camp as 20 kilometers. The bulk of the people spend their time in the shade, or otherwise go fishing or hunting when

conditions are right and the people feel like it.

It is clear from the above presentation of time allocation and from the migratory chart of Figure 4.3 that labor resources are not efficiently utilized within the subsistence system. About 5 months of the year are spent between the villages and the flood plains doing repetitive jobs. Work discipline is informal and depends on tasks as they arise. The work environment of the subsistence economy contrasts sharply with that of the urban wage earner who must work an eight-hour six-day week all year. The hours worked by the urban worker also contrast sharply with the double digit figures of his counterpart in Europe during that region's early stages of industrialization.

There is some indication in the foregoing presentation that there is plenty of unused, unusable or underutilized human capacity in the JPA. The extent to which labor constrains agricultural production and goes unutilized during much of the year and the reasons for this are considered later in the linear programming section of Chapter VI.



CHAPTER IV. ANALYTICAL FRAMEWORK AND MODELS

Chapter IV is divided into four parts. Sections one and two present the "means-ends continuum" analytical framework as developed in the literature and as adapted to this study to achieve the first objective of the study. Key concepts used in the adaptation, such as strategy, rural development strategy and agrarian structure, are defined in these sections. Section three presents the basic linear programming model, which is used to supplement the "means-ends continuum" analytical framework in pursuing the remaining objectives of the study. Section four discusses application of the linear programming model to the JPA including presentation and discussion of data used.

The "Means-Ends Continuum" Analytical Framework

The "means-ends continuum" analytical framework, developed in the literature on the theory of inquiry (45:13) is applied to the JPA in identifying and selecting appropriate rural development strategies for socio-economic development in the area. Once an appropriate rural development strategy is selected, the requisite agrarian structure and institutions (these terms are defined in the following pages) can be established either gradually or rapidly depending upon the desired and feasible tempo of development. Institutions which obstruct the process of socio-economic development can either be removed or modified; those that facilitate the process

can be strengthened; while new ones can be discovered, invented or adapted.

The means-ends continuum framework is schematically illustrated in Figure 4.1. This diagram is an application of Timmons's conceptualization of the continuum. In this continuum, ends or goals perform a two-fold function in social inquiry. According to Adam:

> They serve to establish the norm from which the problematic situation may be determined 'as the gap between the norm and the present situation'. Ends also serve 'as criteria for evaluating particular means' to determine the extent to which the means yield consequences which narrow the gap or reduce the difference between the present and the desired situation (1:26).

Within the logical framework of the means-ends continuum, Gittinger argues that ". . .every immediate goal or end becomes an end-in-view in relation to a more ultimate goal until the basic ends are reached" (42:130). Each end-in-view in Figure 4.1 can therefore be considered as a means to another end-in-view until the ultimate goals of socio-economic development are reached at the top of the ladder.

The term "socio-economic development" is interpreted to include aspects of the process of economic and social change that were not covered by the concept of "economic development" in the sense that this latter term was used in the three decades following the Second World War. Social scientists used the concept of economic development during this period to describe the process as a quantitative growth in incomes and per capita Gross National/Domestic Product. Although growth in incomes and per capita income still remain dominant

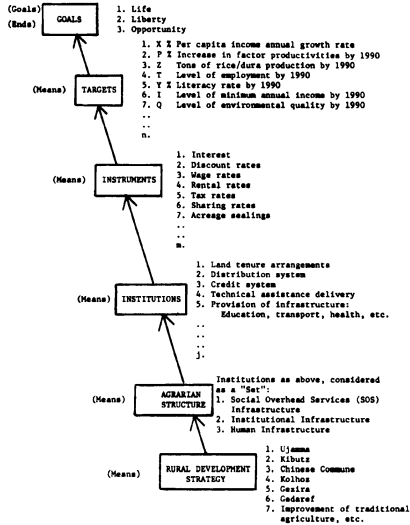


Figure 4.1. Schematic illustration of the means-ends continuum model applied to agricultural development

aspects in the process of development, other social, political and quality of life aspects relating to equity, widespread and continuing participation, political and social stability and environmental quality have been incorporated into the definition of socio-economic development. Development, as Ahmed writes, should concern itself with man:

> The most satisfying and acceptable answer (regarding the nature of development) is that development has to concern itself with man and not just the growth of things which are mainly means. The whole process has to be geared to the satisfaction of needs beginning with basic ones of the poor who constitute the majority. At the same time this development has to go beyond the basic needs to ensure the humanization of man by the satisfaction of his needs for expression, creativity and participation in decisions concerning his own destiny (5:1).

Following Timmons (95), Gittinger (42), Adam (1), and Vigues-Roig (100), it is presumed that the basic ends that are common to all societies are life, liberty and opportunity.[1] These goals are the ultimate ends of socio-economic development. They are broadly expressed in Sudan's Perspective Plan, 1977/78-1994/95 (24) and in the Southern Region's Six-Year Development Plan for Social and Economic Development, 1977/78-1982/83 (25).

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[1]See the Magna Charter of 1215, the United States Declaration of Independence of 1776, and more recently, the Indian Constitution of 1949 (which secures to all citizens of India ". . .JUSTICE, social, economic and political; LIBERTY of thought, expression, belief, faith and worship; EQUALITY of status and opportunity"). Sudan's Permanent Constitution of 1973 affirms the rights of life, liberty and opportunity in Articles 2, 3, 19, 22, 23 and 26 of the Universal Declaration. Other important documents, where nations stated their ultimate ends for existence, have emphasized these ends in terms of human life, liberty and opportunity, sometimes expressed as "pursuit of happiness."

Within the context of the means-ends continuum, agriculture development itself is an end as well as a means for attaining superior goals. As a means, agricultural development entails a deliberate and purposeful modification and/or complete overhaul in rural development strategies and agrarian structures and institutions.

At the bottom of the ladder in the means-ends continuum schema of Figure 4.1 are rural development strategies. The term "strategy" is traditionally a military category, but it is sometimes used more broadly to cover non-military situations. The Encyclopedia Americana defines strategy as follows:

> Strategy in its general sense is the art and science of developing and employing the political, economic, psychological and military forces of a nation, during peace and during war, to afford the maximum support to national policies. . . . In its military sense, strategy is the art and science of employing the armed forces of a nation to secure the objects of national policy by the application of force or the threat of force (30:772).

The art and science of strategy has been found a useful analogy and has been incorporated into the vocabulary of social and economic development (83:52). This incorporation is logical since most underdeveloped countries profess to having "declared war on poverty, illiteracy and disease." This type of war (against underdevelopment), like all wars, must have its strategy and tactics if victory is to be achieved at minimum time and cost. In the context of the JPA, an appropriate rural development strategy constitutes the science and art of employing existing and potential physical, institutional

and economic resources from within and from outside the area in order to obtain and secure the goals of regional and national Sudanese policy. Examples of rural development strategies from world experience are suggested in Figure 4.1. Two of these strategies, from Sudanese experience, are discussed in the remedial phase of this study in Chapter VII.

Following "strategy" in the means-ends continuum schema comes "agrarian structure." This term is used to mean the institutional, service and human resource framework within which agricultural production takes place. This concept is similar to the following definition developed by the United Nations Department of Economic Affairs:

> This term (agrarian structure) is here used to mean the institutional framework of agricultural production. It includes in the first place, land tenure, the legal or customary system under which land is owned; the distribution of ownership of farm property between large estates and peasant farms or among peasant farms of various size; land tenancy, the system under which land is operated and its product divided between operator and owner; the organization of credit, production and marketing; the mechanism through which agriculture is financed; the burdens imposed on rural populations by governments in the form of taxation; and the services supplied by governments to rural populations, such as technical advice and educational facilities, health services, water supply and communications (98:5).

In Figure 4.1, the various elements of agrarian structure are grouped under three categories, borrowed from Onoh's "Preconditions for Economic Development." These categories are social overhead services (SOS) infrastructure, the institutional infrastructure and the human infrastructure. Hirschman defines the SOS

infrastructure to mean:

> . . .those basic services, without which primary, secondary, and tertiary productive activities can not function. In its broader sense it includes all public services from law and order through education and public health to transportation, communications, power and water supply, as well as such agricultural overhead capital as irrigation and drainage systems (496:83).

In the JPA, the SOS infrastructure is at a very rudimentary stage of development. Much of the current development efforts by the Executive Organ and integrated rural development efforts by UNDP/ILACO are directed at construction of the SOS infrastructure.

The institutional infrastructure is composed of both state and market institutions. State institutions include the various departments of government including the legislature, the executive and the judiciary as they impact upon control and regulation of agricultural production. Market (or state planning in nonmarket situations) institutions include banking, credit and other financial organizations.

Finally, under agrarian structure, the human infrastructure includes the various institutions for human capital formation in rural areas. These include formal and adult education, vocational training and the dissemination of agricultural information through extension work.

A particular agrarian structure is composed of institutions galvanized together over time by the rural development strategy pursued for the purposes of agricultural development. Institutions can be defined as a patterned way of life through which collective

action controls, liberates and/or expands individual action (16:21). Schotter formally defines a social institution as ". . .a regularity in social behavior in specific recurrent situations, and is either self-policed or policed by some external authority" (90:11). Timmons considers institutions as among the most important means through which agricultural adjustment toward economic progress is either obstructed or facilitated:

> Institutions constitute important failure elements which slow up and at times obstruct agricultural adjustment toward economic growth both within and outside the agricultural industry. Likewise, in prospect, land institutions provide important potential means for implementing the achievement of agricultural adjustment toward economic growth. This means that the economist cannot ignore, hold constant, or assume away the institutions within which decisions are made and implemented without losing relevance with the problems he seeks to remedy (94:174).

Instrumental variables, unlike institutions which are more stable, are used to measure change and to adapt the economy to small and frequent changes in what Tinbergen calls "other data," that is, the features over which the policymaker exerts limited influence such as prices of imports (93:3). Examples of instruments relevant to agrarian institutions are given in Figure 4.1.

The last class of means in the means-ends continuum schema are the targets. Like instruments, targets are usually quantitative (Figure 4.1) variables which incorporate the immediate goals of the policymaker. Target variables can be either fixed or flexible. They are periodically revised according to the extent to which goals are realized and as hitherto unavailable information comes to light.

Given the means-ends continuum model and assuming that the policymaker is operating in the short run in an agrarian situation in which the rural development strategy and its agrarian structure and institutions are well established, the problem of socio-economic development policy becomes quantitative in the sense that policy instruments are used to achieve specific socio-economic goals (usually stated in terms of predetermined targets). In the case of the JPA, where the agrarian structure and institutions are of a subsistence nature and centrally planned agrarian structures and institutions are either nonexistent or extremely weak, it would appear quite unlikely that policy instruments can be effective in stimulating socio-economic development without institutional, structural and strategic changes at a comprehensive level. As argued by Giles:

> . . .the use of instruments in changing tax rates, interest rates, capital investment and wage rates, . . . assumes that the structures have been fashioned which permit the exercise of the instruments. In more developed countries instruments constitute the main policy means used for stimulating economic development. However, in the less developed countries, structures are not yet developed to provide the policymaker with the instruments which he may use in economic development (41:6).

Giles underlines the major hypothesis underlying this study that at present, the fundamental issue of socio-economic development in the JPA is the identification, selection and development of an appropriate rural development strategy and formation of the requisite agrarian structure, institutions and instruments to bring about socio-economic development consistent with the aspirations of the

inhabitants and national goals. The "means-ends continuum" can be used as a framework for identifying and selecting rural development strategies appropriate for socio-economic development of the JPA.

Developing the Means-Ends Continuum for Identifying and Selecting Rural Development Strategies in the JPA

Timmons (94) applies the means-ends continuum framework to develop a model for analyzing agricultural development through modifying land tenure arrangements, one of the institutions in Figure 4.1. This study modifies and applies the Timmons framework to provide an analytical model for identifying and selecting rural development strategies for socio-economic development of the JPA. Figure 4.2 presents the analytical framework developed and used in this study. The concepts in Figure 4.2 have already been defined in conjunction with the means-ends continuum conceptual framework in the preceding section.

In applying the means-ends continuum paradigm, Timmons identifies three main steps which constitute the analytical model. These steps, identified in Figure 4.2 are the delimiting phase, the diagnostic phase and the remedial phase. According to Timmons:

> Under the delimiting phase, goals are identified; the existing situation is stated; and the problematic gap between the goals sought and the existing situation is indicated. The diagnostic phase identifies and measures, insofar as possible, the failure elements and the success elements. The failure elements are those factors that cause the existing situation to differ from the desired goal. The success elements are the factors that have prevented the gap from being larger than it is. The

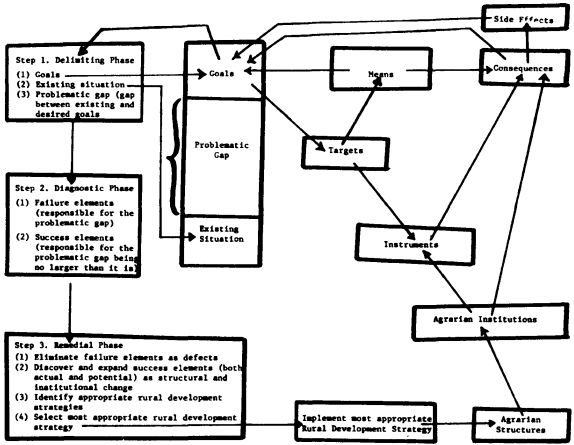

Figure 4.2. Analytical framework for identifying, selecting and implementing rural development strategies for socio-economic development of the JPA

> remedial phase consists of corrective action. This phase includes two parts. Part one consists of the removal of failure elements that were identified in the diagnostic phase. In part two, the success elements that were identified in the diagnostic phase are expanded. Also, in part two, new success elements are development (94:88).

The analytical framework of Figure 4.2 provides a comprehensive analytical system within which the various conflicting issues in identifying and selecting appropriate rural development strategies for the JPA, or any region, could be debated and resolved. It is suggested that the current debate on the efficacy of the "improvement" and "transformation" approaches in the JPA be conducted within the logical framework of Figure 4.2. If debate on appropriate rural development strategies is conducted within the framework of Figure 4.2, it would proceed along the steps indicated.

In step one, goals of socio-economic development are identified and stated unambiguously and the existing situation is evaluated and compared with the stated goals to determine the problematic situation requiring solution. This step, termed the delimiting phase, is extremely important because without specific goals and a clear grasp of the existing situation, it would be difficult to design rural development strategies that have a reasonable probability of success if implemented. Step two, termed the diagnostic phase, identifies failure elements that are responsible for the problematic situation and success elements that are responsible for the problematic situation not getting larger than it is. Step three, termed the remedial phase, seeks to eliminate the failure elements

identified in the diagnostic phase, and to expand and discover success elements. Rural development strategies that are consistent with eliminating the failure elements and expanding and discovering the success elements are also identified in the remedial phase. The most appropriate rural development strategy is selected from the "appropriate" strategies identified in the remedial phase.

Once an appropriate rural development strategy is selected, the remedial phase continues with formation and development of the requisite agrarian structure. As argued earlier, this study maintains the hypothesis that each rural development strategy maps or implies a unique set of agrarian institutions which constitute the strategy's agrarian structure. Agrarian institutions and their instrumental variables constitute the necessary measures for achieving the goals developed and stated in the delimiting phase.

Achievement of targets, which incorporate immediate goals of the policymaker, completes the first round of analysis and implementation. However, since targets are usually achieved at varying levels of success, steps 1, 2 and 3 of Figure 4.2 are repeated over and over. During each repetition of analysis and program implementation, consequences and unforeseen side-effects of the preceding action are incorporated. These repetitions imply that rural development strategies and the agrarian institutions which they generate are dynamic rather than static, since they can be modified during the course of analysis, planning and program implementation. The framework of Figure 4.2 thus provides a

potentially powerful and complete method of analysis and implementation of rural development strategies for the JPA.

The Delimiting Phase

The delimiting phase of this study, contained in Chapter V, identifies the major physical, institutional and economic resource situation of the Sudan in relation to the JPA in terms of the expected area's agricultural contribution to the national economy. Within this context of the potential contribution of the area to the national economy, the goals of socio-economic development for the JPA are stated. Results from linear programming models are used to provide a quantitative determination of the present state of development of JPA's potential contribution. The problematic situation is delineated as the difference between the stated goals and the existing situation in the JPA.

Involving physical, institutional and economic aspects, the delimiting phase is necessarily multidisciplinary in approach. This study recognizes the multidisciplinarity approach in planning, formulating and implementing development projects in the JPA. However, since the thrust of this study is to provide a framework for debating and resolving the important issue of appropriate rural development strategies for the JPA, the presentation in the delimiting and subsequent phases is intended as illustrative of application of the framework developed in this study for use by an interdisciplinary JPA team.

The Diagnostic Phase

Presented in Chapter VI, the diagnostic phase identifies and analyzes interrelationships among the physical, institutional and economic resources of the JPA which have led to failure or success in achieving the goals identified in the delimiting phase. As in the delimiting phase, the diagnostic phase is necessarily multi-disciplinary. Physical and biological scientists are concerned with physical and biological possibilities. Anthropologists and sociologists are concerned with social and cultural aspects of institutions that impede or promote socio-economic development. Similarly, political scientists and development administrators are concerned with prevailing political and administrative institutions as they impact upon socio-economic development. Economists are concerned with analyzing the efficiency of resource allocation and how particular agrarian structures, institutions and rural development strategies allocate resources.

Investigations of the efficiency of resource allocation in a "composite farm" of the JPA are made to complement the means-ends continuum model in identifying resource constraints which restrict increasing agricultural output. These investigations are concerned with identifying success and failure elements to achieving the stated goals. Similar investigations in other disciplines regarding failure and success elements are needed.

The Remedial Phase

The remedial phase, presented in Chapter VII, is divided into five parts. The first part discusses the "improvement" and "transformation" approaches to rural development strategy in relation to the failure and success elements developed in the diagnostic phase. Section two evaluates the strategy of integrated rural development (IRD), currently under implementation in the JPA, as an illustration of how the improvement approach address the failure and success elements relating to rural development in the JPA. Section three discusses the proposed Pengkon Plain Development Project and the Jonglei Irrigation Project as transformation approaches to rural development in the JPA. Section four discusses the Gezira and Gedaref rural development strategies as comparative experiences of the transformation approach in North-central and North-eastern Sudan. Finally, section five suggests planning elements upon which an appropriate rural development strategy for the JPA might be based. The fourth and last objective of this study is achieved in this section.

The strategies in sections two, three and four are discussed under four criteria of success elements. These criteria relate to knowledge, capital generation, incentives and the way in which a strategy defines the role of traditional society in relation to the stipulated new forms of modern agricultural production. These strategies are discussed in terms of how each of them promotes or

impedes knowledge, capital generation, incentives and the manner in which each promotes transition of traditional subsistence production to sustained commercial production. In developing the first three of these criteria, Timmons argues that:

> Under certain assumptions we may specify that (1) incentives, (2) knowledge, and (3) capital are essential elements for development. If so, what are the land tenure institutions that tend to prevent these elements from encouraging development? Or, alternatively, what are the land tenure institutions that tend to make these elements generate development? (94:90)

Whereas Timmons's study analyzes land tenure institutions, the criteria can be extended to analysis of rural development strategies, agrarian structures in general, or any specific agrarian institution as in the land tenure case considered by Timmons.

Development of Linear Programming Models

In the context of this study, linear programming is used to supplement the "means-ends continuum" analytical framework. Results from linear programming models applied to the JPA are used in delimiting the problem of rural development in the JPA. The magnitudes of crop acreages in the optimal solutions, and of optimal incomes provide approximate measures of the existing situation in the JPA. These results, and those in range analyses of the linear programming models, are used also in the diagnostic phase as measure of the extent to which failure and success elements impede or promote achievement of rural development goals in the JPA.

Utility of linear programming to the JPA

During the last few decades, linear programming has become a widely used technique for analysis and planning at both the micro and macro levels. The major advantage of linear programming is the ease with which it can handle different types of firm organization and management problems. This flexibility is achieved by carefully defining the objective and in manipulating the constraints. The constraints make it possible for the planner to impose any norms which may be necessary or desirable. Thus, the method allows one to examine a wide range of alternative adjustments and to analyse their consequences thoroughly and efficiently. As Beneke and Winterboer point out: "The principal advantage of linear programming as a planning method is not that it leads to one fool-proof plan but that it provides a means for analysing a variety of alternative decisions" (12:4). This quality makes the method very suitable for the JPA where many alternative decisions will have to be considered and choices made at the onset regarding rural development strategies and the initiation and implementation of socio-economic development programs.

Despite the importance and usefulness of linear programming in solving maximization (minimization) problems in the real world, Dorfman, et al. caution that linear programming models are not necessarily strict representations of the economic situations with which they deal. Linear programming is subject to the restrictive assumptions of additivity, divisibility and finiteness of activities

and resources, and the assumption of single-value expectations that the parameters of the model are known with certainty. Although these assumptions including their modifications and extensions have been discussed at length in the literature (26;46;12), nevertheless, it needs point out, as noted by Dorfman, et al. that strict descriptive faithfulness is an unreasonable demand to make of any conceptualization: "What we have a right to ask of a conceptual model is that it seizes on the strategic relationships that control the phenomenon it describes and that it thereby permits us to manipulate, that is, think about, the situation" (26:9).

The basic linear programming model

Linear programming is a mathematical technique used to maximize or minimize a linear objective function subject to a number of linear constraints. The maximization form of linear programming used in this study is expressed in the following three equations:

Maximize: $$Z = \sum_{i=1}^{n} c_i x_i \quad (1)$$

Subject to: $$b_j \geq \sum_{i=1}^{n} a_{ij} x_i \quad (2)$$

and all: $$x_i \geq 0 \quad (3)$$

where Z = value of the program or solution,

x_i = activity (process) i,

c_i = net contribution to Z by activity i,

b_j = amount of resource j available,

a_{ij} = amount of resource j required by one unit of activity i,

i = 1, ..., n

j = 1, ..., m.

Equation (1) is the objective function which is to be maximized or minimized. Equation (2) expresses resource availability constraints, that is, resources are restricted to what are available. Equation (3) ensures that each activity enters the solution at a nonnegative level. A linear programming model thus has three quantitative components: an objective function to be maximized (minimized), alternative methods or activities for achieving the objective, and resource and/or other constraints. Modifications and extensions of the basic LP model have been developed and discussed in detail by economists including Heady and Candler (46), Beneke and Winterboer (12), and Dorfman, Samuelson and Solow (26).

The objective function In a linear programming model applied to farm planning, the objective function expresses the goal of the farm enterprise, that is, the variable which the farm manager intends to maximize or minimize. In maximization problems, several objective functions have been developed in the literature for various kinds of farming situations (47; 49; 85). However, these farming situations differ from the JPA, since in the former inputs and outputs are bought and sold in the market; while in the JPA, production is for subsistence consumption and most inputs are either owned or produced by the family farm.

Some attempts have been made to apply linear programming to subsistence economies by use of additional assumptions and proxy data. Asefa, for example, assumes that the farm manager first satisfies minimum subsistence requirements before selling the "surplus" (4). Delgado applies the simple linear programming model expressed in equations 1, 2 and 3 to a subsistence situation in Upper Volta (17). Delgado's simple formulation is applied in this study for analysis of a "composite farm" in the JPA. In this case the objective function to be maximized is agricultural output from the various farm activities, subject to family resource constraints. The price weights used are those prevailing in Bor Town during the period of analysis.

Structure of the linear programming models and data requirements

As noted earlier in this study, the economy of the JPA is exclusively of a subsistence nature. No financial services are available to the rural people, and other market institutions are either nonexistent or very underdeveloped. Government services and central planning hardly reach the rural areas, except for rural towns such as Bor. Farm input-output data are extremely difficult to obtain and have never been collected in a systematic way. El Sammani and Hassan have made rough estimates of acreages and yields of a small sample of farms without any assessment of labor and other inputs (29:19). Because of limited time and other resources, this study was unable to collect farm input-output

data directly from the cultivators. Proxy data from the Pengko Plain Pilot Project (PPP) are therefore used to reconstruct a "composite farm" in Bor and Kongor districts of the JPA. The PPP is wholly managed by the International Land Development Consultants (ILACO) under contract with the Government of the Netherlands through a bilateral agreement with the Government of the Sudan, Southern Region (see Chapter VII).

The data used in the linear programming part of the study were collected at the PPP during October, November and December, 1980. Several qualifications are required in the use of these data. In the first place, observations are based on experimental trials and may thus be unrepresentative of the real world situation. Secondly, several gaps had to be filled with estimates by the author in consultation with PPP agronomists and other technical experts in the field. Nevertheless, the data used permitted application of the procedures and demonstrated the nature of results from their application as well as shedding some light on the major issues under investigation.

Assumptions made about the "composite farm" A single-period linear programming model was developed to analyse the production activities of a "composite farm" in Bor and Kongor Districts. The following characterizations and assumptions pertain to the "composite farm".

1. Household size. The farm household consists of 7 members (28:10) who together contribute 4 labor-days per calendar

day. The farm household daily labor contributions are weighted as follows (62:85):

(a) 2 male adults (both between ages 15 and 60) each contribute one labor-day.

(b) 1 female adult (aged between 15 and 60) contributes 0.75 labor-day.

(c) 2 children (both between ages 7 and 14) each contribute 0.5 labor-day.

(d) 1 child, under 7 years old, contributes no labor.

(e) 1 aged dependent, over 60 years old, contributes 0.25 labor-day.

One labor-day, as assumed by the PPP, is equivalent to 4 hours.[1] In addition, labor-days of 6 and 8 hours, respectively, are considered in the parametric application of the model. The three levels of labor supply are designated as B_1, B_2, and B_3, respectively. B_1 is 224 labor-hours, B_2 is 336 labor-hours, and B_3 is 448 labor-hours.

