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On-Going Evaluation of the Planning, Implementation and the Tenancy (Farm) Size of the Rahad Irrigation Project of Sudan

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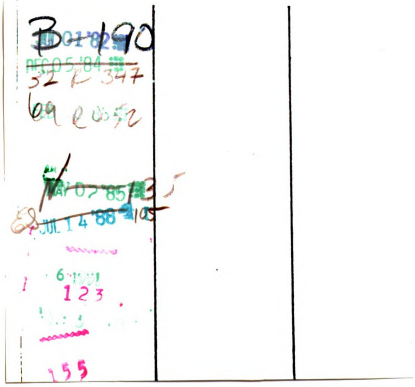

AN ON-GOING EVALUATION OF THE PLANNING, IMPLEMENTATION, AND TENANCY (FARM) SIZE OF THE RAHAD IRRIGATION PROJECT OF THE SUDAN

By

Elsayed Ali Ahmed Zaki

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ABSTRACT

AN ON-GOING EVALUATION OF THE PLANNING, IMPLEMENTATION, AND TENANCY (FARM) SIZE OF THE RAHAD IRRIGATION PROJECT OF THE SUDAN

By

Elsayed Ali Ahmed Zaki

Agriculture plays a major role in the Sudanese economy and generates about 40 percent of the GDP. Irrigated agriculture, which is largely owned by the public sector, contributes one half of the agricultural output.

The Rahad project is a 300,000 feddan irrigation scheme currently under construction and implementation in the Sudan. Settlers were established in the Rahad project in 1977, and by 1978/79, 40 percent of those planned, or about 5,000 households, had been settled. Tenants were assumed to have an average household size of five, and all tenants were allocated a 22 feddan tenancy irrespective of their household size and composition. Since numerous problems were encountered in the planning and implementation of the project, it is appropriate to conduct an on-going evaluation of the project to provide guidelines for the Rahad project management and policy makers who are planning to bring two million feddans of irrigated land under cultivation over the next decade. The objectives of the study are to:

1. Study the planning of the Rahad project in historical perspective

2. analyze the implementation of the project
3. describe the socio-economic characteristics of the tenants
4. study the economics of tenancy size and recommend alternative tenancy sizes consistent with the needs of settlers and the objectives of the project
5. recommend improvements in the preparation, implementation and distribution of land in the project

The data were obtained from various sources: the International Bank for Reconstruction and Development, the Ministry of Planning, the Rahad project publications, the project consultants, Sir M. MacDonalds and Partners, Tambul Pilot Farm, an interview with the project planners and managers and a field survey of 125 tenants in April, 1978.

During the planning stage, the major concern was with the macro aspects of the project. Although six appraisals were carried out in the period 1965/73, problems of implementation, tenancy size and the tenants' role in farming were overlooked or not treated adequately. Mechanisms could have been adopted before project approval in 1973 to handle the widely recognized problems of inadequate preparation, resource limitations, uncertainty and lack of coordination (even though coordination was effective later on in trouble shooting). Overall, more appropriate monitoring techniques could have been used. Such

measures should help the project (chosen from among competing designs) achieve its potential.

The field survey revealed that tenants have a modest role in decision making. Tenants control only about 2 percent of the production costs. A strong case can be made on efficiency grounds to increase the role of the tenant in decision making, including the number and timing of water application, labor allocation and whether mechanical power should be used for various field operations.

The analysis of the tenant survey revealed that an equity problem exists under the present fixed tenancy allocation policy. The tenant households were heterogeneous: absolute, labor and consumer equivalents per tenant household ranged between 1 and 16, 1 and 8.3 and 1 and 10.7 respectively. There was a wide variation in the tenant annual household expenditures ranging between Ls 600 and Ls 1600. A method was developed for computing alternative tenancy sizes on the basis of tenant household sizes, annual expenditures (the tenancy being almost the exclusive source of income), coefficients of productivity and net returns per feddan obtained from the field survey. Since the policy of fixed tenancy size may lead to wide income differentials, variable tenancy sizes of 11, 22 and 33 feddans for small, medium and large tenant households are recommended. Under this proposal, after the original number of households receive land, 15 percent of the land would still be available for additional

households. Since the project is only 40 percent settled, the proposed change in tenancy size should be undertaken as soon as possible.