2. Livestock holdings. The livestock holdings are 10 head of cattle, each valued at LS 100.000 and earning an annual income of LS 15.000; and 5 small ruminants (sheep and goats) each valued at LS 5.000 and earning an annual income of LS 1.500. It is further assumed that livestock provides the only money capital available to the "composite household farm," and that no money capital is used in the cropping activities. The reason for these assumptions is to

[1]From interview with managing director of the PPP.

allow livestock to compete with crop production activities for labor, which is the main scarce resource on the farm (17:109). An alternative assumption is to adopt the PPP assumption that 57 percent of family labor is devoted to agriculture and the remainder to livestock production (62:86). Both assumptions were used in the applications of the model.

3. Technological packages. The farm household is assumed to choose between four different technological packages as follows:

(a) Traditional technology (as currently practiced in the area, using mainly the hand hoe), here designated as T_1. The agricultural implements used in much of the JPA under hand-powered technology are either locally made or purchased in the local shops. These implements include the maloda (hoe), axe, sickle, knife and planting stick.

(b) Herbicide/fertilizer technology, T_2 (the government is assumed to provide 100 percent subsidy to the composite farm). The herbicides used at the PPP are Propanye (Stam F 34) for rice and Atrazine for dura. The fertilizer application most used is (50 Kg N + 20 Kg P_2O_5) per hectare (62:121).

(c) Oxen technology, T_3, is also assumed to be subsidized by the government except for the oxen which the farmer has in his herd. An effective oxen-powered technology would require a plow, weeder, seeder, cart and two oxen. The present demonstration practices from which the data were drawn include only a plow and two oxen. The data used under T_3 are therefore from use of an

oxen-plow only.

4. The agricultural calendar. The agricultural calendar starts in April/May when sustained rains begin, and it has been divided into fortnights (the data were collected each fortnight beginning May 1st between 1976 and 1980). A schematic summary of agricultural and livestock activities during the year is given in Figure 4.3. The livestock activities in this figure are from Payne et al. (84:26).

5. The A_{ij} matrix. The A_{ij} matrix of the elements a_{ij} of the "composite farm" is assumed to be the same as that of the PPP trials. This assumption may appear unduly unrealistic since the PP presumably has higher managerial inputs, but as stated earlier, this discrepancy does not significantly alter the conclusions of this study. The coefficients were constructed from data accumulated over a period of four years and it is the yearly averages that are used for the "composite farm."

Activities, resource constraints and data requirements

In the listing of activities and restraints that follow, the activities are designated by the letter "P" (for process), and the constraints by the letter "R" (for restraint).

1. Crop production and growing activities. These activities include land preparation, sowing, first and second weeding, bird scaring and harvesting. The unit of activity in each case is one feddan (1 feddan = 1.038 acres). Labor requirements per unit of activity for the four cropping activities are given in Table 4.1. Crop yields and prices are given in Table 4.2. The activities are:

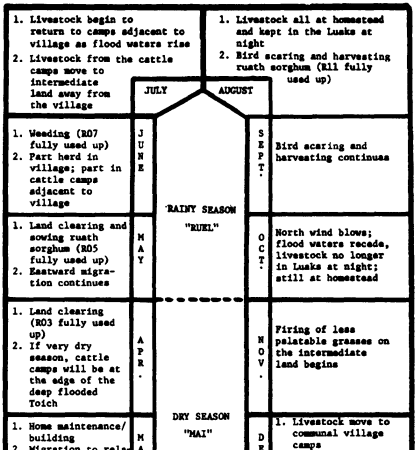

Figure 4.3. The agricultural calendar and annual transhumance in Kongor District, JPA

Table 4.1. Summary of labor requirements for cropping activities under the various technologies

Ruath sorghum		Angul sorghum		Maize		Beans	
Fort-night no.	Labor-hours	Fort-night no.	Labor-hours	Fort-night no.	Labor-hours	Fort-night no.	Labor-hours
Hand (T_1)							
1	80	17	32	1	80	2	80
2	32	18	67.2	2	32	3	32
3	67.2	21	75	3	67.2	4	67.2
5	67.2	22	32	5	67.2	5	67.2
9	75			9	60	6	75
10	32			10	32	8	82
Herbicide/fertilizer (T_2)							
1	80	17	32	1	80	2	80
2	32	18	57.1	2	32	3	32
3	57.1	21	75	3	47	4	53.8
5	57.1	22	32	5	47	5	53.8
9	75			9	60	6	75
10	32			10	32	8	82
Oxen (T_3)							
1	44	17	22	1	44	2	44
2	22	18	37	2	22	3	22
3	37	21	75	3	32	4	30
5	37	22	32	5	32	5	30
9	75			9	75	6	75
10	32			10	32	8	82

Table 4.2. Summary of crop yields in kilograms (Kg) of grain per feddan under the various technologies, and output prices in Sudanese Pound (LS) per Kg

Crop	Yield in Kg/feddan			Price LS/Kg
	T_1	T_2	T_3	
Ruath sorghum	350	500	580	.11
Angul sorghum	350	500	580	.11
Maize	151	230	265	.12
Beans	47	70	85	.20

P01: Producing and growing wet season Ruath Dura (a sorghum variety).

P02: Producing and growing dry season Angul Dura (a sorghum variety).

P03: Producing and growing maize (corn).

P04: Producing and growing cowpeas.

2. Livestock producing activities. These activities include milking, tethering, grazing, cowdung preparation (for fuel) and the general care of the animals. Average labor requirements per unit of activity for the livestock activities is given in Table 4.3.

P05: Producing and raising cattle. The unit of activity is one head of livestock.

P06: Producing and raising sheep and goats. The unit of activity is one small ruminant.

3. List of nonlabor restraints.

R01: A restraint on financial capital. The unit of restraint is one Sudanese Pound (LS. 1.000 = $2.00).

R02: A restraint on land. The unit of restraint is one feddan. A figure of 30 feddans, an arbitrarily large quantity, is used. Although suitable "highland" in the flood conditions is scarse, land can be considered unlimited under present technologies, especially after construction of the canal as more suitable land will be opened up by the drainage effects of the canal.

Table 4.3. Summary of labor requirements for the livestock activities[a]

Fortnight no.	Labor constraint code	Labor-hours Cattle	Unit of activity Small ruminant
1	R03	5.6	1.0
2	R04	5.0	1.4
3	R05	5.7	1.6
4	R06	6.7	2.3
5	R07	8.5	2.7
6	R08	6.7	2.4
7	R09	6.7	2.4
8	R10	6.8	2.6
9	R11	7.3	2.7
10	R12	7.4	2.8
11	R13	7.8	2.9
12	R14	5.5	1.5
13	R15	6.0	1.0
14	R16	6.0	1.0
15	R17	6.0	1.0
16	R18	6.0	1.0
17	R19	6.0	1.0
18	R20	6.0	1.0
19	R21	6.0	1.0
20	R22	6.0	1.0
21-26	R23	42.0	7.0

[a]These data were derived from comparative experience (17) as it was impractical to collect primary data. The PPP assumes that 43 percent of family labor is allocated to livestock activities. The models are run also under the PPP assumption as a counter check of the method used to derive the above data.

4. Labor restraints by fortnight, starting May 1st.

R03: A restraint on labor in fortnight 01

R04: A restraint on labor in fortnight 02

R05: A restraint on labor in fortnight 03

R06: A restraint on labor in fortnight 04

R07: A restraint on labor in fortnight 05

R08: A restraint on labor in fortnight 06

R09: A restraint on labor in fortnight 07

R10: A restraint on labor in fortnight 08

R11: A restraint on labor in fortnight 09

R12: A restraint on labor in fortnight 10

R13: A restraint on labor in fortnight 11

R14: A restraint on labor in fortnight 12

R15: A restraint on labor in fortnight 13

R16: A restraint on labor in fortnight 14

R17: A restraint on labor in fortnight 15

R18: A restraint on labor in fortnight 16

R19: A restraint on labor in fortnight 17

R20: A restraint on labor in fortnight 18

R21: A restraint on labor in fortnight 19

R22: A restraint on labor in fortnight 20

R23: A restraint on labor in fortnights 21 to 26 (dry season--no agricultural activities. There is sufficient labor for livestock, home maintenance and other household production activities).

CHAPTER V. DELIMITING THE PROBLEMATIC SITUATION FOR RURAL DEVELOPMENT IN THE JONGLEI PROJECTS AREA

In this chapter, the problem of rural development, and therefore of socio-economic development, in the JPA is delimited. Section one states the context within which the goals for rural development are presented, while section two develops and states goals of rural development as expounded in official publications and in interviews with Southern Sudanese officials. Section three presents the existing situation with respect to rural development in the JPA. Having presented the goals of rural development in the JPA and the existing state of natural resource development, the problematic situation for socio-economic development in the JPA is stated in the final section.

Context for Rural Development Goals in the JPA

Several observers have written flatteringly on the agricultural potential in the Southern Sudan. In 1952, for example, a British economic survey team concluded that "given the money, the technical proficiency, and the experts, Southern Sudan could easily become one of the richest areas in Africa" (92:157). More recently, David Hopper (50:201) observed that:

> The Southern half of the Sudan is potentially one of the richest farming regions in the world, with the soil, sunlight and water resources to produce enormous quantities of food -- as much perhaps, as the entire world now produces! The water is useless today; the headwaters of the White Nile, blocked in their northward flow . . . spill out over the land to form great swamps. To unlock the

> promise of the Southern Sudan those swamps would have to be drained, a rural infrastructure put in place, and the nomadic cattle raisers of the region somehow turned into sedentary farmers. The capital costs of such an undertaking would be as large as the promise . . . yet the potential is real and untapped, and as world food shortages persist such a reserve can no longer be neglected.

The factors that make Southern Sudan a major part of Sudan's potential to become the "Breadbasket of the Middle East" have already been discussed in Chapter II. In this chapter, the problem of socio-economic development in the JPA is delimited with the context of JPA's agricultural potential and the overall national context of goals, plans and objectives.

Goals for Rural Development in the JPA

The overall national means for achieving the ultimate ends of life, liberty and opportunity for all Sudanese citizens is transformation of the country into the "Breadbasket of the Middle East" and a major granary of the world (71:33). To achieve these goals, the ends-in-view for the agricultural sector, as stated in Sudan's development plans (24; 25) are: (1) improved productivity and use of resources, (2) a more equitable distribution of growth and the resulting gross value of agricultural output in terms of factor payments or earnings, (3) an accelerated increase in total agricultural production to meet domestic and international market demands, and, as a consequence of achievement of the preceding ends, (4) an accelerated increase in per capita real income and quality

of life for the agricultural population.

As stated by Adam, some of the above goals are occasionally in conflict and sometimes complementary. This is particularly the case when these goals are related to the means through which they could be achieved, and if these means are scarce. For example, if the objective is to improve productivity and use of resources, the scale of operation must be enlarged to allow investment of indivisible capital equipment and the use of modern agricultural techniques. On the other hand, if it is a more equitable distribution of growth, incomes or wealth, the means of production must be redistributed and private accumulation restricted. Finally, given the efficiency and equity norms, if the end-in-view is to increase total agricultural output and maintain a sustained accelerated increase in per capita real income of the agricultural labor force, then labor productivity must be raised, the land base should be expanded where possible, and job opportunities should be provided to absorb surplus labor released from agriculture.

Nevertheless, if agricultural development is identified to mean all of the above four goals in combination, the means-ends continuum framework could serve as a basis, as emphasized by Gittinger (42:20) and Adam (1:27), to resolve the "conflict between ends-in-view" where the extent to which each is emphasized and the criteria for balancing one end-in-view against another are the more ultimate ends-in-view."

Within the context of the preceding national goals for the

agricultural sector, the specific goals for the JPA are in terms of expected contributions from its agriculture to the general "bread-basket" objective of the nation. To arrive at a realistic identification of these contributions, it is necessary to determine the physical, institutional and economic resources of the JPA. No systematic investigation of these resources has yet been completed for the area, but such an assessment is the subject and justification for the research and development studies of Appendix E to Chapter VII that are currently underway in the area. This assessment is truly multidisciplinary. An estimate of the actual potentialities of the land in the JPA, for example, is a technical appraisal that has to be made by agronomists, soil specialists, livestock specialists, and other related disciplines. The social and economic appraisal is being conducted by Sudan's Social and Economic Research Council. An economic appraisal remains to be conducted in terms of costs and time required to bring land into operation, estimate of productivity levels and production costs for different crops grown under different farm organization systems, and at least broad magnitudes of present and potential effective domestic and international demand for the agricultural products of the area.

Once the above interdisciplinary resource surveys are completed, the specific targets or objectives can be established for agriculture of the JPA. At the present, only broad targets for agriculture of the JPA can be proposed. These propositions are:

1. To increase agricultural, livestock, and fisheries production in order to (a) satisfy subsistence and domestic market needs, (b) meet the expected and potential contribution of the JPA to the "breadbasket" objective with respect to agricultural exports, and (c) raise per capita incomes and the quality of life for inhabitants of the area;

2. Increase the efficiency of productive factors;

3. Transfer new production factors and techniques, including institutions and organizations, into the JPA--this should be coupled with equity in access to these factors and techniques; and

4. Provide employment opportunities to absorb surplus agricultural labor that would likely result from the process of agricultural transformation in the JPA.

The above four propositions are used in this study as guideline targets in identifying and selecting rural development strategies for the Jonglei Projects Area. These propositions are based on official publications (18; 21; 22; 23; 24; 25) and on results of interviews with officials of the Jonglei Development projects and the Southern Region (Appendix A). Most of the goals listed above recurred in interviews with the Chairman of the National Council for Development projects in the JPA, Commissioners (Governors) of Jonglei and Upper Nile provinces in the JPA and other high ranking officials of the Executive Organ and the two provinces. But what is the natural and institutional resource situation within

which these goals are to be achieved? This question is answered in the next section where the existing situation is delimited.

The Existing Situation With Respect to Rural Development in the JPA

The agricultural potential in the JPA in relation to other regions of Sudan was evaluated in Chapter II. The existing situation in the JPA with respect to the state of development of physical and institutional resources was discussed in Chapter III. These discussions in Chapters II and III provide a general assessment of the existing situation in the JPA for delimiting the problematic situation for socio-economic development of the JPA.

The existing state of development of the physical and institutional resources of the JPA is further indicated by results of the linear programming models. In all, there are nine linear programming models corresponding to the three levels of technology (T_i) and the three levels of household labor supply (B_j). These models are referred to as T_iB_j ($i, j = 1, 2, 3$). T_1B_1, for example, refers to hand technology and a labor-day of 4 hours; T_1B_2 assumes a labor-day of six hours. The technologies and labor supply definitions and assumptions are discussed in Chapter IV.

Table 5.1 shows optimal levels of income at various levels of technology and labor supply. In part 1 of the table, livestock activities were allowed to compete with cropping activities. The optimal livestock production is 10 head of cattle, each earning

an annual income of LS 15; this income has been deducted to get the income from the cropping activities reported in the table. Part 2 reports optimal income from cropping activities with livestock activities excluded from the models. The models were run under the PPP assumption that 57 percent of household labor is devoted to agricultural production, while the remaining 47 percent is allocated to labor activities (62:86).

Table 5.1. Summary of optimal levels of income for all the models, T_iB_j

Labor supply level	Part 1 Sudanese pounds			Part 2 Sudanese pounds		
	T_1	T_2	T_3	T_1	T_2	T_3
B_1	160	233	323	130	191	271
B_2	275	402	559	195	287	407
B_3	389	569	795	260	383	542

Assuming that mean household labor supply for the "composite farm" is B_2, optimal income from cropping activities under hand technology (T_1) is LS 275 in part 1 of Table 5.1 and LS 195 in part 2. The "composite farm" makes another LS 150 from livestock activities. Since the "composite household" is composed of 7 members, these incomes translate to LS 60 and LS 40 per capita in parts 1 and 2, respectively. Sudan's per capita GDP was estimated

at LS 100 in 1980 (24:27). In terms of per capita production, the JPA lags behind the rest of the country by 40 to 50 percent. The developmental situation is even worse than that revealed by this study according to an ILACO report that estimates per capita production at LS 34 (65: Vol. 1, p. 18).

The low income level in the JPA is taken as a proxy measure of the low level of development of the potential contribution of the area to the "breadbasket" objectives of the Sudan. Sudan plans to triple per capita GDP to LS 300 by 1995. Assuming per capita production to be LS 55 (the average between part 1 and part 2 in Figure 5.1), the JPA would need to increase per capita output by about 450 percent between 1980 and 1995 to catch up with Sudan's average development. It is doubtful that the inhabitants of the JPA can mobilize sufficient capital resources from their low incomes to achieve this level of development by 1995. If development is subsidized by outside resources as seems likely, it is also doubtful that the "improvement approach" is the most appropriate strategy that will enable the JPA to catch up with the rest of Sudan and realize its contribution to the breadbasket potential of Sudan. These arguments are fully developed in the next chapter on the diagnostic and remedial phases.

The Problematic Situation for Rural Development in the JPA

As discussed in Chapter III, drainage and water-logging and backward institutional and infrastructural resources are the major drawbacks to agricultural development in the JPA and in the Southern Clay Plains in general. However, from the point of view of water availability and soil quality, the JPA and the Southern Clay Plains offer great potential to the Southern Region and Sudan's "breadbasket" objectives, especially as the North-central and North-eastern growth areas run out of water.

The problem of water-logging will be solved as the swamps will be drained (see the discussion on water resources in Chapter II), since Egypt and North Sudan growth areas will need the extra water, which ironically is not needed in the JPA. World food shortages will persist and even get worse in the years to come (99). The pressure and challenge to extract the vast agricultural potential in the JPA and Southern Clay Plains will be great and immediate on the national government, and especially on the Regional Government.

For the process of socio-economic development through agricultural development in the JPA to become viable and an integral part of national development, broad goals have been formulated and stated within the context of the overall national objectives for the agricultural sector. The existing situations in the Sudan and the JPA have been presented in Chapters II and III as preliminary evidence of the validity of the context within which these goals

have been stated.

The problematic situation with respect to agricultural development in the JPA can then be stated simply as the design and implementation of rural development strategies, agrarian structures and institutions on a scale adequate enough to achieve the regional and national goals as predicated on the potentialities of the area and the existing situation within and with respect to other regions of the Sudan. Based on results of the linear programming models and national goals, an approximate quantitative statement of the problematic gap for socio-economic development in the JPA is to raise per capita rural output from its level of LS 55 in 1980 to LS 300 by 1995.

CHAPTER VI. THE DIAGNOSTIC PHASE APPLIED TO THE JPA

This chapter presents the diagnostic phase in which the JPA is analysed to determine the extent to which specific physical, economic and institutional elements contribute to failure or success in achieving the goals and, therefore, in eliminating the problematic situation delimited in the last chapter. Section one provides a conceptual framework for identifying physical, economic and institutional interrelationships used in the analysis. Section two identifies failure and success elements from the major physical and institutional characteristics of the JPA as discussed in Chapter III. Section three presents results and interpretation of the linear programming models to determine the extent to which the physical and institutional elements impact on farmer decision making. Results from parametric programming are used to evaluate the adequacy of the existing agrarian structure and the "improvement approach" as means to realizing the resource potential in the JPA and achieving the goals developed in the delimiting phase of the last chapter. The second objective of the study is achieved in this section. The last section summarizes failure and success elements to be used in the remedial phase in the next chapter to achieve the last two objectives of study.

Conceptual Framework for the Diagnostic Phase

The process of identifying, formulating and implementing appropriate rural development strategies for achieving desired socio-economic

goals and to eliminate the problematic situation requires expertise and data from many disciplines. The essence of such interdisciplinary research and development does not result from the contributions of separate disciplines acting singly, although the individual contributions are important. The essence of interdisciplinary research and development involves cooperative and coordinative efforts among many disciplines.

Figure 6.1 illustrates the interrelationships involved in interdisciplinary research aimed at formulating, developing and implementing rural development strategies for socio-economic development of the JPA. The physical factors include the natural resource, biological, chemical and engineering disciplines. The economic factors include supply and demand, price weights, efficient allocation of resources, and socio-political factors related to socio-economic development including development strategies. The institutional factors include political, legal and social institutions, or methods which enable the physical and economic disciplines to interact in the process of formulating and implementing rural development strategies.

The simplified conceptual illustration of Figure 6.1 suggests some of the important linkages among the physical, economic and institutional factors relevant to socio-economic development in the JPA. For illustrative purposes, the current research and development activities of the Executive Organ, included as Appendix E, have been conceptualized into the framework of Figure 6.1. Furthermore,

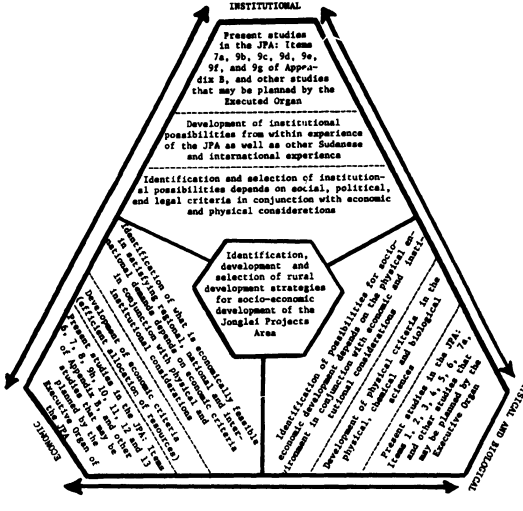

Figure 6.1. Conceptual framework for identifying physical, economic and institutional interrelationships used in formulating rural development strategies for the JPA

the conceptualization in Figure 6.1 can be used by the Executive Organ to identify more areas for research that are not included in Appendix E but that may become necessary in future.

The conceptual framework of Figure 6.1 can be used by an interdisciplinary research team to identify various constraints which restrict the cultivated area and agricultural output. These constraints can be used to identify elements of the farming system that need to be eliminated and those that need to be strengthened. The accumulated information can be used in formulating appropriate rural development strategies for the area.

Failure and Success Elements Identified in the Diagnostic Phase

Within the "means-ends continuum" model, appropriate rural development strategies can be developed from failure and success elements identified in the diagnostic phase. Major failure and success elements affecting achievement of the goals developed in the delimiting phase are summarized under the physical, institutional and economic categories of Figure 6.1. Boundaries between elements of these three categories are not absolute, and a measure of flexibility should be exercised in classifying some of the failure and success elements.

Physical and technological

As discussed in Chapter III, major physical and technological failure elements constraining agricultural development in the JPA

include: (1) flooding and water-logging, caused by lack of slope, impermeable clay soils and heavy rains; (2) erratic and irregular patterns of rainfall, which cause rapid alternations between floods and droughts during the agricultural season; (3) inadequate technology and its primitive agricultural tools, all of which result in severe physical disincentives for crop husbandry; (4) long distances from seaports and large urban centers in Northern Sudan combining to shut off the JPA from national and international markets; and (5) a host of plant diseases and pests ranging from elephants to the little weavel bird. These failure elements, as shown in the linear programming analysis of the next section, effectively limit extension of the cultivated area and expansion of agricultural output.

Some of the failure elements, such as floods, droughts, and pests frequently cause complete crop failure, and make subsistence based on agriculture unreliable and precarious. Moreover, traditional technology based on the hand-powered hoe, is completely inadequate in the face of the severe physical constraints. Family labor gets quickly used up, and severe labor bottlenecks develop during peak periods of land preparation, weeding, bird scaring and harvesting. As a consequence of the failure elements, results of the LP models show that more than 50 percent of available labor is rendered redundant during the year (see Table 6.3). Use of new and "appropriate" technology such as oxen plowing would probably increase the cultivated area by about 50 percent, but this would

only be to 3.1 or 5.4 feddans at the most (see Table 6.1). Use of herbicides would result in virtually no increase in the cultivated area, while it would likely reduce yields through inappropriate application.

On the other hand, there are also plenty of success elements in the physical setting of the JPA that can be used in achieving the goals delimited in previous chapters. These success elements include: (1) tremendous amounts of land endowed with fertile soils; (2) abundance of water resources; (3) abundance of natural pastures; and (4) the Jonglei Canal, which when completed will provide a vital infrastructural resource for cheap transport in addition to its other uses for drainage and irrigation.

An appropriate rural development strategy needs to include in its base the maintenance and expansion of existing success elements as well as development of new success elements. An example of maintenance of an existing success element is soil conservation practices to maintain and improve soil fertility; while an example of expanding existing success elements is to make full transportation use of the Jonglei Canal by developing adequate transport links between the northern end of the canal and transport systems to Northern Sudan, and between the southern end and transport systems to Eastern and Central Africa. Examples of new success elements include: (1) drainage and storage of water, when it is not needed, for use in supplemental irrigation during the intermittent droughts; (2) introduction of new forms of farm

power to replace muscle power; (3) irrigation during the long dry season from stored water from the rainy season, or from the canal itself; and (4) provision of drinking water and fodder during the long dry season in order to avoid transhumance.

An appropriate rural development strategy for the JPA can then be identified from its association with existing and potential physical and technological failure elements. If development is physically not possible, if technology can not ameliorate the physical disincentives in the JPA, then clearly whatever social and economic incentives that might be offered farmers would most likely come to naught; and herein lies the interrelatedness among the physical, institutional and economic elements in the process of identifying and selecting rural development strategies.

As results of linear programming show in the next section, economic incentives in the form of output and input prices are completely dominated by physical disincentives in the environment of production in the JPA. A rural development strategy based on elimination or modification of physical and technological failure elements, and on maintenance and expansion of existing and potential success elements provides the necessary physical incentives without which social and economic incentives would be useless.

Social and institutional

Under the social and institutional environment, major failure elements include: (1) communal land tenure, a major institutional constraint, as it provides no security of tenure to foster the necessary economic and social incentives that encourage land development; (2) the legal status of land in Southern Sudan, under which land is considered as unregistered and unsettled, constitutes an additional source of uncertainty to potential land developers; (3) traditional settlement patterns, consisting of scattered households and scattered family farm-plots, result in considerable waste of labor and make provision of infrastructural services costly; (4) the annual transhumance of the inhabitance of the JPA wastes considerable amounts of labor; (5) the high social status of cattle prevents their use as draught animals, or as capital that can be marketed and reinvested in crop and/or further livestock production; (6) absence of organized local markets, and absence of access to national and international markets encourage perpetuation of a subsistence mode of life; and (7) the high risk aversion of the people, a product of centuries of experience and pragmatism, makes them conservative in adopting new innovations.

Any process undergoing progressive change is often pregnant with potential failure elements, and this is especially the case when eliminating or modifying failure elements in the social and institutional environment. Communal tenure, for example, has

been known to undergo fundamental changes in many parts of the world during the transition from subsistence to commercial agriculture. This transition has often been characterized by three potential failure elements in communal tenure; namely: (1) emergence of absentee landlordism; (2) rack-renting of land; (3) individualization of tenure and eventual concentration of land; and (4) eventual dispossession, commercialization and pauperization of the original communal land owners. These failure elements, which are potential in the present communal and subsistence economies of the JPA, have been the subject of land reform and revolution over the years in Asia and Latin America; while in the Gedaref area of Northern Sudan, they are presently emerging rapidly as a result of uncontrolled changes in communal tenure. An appropriate rural development strategy for the JPA, while eliminating or modifying failure elements in the social and institutional environment, should also seek to avoid emergence of potential failure elements that could be predicted from comparative experience.

The social and institutional environment of the JPA is not composed of failure elements alone; there are success elements as well. Success elements within traditional institutions that could be developed and incorporated into a strategy designed to achieve the goals developed in the delimiting phase include certain aspects of communal tenure and communal economic, political and administrative organizations of tribes and clans. Certain aspects of communal tenure, such as communal ownership, production, distribution and

consumption could provide endigenous bases for development of modern group or cooperative farming. The social, political and administrative forms of communal organizations into tribes and clans could impede progress, since they are not based on efficiency criteria, and since they normally exclude or discriminate against nonmembers. Nevertheless, the communal organizational form is a social reality that can not simply be wished or scrapped away; instead, the charts of Appendix A could be adapted to provide structural forms for producer and marketing cooperatives.

As with physical and technological elements, the preceding social and institutional success and failure elements, both present and potential, are necessary factors in identifying and selecting an appropriate rural development strategy for the JPA.

Economic

Finally, failure and success elements in the economic environment have to be incorporated in the design of strategy, since what is physically and institutional possible may not be economically feasible. Major failure elements in the economic environment of the JPA include: (1) subsistence production, insofar as it embodies low resource productivities, low incomes and consequently, low market demands and lack of division of labor; (2) subsistence consumption, insofar as it fosters conspicious consumption and no accumulation of surplus; (3) low output price incentives to producers; (4) lack of access to modern inputs and high input price disincentives to

producers; (5) a local market that is constricted by low incomes and low demands; and (6) high transport costs for goods moving in or out of the area.

Some of the above failure elements sometimes impede agricultural development severely. Very low farm output prices, often resulting from price subsidies (bribes) to the politically vocal but often unproductive urban workers and often enforced by the police might of the state, sometimes result in huge unnecessary additional losses to farmers. In 1976, for example, local farmers around Bor, the capitol of Jonglei Province (JPA), sometimes had their farm produce confiscated, ended up spending more than 48 hours in jail and paying the prescribed fines for selling above the Local Government Council so-called "essential products" prices.

There are also potential failure elements in the economic environment of the JPA. These pertain to the following considerations: (1) the development policies of the nation, which favor urban areas, force the rural people to migrate to towns to solicit for cash and modern consumer goods, or to look for employment in their own right; and thus sometimes deprive rural agricultural production of labor during critical labor peak periods; (2) the low level of incomes in rural JPA makes it unlikely that the inhabitants of the JPA can be able to generate adequate capital for self-sustaining development without initial and continued doses of outside interventions; and (3) as the JPA gets engulfed in commercial agriculture and in international trade relations, the

erratic whims of nature under the present subsistence agriculture may be replaced by erratic movements in crop commodity prices of international markets.

Finally, there are also success elements in the economic environment of the JPA. The success elements include (1) considerable amounts of wealth in the form of stocks of cattle that could be converted into capital investment, and (2) presently redundant amounts of off-season labor that could be mobilized for productive activities. Potential success elements include (1) opening up of the JPA by the Jonglei Canal and lowering of transport costs to national and international markets, and (2) presence of potential markets for JPA farm products in the Middle East. The Middle East provides a convenient potential market for rice, one of the crops that could be successfully grown in the JPA on a large scale. As an illustration of this market potential, Saudi Arabia purchased $270 million of rice from the United States of America in 1980, while Egypt purchased $155 million worth from the same source in 1977.

Interpretation of Results of the Linear Programming Models

This section presents interpretation of results of the linear programming models developed in Chapter IV. The analysis focuses on the extent to which failure elements in the physical, institutional and economic environment of the JPA, as summarized in the

last section, impact on farmer decision making to constrain the cultivated area and agricultural output. Results of sensitivity analysis and parametric programming are used to assess the viability of the technologies considered.

The models assume 1980 as the base year for prices. Parameterization of the objective function was conducted at 150, 200 and 250 percent of base prices. No significant increases in acreage were observed as a result of the price increases. The main effect of a price increase appears to be an increase in income accompanied by a change in the composition of the crops in the optimal plan. These results only emphasize the severity of labor constraints during particular peak periods. One price level, supplemented by range analysis, is therefore considered sufficient for the three levels of parameterization in labor supply.

Cropping activities

Table 6.1a summarizes optimal farm plans for all the models with livestock activities incorporated to compete with cropping activities. In the table, the cropped area is twice the cultivated area because the same area is cultivated twice during the year.

Assuming the same labor supply, B_1, Table 6.1a reveals that there is no significant difference in optimal feddanage between hoe technology (T_1) and herbicide technology (T_2). Adoption of herbicide technology increases the cultivated area by only 0.2

Table 6.1a. Summary of optimal feddanage (acreage) under all the models T_iB_j, with livestock activities incorporated

	Feddans								
	T_1			T_2			T_3		
Activity[a]	B_1	B_2	B_3	B_1	B_2	B_3	B_1	B_2	B_3
P01	2.0	3.5	4.9	2.0	3.5	4.9	2.0	3.5	5.1
P02	2.1	3.6	5.1	2.1	3.6	5.1	2.1	3.6	5.2
P03	0.1	0.1	0.1	0.1	0.1	0.1	1.2	2.8	3.9
P04	-	0.2	0.5	0.3	0.9	1.5	0.2	0.9	1.8
Total cropped area	4.2	7.4	10.6	4.5	8.1	11.6	6.1	10.8	16.0
Total cultivated area	2.1	3.7	5.3	2.3	4.1	5.8	3.1	5.4	8.0

[a]See page 110 for crop codes

feddan under B_1 labor, by 0.4 feddan under B_2 labor, and by 0.5 feddan under B_3 labor. However, if labor supply is increased under the same technology, the cultivated area increases considerably. Under hoe technology, for example, the cultivated area increases by 1.6 feddans if the family work 6-hour labor-days (B_2) instead of 4-hour labor-days (B_1); while it more than doubles if they work 8-hour labor-days. These results indicate that use of herbicides may alleviate labor shortages during weeding, but the technology does nothing to labor bottlenecks during land preparation, planting, bird scaring and harvesting. Introduction of herbicides in the JPA would thus not increase the cultivated area by much. Moreover, it is possible that

use of herbicides by traditional farmers could lower yields, at least in the short run (58; 61; 63).

Adoption of oxen technology (T_3) increases the optimal cultivated area under B_1 labor supply by 48 percent to 3.1 feddans. Under B_2 and B_3, the optimal cultivated area increases to 5.4 and 8.0 feddans, respectively. The use of oxen ploughs partially alleviates labor bottlenecks during land clearing, but weeding, bird scaring and harvesting continue to be major constraints to increasing the cropped area and agricultural output.

All the models were also run under ILACO's assumption that 57 percent of household labor is allocated to crop production, while the remaining 43 percent goes to livestock activities. The models were thus run under parameterization of the B_j's at 57 percent, with livestock activities excluded. Table 6.1b shows optimal farm plans under this procedure.

Comparison of Tables 6.1a and 6.1b shows no major differences. The two tables serve as counter checks for the underlying assumptions. Generally, entries in Table 6.1b are smaller than the corresponding entries in Table 6.1a. The difference could be an indication that the composite household in the JPA allocates more than 57 percent of its labor to crop production, or it could be accounted for by underestimation of livestock labor requirements in Table 4.3. In other respects, interpretation of Table 6.1b is the same as that of Table 6.1a.

Table 6.1b. Summary of optimal feddanage (acreage) under all the models

	Feddans								
	T_1			T_2			T_3		
Activity[a]	B_1	B_2	B_3	B_1	B_2	B_3	B_1	B_2	B_3
P01	1.6	2.4	3.2	1.6	2.4	3.2	1.7	2.6	3.4
P02	1.7	2.6	3.4	1.7	2.6	3.4	1.7	2.6	3.4
P03	-	-	-	-	-	-	1.2	1.8	2.4
P04	0.3	0.5	0.6	0.7	1.0	1.4	0.9	1.3	1.8
Total cropped area	3.6	5.5	7.2	4.0	6.0	8.0	5.5	8.3	11.0
Total cultivated area	1.8	2.8	3.6	2.0	3.0	4.0	2.8	4.2	5.5

[a]See page 110 for crop codes

It is interesting to note that the optimal farm plans for hoe technology under B_1, B_2, and B_3 labor supplies are similar to results of a random sample of 12 farms that were surveyed in Kongor District in 1977 by El Sammani and Hassan (29:19). The cultivated area in this sample ranged from 0.8 feddan to 12 feddans, with an average of 2.5 feddans. The wide range in the size of farms possibly reflects differences in the length of the labor-day among farm households. A more general survey that was conducted by ILACO in Bor District (Gok) reports an average household farm of 0.96 hectare (2.4 feddans), a finding that is not different from that of El Sammani and Hassan.

The results in Table 6.1a show an optimal farm plan of 2.1 feddans under hoe technology if the household works 4-hour days, and 5.3 feddans if it works 8-hour days. A labor-day of 6 hours appears to be more reasonable for the JPA, that is, the composite household works from 6:00 to 10:00 in the morning, and from 4:00 to 6:00 in the evening. Under these assumptions, the optimal farm size in the JPA is 3.7 feddans. Under ILACO's assumption in Table 6.1b, optimal farm size is 2.8 feddans which is not much different from the empirical findings of ILACO and El Sammani and Hassan, and the same with ILACO's finding.

If an optimal size of 3.7 feddans is assumed for the composite farm in the JPA, a shift to herbicide technology would increase optimal farm size (cultivated area) by only 11 percent, to 4.1 feddans; while a shift to oxen technology would increase it by 46 percent, to 5.4 feddans. Under maximum conditions of technology (T_3) and labor supply (B_3), the optimal household farm size could be increased to 8 feddans. This latter case means that for the traditional JPA farmer to bring 8 feddans under cultivation, the household would need to work 8 hours per day and, in addition, adopt oxen technology.

Range analysis of the optimal farm plans

Additional information with respect to interpretation of the optimal farm plans is afforded by range analysis. Range analysis provides useful information regarding stability of optimal farm

plans. It provides insights into the magnitudes of income penalties which attach to departing from the optimum, either by producing more or less, and the range over which these penalties are effective. Table 6.2 summarizes results of Section IV of range analyses for models T_1B_j and T_3B_j ($j = 1, 2, 3$).

Table 6.2 shows that the optimal farm plan for each cropping activity is valid over a very wide range of prices and yields. The price of a sack (100 kilograms) of Ruath Sorghum grain in model T_1B_1, for example, can vary between LS 5.2 and LS 33.4 before changes in optimal feddanage can occur, assuming that the yield per feddan remains constant. The same optimal feddanage remains valid if the price remains constant while the yield varies between 165 and 1,064 kilograms of grain per feddan. Below a price of LS 5.2 per sack, or a yield of 165 kilograms per feddan, production of Ruath Sorghum drops to zero; while above the upper price (or yield) production increases by only 0.1 feddan. Empirically, the price of sorghum grain has varied between LS 5.0 and LS 40.0 between 1975 and 1981 without noticeable increases in the cultivated area. Even during the course of the same year, farmers have been observed to sell their grain at very low prices, say LS 10.0 per sack to local merchants, during harvest and to buy it back at three times that price during the seasonal famine that occurs just before the following harvest. There may be storage problems, nevertheless the large price differential should be sufficient incentive for farmers to increase the cultivated area and to solve the storage problems.

Table 6.2. Summary of results of range analysis on stability of optimal farm plans under models T_1B_j and T_3B_j

Cropping activity	Price LS/Kg	Optimal feddans	Price range LS/Kg Low	Price range LS/Kg High	Yield range Kg/feddan Low	Yield range Kg/feddan High	Increase in optimal feddans at higher price/yield
Model T_1B_1							
P01	0.110	2.965	0.052	0.334	165	1,064	0.100
P02	0.110	2.147	0.052	0.383	165	1,218	0.100
P03	0.120	0.100	0.063	0.255	79	321	1.900
P04	0.200	-	-	-	-	-	-
Model T_1B_2							
P01	0.110	3.458	0.052	0.349	165	1,109	0.030
P02	0.110	3.640	0.052	0.400	165	1,274	0.020
P03	0.120	0.007	0.063	0.255	79	321	3.460
P04	0.200	0.207	0.200	0.386	47	90	0.007
Model T_1B_3							
P01	0.110	4.865	0.052	0.465	165	1,479	0.735
P02	0.110	5.133	0.052	0.420	165	1,338	0.84
P03	0.120	-	-	-	-	-	-
P04	0.200	0.474	0.200	0.819	47	192	4.12
Model T_3B_1							
P01	0.110	1.965	0.060	0.120	314	632	1.022
P02	0.110	2.147	0.060	0.122	314	643	0.84
P03	0.120	1.790	0.067	0.189	147	417	0.314
P04	0.200	0.159	0.200	0.244	85	104	1.400
Model T_3B_2							
P01	0.110	3.458	0.060	0.120	314	632	1.022
P02	0.110	3.640	0.060	0.122	314	643	0.840
P03	0.120	2.840	0.067	0.189	147	417	0.314
P04	0.200	0.930	0.200	0.244	85	104	1.379
Model T_3B_3							
P01	0.110	4.951	0.060	0.120	314	632	1.022
P02	0.110	5.133	0.060	0.122	314	643	0.840
P03	0.120	3.894	0.067	0.189	147	417	0.314
P04	0.200	1.700	0.200	0.244	85	104	1.379

The wide range in shadow prices or equivalent yields within which the optimal farm plans in Table 6.2 are valid is more likely explained by the severity of labor bottlenecks during peak labor periods than any other factors. Maximum family labor supplies are quickly reached during land clearing, weeding, bird scaring and harvesting, and become fully constraining to extension of the cultivated area and increased agricultural output irrespective of the level of price. The physical disincentives to increasing the cultivated dominate the economic incentives.

Labor activities

A summary of labor that is used and that which goes unused during the year is given in Table 6.3 for hoe and oxen technology. Results for herbicide technology are similar to the ones presented in Table 6.3, and are therefore omitted.

As shown in Table 6.3, the maximum amount of family labor that is available during the period is fully used up in fortnights 1, 3, 5, 9 and 19 in all the models. During fortnights 1 to 3, eastern migration from the Toich (see Figure 4.3), land preparation, sowing and first weeding are the major activities that exhaust family labor. Towards the end of fortnight 4 and during the whole of fortnight 5, second weeding is a major labor bottleneck. Bird scaring and harvesting of Ruath and Angul sorghum fully exhaust family labor during fortnights 9 and 19, respectively. Thus, the major labor bottlenecks to expanding the cultivated area occur

Table 6.3a. Summary of labor utilization and labor slack, models T_1B_j

Fort-night	Labor supply B_1		Labor supply B_2		Labor supply B_3		Remarks
	Used	Slack	Used	Slack	Used	Slack	
01	224	---	336	---	448	---	Land preparation and sowing
02	117	107	180	156	246	202	
03	224	---	336	---	448	---	Weeding 1
04	70	154	84	252	102	346	
05	224	---	336	---	448	---	Weeding 2
06	70	154	86	250	106	342	
07	73	151	71	265	70	378	
08	73	151	89	247	110	338	
09	224	---	336	---	448	---	Bird scaring and harvesting
10	141	83	188	148	233	215	
11	82	142	82	254	82	366	
12	58	166	58	278	58	390	
13	58	166	58	278	58	390	
14	63	161	63	273	63	385	
15	132	92	180	156	227	221	
16	207	17	308	28	408	40	
17	63	161	63	273	63	385	
18	63	161	63	273	63	385	
19	224	---	336	---	448	---	Bird scaring and harvesting
20	132	92	180	156	227	221	
21-26	441	903	441	1,575	441	2,247	
Percentage of total	51%	49%	44%	56%	41%	59%	

Table 6.3b. Summary of labor utilization and labor slack, models T_3B_j

Fort-night	Labor supply B_1		Labor supply B_2		Labor supply B_3	
	Used	Slack	Used	Slack	Used	Slack
01	224	---	336	---	448	---
02	142	82	232	104	332	126
03	224	---	336	---	448	---
04	75	149	98	238	121	327
05	224	---	336	---	448	---
06	82	142	140	196	198	250
07	205	19	284	52	362	86
08	142	82	238	98	335	113
09	224	---	336	---	448	---
10	141	83	188	148	236	212
11	82	142	82	254	82	366
12	58	166	58	278	58	390
13	58	166	58	278	58	390
14	63	161	63	273	63	385
15	110	114	143	193	176	272
16	142	82	198	138	253	195
17	63	161	63	273	63	385
18	63	161	63	273	63	385
19	224	---	336	---	448	---
20	132	92	179	157	227	221
21-26	441	903	441	1,575	441	2,247
Percentage of total	54%	46%	48%	52%	46%	54%

during 5 fortnights only, or 2 to 3 months of a calendar year. In much of the remaining 9 to 10 months, considerable amounts of labor go unutilized.

Unless the family can hire labor or use labor-saving technologies, the optimal cultivated area can not be increased beyond the results given in Tables 6.1a and 6.1b. Hiring of labor is normally not practiced in the JPA. No family can afford to hire out labor during peak labor periods. However, mutual work parties for tasks such as land clearing and weeding are arranged whenever possible. Food and beer are served at such work parties. The mutual form of labor hiring is offsetting, since a family member is obligated, sooner or later, to reciprocate at a neighbor's work party.

In terms of magnitudes of unused labor, 49 percent of family labor goes unutilized during the year under hoe technology and B_1 labor. If labor supply is increased to B_2, the amount of slack labor increases to 56 percent; while under B_3, almost 60 percent of the labor is redundant. Under oxen technology, the results are similar; 46 percent of family labor goes unused at B_1 labor supply, increasing to 52 and 54 percent for B_1 and B_2 labor supplies, respectively. These results also indicate that there is a tendency for labor bottlenecks to get aggravated as labor supply and the cultivated area increase, since proportionately more labor goes into slack.

Shadow prices for labor activities that are fully used up in the optimal plans are given in Table 6.4. Shadow prices express the extent to which the value of the optimal plan would be reduced if the quantity of labor used in the optimal plan is reduced by one labor-hour. The shadow prices of labor activities that are not fully

Table 6.4 Summary of shadow prices, in Sudanese pounds (LS) per labor-hour

Labor activity[a]	Model T_1			Model T_2			Model T_3		
	B_1	B_2	B_3	B_1	B_2	B_3	B_1	B_2	B_3
R03	0.109	0.254	0.363	0.370	0.370	0.500	0.321	0.321	0.321
R05	0.125	0.125	0.252	0.225	0.225	0.382	0.436	0.436	0.436
R07	0.270	0.141	0.141	0.264	0.264	0.264	0.551	0.551	0.551
R11	0.271	0.271	0.271	0.331	0.331	0.362	0.392	0.392	0.392
R21	0.513	0.513	0.513	0.730	0.730	0.730	0.853	0.852	0.852
Average shadow price	0.258	0.258	0.308	0.347	0.347	0.448	0.510	0.510	0.510

[a]See page 112 for labor activity codes

used up in the optimal are zero, and have not been included in the table.

The labor that goes unused during the year in JPA type economies has traditionally been referred to as "surplus labor" in the literature on economic development (67; 54; 34). It has been further argued

that if such surplus labor were withdrawn from agriculture, there would be no change in agricultural output (67). There may be no change in agricultural output in a labor surplus economy only if such labor is withdrawn during labor slack periods and promptly reinstated during labor peak periods, assuming that there is no change in the technology of agriculture. The shadow prices in Table 6.4 indicate that the value of the optimal plans would be reduced if any amount of labor were removed from agricultural production during the 5 fortnights indicated.

The phenomenon of labor scarcity within labor abundance that characterizes the JPA is likely explained by the seasonal distribution of work, the low level of technology, and the difficult physical conditions, all of which combine to make labor requirements per unit of activity very high, and result in labor bottlenecks during certain periods of the year. Of course, during other times, there are considerable amounts of slack labor that can be productively employed elsewhere.

Implications of the Linear Programming Results for the Improvement Approach

The linear programming results support Evans-Pritchard's contention that the economies of the JPA have reached a low stationary equilibrium. Under present technologies, agrarian structures and institutions in the JPA the "composite farm" of the linear programming models can bring about 3.7 feddans (1.4 hectares)

under cultivation at the optimum, assuming the household works days of 6 labor-hours. Clearly, the existing technologies and agrarian structures are inadequate means for realizing the resource potential in the JPA and achieving the goals identified in the delimiting phase of this study.

The results are also important for the "improvement approach" as an appropriate rural development strategy for the JPA. The "improvement approach" advocates improvement in crop production within existing traditional subsistence production units and institutions through extension methods involving use of new inputs, such as fertilizers and herbicides, and introduction of new and "appropriate technology." The appropriate technologies recommended include oxen technology. As noted earlier, under maximum conditions of technology (T_3) and labor supply (B_3), the composite farm could bring 8 feddans under cultivation. Under maximum conditions for the "improvement approach," the traditional JPA farmer would need to work 8 hour-days and in addition, adopt oxen technology. In light of this finding, policymakers will need to determine: (1) whether a household farm size of 8 feddans is an adequate target in terms of the objectives developed in the delimiting phase of this study; (2) whether traditional farmers in the JPA can be induced to work 8-hour days; and (3) whether oxen-farming can be successfully adopted by traditional farmers in the JPA.

Although none of the above issues can be definitively resolved by this study, the results appear to indicate that the "improvement approach" may not be the most appropriate strategy for the JPA. Using comparative Sudanese experience, it can be pointed out that, with respect to the first issue, the average farm size is about 21 feddans in agricultural schemes such as the Gezira and Rahad in Northern Sudan. With respect to the third issue, experience warns that it will be extremely difficult for oxen farming to take root in the JPA. Oxen-farming was introduced in the area about 30 years ago, and no farmer has adopted the technology to the present. As alluded to in the last section, social factors are largely responsible for lack of adoption. Moreover, oxen-farming is quite labor-intensive, while labor is a scarce resource in the JPA. ILACO summarizes the social situation regarding the use of cattle as draught animals in the JPA as follows:

> Cattle have a high economic, social, religious and emotional value. As a result, some Dinka do not expect their cattle to do any work. Even carrying the pegs to which they are tethered, is not done by the cattle but by the children. This has, so far, prevented the extension of draught ploughing, a program that was started in Bor in the early fifties and since then has been reactivated in the mid-seventies (57:8).

The experience of extension workers is underlined by findings of this study. All respondents indicated during field work interviews that they would not allow their cattle to plough the fields. A recurrent reason given for refusal to use cattle for draught purposes is that God did not give the Dinka cattle for that purpose. In a

recent 1980 report, ILACO indicates that the public are either apathetic or outrightly hostile to ILACO's oxen training program. ILACO complained that ". . .the social problems appear to be still a major constraint as the ox-trainer and his assistants are frequently abused on the road" (60:19).

Summary of Failure and Success Elements

The failure and success elements developed in this chapter are summarized in Table 6.5, which is presented as a suggested working sheet format for identifying appropriate rural development strategies for the JPA. The table can, of course, be expanded by an inter-disciplinary research team charged with design of an appropriate rural development strategy for the JPA. Such a development strategy, as underlined in this and previous chapters, should neither be based on physical and technological failure and success elements alone; nor on social and institutional considerations alone; nor on economic criteria alone. The essence of an appropriate rural development strategy, implementation of which would result in achieving the goals developed in the delimiting phase of this study, hinges on the fusing of elements of Table 6.5 into a coherent and operationally feasible master plan.