Dedicated with gratitude and appreciation to my parents, my wife Widad M. Eisa, our son Elsiddig and daughter Bashaer. Also dedicated to my Muslim brothers who are working for the Islamic cause.

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For this work (and for everything), my praise and thanks be to Almighty Allah "God", the Creater of the Worlds, Most Gracious and Most Merciful. May He be pleased with me.

TABLE OF CONTENTS

List of Tables. xi

List of Figures xiii

List of Terms and Abbreviations xiv

CHAPTER PAGE

I. INTRODUCTION. 1

A. Agriculture in the Sudanese Economy 2
B. Public Investments in Irrigation Projects . . 4
C. The Need for On-going Evaluation. 7
D. Justification for the Choice of Rahad Project as a Case Study 10
E. The Statement of the Problem. 11
F. The Objectives of the Study 16
G. The Organization of the Study 17

II. PROJECT DESCRIPTION, SOURCES OF DATA, METHODOLOGY AND DATA COLLECTION 18

A. Description of the Rahad Project. 18

1. Project location. 18
2. The Irrigation Network. 20
3. The Tenant Settlement 20
4. The Agricultural Production 21

B. Sources of Data 21

C. Data Collection 22

D. The Method of Analysis. 26

III. PLANNING FOR THE RAHAD PROJECT. 28

A. The Roseires Dam. 28

1. Intensification and Diversification of Already Existing Schemes 29
2. Extensions of the Gezira Scheme (Managil) and Construction of New Pump Irrigation Schemes 30

3. Hydroelectric Power. 31

B. Rahad Project Preparation. 32

1. Preparation Stage I: Identification As Part of the Roseires Preinvestment Survey 32
2. Preparation Stage II: IBRD Appraisal Missions 36
3. Preparation Stage III: The Gravity-Pump Irrigation Controversy. 40
4. Preparation Stage IV: The Rahad Pump Irrigation Project 44

C. Summary. 46

IV. LESSONS FROM THE IMPLEMENTATION OF THE RAHAD PROJECT. 50

A. Towards A Conceptual Framework For An Evaluation of the Implementation of Projects 51

1. Literature Review. 51
2. A Conceptual Framework 55

B. Evaluation of Project Implementation 59

1. Problems of Measuring the Evaluation of Implementation. 59
2. Criteria for Evaluating Implementation . 63

C. The Implementation of the Rahad Project. . . 65

1. Project Objectives 65
2. Coordination of Project Implementation . 70

a. The Need for Coordination in the Rahad Project. 70
b. The Effort to Coordinate the Implementation of the Rahad Project. 73

3. The Interdependence of the Project Components 78

D. The Main Factors Contributing to Delays in Project Implementation 81

E. The Tenant As The Producer 84

F. Summary. 89

V. RÔLE AND RELATIONSHIP OF THE TENANT WITH THE PROJECT MANAGEMENT AND SOCIO-ECONOMIC CHARACTERISTICS OF THE TENANTS. 92

A. The Role of the Tenant and the Project Management in Decision-Making 93

1. The System of Payment For The Use of Irrigation Water, land and other Resources 95
2. Irrigation Control. 96
3. Choice of Crops and Crop Mix. 98
4. Production and Marketing. 100
5. Non-Farm Occupation 103
6. Provision of Service. 103

B. Socio-Economic Characteristics of the Tenant. 105

1. Household Composition 105
2. Previous Occupations of Tenants 111
3. Occupation Outside the Tenancy. 112
4. Experience in Irrigated Farming 114

C. Summary 115

VI. ANALYSIS OF TENANCY SIZE. 117

A. Evolution of Tenancy Size in the Rahad Project 117

B. Change of Crop-Mix and Rotation 119

C. A Method for Generating Policy Options on Tenancy Size. 120

1. Assumption About Sudan Government Policies Concerning Irrigated Agriculture 121
2. Variables Affecting Tenancy Size 122
3. Tenancy Size Computation Formulae 122
4. Labor Requirements Computation Formulae . 125
5. Potential Supply of Household Labor Computation Formulae. 127