The failure and success elements in Table 6.5 are used in the remedial phase of the next chapter for further evaluation of the "improvement" and "transformation" approaches as appropriate rural

Table 6.5. Summary of failure and success elements in the physical and technological, social and institutional, and economic environments of the JPA

Problem area	Failure elements to be eliminated or modified	Success elements to be maintained and expanded	Potential Failure elements to be avoided	New Success elements to be incorporated and developed
Physical and techno-logical	1. Flooding and water-logging 2. Erratic and irregular rain-fall, and rainy season droughts 3. Inadequate technology and primitive agri-cultural tools 4. Long distances from internation-al and national markets 5. Pests and plant diseases	1. Abundance of fertile lands 2. The Jonglei Canal in its drainage use 3. The Jonglei Canal in its irrigation use 4. The Jonglei Canal in its transport use	1. Exhaustion of soil fertility	1. Drainage of excess water and its use for irri-gation during dry spells and during the dry season 2. Introduction of new forms of farm power 3. Provision of drinking water and fodder during the long dry season 4. Research and development institute
Social and insti-tutional	1. Scattered households 2. Scattered family farms	1. Traditional self-reliance as a possible basis for modern self-reliance	1. Emergence of absentee land-lordism	1. New forms in or modifications in tenure

	3. Communal tenure and legal status of land 4. Transhumance 5. Lack of adequate social overhead services (SOS) 6. High social status of cattle 7. High risk aversion among the population	2. Traditional organizational forms as bases of modern cooperative structures 3. Communal ownership of land, and communal production, distribution and consumption as bases for development of modern producer and marketing cooperatives	2. Emergence of rack-renting of land 3. Emergence of individualization of tenure and eventual concentration of land 4. Break of traditional societies their dispossession of land and eventual pauperization into agricultural wage earners	2. New spatial organization of households into more compact villages 3. Development of new appropriate institutions
Economic	1. Subsistence production and conspicuous consumption 2. Low output price incentives 3. Lack of access to modern inputs 4. High input price disincentives 5. A restricted market 6. High transport costs	1. Abundance of cattle wealth that could be used as investible capital 2. Considerable amounts of off-season labor that could be mobilized for productive activities	1. Possible future shortage of labor resulting from policies favoring urban areas 2. Inadequate capacity to generate investible capital 3. Erratic behavior of commodity prices in international markets	1. Lowering of transport costs from opening up of the JPA by the JPA 2. Presence of potential markets for JPA farm produce in the Middle East

development strategies for the JPA. Comparative Sudanese rural development strategies are also evaluated in the next chapter in terms of how these failure elements have been addressed by these strategies.

CHAPTER VII. THE REMEDIAL PHASE RELATED TO IDENTIFICATION AND SELECTION OF RURAL DEVELOPMENT STRATEGIES FOR SOCIO-ECONOMIC DEVELOPMENT OF THE JPA

Chapter VII presents the remedial phase of this study for identifying and selecting rural development strategies for socio-economic development of the JPA. Like the previous two phases, the remedial phase should be interdisciplinary. However, since the primary purpose of this study is to develop an analytical framework for debating and resolving the relevant issues on development strategy, the remdial phase consists of a general procedural outline, with specific illustrations based on discussion of failure and success elements of the diagnostic phase and comparative Sudanese experience with rural development strategies in North-central and North-eastern Sudan.

The Improvement and Transformation Approaches to Rural Development in Relation to the Failure and Success Elements Developed in the Diagnostic Phase

In order to relate the failure and success elements of Table 6.5 to the improvement and transformation approaches to rural development in the JPA, it is necessary to recapitulate on these approaches. The improvement approach holds that modernization of the present traditional subsistence agriculture in the JPA could be achieved within existing traditional subsistence production units and institutions. The improvement approach thus avoids fundamental and drastic changes in traditional society, while at the same time

it seeks to modernize traditional subsistence production into a commercial one. The transformation approach, on the other hand, embraces from the onset commercial agriculture production with a large export potential. The transformation approach thus calls for immediate transformation of subsistence agriculture through mechanized or semi-mechanized agricultural schemes comparable in scope to those in North-central and North-eastern Sudan.

Regarding how the two approaches address failure and success elements in Table 6.5, the approaches are probably not in conflict with respect to incorporation of the economic failure and success elements into operational plans. Both approaches call for provision of input and output price incentives to farmers; both require that farmers have access to modern inputs; both seek lowering transport costs and extending the market; both seek ways to utilize the considerable amounts of cattle wealth and off-season agricultural labor in the JPA; and both aim at commercial production in place of the existing subsistence agriculture. However, the two approaches differ greatly with respect to means for overcoming the physical and technological, as well as the institutional and social, disincentives identified in Table 6.5.

With respect to physical and technological disincentives, a basic technological package under the transformation approach would embrace drainage, irrigation and mechanization. Most of the physical and technological disincentives in Table 6.5 would be remedied by mechanized or semi-mechanized agricultural schemes in

the JPA. On the other hand, the improvement approach would seek to assist inhabitants of the JPA in flood control measures and provision of improved agricultural implements. There would be no consideration of irrigated agriculture either during the dry season or on a supplemental basis during the wet season. Generally, the improvement approach does not offer specific technologies to overcome the considerable physical and technological failure elements in the JPA. Proponents of the improvement approach appear to place hopes in applied research to provide "technologies appropriate to the physical and social environment of the Jonglei Canal Area." It is argued that these technologies can not be specified at present, since they depend on results of future research.

As argued earlier in the interpretation of results of the linear programming models, the principal failure elements limiting agricultural production in the JPA are physical and technological disincentives, which have made the existing agrarian structure inadequate and not viable for future development of the area. Improvement and "appropriate" technologies, such as oxen-farming, were found earlier to be of limited potential for increasing the cultivated area. Until after "appropriate" technologies are specified and tested, programs based on the improvement approach can not be counted upon to result in achievement of the goals developed in the delimiting phase of this study. In the meantime, construction and operation of the Jonglei Canal will result in major and sudden changes in the physical environment upon which the

traditional economies of the area have depended for long.

Finally, with respect to the social and institutional failure elements of Table 6.5, the improvement approach has very little to offer since it is based on preservation and gradual modernization of traditional society. A development program based on the improvement approach would have no immediate plans for dealing with scattered households, scattered family farms and changes in communal tenure. Development programs based on the improvement approach would probably emphasize modernization of transhumance, provision of SOS infrastructure and new agricultural tools and other inputs. On the other hand, under the transformation approach the scattered households and scattered family farms would have to be regrouped and transhumance would be abolished or drastically modified in order to remove the social and institutional disincentives.

Under the transformation approach, provision of SOS infrastructure and new inputs complement heavy investments in the physical and social environments of the JPA. Under the improvement approach, emphasis is on provision of SOS and new agricultural inputs, presumably as means to effect income transfers to rural areas, but there is little commitment to making heavy investments in the physical and social environment to justify the income transfers and to make them productive.

In subsequent sections, IRD programs currently under implementation in the JPA and two planned large scale drainage and irrigation projects are discussed to illustrate and amplify the

arguments made in this section regarding relation between failure and success elements in Table 6.5 and the improvement and transformation approaches. In addition, two comparative Sudanese experiences with the transformation approach are considered in order to highlight how the approach has addressed failure and success elements in areas similar to the JPA.

The Strategy of Integrated Rural Development in Relation to the Remedial Phase

The strategy of integrated rural development, hereafter called IRD, has been under experimental implementation in the JPA from 1979. Since IRD is the only strategy under implementation in the area and since it represents the "improvement approach," it is worthwhile to relate it to the remedial phase of this study. The presentation that follows seeks to (1) provide background perspective on IRD; (2) provide a sample of definitions of IRD in order to illustrate the vagueness of the strategy and the resulting difficulties encountered in its implementation; (3) relate formulation and application of IRD in the JPA to some of the failure elements in Table 6.5; and (4) hypothesize on prospects of IRD in the JPA.

Background to the concept of IRD

Integrated rural development is a recent addition to a long list of development strategies and ad hoc prescriptions that has characterized the literature. It is improbable that a social

phenomenon can be relevantly appraised without prior appreciation and understanding of its historical setting and development. In order to assess the relevance of IRD to the JPA, it is necessary to discuss its background within the context of economic development theory and practice.

Economic development itself, as a formal branch of economics, is a post World War II development that was necessitated by needs and demands of former colonies to change the inherited and deteriorating conditions of their economies. But what kind of change? The process of economic development was assumed to be essentially one of 'modernizing' primitive societies into industrialized capitalist societies. Wilbert Moore summed up this concept of modernization when he observed that it denoted

> . . .a total transformation of a traditional or pre-modern society into the type of technology and associated social organization that characterizes the advanced, economically prosperous, and relatively politically stable nations of the Western World (72:89).

Based on this assumption of modernization, an underdeveloped country (UDC) was conceptualized in terms of dualism, since traditional society could not be transformed at once. Dualistic and sectoral approaches to development dominated the two decades following nominal political independence of most UDCs. One sector still remained primitive, backward, subsistence-bound, traditional, rural, or informal; while the emerging sector was becoming modern,

progressive, market-oriented, capitalist, industrial, urban, or formal.[1] According to this paradigm the world economy and its development were viewed as schematically represented in Figure 7.1.

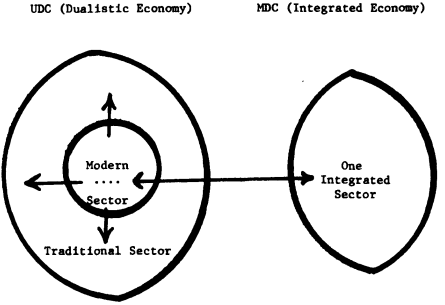

Figure 7.1. A schematic paradigmatic illustration of the world economy

[1]For extended discussion of dualistic models see: W. A. Lewis (67); J. C. Fei and D. Ranis (34); D. W. Jorgenson (54); H. Myint (75); and more recently, Marwan Ghandour and Jurgen Muller (40).

Economic development of a typical UDC, in the above schema, was defined as the process of growth of the modern sector and the decline and eventual elimination of the traditional sector. The process of development would naturally follow technological modernization based on post-Newtonian scientific principles (Rostow (87)). Once a Rostowian 'take-off', or Lewis's industrial capitalist class became dominant, compound interest (Rostow (87)) took over, and the Great Ascent (Heilbroner (48)) was possible; total transformation of society would eventually lead to prosperity for all through a 'trickle down' mechanism, as has been the case in the West.

When on the one hand, the 'take-off' did not happen in many UDCs, and the Great Ascent was fast becoming the Great Descent leading to a widening gap (Zimmerman (110)) between UDCs and MDCs; and on the other hand, the income gap between the modern sector and the traditional sector in many UDCs was also widening, social science was thrown in disarray. A long list of 'explanations' and 'solutions' to the maladies mushroomed.

On the side of explanations, one group of social scientists maintained that various noneconomic factors (traditional values, social and ritual obligations, etc.) enter into the entrepreneur's decision-making process and that these must be taken into account when dealing with nonindustrial situations in UDCs (Foster (35), Georgescu-Roegen (38), Yamey (108), etc.). Anthropologists and sociologists, therefore, set out to ascertain the socio-cultural constraints to the acceptance of Western technology, management, and

organizational methods.

Another group of theorists contended that peasants (the majority of UDC entrepreneurs) were rational people, who were no more tradition-bound than an Iowa farmer (Schultz (91), Mellor (69), Johnson (52), etc.). In Transforming Traditional Agriculture, Schultz described peasants as efficient and profit oriented, but he pointed out that traditional agriculture had reached an equilibrium state where further capital formation was relatively unprofitable. According to Schultz, the primary factor needed to change the low equilibrium trap in UDCs was investment by outside nonagricultural sources to provide new inputs that would be profitable for farmers to adopt. New agricultural inputs were indeed produced (the Green Revolution),[1] and farmers were provided with credit in order to obtain them. The Green Revolution, however, exacerbated the already widening gap between the modern and traditional sectors in UDCs.

A third group of scientists argued that the problem in UDCs was neither that of noneconomic factors entering UDC entrepreneur's

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[1]The Green Revolution refers to genetic developments in new strains of seeds that increased yields 2 to 3 times in rice, corn and wheat about 20 years ago. In most UDCs, the Green Revolution increased production substantially for large farmers with access to the complementary inputs of management, fertilizers, pesticides, herbicides, machines and water. However, small farmers without access to these resources were made worse off, as their output remained the same while output prices fell due to increased production by large farmers. In subsequent years, the World Bank designed aid programs to assist small farmers and the rural poor. Problems of the Green Revolution are discussed by Nicholas Wade, "Green Revolution (II): Problems of Adapting a Western Technology," in Science 186 (December, 1974):1186-1192.

decision-making process nor that of a low income equilibrium trap. The third school warned that the structure of the world economy led to a dependency trap (Baran (8c), Frank and Cackroft (36), Rodney (86), etc.) in which MDCs exploit UDCs, and modern sectors in UDCs exploit traditional sectors, and that these exploitative relations would get worse over time.

Many other explanations of development and underdevelopment are variations of the preceding three basic themes regarding causes of the poverty situations in UDCs. Explaining underdevelopment, however, although necessary, is not sufficient. The next relevant question was how to rid UDCs of underdevelopment.

On the side of "solutions" there mushroomed as many strategies and packages of advice as there were advising "experts." A sample of development strategies compiled by Muhbub Ul Haq includes the following: (1) provide capital formation by mobilizing labor; (2) import-substitution industries are the key to development; (3) place your faith in agricultural extension; (4) import-substitution is no good; export expansion is the answer; (5) agricultural extension is useless; only the incentive system will work; (6) put all your emphasis on education, particularly technical training; (7) industrialization is an illusion; rapid agricultural growth is the answer; (8) UDCs are going to be submerged by population explosion; give top priority to family planning; (9) break all dependency links with Western industrial and financial capitalism,

and institute independent self-reliant development; and (10) integrated rural development is the only policy that can reach the poorest of the poor (97:15).[1]

The above prescriptions and many others appear to be based on statistically observed characteristics of UDCs that are judged to cause poverty and underdevelopment. Professor Harvey Leibenstein gives a comprehensive list of some 35 characteristics of a typical UDC under four headings: (1) economic, (2) basic characteristics in agriculture, (3) cultural and political, and (4) technological and miscellaneous (66:2). The choice of characteristics or group of characteristics upon which to base a development strategy probably depends on the technical training and disposition of the advising expert.

If IRD is viewed from the foregoing perspective, it can be argued that IRD was developed as a means to bridge the widening gap between traditional and modern sectors in UDCs; while the proposed New International Economic Order (NIEO) is a similar response to the widening gap between UDCs and MDCs. If this argument is valid, it can further be suggested that IRD may not be a development strategy, but rather a strategy for what Axinn has called "misery management" (8a:75). Definitions of and experience with IRD appear to indicate that IRD can end up as a means for "misery management," unless it is implemented on a financially massive scale.

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[1]Items (9) and (10) were added to Ul Haq's list by the author.

Some current definitions of IRD

Most formulations of IRD strategy embody three basic features: (1) dissatisfaction with past theory and practice of economic development in UDCs; (2) targeting of a specific group, the rural poor, for development; and (3) comprehensiveness in approach, so that, it is said, multiple causes of poverty are attacked simultaneously. A sample of definitions, from international organizations and two from academics, illustrates these basic features of IRD strategy.

1. One formulation of IRD is provided in a recent report of a FAO/SIDA/DSE Interregional Symposium on IRD. The symposium observed that:

> IRD is a radical concept. It is, in fact, an ideology which carries implied criticism of existing institutions and socio-economic policies in the poor countries. It is multidisciplinary in approach and multisectoral in operation. Hence, it is hard to comprehend and implement (33:9).

Nevertheless, the report goes on to specifically define IRD as a policy to ". . .narrow the gap between urban-rural life and reduce disparity between various income groups."

2. The World Food Conference (WFC), on the other hand, does not provide a formal definition of IRD. Instead, they leave the definition to individual countries, arguing that the concept of IRD is ". . .sufficiently flexible for countries to design operational strategies appropriate to their own circumstances." The Conference makes an analogy with water to underline the reported flexibility of IRD: "Like water, it has no shape or

color and, therefore, fits into any socio-political frame, with or without adjustment" (33:10). The Conference therefore merely calls upon, invites, and urges governments to implement all the comprehensive programs that IRD entails.

3. The definition of the World Bank is the one most frequently quoted and accepted by students and practitioners of IRD. The Bank's sector paper on rural development defines it as follows:

> Rural development is a growth strategy for a particular target population--the rural poor. It involves extending the benefits of development to those whose future lies in the pursuit of a livelihood in rural areas. These include small-scale farmers, tenants and the landless (107:3).

The World Bank definition, like other formulations of IRD, is heavily distribution-oriented, though the bank is quick to point out that the strategy is not viable unless employment and productivity are raised as a result of the resource transfers to rural areas.

4. L. Moore, in a report of advice on IRD to the Government of Pakistan, says that IRD is made up of many elements which link together in an interrelated manner, in programs that constitute IRD strategy:

> The sum of these elements . . . constitutes a synthesis of the concept as a whole. Although the idea of IRD may be approached from different sides, it is unitary in nature. The comprehensive approach to IRD grows out of the need to attack multiple causes of poverty and dualism found in rural areas. These causes include high birth rates, under and unemployment . . . (71c:55).

5. Finally, Mosher, like Moore, provides a very comprehensive definition of rural development. According to Mosher, rural development is a trend in the technologies, organizations, activities, and values of society that:

> (1) increases the opportunities of all of its rural people for vigorous health, broadening mental horizons, increasing knowledge and skills, and expanding opportunities to participate both constructively and pleasurably in the activities of their cultures;
> (2) progressively provides more effective means for adjusting as peacefully as possible the conflicts and injustices that invariably arise as technology and other cultural changes take place;
> (3) maintains or progressively approaches an optimum balance between each rural person's opportunities for freely-chosen self expression and the corporate needs of the culture in which he lives; and
> (4) increasingly brings all present and potential farm land into its most effective use--all without irreparable damage to the Earth's ecosystem (73:10-11)

As illustrated in the above sample of definitions, most formulations of IRD are so comprehensive and so liberal as to almost border on utopia. Before embracing IRD strategy, it is worthwhile for policymakers in an UDC to ponder the realism of IRD strategy, whether the nation can afford it (especially after the international initiators withdraw),[1] and whether resources earmarked for IRD could not be better utilized under alternative rural development strategies. The income transfer and comprehensive

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[1]IRD in the JPA was initiated and is financed by UNDP and other international organizations. Future UNDP assistance will depend on reports of an Evaluation Mission (18:66). It will also depend on international politics, including willingness of nations to contribute to organizations like UNDP.

features of IRD raise serious problems for implementation of IRD in the JPA.

With respect to income transfers to rural areas, IRD appears to have little to offer in countries like Southern Sudan where the urban sector, almost as impoverished as the rural sector, has nothing or little to transfer. It is to be noted again that 100 percent of the population in the JPA and 95 percent in Southern Sudan live in rural areas. Rural development in Southern Sudan is therefore almost synonomous with regional or national development. If international organizations and the Central Sudanese Government provide some resource transfers to rural JPA, it is doubtful whether use of such resources in IRD projects is an appropriate strategy for rural (national) development in the JPA. Unless operational plans incorporate failure elements in Table 6.5, such as resettlement of the population and changes in tenure arrangements, IRD in the JPA could likely end up being "management of misery."

The comprehensive feature of IRD strategy makes its formulation into operational plans problematic. According to Grindle, an appropriate IRD operational plan would entail:

> . . .that credit on terms acceptable to the peasant population be made available to purchase improved seeds, fertilizer, insecticides, and basic farm implements; that extension agents be able to address the wide range of problems that arise in peasant production; that consumer credit be made available so that the peasants are not exploited by local merchants or crop purchasers during nonharvest seasons; that irrigation works be constructed to service small holdings; that government supported prices be offered for the crops produced; that roads,

> storage facilities, and transportation be available to rural dwellers to allow access to markets; that schools and health facilities be available to improve the quality of life in rural areas; that rural industries and public works provide employment during idle seasons; and that peasants be organized to participate effectively in the new programs (43:54).

It is difficult to comprehend the type of a single organization, short of a government or a Gezira type organization,[1] that can perform all these functions. The administrative complexity of such an organization, the expenses involved, and the informational needs of the tasks are bound to be tremendous.[2] Grindle, for example, reports the commitments involved for an IRD program undertaken in Mexico from 1975 to 1978 to benefit thirty small regions with a total population of 1.5 million (about the size of the JPA). The total program financial outlay of $295 million was provided by the national government of Mexico ($178 million) and a loan from the World Bank ($110 million); while program beneficiaries were expected to contribute the remaining $7 million. When this program is completed in 1982, it is projected to cost $1.2 billion (43:57). In contrast, the financial outlay for UNDP's Kongor IRD program for the first 4 years is only $9.4 million.[3]

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[1]The Gezira Scheme is discussed shortly in this chapter.

[2]For a recent critique of IRD strategy see Merilee S. Grindle, "Anticipating Failure: The Implementation of Rural Development Programs," Public Policy 29 (No. 1, 1981):51-74.

[3]UNDP's Kongor IRD program is discussed shortly in this section.

IRD Strategy as an Improvement Approach in the JPA

IRD strategy was introduced in the JPA in 1976 when the Executive Organ of the Jonglei Development Projects formulated its "Jonglei Area Development Program" and published it under the title "A Request for Funding of Development Projects in the Jonglei Area" (23). The Request for Funding was directed to foreign governments and international organizations that might be interested in funding any of the 13 research and development projects it contains. These 13 projects are included as Appendix E. IRD was included as Items 11, 12, and 13 in the Request for Funding.

The request for funding itself, which is the basic interim[1] development strategy for the JPA, was prepared by the United Nations Development Program (UNDP) and their consultants. Acknowledging UNDP input into the document, the Commissioner of the Executive Organ wrote:

> The Commissioner, Jonglei Development Projects, wishes to acknowledge the very considerable assistance that he has received from the UNDP in the preparation of this request. In particular, he wishes to thank Mr. Charles H. La Muniere, Resident Representative, who has been mainly responsible for the compilation of this request. The UNDP funded consultant, Mr. Roger M. Berthelot, a Senior Technical Advisor from UNDP Headquarters in New York and Dr. Thayer Scudder of the California Institute of

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[1]In an interview with H. E. Sayed Abel Alier, Vice President of Sudan, President of Southern Sudan and Chairman of the National Council for Development Projects in the Jonglei Area, the author learned that a "Master Plan" for development of the JPA would be formulated after December 1981 when results of current studies (Appendix E) in the area become available.

Technology, together with the UNESCO funded consultant, Dr. I. G. Dunn, also provided advice and information (23:iii).

In 1979, the UNDP and the Government of the Netherlands expressed interest in Item 13, "Integrated Rural Development in a Dinka District," in the Request for Funding. Subsequently, in April, 1979 the UNDP published their version of IRD: "Integrated Rural Development in the Kongor District, Jonglei Province, Southern Region (SUD/78/016)" (18). In August, 1979 the International Land Development Consultants (ILACO), acting for the Dutch Government published their version of IRD: "Kongor Integrated Rural Development Project, Project Plan" (55).

The ILACO version of IRD in the JPA

The ILACO document on IRD in Kongor District was formulated by a mission consisting of eight ILACO Dutch experts that conducted its business in the area between January 15, and February 15, 1979. According to ILACO, the objective of the Kongor Integrated Rural Development Project is to ". . .stimulate the development of the rural population around Kongor." To reach this objective ILACO lists several tasks which the project would be required to engage in:

1. Assist in the development of crop husbandry and animal husbandry in order to change the subsistence economy into a market economy. This will require the following activities; (i) investigate the possibilities of and develop systems for improving the present traditional agriculture and animal husbandry practices of the Dinka and advice on flood control measures; (ii) conduct applied research on rainfed crops including land preparation, cultivation, and harvesting methods, and of the new methods, proper utilization of rain water,

and adequate drainage and flood protection techniques; (iii) study aspects of farm management and the actual cost/benefit of the traditional methods; and of the new methods to be used; (iv) study marketing aspects of agricultural produce and the possibility of the creation of cooperatives; (v) development of systems for training staff, farmers and laborers in applying modern agricultural methods and techniques, and in farm management.

2. Study the creation of new job opportunities and encourage the constitution of community self-help projects. For this it is necessary to gain insight into employment, resettlement and related social aspects and to investigate ways and means of improving rural life. This will include: (i) public health facilities; (ii) primary school facilities; (iii) general adult education facilities; (iv) improvement of rural water supplies, and (v) improvement of communications (55:5).

With respect to immediate operational plans of IRD, ILACO argues that the major thrust of Kongor Integrated Rural Development in the initial phase (three years), should be in the area of animal husbandry:

> The Dinka are reputed cattlemen, and livestock forms their main resource at present. It is likely that any real economic development in the future will be generated by livestock improvement. However, interference in pastoral systems has proven to be difficult and a number of constraints have to be removed before a sizeable development can be expected. Food supplies (mainly dura) should be guaranteed; there should be enough market outlets to sell cattle; veterinary support should be greatly improved, better grazing during the flood periods should be provided; and drinking water in the intermediate lands should be secured for the dry season. The program for the first three years involves the improvement of the veterinary infrastructure, building of hafirs, carrying out research on new forage species, ox-ploughing methods, and water manipulation through the budding system (55:c).

For agricultural development, ILACO argues that crop production can be accomplished by enlarging the cultivated area, improving

production per unit area, and by improving storage of crop produce. To achieve these improvements, ILACO recommends that agricultural extension services be established in the Kongor area to run a demonstration farm for improved farming practives, and then ". . .prominent farmers are to be selected to serve as model farmers . . . they will in turn form small groups to which they convey their newly learned knowledge" (55:c).

ILACO estimated IRD project costs for Phase I at LS 3.37 million ($6.74 million), of which almost 90 percent was to be contributed by the Government of the Netherlands and the remainder by Sudan.

The UNDP version of IRD in the JPA

The UNDP document on IRD in Kongor District describes the objectives of IRD strategy in almost the same terms used in the sample of definitions of IRD in this chapter. According to the document, the long term objective of IRD in the area is provision of ". . .some of the means and institutional framework within which the Dinka in the Kongor District of Jonglei Province can (a) mobilize resources to improve their livestock, agricultural and fishing economies and develop their educational, health and social services; in order to (b) foster a development process adapted to the ecological and sociological realities of the area; and thereby (c) facilitate the process of change and smooth transformation and modernization of their economies and social life" (18:20).

It is argued that the above formulation of IRD makes the project ". . .unitary in concept, but with multisectoral development objectives." Furthermore, UNDP observes that it is unlikely that the above long-term objectives can be achieved, at a minimum, in less than ten years. The project is therefore phased. The immediate objectives during Phase I (4 years) cover animal husbandry, agriculture, fisheries, SOS infrastructure and introduction of new and appropriate technology. A detail of these objectives is given in Appendix F.

UNDP estimated the costs of the IRD project in Kongor District during Phase I at about $9.4 million, contributed by UNDP ($4.9 million), UNDCF ($2 million), Dutch Bilateral Aid ($1 million), and the remainder by Sudan.

The UNDP version of a Kongor Integrated Rural Development Project was the one finally approved by Sudan Government. Implementation of its Phase I started in October, 1979, and is expected to end in September, 1983. The ILACO version will probably be modified and implemented in Bor District, immediately south of Kongor. ILACO is actually already involved in Bor District, managing the Pengkou Pilot Project and conducting rural studies aimed at implementing IRD in Bor (Gok).

Prospects for IRD strategy in the JPA

It is probably too early to write quantitatively on IRD in the JPA since implementation has just begun. Nevertheless, the "means-ends continuum" model and the delimiting, diagnostic and remedial

phases of this study are applied here to shed some important insights on prospects for IRD implementation in the JPA.

In terms of the "means-ends continuum" model, it is not clear what type of agrarian structure the Executive Organ aims to establish in the JPA. In order to determine the type of agrarian structure in the JPA, it is necessary that goals (or ends) of socio-economic development be clear and specific; but this is not the case in either UNDP's or ILACO's versions of IRD presented in this section. Generally, according to either version, IRD in Kongor District seeks to provide some of the means for the Dinka ". . .to improve their livestock, agricultural and fishing economies."

Specificity and clarity of objectives (ends) is necessary in the "means-ends continuum" model because formulation of unique appropriate development strategies (and their respective agrarian structures, institutions and instruments), depends on the ends sought, the magnitude of the problematic gap and failure and success elements that account for that gap. If, however, the objective of IRD is merely to "improve . . .," then a good number of strategies, agrarian structures, institutions and instruments may be appropriate and sufficient, including the present agrarian structure in the area.

Indeed, there appears to be an implicit assumption in both UNDP's and ILACO's versions of IRD that the stipulated "improvements" could be made without fundamental changes in the traditional agrarian structure. Hence, it is deemed sufficient to ". . .stimulate the

development of the rural population around Kongor." In terms of the "means-ends continuum" model, a relevant question is; stimulate development of the rural population around Kongor using what "instruments"? The traditional agrarian structure that is in place in the JPA has evolved over the centuries in response to a rural strategy of subsistence; and, as shown by results of linear programming, it is unlikely that it can be stimulated appreciably using the modern instruments of agricultural extension that are suggested by IRD strategists. Having glossed over the question of goals for socio-economic development in the JPA under the rubric of "improvements," IRD strategy, as formulated in the JPA, does not address the greater issues of changes in the traditional agrarian structure, such as in communal tenure, reshaping of settlements, etc. (see Table 6.5), except in passing or as issues of remote concern.[1] An appropriate rural development strategy must be based on elimination of failure elements and expansion and discovery of success elements such as the ones listed in Table 6.5.

Another consideration regards the philosophical basis of IRD. As discussed earlier in this chapter, IRD evolved as a strategy to bridge the gap between traditional (rural) sectors and modern

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[1]In earlier formulations of development strategy, the Executive Organ considered resettlement, and there was a Resettlement Unit established for that purpose. Two large-scale drainage and irrigation schemes were also considered for Kongor and Bor Districts (see Fig. 7.2 and Fig. 7.3). However, since the intellectual and practical invasion of the area by IRD strategy, these ideas and projects have been quietly forgotten and shelved. The irrigation canal that was to run parallel to the main canal appears to have been cancelled, as the author learned from the French company (C.C.I.) that is digging the main canal.

sectors in UDCs; and this, ipso facto, implies income transfers to rural areas. The magnitude of the transfers involved in the case of the JPA (less than $10 million over 4 years) can at best cover administrative costs of implementing agencies, plus maybe a school, well, health clinic, or a dyke built here or there, and inaugurated with the usual fanfare. The likely impact of IRD under these circumstances will likely be employment of some local urban elite and international experts and consultants, and some degree of "misery management" for the "target population." Approximately 40 percent of UNDP's contribution to Kongor IRD project, for example, is earmarked to be paid out to foreign experts in the form of salaries, travel, incentive stipends and consultancy fees (18:68). The Executive Organ for Development Projects in the JPA has almost become an employment agency. It was learned during field interviews that the Executive Organ Headquarters at Lang-Baar in Bor employed 139 officials and workers in September, 1980. Of these, 30 were drivers and assistant drivers, while another 30 were doing devious jobs as messengers, cooks, assistant cooks, housekeepers, Kaffirs and compound laborers. Most of the remaining 69 spend their time between Bor, Juba and Khartoum on "official duties" in expensive hotels and earning traveling allowance all paid for by the Executive Organ. In general, the work of the Executive Organ at Lang-Baar appeared to have little relation to rural areas.

The preceding considerations make it likely that IRD in the JPA runs the risk of being too general in scope and too thinly

spread to gather moss of any consequence. Despite exhortations that IRD must be self-reliant and self-sustaining, there do not seem to be technologies to make this possible. There is even no revenue aspect incorporated into IRD plans in either the UNDP or ILACO versions, and IRD can hardly be expected to be self-reliant and self-sustaining if it generates no revenue to the implementing agency(ies).

IRD strategists in the JPA seem to cling to the hope that somehow "appropriate" technology will pop out of applied research soon or in due course. Ox-plowing, the prospective "appropriate" technology that could assist muscle power in the JPA has already been discussed in the linear programming section of the diagnostic phase of this study, and its future wide use in the JPA does not appear promising. Similarly, the use of herbicides and fertilizers is unlikely to be viable in the JPA without concomitant provision of complementary inputs (management, machines, etc.) and elimination of major physical, institutional and economic disincentives (failure elements) such as in Table 6.1. One would tend to agree with Ruttan that:

> . . .the absence of any well-defined rural or community development technologies around which professional capacity or resources can be organized or institutionalized casts considerable doubt on the viability of integrated rural development efforts (88:16).

Finally, the fact that IRD in the JPA is formulated outside the broader framework of the national development goal of turning the country into a "Breadbasket of the Middle East" places the JPA

in a rather peripheral position with respect to national priorities and allocations. The dominant form of modern agricultural development in the Sudan is of the Gezira-Rahad model. Government interest and finances will most likely be concentrated in these types of projects in the future because they generate revenue and foreign currency, which Sudan badly needs. It is quite unlikely that IRD projects can generate even 10 percent of outlays for schemes such as the Rahad whose total outlay is estimated at $400 million.

Unless IRD becomes the dominant mode of agricultural development in the Sudan, designated IRD regions are likely to end up as labor-reserve hinterlands for schemes such as the Gezira and Rahad. They will also probably continue to attract some attention from international organizations and academics interested in social experimentations "in the real world." Eric J. Miller, for example, writing about an IRD project in Mexico in which he was involved, expresses the value of IRD projects for social experimentation as follows:

> With or without the benefit of my advice, the program was expanding rapidly. By the end of 1975, about 5,000 communities all over the country had received or were in the process of receiving investments under the program, and with some there had been contact for two and a half years. We had here a large-scale natural experience in which it was possible to generate and begin to test hypotheses (70:73).

The Pengko Plain Development Project and Jonglei Irrigation Project as Transformation Approaches in the JPA

Background to the transformation approach in the JPA

The economic and social life of the people of the JPA, the Dinka, Nuer, Shilluk, Anyuak and Murle has not changed significantly since the intrusion of colonialism in the country nearly a century ago. Only when there has been talk about construction of the Jonglei Canal has there been serious concern about social and economic development in the area.

The first serious talk about socio-economic development of the JPA surfaced in the 1940s when the Egyptian Ministry of Works first submitted to the Government of Sudan proposals for digging the Jonglei Canal. The Colonial Governor General of the Sudan appointed the Jonglei Investigation Team (JIT) to study the effects of the proposed canal project on local interests and to recommend remedial measures.

The terms of reference of the Jonglei Investigation Team were later specified as follows (53:v):

1. To estimate how much riverian pastures, and other assets of vital concern to the people of Sudan, would be lost as a result of the altered regime of the Nile, and to assess the extent of the remedial measures required;

2. To find out what natural alternatives would be available and where these are lacking what remedial schemes could be applied; and

3. To assess the cost in money and water of such remedial measures.

The JIT published their findings and recommendations in 1954 in four volumes and a Summary Report (53). Although JIT's recommendations were formulated in terms of what has been termed the "improvement approach" in this study, the team appreciated the necessity and eventuality of the "transformation approach" in the JPA when they concluded as follows: "We do not think that a complete change in economy and mode of life should be excluded from our recommendations if it is economically essential, provided the people are given technical and educational assistance" (53:575). None of these recommendations were implemented since the canal was never dug. Nevertheless, the work performed by the JIT provided an important benchmark for subsequent research and development activities in the JPA, including the 100,000 feddan Jonglei Irrigation Project to be discussed shortly.

A related work, although more general since it covered the whole of the Southern Region, is the Report of the Southern Development Investigation Team published in 1955 (92). This document also stands out as another important pre-independence research and development activity which recommended the transformation approach in the JPA.

When the Sudan attained independence from Anglo-Egyptian condominium rule on January 1, 1956, the Southern Sudan had already become engulfed in a protracted war of liberation (1955-1972) waged by the Southern Sudan Liberation Movement (SSLM) and the Guerrilla

AnyaNya National Armed Forces (ANAF). Neglect of Southern Sudan by the colonial regime and what Southern Sudanese saw as imminent domination by Northern Sudanese in an independent Sudan led to a pre-independence mutiny by the Southern Corps at Torit in August 1955. This mutiny was the beginning of the 17-year war. For background information on the causes, consequences and end of the war see (6; 13; 14; 31; 81; 82).

During the war period there was neither talk nor much effort at socio-economic development in the JPA. The state of development in the JPA by the end of the war in 1972, and indeed at the present time, is summarized by the Executive Organ in the following words:

> At present (1979) there is very little in the Jonglei Canal area in terms of development inputs. Except for the Pengko Plain Project, there is actually nothing in the area of agricultural development. The same is true of the livestock sector; being limited to the dry season visits of vaccination teams operating from Bor or Malakal. True, many schools, dispensaries and bore-holes, etc., have been added following the conclusion of the Addis Ababa Accord (ending the war), however, all these services suffer from one form of inadequacy or the other. In fact, they are all in bad shape (21:46).

Serious talk and concern with socio-economic development in the JPA surfaced again when the Egyptians again proposed the canal project, especially after its construction was approved. As mentioned in Chapter I, the President of the Democratic Republic of the Sudan issued orders establishing the NC-JPA and its Executive Organ. In order that the NC-JPA accomplishes its main objectives,

its powers were widened to include the discharge of the following functions:

1) Formulation of integrated policies for the social and economic development in the Project Area, the supervision of their execution and the promotion of studies related to the effects of the Project on the livelihood and conditions created by the Project in the area;

2) The implementation of the projects in accordance with the social and economic development policies of the Nation;

3) Preparation and approval of the execution of programs and the related funds earmarked for the agricultural, industrial, settlement and social services projects;

4) Making administrative rules and procedures and establishing the functions of the Executive Organ;

5) The ascertainment of the relations of production pertaining to agricultural, industrial and other development schemes; and

6) Determining areas of and securing aids, grants and technical assistance donated to the Executive Organ (22:5).

In pursuing the preceding objectives and functions, the Executive Organ has formulated the Research and Development Program in the Jonglei Area of Appendix E, which contains both improvement transformation approach projects. These research and development activities are considered to be pre-investment. According to the Executive Organ ". . .the eventual aim will be to use data obtained from these surveys and studies to formulate plans for a type of development that will ensure orderly change and gradual but total transformation and modernization of economic and social life of the Region" (23:9).

The Jonglei irrigation project

A major transformation approach project included in Appendix E is a large irrigation project (200,000-240,000 feddans) known as the Jonglei Irrigation Project (JIP) to become operational once the canal is completed (56). The proposed site of the JIP is near the intake of the old canal version just north of Jonglei Village (see Figure 7.2).

A pilot project, the Jonglei Pilot Scheme (JPS), Item 6 of Appendix E, is planned in order to study major aspects relevant to the establishment of the JIP. Late in 1974, the Governments of the Democratic Republic of the Sudan and the Kingdom of the Netherlands agreed to cooperate in conducting studies for the establishment of the pilot scheme. The International Land Development Consultants (ILACO) of the Netherlands were invited to carry out these studies. An ILACO team of investigators conducted field work in the area and submitted a preliminary report to the Executive Organ in June 1976.

Not much planning appears to be continuing with respect to the Jonglei Pilot Scheme. The canal has since been realigned (see Figure 3.3). The Executive Organ is uncertain as to whether to conduct new studies for establishment of both the JIP and its pilot scheme. Moreover, there are tendencies among policymakers and expatriate advisors to avoid transformation approach projects in the JPA; instead, more emphasis appears to be placed on integrated rural development projects designed to improve

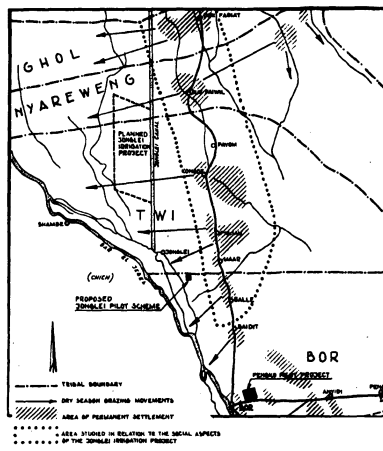

Figure 7.2. The proposed Jonglei Irrigation Project and Jonglei Pilot Scheme (56:19)

traditional agriculture by means of so-called "appropriate technologies." The future of JIP is therefore uncertain. Nevertheless, the planned JIP addresses most of the major failure elements in Table 6.5. The objectives of the JIP Scheme Study include: (1) construction of irrigation and drainage canals; (2) conduct of applied research into both rainfed and irrigated crops, and testing of land preparation, cultivation and harvesting methods; (3) development of systems for training staff, farmers and laborers in applying modern agricultural methods and techniques, and in farm management; (4) gaining of insight into aspects of employment, resettlement and related social aspects; (5) provision of various social services (health, education, community development, etc.); and (6) investigation of possibilities for improving the present traditional agriculture and animal husbandry (56:ix).

The Pengkon plain development project

The Ministry of Agriculture and Natural Resources, Southern Region, has also been active in the JPA since the end of the war in 1972. The Ministry has made continued attempts to improve traditional agriculture by means of the improvement approach through introduction of new farming techniques, tools, seeds, etc. However, the impact of these efforts has been marginal. A major thrust was made in introducing oxen plowing as an "appropriate technology" in the region. A new post for an Inspector General for Oxen Plowing was created in the Ministry in 1974/75. None of

these subsidized oxen plows (LS 15 or $30 per plow) has ever been purchased in the JPA. All of the 300 oxen plows sent to Malakal by the Ministry in 1977 have been in storage ever since, according to the Inspector of Agriculture for the Province. The reasons given for the poor adoption rate of oxen farming range from lack of interest on the part of the JPA farmer because of alleged traditional values about cattle to lack of qualified trainers, demonstration farms and extension staff.[1]

A major undertaking by the Regional Ministry of Agriculture in the field of large-scale farming in the JPA is the Pengo Plain Development Project (PPDP). The Pengko Plain, which takes its name from the former Village of Pengko, where the JIT conducted extensive field experiments in the 1950s, is part of the Eastern Plain. The Eastern Plain is the area bounded by the Bahr el Jebel, White Nile and Sobat Rivers in Upper Nile and Jonglei Provinces (see Figure 3.4). The Pengko Plain covers approximately 1,500,000 feddans (600,000 hectares) in the Southern reaches of the Eastern Plain (Figure 7.3).

The Pengko Plain Development Project was identified as early as 1954 by the Southern Development Investigation Team. In their assessment, the Team wrote the following about the PPDP:

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[1]From results of interviews with commissioners and inspectors of agriculture in Jonglei and Upper Nile Provinces.

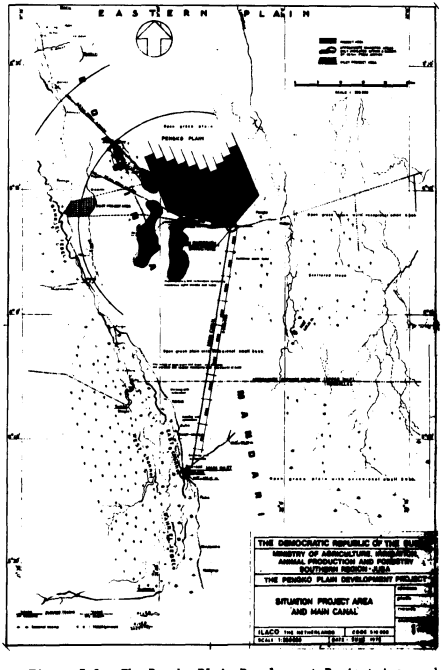

Figure 7.3. The Pengko Plain Development Project Area and the Gemmerza-Pengkon Main Canal (65)

> The most economical way in which irrigation water can be used is to supplement rainfall rather than to irrigate in areas of low rainfall. It would follow . . . that the best place for the waters of the Nile to be used for irrigation would be in the Southern Provinces where, at Juba, for instance, 1,000 cubic meters of water would produce crops on 0.57 feddan, compared with 0.27 in the Gezira . . . (In the Southern Provinces) the physical potential exists for schemes of Gezira magnitude (2 million feddans), and since the waters of the Nile are limited, this potential should be borne in mind when devising plans for the use of the Nile waters. One potential large-scale scheme is on the Eastern Plain where a main canal leaving the Bahr el Jebel at Gemmeiza could command millions of feddans north of Pengko (92:24).

In late 1974, the Regional Ministry of Agriculture revived the PPDP in order to complement its improvement approach to rural development in the area. According to ILACO, which was asked for technical advice on study of the development potential of the Pengko Plain,". . .faster development for more Dinka is possible, if the improvement of traditional agriculture and livestock production is complemented by a large modern project to be started in the Pengko Plain" (65:3). A team of three ILACO investigators conducted limited field work, and recommended that further studies were necessary. Subsequently, an agreement was reached between the Government of the Democratic Republic of the Sudan, Southern Region, and the Government of the Kingdom of the Netherlands about cooperation in these more detailed studies. ILACO was invited to carry out the detailed studies, and another team of ILACO investigators worked in the field from February to May 1975. The Team published their results and recommendations in three volumes titled "Pre-feasibility Report" (65). The ILACO conclusions and

recommendations about development potential of the Pengko Plain was very favorable:

> Our studies reveal that the Pengko Plain contains good opportunities for agricultural development. We recommend to establish as soon as possible a pilot project near Bor, with a sub-station in the Pengko Plain. . . . We hope that an early implementation of the Bor Pilot Project will contribute to the development of the Bor area, and large-scale development in the Pengko Plain in the near fugure (65:i).

The ILACO Team made elaborate drainage and irrigation designs for the PPDP as a large-scale irrigation project (see Figure 7.4). In drawing up their recommendations for large-scale production in the Pengko Plain, the ILACO Team based their studies on an organization model of highly mechanized, centrally managed, large-scale farm that would provide employment for up to 13,000 permanent workers and up to 5,000 seasonal workers (65:42).

The Pilot Project phase of the PPDP has already been implemented. The Pengko Pilot Project (PPP) was established three kilometers from Bor in 1975 as a miniature of the PPDP to investigate the many problems that are likely to be encountered by large-scale farming in the area. Since 1975, the PPP has conducted research into these problems including creeping flood characteristics, drainage, irrigation, depth and speed of soil tillage, choice of crop varieties and periods of planting, maintenance and build-up of soil fertility, weed control, pest control and methods of harvesting.

A more detailed feasibility study of the PPDP was scheduled

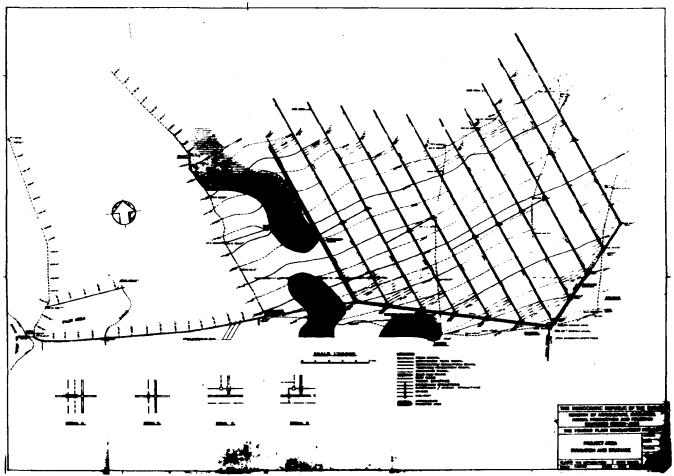

Figure 7.4. Drainage and Irrigation Design for the Pengko Plain Development Project (65)

to begin in 1979, but had not been started by December, 1980. During field work interviews for this study, ILACO reported that the final results and recommendations of five years of PPP investigations were to be published in 1981/83. ILACO, however, appears to be drifting away from their commitment to large-scale farming in the Pengko Plain and towards improvement of traditional agriculture through the improvement approach and conventional extension services (62:123). However, government officials in Southern Sudan appear to be hopeful that construction of the Gemmeiza-Pengko Main Canal, initially scheduled to begin in 1981, will be started in the future. In an interview with the President of the Autonomous Southern Region, the author learned that plans for the PPDP for at least 100,000 feddans were still active under the transformation approach.

The preceding background information and discussion of development efforts in terms of the improvement and transformation approaches in the JPA point to the need for a coherent and determined rural development strategy for the area. Policymakers and advisors realize the need for large scale agricultural projects in the area. The Regional Ministry of Agriculture calls for "more advanced systems of agriculture" in its policy declarations (25:1), and according to ILACO "improvement of traditional agriculture and livestock production must be complemented by a large modern project (65:3). However, when difficulties of large scale farming are encountered

there is considerable vacillation regarding the wisdom of the transformation approach for the area. In a candid retreat from its commitment to the PPDP and large scale farming in the JPA, ILACO recently reported that "the feasibility study for large scale production will be carried on but the recommendations of the Democratic Republic of the Sudan are more directed towards a rural development project" (62:123).

Transformation approach projects such as the PPDP and JIP are costly and difficult to implement since they call for large overhead outlays and for fundamental changes in traditional society. However, to overcome the physical, institutional and economic disincentives in the JPA, as discussed in this study and summarized in Table 6.5, the transformation approach may be necessary in the future. The tendency for decision making to gravitate towards the improvement approach and IRD projects is understandable since any resource transfer activity to rural areas under this approach can be considered as an improvement. On the other hand, resource transfers to rural areas under the transformation approach must be justified on grounds of economic profitability and revenue generation to the government.

The Gezira and Gedaref as Comparative Experience of Transformation Approach in North-Central and North-Eastern Growth Areas

The utility of the "means-ends continuum" model for identifying rural development strategies appropriate to the JPA is illustrated in

this section by discussing selected rural development strategies that are of comparable experience and are under implementation elsewhere. There is no suggestion here that any of these strategies should or can be imported for socio-economic development in the JPA. The aim of the selection is to illustrate how each of these strategies has generated its particular agrarian structure, institutions, instruments and targets as means for achieving specified goals. Conversely, as suggested in Chapter IV, development of a particular rural development strategy is dependent upon the specific goals sought, the problematic gap between these goals and the existing situation, and the failure and success elements, both actual and potential, that account for the problematic gap.

At present, the principal policy issues in the JPA are identification, selection and implementation of an appropriate rural development strategy in order for the area to make the transition from subsistence production to sustained production and socio-economic development. Such a transition has been made and is being made elsewhere in Africa and the world. The selection of rural development strategies in this section therefore seeks to relate how the transition has been made or is being made, and to relate it to identification and selection of rural development strategies in the JPA through the "means-ends continuum" model.

The Gedaref and Gezira rural development strategies are selected for the purposes of this study because of proximity in

issues and geography, both areas being in the Sudan. Various aspects of these strategies have been discussed extensively elsewhere.[1] The discussions that follow will therefore be confined to how the expressed goals, the problematic situation and major failure and success elements in the physical, institutional and economic environments have shaped the rural development strategy, and what impact the strategy has had or is having on traditional society.

The Gedaref rural development strategy

The agrarian structure that has evolved in Gedaref District in the Central Clay Plains of Central and Eastern Sudan is an example of how a development strategy has led to disruption of traditional society, and destruction of the soil resource. The Gedaref strategy is based on mechanized rainfed agriculture under leasehold of land to private individuals who are able or enabled by the government to afford the large capital investments.

The strategy was conceived during the early years of World War II. Its primary goal was to satisfy the increased demand for sorghum

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[1]For the Gezira, see for example, A. Gaitskell (37); a critical view is given by Tony Barnett (11). For Gedaref, see Farah Hassan Adam and El-Tayeb El-Amin Mohammed (3).

grain to feed British armies in East and North Africa (3:2). The inability of traditional subsistence agriculture, from which grain had been extracted, to cope with increased war demands delineated the problematic situation. Mechanization of agricultural production was suggested as the remedial alternative that would ensure adequate and reliable grain supply for the war effort.