D. The Computation of Alternative Tenancy Sizes. 128

1. Calculation of the Financial Net Returns Per Feddan of Crop. 128

2. Test of Variation in Net Returns to Household Labor Per Feddan of Cotton. . . 130

a. Labor Equivalents and Classification of Tenant Households 130
b. A Statistical Test of the Variation in Net Returns of Cotton 133

3. Tenant Household Annual Expenditures: A Basis For Tenant Target Incomes. 137

a. Variations in Tenant Annual Household Expenditures. 137
b. Consumer Equivalents and Classification of Tenant Households 138
c. Tenant Target Incomes. 139

4. Crop Land Ratios For Different Rotations . . 140

5. Results and Analysis of Tenancy Sizes. . . . 143

E. Comparison of Monthly Labor Requirements For A 22 Feddan Tenancy With The Potential Household Supply of Labor. 145

1. Monthly Labor Requirements (Demand) For A 22 Feddan Tenancy. 145

2. Maximum Potential Household Supply of Labor. 149

3. A Comparison of the Peak Demand For Labor in Cotton Crop Establishment and Groundnuts Production Activities With The Potential Household Supply of Labor. 150

F. Comparison of Net Returns From A 22 Feddan Tenancy With Annual Household Expenditures By Consumer Equivalent Household Groups 153

G. Summary. 155

VII: SUMMARY, POLICY IMPLICATIONS AND SUGGESTIONS FOR FUTURE RESEARCH. 157

A. Summary. 157

B. Policy Implication 165

1. Planning of Irrigation Projects. 165
2. Implementation of Irrigation Projects. . . . 167
3. Tenancy (Farm) Size. 170

C. Suggestions for Future Research. 174

APPENDICES

Appendix A. Detailed Computations of the Financial Net Returns to Tenant Household Labor Per Feddan of Cotton. .178

Appendix B. The Percentage of the Production Costs Paid Directly by the Tenant . . .186

Appendix C. The Labor and Consumer Equivalents of Tenant Households. 189

Appendix D. The Percentage Share of Hired Labor in Harvesting and Post Harvesting Activities of Cotton Under the Responsibility of the Tenant. 192

Appendix E. Approximations of Annual Household Expenditures of Tenants 195

BIBLIOGRAPHY. 198

LIST OF TABLES

TABLE		PAGE
1.1	Percentage Contribution of Agriculture in the Sudan to the Gross Domestic Product at Factor Costs and Current Prices, Selected Years 1955/56 to 1982/83.	3
1.2	Three Years Average of the Percentage of the Cultivated Area and the Percentage Share of the Total Production of the Main Crops in the Sudan	8
1.3	The Expansion Plan for Irrigation Projects in the Sudan.	8
1.4	Differences Among Irrigation Projects in Gross Tenancy Size, Maximum Number of Tenancies Allowed Per Tenant, Crops Grown, Cropping Intensity and System of Production in the Sudan . .	14
2.1	Sample of Tenants Surveyed, Number and Percentage of Tenants to the Block and Village Population.	24
3.1	The Different Characteristics of The Competitive Rahad Projects Evaluated at the Various Stages of the Project Preparation.	33
4.1	Rahad Project Objectives As Reported By The Implementation Executives Interviewed	67
4.2	List of Studies Undertaken After the Approval and During The Implementation of the Rahad Project	69
4.3	Tenants Ranking of Selected Problems in the Rahad Project	85
4.4	Tenants Ranking of Reasons For Late Settlement in the Rahad Project Area.	87
4.5	Tenants Ranking of Settlement Difficulties in the Rahad Project.	88

5.1 Tenant Household Composition by Age-Group, Absolute and Percentage Distribution. 106

5.2 Age, Sex and Percentage Distribution of Sample of Tenants. 108

5.3 Marital Status of Sample of Tenants, Number and Percentage Distribution 108

5.4 Sample of Tenant Households, Age, Sex Composition and Distribution by Relationship. 110

5.5 Occupation, Number and Percentage Distribution of Sample of Tenants. 113

6.1 Adult-Male Labor Equivalent Weights by Sex and Age 132

6.2 Classification of Households According to the Adult Male Labor Equivalents and the Net Returns to Household Labor Per Feddan of Cotton 134