Large mechanized crop production schemes (MCPS) under state management were established. Labor requirements were met by recruitment from displaced peasantry in the towns.

After the war, it soon became clear that the MCPS could not be run profitably under state capitalism. A system of participating cultivators was therefore introduced as an agrarian reform measure. Under the new system, government management was responsible for plowing and sowing the fields, while the cultivator weeded and harvested the crop. Profits were divided equally between the two partners, with the cultivator paying 10 percent of his share in taxes.

State-sharecropper capitalism, however, was an unstable and unhappy marriage based on seasonal love. The annual weddings proved to be costly. Neither government management nor sharecroppers had an ultimate stake in agricultural development; since for the former, salaries and therefore livelihood were only remotely related to efficiency; while the latter could easily and quickly fall out of love and not recontract if alternative more renumerative employment

could be found. According to Adam and Mohammed, the schemes failed for the following reasons:

> (1) Production was seasonal and the sharecroppers had to look for alternative employment during off-season and there was often uncertainty as to which of the sharecroppers would come back the following year; (2) sharecroppers or government did not construct permanent settlements because of these uncertainties; (3) scarcity and inefficient management of capital; (4) high administrative costs--all these factors caused government to run the schemes at a loss (3:3).

The MCPS could not be run at a loss indefinitely. In 1959, the government abolished state-sharecropper capitalism all together. Instead, a system of leasehold to private individuals was instituted. Under the new system land allotments were made through "native" land allotment boards to partnerships, to individuals in the locality who could purchase mechanized equipment and to Sudanese from other areas on an 8-year lease at a nominal rent of one piastre per feddan ($0.019 per acre). One lease was set at 1000 feddans and, according to Adam and Mohammed, a capital of LS 2,000 to 2,500 has usually been necessary to farm it. With efficient operation, net profits of over LS 5,000 in one season have been possible under the leasehold system.

The 8-year lease was certainly an improvement over the one-year lease but still ". . .the inadequacy of legal provisions to ensure better management of land and the fixation of rents below the economic level acted as incentives for lessees to mine the soil through unplanned extensive use of the land" (3:5). Faced with a rapidly deteriorating soil quality, the government established the

Mechanized Farming Corporation (M.F.C.) in 1968, and ". . .entrusted it with the responsibility of disposal of rainlands in an attempt to cure some of the insufficiencies of the 'leasehold' system" (3:6). Under the M.F.C., the size and period of lease were increased to 1,500 feddans and 25 years, respectively, by 1970.

At the beginning of the present Six-year Plan (1977/78 to 1982/83), the private mining of land in Gedaref district was broadened to include participation by foreign capital as well. According to Adam and Mohammed:

> Future plans for development of rainfed mechanized agriculture advocate an "open door" policy with respect to the 'flow' of foreign capital into mechanized farming. The Six-year Plan for the M.F.C. gives absolute priority to private investment (foreign and/or domestic) for the horizontal expansion of mechanized rainfed schemes into new areas, while the role of the government subsector is perceived only in the sphere of consolidating and improving the existing situation in infrastructure through the sale of "package deals" of technological inputs and facilities with high capital intensity and of low public profitability. . . . Out of a total net area of 5 million feddans that 'shall' be allotted and developed during the Six-year Plan period, about 1.5 million feddans have already been conceded to large foreign agricultural concerns (3:8).

In terms of the "means-ends continuum" model, the preceding brief presentation shows how the prevailing and emerging agrarian structure in the Gedaref area is being generated by a rural development strategy that is based on extensive mining of the soil resource and exploitation of displaced labor from traditional society. The initial aim of the strategy has been slightly changed to become that of making large profits in the shortest time possible.

The institutions that have evolved, (such as state farms, state-sharecropper capitalism, private leasehold tenure, seasonal employment arrangements, etc.) and the policy instruments that have been used from time to time (such as changes in size and period of tenure, government loans, extension of leasehold to international capital, wage rates, etc.) have all been designed to enhance the primary goal of making quick profits.

The Gedaref strategy has sought to eliminate or modify failure elements, or to expand success elements to the extent possible only when they impeded or promoted the primary goal of private local and international capital. Not much consideration is given to failure and success elements in the physical environment and in the institutional and economic environment of traditional society unless these elements are directly related to the strategic goal of making quick profits. The soil resource, for example, is completely forsaken. Since agricultural production is temporary from the point of view of both the leaseholder who moves to a new area every five years, and the seasonal agricultural labor, the situation of extensive soil mining that prevails can only be expected. Soil mining will likely aggravate desertification in the region since Gedaref boarders the Sahara Desert.

In the context that the soil resource and the indigenous sedentary and nomadic communities of the region are neglected and abused, it can be said that the Gedaref model is not a rural development strategy, but rather, a natural resource mining

operation. Nevertheless, the proces of identifying and selecting appropriate rural development strategies for the JPA can benefit from the experience of Gedaref.

More specifically, an appropriate rural development strategy for the JPA would need to avoid four major insufficiencies and excesses of the Gedaref strategy.

1. Emergence of absentee leaseholdism, rack-renting and eventual concentration of land. Experience with the Gedaref strategy shows that the majority of the leases are allocated to ". . .big merchants, big owners of animal wealth, businessmen and pensioners of the military and civilian bureaucracies." Moreover, those with limited capital who acquire leases ". . .resort to big farmers and/or merchants to finance such schemes on their behalf." The emergence of a class of absentee leaseholders, rent-racketeers and eventual landlords is evident in the Gedaref area. This trend of concentration of the means of production in land in few hands has been known to impede agricultural development in Asia and Latin America, and is the subject of land reform and revolutions at present in these regions.

2. Transfer of agricultural surplus into unproductive investments and conspicious consumption. The types of investors who obtain leases, as above, ". . .manage to drain a substantial proportion of surplus production into unproductive uses, leaving only a negligible fraction for reinvestment into productivity activity." According to a study by El Amin among the leaseholders of Habila area in the Gedaref area ". . .56 percent of the total accrued economic

surplus is invested in trade; 25 percent in real estate and/or nonproductive activities like weddings and circumcision festivals; while only 19 percent is reinvested in agriculture" (71b:20). The Gedaref strategy thus serves neither agricultural nor industrial development.

3. Neglect and mining of the soil resource. The preceding insufficiencies and abuses constitute mining and eventual exhaustion of the soil. In effect, the Gedaref strategy falsely assumes that land is abundant and therefore inexhaustible. Leaseholders, out of private and against social interest, find it cheaper to move to new areas instead of conserving and developing the soil resource in the same area. Adam and Mohamed see deteriorating soil quality as a major constraint on capital accumulation in the long term. According to the authors:

> The process of capital accumulation is further restricted by severe exhaustion and undermining of the natural resources made possible by the "unplanned" extensive use of the land and the instability of the farming system, allowing the scheme operators to shift to new locations every five years on the average (3:20).

4. Neglect and immiserization of traditional society. The basic aim of socio-economic development, as expounded in Sudan's development plans, should be people and their needs (24; 25). The primary goal of an appropriate rural development strategy, as developed in this study from this official assumption, is therefore to enable the people of the JPA to make the transition from subsistence production to sustained production and socio-economic development in their

own benefit and that of the region and nation. However, as observed by Adam and Mohamed, the impact of the Gedaref strategy has been ". . .intervening with the customary land and water rights of the 'traditional' communities and forcing both the nomad and the sedentary 'subsistence' cultivator out of his 'homeland' into an uncertain market of wage employment" (3:9).

A major policy implication of the Gedaref strategy with respect to traditional society is to transform it into a labor reserve hinterland, for surely the strategy is inviable without immiserization of traditional society. According to Adam and Mohammed:

> The deterioration in the production and living conditions of the 'subsistence' communities made possible by the expansion of mechanized agriculture on a massive scale has . . . ensured a readily available flow of labor more than adequate to cater for the seasonal needs of mechanized schemes . . . the majority of the workers are unskilled seasonal immigrants withdrawn largely from the nomadic and sedentary village communities inhabiting the Central Clay Plains region, and are paid variable daily wage rates, commonly set on miserable levels depending on the type of the agricultural task performed, the age and sex composition of the work force and the general conditions of supply and demand for labor (3:21).

In relation to what to do with traditional society, the IRD and Gedaref strategies can be viewed as polar opposites. While IRD strategy seeks to preserve traditional society, making only marginal changes and improvements (what has been referred to in this study as misery management), the Gedaref strategy seeks to destroy traditional society, and to utilize the resulting misery for enrichment of local and international leaseholders.

The Gezira rural development strategy

The Gezira model is an example of a unique way failure and success elements in the physical, social and economic environments of an area have been successfully forged together into a rural development strategy that has produced the largest farm on earth under one management. The JPA, as well as other regions in Sudan and Africa, have a great deal to learn from experience of the Gezira strategy.

Gaitskell traces development of the Gezira scheme to the beginning of this century. The Gezira model, like Gedaref of the previous section, evolved from a necessity to satisfy external economic demands during the colonial period. Specifically, the Gezira Scheme was a response to demand by the Lancashire Cotton Industry which, until the beginning of the twentieth century, had monopolized world cotton trade, but was increasingly becoming threatened by growing competition from the United States, Germany and to some extent China. These areas were competing with Lancashire in both the output and input markets.

The Sudan, then under British occupation, was found to provide excellent conditions for safe and cheap extraction of raw cotton in the Gezira, the "island" between the White and Blue Nile Rivers south of Khartoum. According to Barnett, ". . .the only way to solve the problem of Lancashire was by creating a safe and dependable supply of long staple cotton . . . from an area in which Britain would have a virtual monopoly of purchase" (10:188).

In their fight to push through Parliament the huge loan (3 million pounds, Sterling) needed to finance construction of the Sennar Dam for irrigation of the Gezira, the Lancashire Members of Parliament were unambiguous in expressing the plight of Lancashire and the concomitant necessity to develop the Gezira. One member summed up consensus of the argument as follows:

> Experiments have abundantly proved that the Sudan is not only the finest cotton growing country in the whole of the British Empire, but, what is more important, that it can grow that sort of cotton Lancashire requires. This is a subject of vital importance to the textile north, and it is essential that the millions engaged in and dependent on the cotton industry should no longer be at the mercy of bad seasons in India or North America. If the shortage of raw materials is to be prevented, Lancashire must be placed above the hazards of speculation and climate. This loan will develop the resources of the Sudan under British guidance in a way which will ensure the more permanent prosperity of the cotton industry (11:5).

The loan was approved and the rest is history. After the interruption caused by World War I, the Sennar Dam was completed in 1925, and the Gezira Scheme finally got under way.

Unlike Gedaref, which is based on crude mining of the soil, the technology of the Gezira strategy relies on complex irrigation and rotation systems. The strategy evolved from realization that the severity of some of the failure elements in the physical, social and economic environment of the Gezira area could not permit the British commercial companies to effectively take advantage of the area's success elements to achieve the primary aim of cheap cotton for Lancashire. Accordingly, a system of tripartite "partnership farming" was organized among the government as "sponsor," the

Lancashire private companies as "management," and the indigenous population as "tenants." The underlying argument is that there are certain services (remedial measures) that one of the partners can deliver effectively, but which one or both of the other partners can not afford.

Under the partnership, responsibilities in the joint farming were defined in a legal contract. The government's function has been to construct dams and build irrigation canals, and to undertake research. The tenant has been responsible for providing the labor necessary during sowing and harvesting and for the general care of the crop(s). Management has been charged with preparation of land, supervision, marketing, and the provision of economic, technical and social services such as erection of agricultural buildings including housing and storage facilities, the provision of credit and other inputs, the ginning of cotton, etc.

When implementation of the strategy started, each tenancy was set at 30 feddans (31.1 acres). One-third of this was planted with cotton, another third with tenant family food crops, and the remaining third was left fallow to "rest." In 1933/34, tenancy size was increased to 40 feddans (41.5 acres), with one-quarter of this allocated to cotton, one-quarter to food crops and one-half left fallow. Tenancy size has dropped over the years and presently ranges between 20 and 40 feddans (20.8 and 41.5 acres); this has probably been due to the following reasons: death of operators, which in practice resulted in parcellation, although the unit of land was not legally

to be passed on as inheritance; the break-up of many partnerships into units operated by farmers singly; the desire by farmers to give pieces of land to relatives whom it was desired to keep in the village; and the desire to avoid hiring labor and therefore the relinquishing of part of the land (89:384).

The shares of the product among the three partners, although varying over time, have maintained the general initial pattern of distribution. Between 1924 and 1950 the farmers got the whole of food and fodder (dura, lubia, vegetables, etc.), while proceeds of the cotton crop were divided into 40, 40, and 20 percent to the government, the tenant, and the managing company, respectively. With the dawn of independence for the Sudan in the early 1950s, the management component of the partnership was nationalized, and the functions of the Lancashire companies were taken over by a government parastal, the Sudan Gezira Board. The division of the net cotton proceeds was revised to be 42 percent for the government, 12 percent for the Board, and 46 percent for the tenants. At present, the tenants as a group receive 50 percent of the net cotton and cotton seed proceeds, while the Government and the Board receive 38 and 10 percent, respectively. The remaining 2 percent is allocated to the Social Development Department of the Sudan Gezira Board for financing adult education, provision of piped drinking water, housing, entertainment, veterinary services, social research in the scheme, etc. The tenant's share includes a 2 percent that

goes to Local Government Councils within the irrigated area as contribution to health and educational facilities in the region. The share of the Board goes to meet its administrative costs, and any surpluses are transferred to the Government as contributions to research and development.

In general outline, the preceding presentation is what has been described as the Gezira model of rural development. There are many issues that could not be covered, as they are beyond the scope of this study.

In terms of the remedial phase of this study, some contributions of the experience from the Gezira model to the process of identifying and selecting rural development strategies for the JPA relate to the following considerations: (1) the technological innovations by which the strategy ameliorates physical and technological disincentives, which, as discussed in the linear programming section of the diagnostic phase, dominate social and economic incentives in the JPA; (2) the way in which the strategy defines the role of traditional society in relation to the stipulated new forms of modern agricultural production; (3) the extent to which the strategy enhances generation of capital and knowledge for sustained socio-economic development and, hence, a test for the viability of the strategy; and (4) the extent to which the str ·egy promotes class differentiation among and within management and tenantry insofar as this impacts on economic and social incentives.

1. Amelioration of physical disincentives. The major physical

disincentives to sustained agricultural production in the Gezira area include insufficiency and unreliability of the rains and the difficult tillage conditions of the heavy clay soils. Specific technological innovations aimed at ameliorating these failure elements, and that are principal aspects of the Gezira model, are irrigation and mechanization of difficult agricultural tasks, such as land preparation and first weeding, that would restrict extension of the cultivated if they were performed wholly by hand. Given the low levels of incomes and knowledge in the Gezira, these technological innovations could not be adopted by traditional farmers without outside assistance. The traditional society simply could not generate sufficient capital to finance construction of dams and irrigation networks. Government intervention to remove or modify principal physical disincentives is therefore a necessary condition in the Gezira-type model. Furthermore, once dams and irrigation networks are put in place, their efficient management and provision of other complementary inputs become necessary.

2. Role of traditional society. The definition of the role of traditional society in the new forms of production, and the underlying assumptions on which such definition is based are extremely important in the process of transition of traditional society from subsistence production to sustained production. This is well illustrated in the Gedaref strategy which defines traditional society as a reserve for agriculture wage labor. It is also well

illustrated in the Gezira model which defines traditional society (tenantry) as partners in the new forms of production, albeit a very junior partner.

The junior status of the tenantry in the Gezira Scheme, which accounts for the continued alienation of the tenants in the production process, has its basis in the colonial origins of the partnership. According to Barnett, the organization of the initial Gezira partnership was based on the "theory of the organization of native labor," which defined such labor as primitive and in need of control for its efficient utilization in production. Barnett lists three assumptions underlying this theory:

> First, native labor is by its nature recalcitrant, and therefore requires authoritarian treatments; second, native labor lacks initiative, and therefore requires very detailed directives and instructions; and third, native labor can within limits, be improved, and the 'civilizing' function of authoritarian methods in some way ligitimizes those methods (10:200-201).

The operational form of the Gezira strategy was therefore ". . .inevitably based on control rather than on communication." The Lancashire companies and after them the Gezira Board became the effective managers in the partnership, determining the use of factors of production including land, capital, water, and even labor. The tenant became relegated to a position where his labor ". . .is to be controlled and manipulated" to achieve the goal of cheap cotton for Lancashire, and now capital revenue and export earnings for the Government.

3. Generation of capital, employment and knowledge. As discussed in the delimiting phase of this study, the Gezira Scheme and its prototypes are central to Sudan's agriculture and national economy in generating capital, employment and applied research. These contributions are well-documented in the literature. Sayigh, for example, summarizes the contributions of the Gezira to the Sudanese economy as follows:

> According to a study by IBRD made in 1966, it is estimated that 66 percent of long staple cotton, 47 percent of beans, . . .and 12 percent of maize (dura) in the country are grown on Gezira land. The Scheme also provides some 30 percent of government revenues (if export fees are included) and 35 percent of export earnings . . . about 7 percent of net domestic product is directly attributed to the Scheme, while indirectly imputable contribution amounts to about 30 percent (89:386).

The Regional Government in Southern Sudan at present has no significant sources of revenues, depending as it does on annual remittances from the Central Government. In so far as the JPA is one of the major potential contributors to Regional development (see the delimiting phase), the Gezira model clearly commends itself as a means for generating government revenue. The Regional Government in the Autonomous Southern Sudan can not continue to be viable for long unless there are schemes in the Southern Region that can generate adequate revenues for Regional Government administration, and for sustained socio-economic development of the Southern Region.

4. Class differentiation and incentives. The relations among the partners in the Gezira Scheme are still characterized by the initial assumptions from its colonial beginnings. Management still

remains a distinct class and retains decision making powers on behalf of the tenants whose function is still assumed to be correct execution of orders. In addition to being a burden on the capital formation capacity of the Scheme, the monopolization of all managerial functions by the government robs the tenants of initiative to increase production and of the educative role of the production process. Dualism is therefore maintained, since the tenant is systematically denied the opportunity of internalizing the various aspects of modern production techniques including decision making procedures.

A second form of class differentiation arises within the tenantry itself. The tendency of the partnership system in the Gezira to lead to creation of ". . .conditions for the rise of a group of differentiated tenants," has been noted by several authors on the Gezira. Adam, for example, reports that:

> Almost more than two-thirds of the tenants are poor, operating a cotton tenancy of five feddans and less, one-third of the tenants are medium operating a cotton tenancy that varies in size between ten and twenty feddans; while only 2 percent of the tenants are rich, supervising one or more cotton tenancies equal to or greater than twenty feddans in size. . . . The rich tenants receive almost half of the income from cotton without contributing to manual work, and the medium and the poor groups of tenants obtain two-fifths of cotton's income offering a part of their labor to meet about a quarter of the total manual labor requirement of cotton, while agricultural wage-labor, both permanent-resident and seasonal-migratory performs almost three quarters of the total cotton manual labor tasks, but receives only one-tenth of the cotton returns (2:10).

Barnett suggests that differentiation among the tenantry was brought about and is maintained by the credit institutions in the

Gezira. Initially, the planners of the Gezira Scheme assumed that a tenancy could be worked by family labor alone; but it has always been necessary to hire labor from within and outside the Scheme during peak labor periods, such as weeding and harvesting. On the other hand, income from a tenancy has often not been sufficient to cover the costs of hired labor. Consequently, the majority of the tenants resort to borrowing in excess of the cash advances made to them by the Board in order to pay for the hired labor. The resulting credit gap has attracted a small group of rich tenants and other nontenant entrepreneurs who provide credit to poor tenants at exorbitant interest rates. Barnett sees the credit system as contributing and maintaining the state of underdevelopment in the Gezira. He argues that:

> The credit arrangements at the village level are vital to the reproduction of the overall structure. The tenant dependent upon his tenancy is able to live on his low income only because he can get credit. Therefore, the cotton which he produces can be sold at a low price. In order to remain viable, in order to subsist, he has to depend upon credit. . . . The tenant is highly dependent on purchasing food and consumer goods from the shops because the Scheme within which he works has removed from him, to a very considerable degree, the possibility of complete production for his own subsistence and that of his family. Thus, in effect, the continued operation of the Gezira Scheme depends upon the willingness of the lenders to lend, and their ability to spend their profits for the purchase of imported goods (10:197).

The preceding sample of insufficiencies and successes of the Gezira strategy are not necessary aspects of the model's operation. Essentially, the Gezira model is a sharing arrangement in which the three partners (Government, management and tenants) share in the

provision of inputs and in the distribution of outputs. The insufficiencies in capital creation, incentives, class differentiation and definition of traditional society, for example, could and would need to be avoided by a rural development strategy that sought to emulate the Gezira experience. Avoidance of such failure elements, as above, depends on specification of clear goals, development of the problematic situation and definition of the relations among the three partners, including the assumptions on which such definitions are based.

Suggested Planning Elements Upon Which An Appropriate Rural Development Strategy For the JPA Might Be Based

It has been emphasized throughout this study that identification and selection of an appropriate rural development strategy for the JPA is necessarily interdisciplinary in approach. An interdisciplinary planning team is best suited to formulating a specific rural development strategy for the JPA. This section explores possible contents of an appropriate rural development strategy for the JPA.

As discussed in Chapter IV, an appropriate rural development strategy for the JPA is the science and art whereby the Executive Organ could employ the existing and potential physical, institutional and economic resources from within and from outside the JPA in order to secure stated goals of regional and national policy. As a science, such strategy can benefit from application of the "means-ends

continuum" model by incorporating its results, such as the existing and potential failure and success elements developed in Table 6.1. As an art, an appropriate rural development strategy evolves and matures through sustained application. As new failure elements are encountered and remedied or modified, and as new success elements are identified and taken advantage of, the strategy grows and matures.

The science and art of rural development strategy could also benefit from comparative experience, such as the ones discussed in this chapter under IRD, Gedaref and Gezira. However, farming models are unique spatially and temporally. Whereas lessons can be learned from comparative experience, the exact form of the model can not be imported in total. The art component of rural development strategy, evolving from practice, can not be universal even if the science component may be universal, and hence, the nontransferability of successful farming models across societies and times. The non-importability of farming models is best summarized by Morss who relates the following story:

> An Asian educated in the West recently had dinner with Mao Tse-Tung after having spent a week studying the agricultural system of China. Moa asked the visitor what was the primary lesson he had drawn from his examination. The visitor said he had been tremendously impressed by all aspects of Chinese farming and urged Mao to make some of his farm experts available to advise other countries that were not doing so well. At this point, Mao looked very pained and said he was very disturbed if this was the major impression the guest had retained. Needless to say, this troubled the guest and asked Mao what his primary impression should have been. Mao replied that there were no easy solutions, that the complex system the Chinese use had evolved over many years and had entailed many mistakes. Mao said it would

> be wrong to attempt to apply the Chinese approach elsewhere, and that the only thing that was replicable from the Chinese experience was the slow, painful, dialectical process of experimentation that the Chinese had pursued over a number of years (72b).

Against the foregoing background, a rural development strategy aimed at achieving the objectives developed in the delimiting phase for the JPA, and based on success and failure elements as developed in the diagnostic phase and summarized in Table 6.5, would likely seek to incorporate the following planning elements in its basis:

1. Development of drainage and irrigation, since it is unlikely that any rural development strategy implemented in the JPA can result in significant development unless the physical disincentives to farming caused by the frequent dangers to crops from floods and droughts are removed or drastically reduced;

2. Introduction of specific mechanical power technology that is adaptable to the area; that takes into account the physical, institutional and economic elements in the environment of the JPA; and that can effectively provide physical incentives for development on the magnitude stated in the delimiting phase;

3. Establishment of at least one training and research institute in the JPA to provide systematic and continuing means for identifying new failure and success elements, and discovering ways to remedy the failure elements or expand the success elements;

4. Introduction of new forms of tenure and firm organization consistent with demands of modern sustained production, but not disruptive of traditional society in a major way;

5. Spatial reorganization of the countryside into more compact villages than the present dispersed pattern of homesteads and farm plots;

6. Full use of the Jonglei Canal, especially in its transportation role, so as to link the JPA with external and national markets;

7. Development of at least one export crop, such as rice, and search for potential external markets;

8. Efficient channels for provision of modern farm supplies and complementary public services in order to prevent emergence of class differentiation as happened in the Gezira and Gedaref;

9. Self-reliance and efficient use of local resources, including abolition of or extensive modification in the annual transhumance;

10. Provision of economic incentives with respect to output and input prices, once major physical disincentives are removed or adequately modified.

Some of the above planning elements could be incorporated into development programs based on either the improvement or the transformation approach. However, as shown in this study, the most critical planning elements (items 1, 2, 4 and 5) that could ensure sustained socio-economic development of the JPA, appear to be consistent with the transformation approach. Development programs based on the improvement approach, such as UNDP's and ILACO's IRD Projects, do not incorporate these four planning elements. It is, therefore, unlikely that the improvement approach can be relied upon

to lead to achievement of the goals development in the delimiting phase of this study.

CHAPTER VIII. SUMMARY AND RECOMMENDATIONS

The central objective of this study is to develop an analytical framework and procedures for identifying and selecting appropriate rural development strategies for the Jonglei Projects Area (JPA) in the Southern Region of the Sudan.

The question of appropriate rural development strategies for the JPA became a major policy issue in the Sudan when Egypt first proposed construction of the Jonglei canal in the 1940s, and again after 1974 when Egypt and Sudan reached final agreement to construct the canal. In both instances, the question of socio-economic development in the JPA was viewed mainly from a localized perspective of how to compensate and protect the inhabitants of the JPA from adverse effects resulting from construction and operation of the canal.

In this study, socio-economic development in the JPA is discussed within the context of the national economy and national goals. The Sudan is among a small number of countries in the world that still has vast agricultural production potential estimated at more than 200 million feddans suitable for agricultural use. It is on the basis of this potential that the Sudan has declared a national objective to become the "Breadbasket of the Middle East" and a major granary of the world. Identification of an appropriate rural development strategy for the JPA is viewed from the perspective of this potential and national goal. This interpretation

of the national context and possible extent of socio-economic development in the JPA is consistent with the mandate of the National Council for Development Projects in the Jonglei Canal Area, which calls for planning and implementation of integrated economic and social development projects in the area and derivation of maximum benefit from the condominiums created by the Canal Project for providing new living conditions to the inhabitants of the Jonglei Canal Area (22:5).

Chapter II develops the justification for considering socio-economic development in the JPA within national priorities and not as a local problem of compensation for adverse effects of the canal. Sudan's breadbasket potential is presented and discussed, and the JPA is identified among regions with the greatest agricultural potential. A major finding of this chapter is that the growth areas of North-central and North-eastern Sudan will run out of irrigation water as early as 1983/84. If Sudan is to realize the objective of becoming the "Breadbasket of the Middle East," modern agricultural schemes must in the future be established in areas that can support rainfed agriculture.

The JPA, delineated in Chapter III to include the whole of the Southern Clay Plains, is the most suitable region in the Sudan for large-scale rainfed agriculture. The relevance of the Jonglei Canal to the Dinka, Nuer, Shilluk, Anyuak and Murle people of the JPA is therefore not that the canal interferes with their traditional ways of life, but rather that it (1) opens up hitherto

dormant opportunities for socio-economic development in the JPA and (2) provides real opportunities for regional and national integration of the area. This study, therefore, concluded that current planning by the Executive Council of the National Council for Development Projects in the Jonglei Canal Area, that emphasizes Integrated Rural Development projects aimed at marginal improvements in the traditional subsistence economies of the JPA, is inadequate and neither in the long-term interests of the inhabitants of the JPA nor those of the nation.

The preceding considerations suggest that formulation and development of an appropriate rural development strategy for the JPA is the most important policy issue for the National Council for Development projects in the Jonglei Canal Area. Chapter IV of this study proceeds with development of an analytical framework and procedures for identifying and selecting appropriate rural development strategies. A preliminary application of these methods to the JPA is made in the following three chapters of this study. However, as argued in this study, identification and selection of rural development strategies is necessarily interdisciplinary, and formation of an interdisciplinary team for this purpose is strongly recommended in this study.

The analytical framework developed in this study suggests that conclusions and recommendations from its application be presented together. The diagnostic phase of the study incorporates conclusions, while the delimiting and remedial phases suggest

recommendations. The remainder of this chapter, therefore, restates the objectives of this study and summarizes the conclusions and recommendations as they relate to each objective.

The objectives of the study are:

1. To provide a framework for examining rural development strategies for socio-economic development of the Jonglei Projects Area (JPA) by focusing on: (a) the goals of socio-economic development in the JPA as they relate to national goals; and (b) the resource potential of the JPA in terms of the area's contribution to regional and national goals;

2. To ascertain the adequacy of the existing agrarian structure and rural development strategies in the JPA as means to realizing the resource potential and achieving the goals referred to in the preceding objective;

3. To evaluate alternative rural development strategies, from within Sudan's experience, that may be adapted in the JPA; and

4. To suggest planning elements upon which an appropriate rural development strategy for the JPA might be based.

An analytical model based on the "means-ends continuum" conceptual framework, is developed and discussed in Chapter IV to achieve the first objective. The model is an adaptation and generalization of a model developed by Timmons (94). This model, schematically presented in Figure 4.2, consists of three main steps.

The first step, termed the problem delimiting phase and applied to the JPA in Chapter V, develops and states specific goals for

rural development and identifies the existing situation of socio-economic development in the area. The difference between the stated goals and the existing situation constitutes the problematic situation upon which development policy focuses.

The second step, termed the diagnostic phase and applied to the JPA in Chapter VI, identifies and analyses (1) failure elements that are responsible for the problematic situation, and (2) success elements that are responsible for the problematic situation not getting any larger. New success elements and potential failure elements are also identified in the diagnostic phase to the extent possible. Within the diagnostic phase linear programming models and procedures are developed for application to the JPA to supplement the "means-ends continuum" analytical framework in pursuing the goals of this study.

The third step, termed the remedial phase and applied to the JPA in Chapter VII, identifies rural development strategies that are consistent with eliminating the failure elements and expanding the success elements identified in the diagnostic phase. A major hypothesis is made in the remedial phase to link identification and selection of rural development strategies to their implementation. This hypothesis is that a particular rural development strategy maps or implies a unique set of agrarian institutions that constitutes the strategy's agrarian structure. Furthermore, agrarian institutions and their instrumental variables are necessary means for achieving goals of rural development. The

remedial phase therefore includes development and institution of agrarian structures that correspond to the particular development strategy that is identified and selected.

The second objective is discussed in Chapter VI. A conceptual framework is provided in Figure 6.1 for use by an interdisciplinary team to identify physical, institutional and economic failure elements which restrict the cultivated area and agricultural output in the JPA. Results of linear programming models are interpreted to determine the extent to which the failure elements impact on farmer decision making, and to evaluate the adequacy of the existing agrarian structure and the strategy of improving traditional agriculture as means for achieving the goals developed in the delimiting phase.

Results from the linear programming models appear to support Evans Pritchard's contention that the economies of the JPA have reached a low stationary equilibrium. Under existing technologies and agrarian structure in the JPA, optimal cultivated area for the "composite" farm is 2.1 feddans if household members work 4-hour days, and 3.7 feddans if they work 6-hour days. These results are supported by empirical results of an average household farm size of 2.5 feddans found by El Sammani and Hassan (29:19), and 2.8 feddans by an ILACO farm survey team (62:92). Furthermore, optimal farm plans for each cropping activity are valid over a wide range of prices and/or yields. The low optimal cultivated area and its insensitivity to increases in prices and/or yields are

taken as proxy measures of the severity of labor bottlenecks during peak periods, and as an indication of the inadequacy of the existing technologies and agrarian structure as means of realizing the resource potential in the JPA.

Results of the linear programming models also show that rural development through the "improvement approach" is unlikely to lead to achievement of the goals developed in the delimiting phase. The "improvement approach" holds that modernization of present traditional subsistence agriculture could be achieved within existing production units and institutions through introduction of new and "appropriate" technologies. The basic technologies of the improvement approach, according to UNDP's and ILACO's versions of integrated rural development project in Kongor District (18; 55), include oxen farming and the use of herbicides and fertilizers.

A shift from traditional farming to herbicide technology would increase optimal cultivated area by only 0.2 feddan if household members work 4-hour days, and by 0.4 feddan if they work 6-hour days.

Adoption of oxen technology would increase optimal cultivated area by 1 feddan and by 1.7 feddans if the household works 4 and 6-hour days, respectively. The conclusion, drawn from results of application of linear programming to the JPA, that oxen technology is not appropriate to the JPA is reinforced by results of interviews that show that the inhabitants of the JPA are unlikely to adopt oxen farming.

The third objective is discussed in Chapter VII. Integrated rural development projects in the JPA and the Gezira and Gedaref models in North-central and North-eastern Sudan are evaluated as alternative rural development strategies for the JPA. A general conclusion is reached that none of these strategies could be adopted in total to the JPA. However, experience from these strategies could benefit identification, selection and implementation of appropriate rural development strategies in the JPA.

The Gedaref strategy is discussed to illustrate how a rural development strategy has led to disruption and immiserization of traditional society and destruction of the soil resource. The process of identifying and selecting appropriate rural development strategies for the JPA can benefit from experience of the Gedaref strategy by avoiding four major insufficiencies and excesses of this strategy. These insufficiencies and excesses are: (1) emergence of absentee leaseholdism, rack-renting of land and eventual concentration of the means of production in land in few hands; (2) transfer of agricultural surplus into unproductive investments and conspicuous consumption; (3) neglect, mining and eventual exhaustion of the soil resource by national and international leaseholders who find it cheaper to move to new areas rather than to conserve and develop the soil resource in the same area; and (4) neglect and immiserization of traditional society for the benefit of local and international leaseholders.

The Gezira is discussed in order to evaluate the unique way failure and success elements in the physical, social and economic environment of the Gezira Region have been successfully forged together into a rural development strategy that has produced the largest farm on earth under one management. The study identifies four issues from experience of the Gezira that are relevant to identification and selection of rural development strategies for the JPA. These issues concern the following aspects of the Gezira strategy: (1) the technological innovations by which the strategy ameliorates physical and technological disincentives; (2) the way in which the strategy defines the role of traditional society in relation to the stipulated new forms of modern agricultural production; (3) the extent to which the strategy enhances generation of capital and knowledge for sustained socio-economic development; and (4) the extent to which the strategy promotes class differentiation among and within management and tenantry.

Finally, the fourth objective is discussed in the last section of Chapter VII. No specific rural development strategy is recommended for the JPA. A specific recommendation of a rural development strategy would result from work of an interdisciplinary team applying the methodology and procedures developed in this study. Nevertheless, the study suggests ten planning elements that could form a basis for an appropriate rural development strategy aimed at achieving the objectives developed in the delimiting phase.

These planning elements are based on the success and failure elements developed in the diagnostic phase and comparative Sudanese experience discussed under the Gezira, Gedaref and IRD Strategies.

The study ends with the conclusion that development programs based on the "improvement approach," such as IRD projects currently under implementation in the JPA, will likely end up merely containing and managing poverty and misery in the area, unless they incorporate four of the ten planning elements suggested in this study. These four basic elements are: (1) development of modern drainage and irrigation works, since it is unlikely that any rural development strategy implemented in the JPA can result in significant development until the physical disincentives to farming caused by the frequent dangers to crops from floods and droughts are removed, or drastically modified; (2) introduction of specific mechanical technology; that takes into account the physical, institutional and economic elements in the environment of the JPA; and that can effectively provide the physical incentives to production on which success of economic and social incentives depends; (3) introduction of new forms of tenure and firm organization consistent with demands of modern sustained production and having their bases in traditional forms of organization; and (4) spatial reorganization of the countryside into more compact villages than the present dispersed pattern of homesteads that dot the JPA.

As argued in this study, the preceding planning elements are

more consistent with the transformation than with the improvement approach. It is therefore recommended that the Executive Organ of the National Council for Development Projects in the Jonglei Canal Area and the Southern Sudan Regional Ministry of Agriculture maintain active interest in "transformation approach" projects, such as the Jonglei Irrigation Project and the Pengkon Plain Development Project.

Suggestions for Further Study

Many qualifications have been made regarding the quality of the data used in the linear programming models. The data are experimental data obtained from the Pengkon Pilot Project, and the "composite farm" used in this study was constructed from these data. This procedure and the data were considered appropriate and sufficient for the methodological purposes of this study. Nevertheless, better data, in the sense of an actual farm survey, could be obtained to check the linear programming results used in this study. Other methods, such as production function analysis could also be used in place of the linear programming models.

The most appropriate use of the analytical framework and procedures developed in Chapter IV of this study could be made by an interdisciplinary team composed of teams of scientists from the

physical, chemical, engineering, biological and social sciences. Each team would develop analytical models for researching problems in their respective fields, and the resulting data used by the whole team to develop an appropriate rural development strategy for the JPA.

This study does not provide specific or general recommendations as to how an appropriate rural development strategy might be implemented, evaluated and monitored as a continuing process for development of the region as part of the national economy. Like the case of the linear programming models within the diagnostic phase, action or implementation models are needed in the remedial phase of Figure 4.2. This study lacked the time and resources to develop and apply these latter models to the JPA.

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APPENDIX A. SAMPLING PROCEDURES AND INTERVIEWS CONDUCTED IN THE JPA

Explorative interviews were conducted to provide perspective for this study. Results of the interviews are summarized in Chapter I of this study.

Two groups of respondents were interviewed. The first group comprised officials of the National Council for Development Projects in the Jonglei Canal Area and its Executive Organ, expatriate advisors and researchers in the JPA and regional and provincial authorities. The second group was the rural people in Kongor and Bor Districts.

The objectives of the interviews were to elicit reactions regarding the following issues: (1) objectives and extent of rural development in the JPA; (2) the political commitment in Southern Sudan to implement fundamental changes in the political, social and economic institutions of the JPA; (3) the state of readiness of the rural people to participate in change and their expectation of such change; (4) people's expectations with respect to government's role in rural development; (5) the types of technologies that could be adapted in the area; (6) how new technologies could be financed; and (7) the type of farm firm organization that could be adapted in the JPA.

With respect to the first group of respondents, the format was to interview according to echelons of responsibility starting with the chairman of the National Council for Development Projects

in the Jonglei Canal Area down to the district executive officer and agricultural officer. Expatriate advisors interviewed were those of ILACO's Pengkon Pilot Project and those associated with the Executive Council.

With respect to the second group, respondents were selected from tribal and clan organizations as shown in Figures A.1 to A.12 of this Appendix for Kongor and Bor Districts of the JPA. Each of these figures represents tribal organizations and Chieftancies in each Court Center. The name of the Court Center and Court President (Head Chief) are given in the top box in each figure. Sub-tribes and their chiefs make up the rest of the chart. The number of taxpayers (male adults, 18 years and over) are included in parentheses under each Chieftaincy. The total population of each Court Center or Chieftaincy is derived by multiplying the number of taxpayers by a factor of 7. Using this procedure, the population of Kongor District would be about 137,000, while that of Bor District would be about 111,000.

Interviews were conducted in seven of the 12 Court Centers in the two Districts. These were Werkak, Kongor, Wangkulei, Paliau, Maar, Jalle and Baai-dit. Two of the other Court Centers, Duk Fadiet and Duk Fawiel were inaccessible by road due to floods. There was no time to visit Anyidi, Makuac, and Kolnyang. In each Court Center, the President, all his chiefs and five elders from each clan were interviewed. The interview was then opened up to others

in the form of discussion. In Kongor and Wekak Court Centers about 1,000 people attended these meetings; in Wangkulei, about 750; in Paliau, about 300; in Maar, about 400, in Jalle, about 400; and in Baai-dit, about 500.

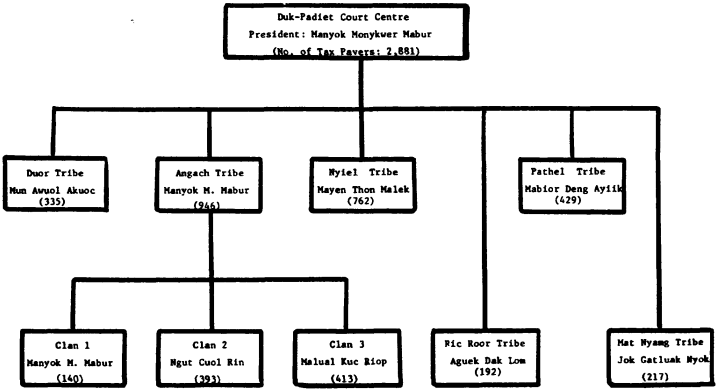

Figure A.1. Duk-Padiet tribal and clan organizations, Kongor District, Jonglei Province, Sudan

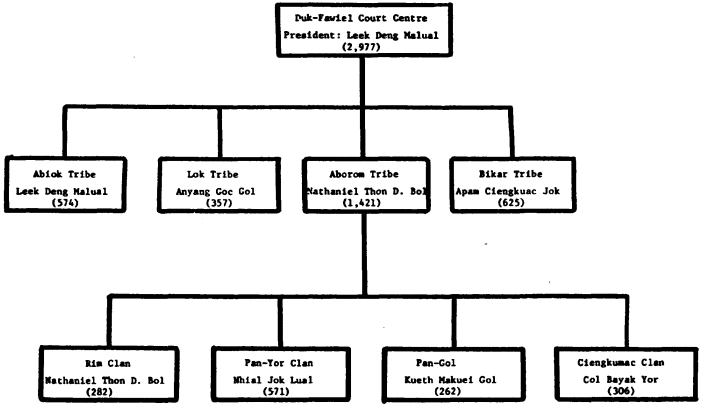

Figure A.2. Duk-Fawiel tribal and clan organizations, Kongor District, Jonglei Province, Sudan

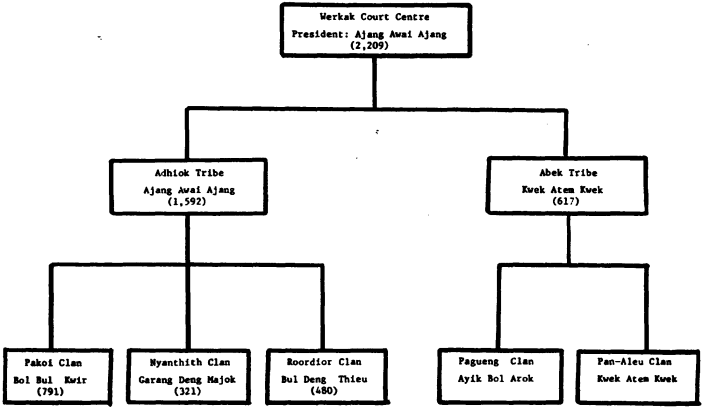

Figure A.3. Werkak tribal and clan organizations, Kongor District, Jonglei Province, Sudan

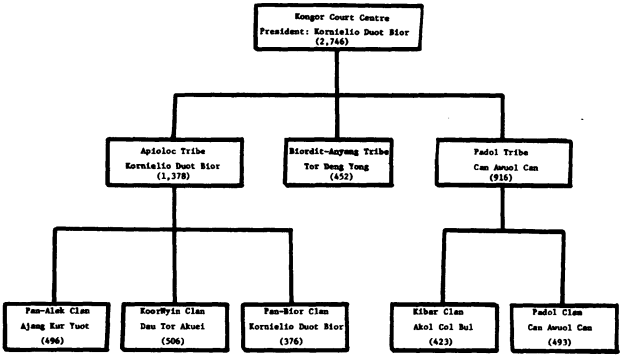

Figure A.4. Kongor tribal and clan organizations, Kongor District, Jonglei Province, Sudan

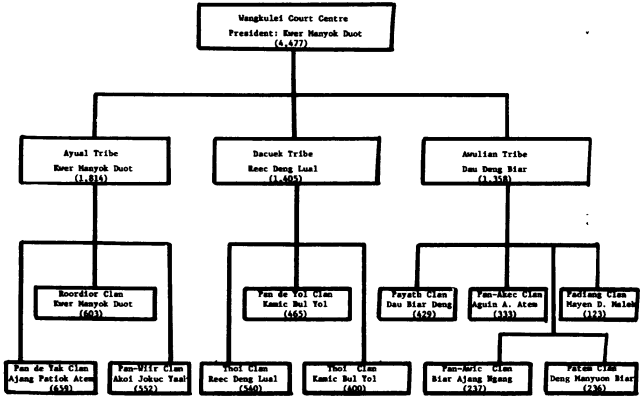

Figure A.5. Wangkulei tribal and clan organizations, Kongor District, Jonglei Province, Sudan

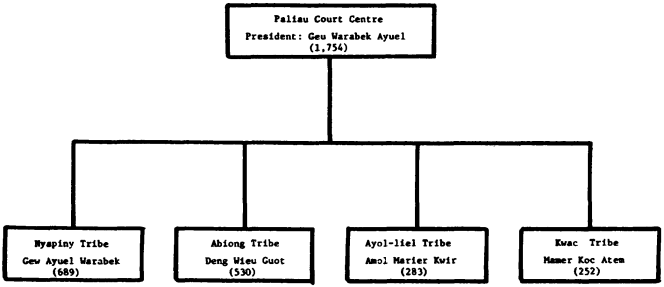

Figure A.6. Paliau tribal and clan organizations, Kongor District, Jonglei Province, Sudan

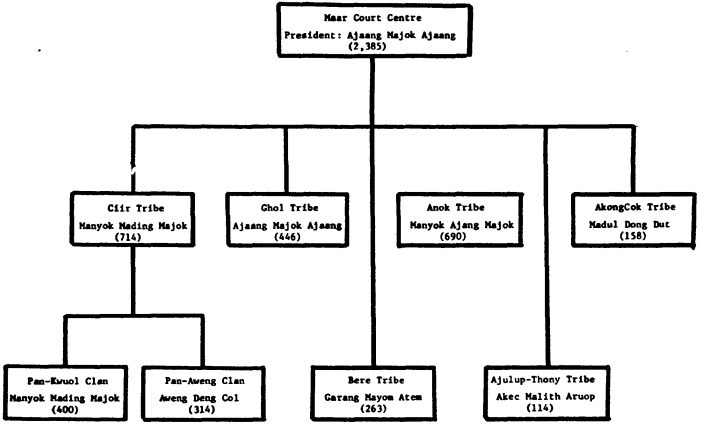

Figure A.7. Maar tribal and clan organizations, Kongor District, Jonglei Province, Sudan

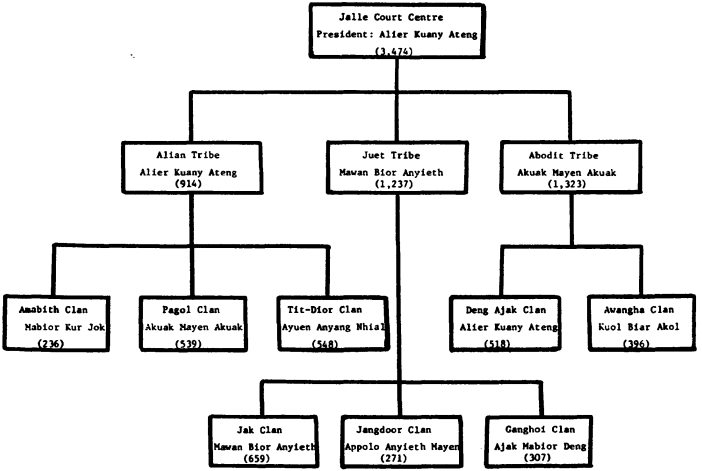

Figure A.8. Jalle tribal and clan organizations, Kongor District, Jonglei Province, Sudan

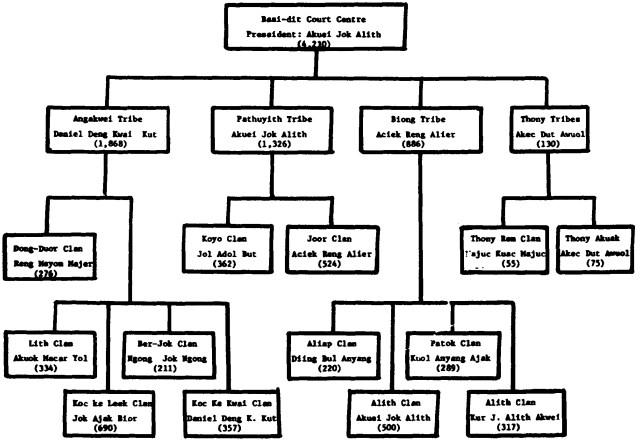

Figure A.9. Baai-dit tribal and clan organizations, Kongor District, Jonglei Province, Sudan

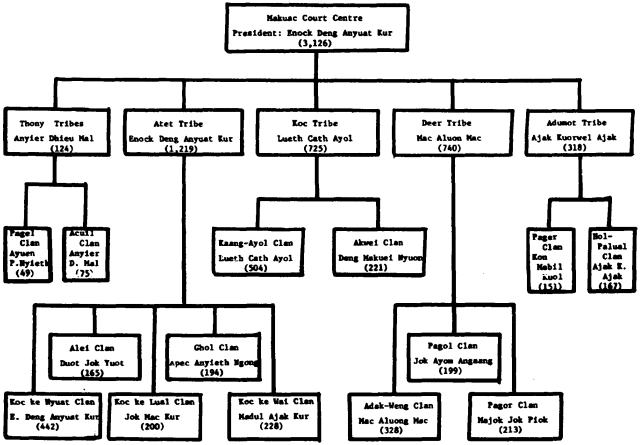

Figure A.10. Makuac tribal and clan organizations, Kongor District, Jonglei Province, Sudan

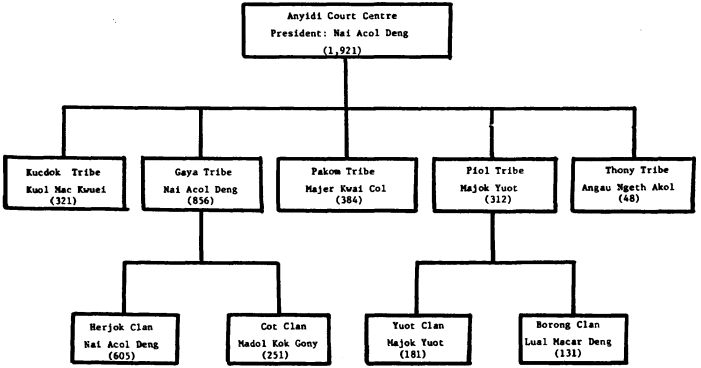

Figure A.11. Anyidi tribal and clan organizations, Kongor District, Jonglei Province, Sudan

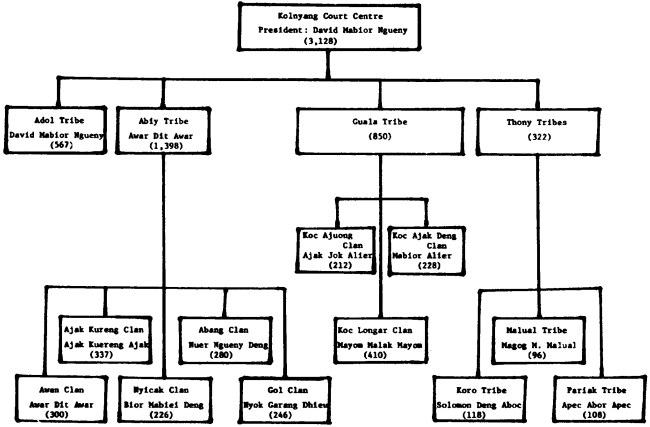

Figure A.12. Kolnyang tribal and clan organizations, Kongor District, Jonglei Province, Sudan

APPENDIX B. TABLE OF WEIGHTS AND MEASURES

Units of area	
1 square meter	= 10.76 square feet
1 square kilometer	= 0.386 square mile
	= 248 acres
	= 238 feddans
1 feddan	= 4,200 square meters
	= 0.420 hectare
	= 1.038 acre
Units of length	
1 meter	= 3.28 feet
	= 1.09 yards
1 kilometer	= 0.621 mile
Units of money	
LS 1.000 (Sudanese Pound)	= $2.00 (U.S.)
Units of volume	
1 cubic meter	= 35.31 cubic feet
	= 1.308 cubic yards
	= 0.000811 acre feet
Units of weight	
1 kilogram (Kg.)	= 2.205 lb.
1 metric ton (1,000 Kg.)	= 0.984 long ton (2,240 lb.)

APPENDIX C. LIST OF ABBREVIATIONS

APC	Agricultural Production Corporation
BM^3	Billion Cubic Meters of Water
DSE	German Foundation for International Development
FAO	Food and Agricultural Organization of the United Nations
GDP	Gross Domestic Product
IBRD	International Bank for Reconstruction and Development
ILACO	International Land Development Consultants
IRD	Integrated Rural Development
JIP	Jonglei Irrigation Project
JIT	Jonglei Investigation Team
JPA	Jonglei Projects Area
Kg	Kilogram
LS	Sudanese Pound
MCPS	Mechanized Crop Production Schemes
MDC	More Developed Countries
MFC	Mechanized Farming Corporation
NC-JPA	National Council for Development Projects in the Jonglei Canal Area
NIEO	New International Economic Order
PPDP	Pengkon Plain Development Project
PPP	Pengkon Pilot Project
SIDA	Swedish International Development Authority
SOS	Social Overhead Services
T_1	Hand Technology
T_2	Herbicide/Fertilizer Technology
T_3	Oxen Technology
UDC	Underdeveloped Countries
UNCDF	United Nations Capital Development Fund
UNDP	United Nations Development Program
USAID	United States Agency for International Development
WFC	World Food Conference

APPENDIX D. TEXT OF THE 1959 NILE WATERS AGREEMENT BETWEEN THE REPUBLIC OF SUDAN AND THE UNITED ARAB REPUBLIC (103:24-28)

[Translation[1] - Traduction[2]]

No. 6519. AGREEMENT[3] BETWEEN THE REPUBLIC OF THE SUDAN AND THE UNITED ARAB REPUBLIC FOR THE FULL UTILIZATION OF THE NILE WATERS. SIGNED AT CAIRO, ON 8 NOVEMBER 1959

As the River Nile needs projects, for its full control and for increasing its yield for the full utilization of its waters by the Republic of the Sudan and the United Arab Republic on technical working arrangements other than those now applied:

And as these works require for their execution and administration, full agreement and co-operation between the two Republics in order to regulate their benefits and utilize the Nile waters in a manner which secures the present and future requirements of the two countries:

And as the Nile waters Agreement concluded in 1929[4] provided only for the partial use of the Nile waters and did not extent to include a complete control of the River waters, the two Republics have agreed on the following:

First

THE PRESENT ACQUIRED RIGHTS

1. That the amount of the Nile waters used by the United Arab Republic until this Agreement is signed shall be her acquired right before obtaining the benefits of the Nile Control Projects and the projects which will increase its yield and which projects are referred to in this Agreement; The total of this acquired right is 48 Milliards of cubic meters per year as measured at Aswan.

2. That the amount of the waters used at present by the Republic of Sudan shall be her acquired right before obtaining the benefits of the projects referred to above. The total amount of this acquired right is 4 Milliards of cubic meters per year as measured as Aswan.

Second

THE NILE CONTROL PROJECTS AND THE DIVISION OF THEIR BENEFITS BETWEEN THE TWO REPUBLICS

1. In order to regulate the River waters and control their flow into the sea, the two Republics agree that the United Arab Republic constructs the Sudd el Aali at Aswan as the first link of a series of projects on the Nile for over-year storage.

2. In order to enable the Sudan to utilize its share of the water, the two Republics agree that the Republic of Sudan shall construct the Roseires Dam on the Blue Nile and any other works which the Republic of the Sudan considers essential for the utilization of its share.

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1. Translation by the Government of the United Arab Republic.
2. Traduction du Gouvernement de la République arabe unie
3. Came into force on 12 December 1959, in accordance with article 7.
4. League of Nations, *Treaty Series*, Vol. XCIII, p. 43.

The net benefit from the Sudd el Aali Reservoir shall be calculated on the basis of the average natural River yield of water at Aswan in the years of this century, which is estimated at about 84 Milliards of cubic meters per year. The acquired rights of the two Republics referred to in Article "First" as measured at Aswan, and the average of losses of over-year storage of the Sudd El Aali Reservoir shall be deducted from this yield, and the balance shall be the net benefit which shall be divided between the two Republics.

4. The net benefit from the Sudd el Aali Reservoir mentioned in the previous item, shall be divided between the two Republics at the ratio of 14½ for the Sudan and 7½ for the United Arab Republic so long as the average river yield remains in future within the limits of the average yield referred to in the previous paragraph. This means that, if the average yield remains the same as the average of the previous years of this century which is estimated at 84 Milliards, and if the losses of over-year storage remain equal to the present estimate of 10 Milliards, the net benefit of the Sudd el Aali Reservoir shall be 22 Milliards of which the share of the Republic of the Sudan shall be 14½ Milliards and the share of the United Arab Republic shall be 7½ Milliards. By adding these shares to their acquired rights, the total share from the net yield of the Nile after the full operation of the Sudd el Aali Reservoir shall be 18½ Milliards for the Republic of the Sudan and 55½ Milliards for the United Arab Republic.

But if the average yield increases, the resulting net benefit from this increase shall be divided between the two Republics, in equal shares.

5. As the net benefit from the Sudd el Aali (referred to in item 3 Article Second) is calculated on the basis of the average natural yield of the river at Aswan in the years of this century after the deduction therefrom of the acquired rights of the two Republics and the average losses of over-year storage at the Sudd el Aali Reservoir, it is agreed that this net benefit shall be the subject of revision by the two parties at reasonable intervals to be agreed upon after starting the full operation of the Sudd el Aali Reservoir.

6. The United Arab Republic agrees to pay to the Sudan Republic 15 Million Egyptian Pounds as full compensation for the damage resulting to the Sudanese existing properties as a result of the storage in the Sudd el Aali Reservoir up to a reduced level of 182 meters (survey datum). The payment of this compensation shall be affected in accordance with the annexed agreement between the two parties.

7. The Republic of the Sudan undertakes to arrange before July 1963, the final transfer of the population of Halfa and all other Sudanese inhabitants whose lands shall be submerged by the stored water.

8. It is understood that when the Sudd el Aali is fully operated for over-year storage, the United Arab Republic will not require storing any water at Gebel Aulia Dam. And the two contracting parties will in due course, discuss all matters related to this renunciation.

Third

PROJECTS FOR THE UTILIZATION OF LOST WATERS IN THE NILE BASIN

In view of the fact that at present, considerable volumes of the Nile Basin Waters are lost in the swamps of Bahr El Jebel, Bahr El Zeraf, Bahr el Ghazal and the Sobat River, and as it is essential that efforts should be exerted in order to prevent these losses and to increase the yield of the River for use in agricultural expansion in the two Republics, the two Republics agree to the following:

1. The Republic of the Sudan in agreement with the United Arab Republic shall construct projects for the increase of the River yield by preventing losses of waters of the Nile Basin in the swamps of Bahr El Jebel, Bahr el Zeraf, Bahr el Gahzal and its tributaries, the Sobat River and its tributaries and the White Nile Basin. The net yield of these projects shall be divided equally between the two Republics and each of them shall also contribute equally to the costs.

The Republic of the Sudan shall finance the above-mentioned projects out of its own funds and the United Arab Republic shall pay its share in the costs in the same ratio of 50% allotted for her in the yield of these projects.

2. If the United Arab Republic, on account of the progress in its planned agricultural expansion should find it necessary to start on any of the increase of the Nile yield projects, referred to in the previous paragraph, after its approval by the two Governments and at a time when the Sudan Republic does not need such project, the United Arab Republic shall notify the Sudan Republic of the time convenient for the former to start the execution of the project. And each of the two Republics shall, within two years after such notification, present a date-phased programme for the utilisation of its share of the waters by the project, and each of the said programmes shall bind the two parties. The United Arab Republic shall at the expiry of the two years, start the execution of the projects, at its own expense. And when the Republic of Sudan is ready to utilize its share according to the agreed programme, it shall pay to the United Arab Republic a share of all the expenses in the same ratio as the Sudan's share in benefit is to the total benefit of the project; provided that the share of either Republic shall not exceed one half of the total benefit of the project.

Fourth

TECHNICAL CO-OPERATION BETWEEN THE TWO REPUBLICS

1. In order to ensure the technical co-operation between the Governments of the two Republics, to continue the research and study necessary for the Nile control projects and the increase of its yield and to continue the hydrological survey of its upper reaches, the two Republics agree that immediately after the signing of this Agreement a Permanent Joint Technical Commission shall be formed of an equal number of members from both parties; and its functions shall be:

a) The drawing of the basic outlines of projects for the increase of the Nile yield, and for the supervision of the studies necessary for the finalising of projects, before presentation of the same to the Governments of the two Republics for approval.

b) The supervision of the execution of the projects approved by the two Governments.

c) The drawing up of the working arrangements for any works to be constructed on the Nile, within the boundaries of the Sudan, and also for those to be constructed outside the boundaries of the Sudan, by agreement with the authorities concerned in the countries in which such works are constructed.

d) The supervision of the application of all the working arrangements mentioned in (c) above in connection with works constructed within the boundaries of Sudan and also in connection with the Sudd el Aali Reservoir and Aswan Dam, through official engineers delegated for the purpose by the two Republics; and the supervision of the working of the upper Nile projects, as provided in the agreements concluded with the countries in which such projects are constructed.

e) As it is probable that a series of low years may occur, and a succession of low levels in the Sudd el Aali Reservoir may result to such an extent as not to permit in any one year the drawing of the full requirements of the two Republics, the Technical Commission is charged with the task of devising a fair arrangement for the two Republics to follow. And the recommendations of the Commission shall be presented to the two Governments for approval.

2. In order to enable the Commission to exercise the functions enumerated in the above item, and in order to ensure the continuation of the Nile gauging and to keep observations on all its upper reaches, these duties shall be carried out under the technical supervision of the Commission by the engineers of the Sudan Republic, and the engineers of the United Arab Republic in the Sudan and in the United Arab Republic and in Uganda.

3. The two Governments shall form the Joint Technical Commission, by a joint decree, and shall provide it with its necessary funds from their budgets. The Commission may, according to the requirements of work, hold its meetings in Cairo or in Khartoum. The Commission shall, subject to the approval of the two Governments, lay down regulations for the organisation of its meetings and its technical, administrative and financial activities.

Fifth

GENERAL PROVISIONS

1. If it becomes necessary to hold any negotiations concerning the Nile waters, with any riparian state, outside the boundaries of the two Republics, the Governments of the Sudan Republic and the

United Arab Republic shall agree on a unified view after the subject is studied by the said Technical Commission. The said unified view shall be the basis of any negotiations by the Commission with the said states.

If the negotiations result in an agreement to construct any works on the river, outside the boundaries of the two Republics, the Joint Technical Commission shall after consulting the authorities in the Governments of the States concerned, draw all the technical execution details and the working and maintenance arrangements. And the Commission shall, after the sanction of the same by the Governments concerned, supervise the carrying out of the said technical agreements.

2. As the riparian states, other than the two Republics, claim a share in the Nile waters, the two Republics have agreed that they shall jointly consider and reach one unified view regarding the said claims. And if the said consideration results in the acceptance of allotting an amount of the Nile water to one or the other of the said states, the accepted amount shall be deducted from the shares of the two Republics in equal parts, as calculated at Aswan.

The Technical Commission mentioned in this agreement shall make the necessary arrangements with the states concerned, in order to ensure that their water consumption shall not exceed the amounts agreed upon.

Sixth

TRANSITIONAL PERIOD BEFORE BENEFITING FROM THE COMPLETE SUDD EL AALI RESERVOIR

As the benefiting of the two Republics from their appointed shares in the net benefit of the Sudd el Aali Reservoir shall not start before the construction and the full utilization of the Reservoir, the two parties shall agree on their agricultural expansion programmes in the transitional period from now up to the completion of the Sudd el Aali, without prejudice to their present water requirements.

Seventh

This agreement shall come into force after its sanction by the two contracting parties, provided that either party shall notify the other party of the date of its sanction, through the diplomatic channels.

Eighth

Annex (1) and Annex (2, A and B) attached to this Agreement shall be considered as an integral part of this Agreement

Written in Cairo in two Arabic original copies this 7th day of Gumada El Oula 1379, the 8th day of November 1959.

For the Republic of Sudan:	For the United Arab Republic:
(*Signed*) Lewa Mohamed TALAAT FARID	(*Signed*) Zakaria MOHIE EL DIN

ANNEX 1

A SPECIAL PROVISION FOR THE WATER LOAN REQUIRED BY THE UNITED ARAB REPUBLIC

The Republic of the Sudan agrees in principle to give a water loan from the Sudan's share in the Sudd el Aali waters, to the United Arab Republic, in order to enable the latter to proceed with her planned programmes for Agricultural Expansion.

The request of the United Arab Republic for this loan shall be made after it revises its programmes within five years from the date of the signing of this agreement. And if the revision by United Arab Republic reveals her need for this loan, the Republic of the Sudan shall give it out of its own share a loan not exceeding one and a half Milliards, provided that the utilisation of this loan shall cease in November, 1977.

ANNEX 2

A

To the Head of the Delegation of the Republic of Sudan

With reference to Article (Second) paragraph 6 of the Agreement signed this day, concerning the full utilization of the River Nile Waters, compensation amounting to 15 Million Egyptian Pounds in sterling or in a third currency agreed upon by the two parties, and calculated on the basis of a fixed rate of $2.87156 to the Egyptian Pound, shall be paid by the Government of the United Arab Republic, as agreed upon, in instalments in the following manner:

£3 million on the first of January, 1960
£4 million on the first of January, 1961
£4 million on the first of January, 1962
£4 million on the first of January, 1963

I shall be grateful if you confirm your agreement to the above.

With highest consideration.

Head of the United Arab Republic Delegation:
(*Signed*) Zakaria MOHIE EL DIN

B

To the Head of United Arab Republic Delegation

I have the honour to acknowledge receipt of your letter dated today and stipulating the following:

[*See Annex 2, A*]

I have the honour to confirm the agreement of the Government of the Republic of the Sudan to the contents of the said letter.

With highest consideration.

Head of the Delegation of the Republic of Sudan:
(*Signed*) Lewa Mohammed *talaat farid*

APPENDIX E. RESEARCH AND DEVELOPMENT PROGRAM IN THE JPA AS CONTAINED IN THE REQUEST FOR FUNDING (23: Table 1, pp. 1-3)

Project title	Tentative estimates of cost		Present status
	External US$	Internal LS	
1. A Mathematical Model of Hydrologic Simulation of the Nile System in the Sudan	450,000	57,000	Requires formulation and funding
2. Soil Survey and Land Suitability Classification in the Jonglei Area	250,000	118,000	Phase 1 operational; requires funding
3. Swamp Ecology Survey in the Jonglei Area	432,200	161,000	Phase 1 operational; requires funding
4. Range Ecology Survey in the Jonglei Area	250,000	75,000	Requires formulation and funding
5. Wildlife Survey in the Jonglei Area	120,000	20,000	Requires formulation and funding
6. Jonglei Pilot Scheme Study	2,748,000	260,500	Operational; partially funded
7. Livestock Projects:			
a) An aerial survey of the Livestock Population of the Jonglei Area	80,000	5,000	Operational; requires funding
b) A Comprehensive Animal Health Control Program	40,000	5,000	Operational; requires funding
c) Livestock Production Investigations, 1977	48,000	11,000	Operational; requires funding
d) Establishment of a Buffalo Breeding Farm	539,200	105,000	Requires funding

APPENDIX E. (Continued)

Project title	Tentative estimates of cost External US$	Tentative estimates of cost Internal LS	Present status
e) Pilot studies on the control of flood water on the range in order to improve livestock feed supplies	455,000	85,000	Requires formulation and funding
f) The provision of water supplies for livestock on the intermediate grazings	500,000	90,000	Requires formulation and funding
g) Pilot studies on the provision of fodder supplies for livestock during the wet season	340,000	65,000	Requires formulation and funding
Total for livestock projects	1,952,200	366,000	
8. Fisheries Development in the Sudd Region	1,400,000	319,000	Requires formulation and funding
9. Economic and Social Research Council Program a) Geographic b) Demographic c) Anthropological and sociological d) Socio-legal aspects e) Medical and social services f) Assessment of the attitude of the people g) Service facilities in the area h) A cost/benefit analysis of the Jonglei Project	100,000	80,000	Operational; further funding required

APPENDIX E. (Continued)

Project title	Tentative estimates of cost		Present status
	External US$	Internal LS	
10. Ministry of Health Epidemiological Survey	Nil	20,000	Operational; no funding required
11. Integrated Rural Development in a Shilluk District	3,000,000	525,000	Will be formulated in 1977/78
12. Integrated Rural Development in a Nuer District	3,000,000	525,000	Will be formulated in 1977/78
13. Integrated Rural Development in a Dinka District	3,000,000	525,000	Will be formulated in 1977/78
Grand Total (Estimates of cost)	16,702,400	3,051,500	

APPENDIX F. OBJECTIVES OF KONGOR INTEGRATED RURAL DEVELOPMENT PROJECT, JPA: UNDP VERSION (18:21)

Immediate objectives:

1. It is unlikely that the above stated overall development objective can be achieved, at a minimum, in less than 10 years. The project will therefore be phased. The immediate objectives required to achieve these objectives may be classified as follows:

   (a) The activities listed in paragraphs 2 and 3, concerned with the completion of a topographical survey of the Kongor district and the improvement and modernization of the existing transhumant livestock system, will be commenced and directly implemented by the project during Phase I.

   (b) A number of supportive activities closely related to the project's main 'thrust' or logistical needs will also be commenced and directly implemented during Phase I. These activities are designated by the word 'supportive' in brackets.

   (c) The remaining activities listed, while essential for the overall socio-economic development for the district, will be funded to a limited extent by the project but will mainly be implemented by other cooperating aid agencies or by the appropriate government organization.

2. <u>The organization of an aerial topographical survey of Kongor district</u>

It is considered that it is essential to give this objective priority, not only to ensure proper planning from the commencement of project activities but also to provide the basic data for the organization of a flood control program in the district.

3. <u>The improvement and modernization of the existing transhumant livestock system with a consequent increase in the commercial offtake of beef cattle</u>

This will be accomplished through the following activities:

(a) Increasing total livestock numbers in the project area by:

(i) improving radically the control of animal disease and internal and external parasites;

(ii) providing adequate water supplies on the intermediate grazings during the dry season;

(iii) increasing the availability of food supplies on the highland area during the wet season; and

(iv) reducing the percentage of infertile mature females in the herds.

(b) Improving the nutrition and hence the productivity of all livestock by:

(i) improving the availability and quality of food supplies on highland areas during the wet season;

(ii) introducing controlled grazing systems both at the villages and at the cattle camps; and

(iii) providing mineral foods where investigations demonstrate that lack of them is a constraint on productivity.

(c) Improving the genetic production potential of the livestock, initially by selection within the present breed and ultimately by the introduction of exotic genes using the mechanism of cross breeding.

(d) Organizing training at all levels at a Community Farm (CF) that will form one part of a Center for the Introduction of New Technology (CINT) to be established by the project.

(e) Planning an infrastructure for the proper marketing of animals, hides, and skins. Details will be elaborated when the investigations of the Project Development Unit (IBRD) into livestock marketing have been completed.

(f) Planning a credit system that can be utilized to support new investment in production and marketing.

4. The improvement of the agricultural basis of the people's economy

This will be accomplished through the following activities:

(a) The conduct of an agronomic investigational program. As Dutch Bilateral Aid will assist in the funding of this sector it has been proposed by UNDP that the agronomic investigational program should be conducted at the Pengko Plains Station during Phase I of the Project while CINT facilities at Kongor are being organized and constructed.

(b) Extension work and training in agronomic techniques; the use of new hand tools, etc., organized from the CINT.

The agronomic investigational program would include the following activities:

(a) Introduction and nursery plots

(i) Introduction plots for exotic forage grasses and legumes (supportive);

(ii) Introduction plots for new varieties of crops at present grown in the Kongor district and for new field and vegetable crops; and

(iii) Nursery plots for growing young fruit, firewood and timber trees for ultimate distribution by the Project to farmers throughout the Kongor district.

(b) Cultivation investigations

Simple trials to evaluate the most suitable methods of cultivation for the production of sorghum.

(c) Fertility investigations

Simple trials to evaluate methods of improving fertility without the use of chemical fertilizers. These would include the introduction of a grain legume into the rotation.

(d) The introduction of work animals

Feasibility trials on the possible use of work animals for cultivation purposes.

(e) The integration of crop and livestock husbandry

Although the first investigation (a small mixed husbandry dairy farm at Kongor) can not be established until Phase II of the project, land requirements would be determined during Phase I.

(f) Irrigated crop agriculture

Investigations of the possibility for irrigated agriculture, particularly in the eastern intermediate grasslands.

5. The improvement of fishing practices, fish preservation and fish marketing in the project area

These objectives will be achieved through the agency of the 'Sudd Fisheries Development Program, Phase I (SUD/79/001).' A marketing cooperative (Bor/Shambe) will be established that will include fishermen from the Kongor district and extension training will be provided in fishing and fish preservation methods. Close cooperation will be established between the fisheries project (SUD/79/001) and the CINT, for the purposes of training and extension work.

6. The improvement of the practical training and educational facilities available to the people in the district

This will be achieved through the following activities:

(a) Practical training in new livestock husbandry techniques at the Community Farm (supportive).

(b) In-service training of intermediate level technicians required by the new services that will have to be provided

at the CINT (supportive).

(c) Practical training in agricultural and fishing techniques, to be gradually introduced at the CINT.

(d) Provision of training in cooperation with the relevant Provincial and Regional Authorities in simple sanitary measures, personal hygiene, household management, cooking and clothes making.

(e) Assistance to formal education by:

(i) Cooperation at all levels with the Regional and Provincial educational authorities in order to improve primary and secondary school facilities in the area. Specific assistance could include the provision of some building materials and possibly limited transport facilities for self-help school building programs.

(ii) Provision of grants to local secondary school graduates for training in specific disciplines at Sudanese institutions, on condition that the recipients return to work in the project area for a specific period.

7. The improvement of water supplies, sanitation and health

These will be accomplished through the following activities:

(a) Water supplies.

There is a critical lack of water for the people and their livestock at the villages during the dry season. Shallow wells at 13 locations will be replaced and deep tube wells

at 16 localities will be rebored and/or reequipped as necessary. The condition of these shallow and tube wells has been surveyed and reported on by the Jonglei Socio-Economic Team in their report entitled, 'The Existing Services in Kongor and Bor Districts' (supportive).

(b) Sanitation.

Planning for simple sanitation facilities in cooperation with the Provincial Medical Authorities, first in Kongor and eventually in other villages. Specific assistance may be provided by UNICEF and through a 'food for work' project by WFP.

(c) Health.

In cooperation with the Provincial Medical Authorities, Dutch Bilateral Medical Aid and UNICEF to plan for improved medical facilities at Kongor and in the district, through the agency of the Primary Health Care Program. In particular, a mobile medical team based on Kongor is required to tour cattle camps during the dry season. Specific assistance would include:

(i) The provision of a 4-W-D vehicle fitted out as an ambulance together with fuel and maintenance during Phase 1.

(ii) Provision for the storage of medical vaccines in the deep freezes to be provided by the Project for the storage of veterinary vaccines at Kongor.

(iii) Funding of part of the foreign currency cost of vaccines and drugs required by the Primary Health Care Program.

8. The improvement of basic infrastructure in the district

This will be accomplished through the following activities:

(a) Radio communications.

Radio communication equipment will be installed linking Kongor to Bor, Malakal, Juba and Khartoum. The service will be available to serve the needs of the local administration.

(b) Flood control.

Assistance will be provided to the administration for the purpose of building an appropriate system of dykes and bunds in order to properly control flood waters. This will include:

(i) The provision of a contour map of the district;

(ii) Technical assistance in planning the dyke and bunds system;

(iii) WFP 'food for work' assistance for voluntary self-help dyke and bund building schemes; and

(iv) The provision of some simple tools for voluntary self-help schemes and mechanical equipment where the latter is required.

(c) Air strip

The construction and maintenance of a 1200 m long, 40 m

wide air strip adjacent to Kongor village.

(d) Bor-Kongor road.

An attempt will be made to obtain assistance for the up-grading of this road to all-weather status.