6.3 Net Returns to Tenant Households Per Feddan of All Crops. 137

6.4 Consumer Equivalent Weights 138

6.5 Approximations of Annual Household Expenditures by Consumer Equivalent Tenant Groups. 140

6.6 Crop Land Ratios for Various Crop Rotations . . . 142

6.7 Computations of Tenancy Sizes in Feddans. 144

6.8 Time Flow of Crop-Establishment Activities of Cotton and Their Labor Requirements per Feddan in Adult Male Labor Days. 147

6.9 Time Flow of Production Activities of Groundnuts and Their Labor Requirements Per Feddan in Adult Male Labor Days 148

6.10 Monthly Calculations of Adult Male Day Equivalents of Cotton and Groundnuts 150

6.11 The Maximum Potential Household Supply of Labor Per Month By Household Labor Equivalent Groups. . 151

6.12 A Comparison of A 22 Feddan Tenancy Returns With the Annual Household Expenditures of Tenant Household Consumer Equivalent Groups. 154

LIST OF FIGURES

FIGURES		PAGE
2.1	The Map of the Rahad Project.	19
4.1	Implementation: A Production Process	56
4.2	Measurable Differences in the Implementation Process	60
4.3	Input-Output Flow of the Rahad Project. . . .	72
5.1	The Organization of Agricultural Production in the Rahad Project.	94
6.1	The Relationship Between Land Ratios of Crops Grown, The Net Return to Tenant Household Labor, and The Household Size.	123
6.2	A Graph Comparing The Tenant Household Potential Supply of Labor With The Labor Requirements of Cotton Crop Establishment and Groundnuts Production Activities.	152

LIST OF TERMS AND ABBREVIATIONS

Abu VI:	The irrigation canal which feed the tenancy.
Abu XX:	The terminal minor irrigation canal which supply Abu IV.
Acala 442:	A variety of medium staple cotton grown in the Rahad project as well as other irrigation schemes.
ADC:	Agricultural Development Corporation (1967-1973)
AF:	Arab Fund
AID:	Agency for International Development-The United States
ARC:	Agricultural Research Corporation
B.K.:	Big Kantar of Seed Cotton, approximate weight is 315 pounds
CEWC:	Central Electricity and Water Corporation
Dura:	Sorghum Vulgare, the staple diet of the Sudan
EDI:	Economic Development Institute of the IBRD
FAO:	Food and Agriculture Organization of the United Nations
Feddan:	A feddan is 1.038 areas
Gaffir:	The irrigation water superintendent
HTS:	Hunting Technical Services: A British Engineering and Consulting Firm
IBRD:	International Bank for Reconstruction and Development.
IDA:	International Development Association of the IBRD
Ground-nuts:	Peanuts, the variety usually grown is Ashford

K.F.: Kuwait Fund for Arab Economic Development

Leguminous fodder: The recommended leguminous fodder for the Rahad project is philibisara

Ls: Sudanese pound

MMP: Sir Murdoch MacDonald and Partners: A British Consulting firm

RAC: Rahad Agricultural Corporation

SF: Saudi Fund for Development

SPC: Supreme Planning Council

Syndicate: Sudan Plantation Syndicate which was responsible for the management of the Gezira scheme and other cotton schemes in the Sudan before Independence.

CHAPTER I

INTRODUCTION

Agriculture plays a central role in the economy of the Sudan. The government of the Sudan is constantly bringing new land under controlled irrigation, and these public investments in irrigation have transformed the agricultural sector. The planning, implementation, and determination of appropriate tenancy size for irrigation projects raise major issues that pose numerous problems for planning authorities and policy makers. The Rahad irrigation project currently under construction presents an opportunity to investigate these issues; an on-going evaluation of this project will provide a better understanding of the problems.

The determination of tenancy size, on which basis the land is allocated to the tenants, affects both the tenants' productivity and the overall project performance. During project implementation, the accumulation of data and information on the socio-economic characteristics of the selected tenants, the identification of technical coefficients of production, and the accurate estimation of financial returns will result in a more accurate determination of tenancy size and equitable land allocation.

A. Agriculture in the Sudanese Economy

While the Sudan is a country of vast agricultural resources, it is in the poorest quartile of the world's nations. Out of 200 million feddans of productive land suitable for both crop and animal production, less than 10 percent is currently used (13,34). The annual per capita income has been between $100 and $120, but because of inflation has recently increased to more than $250 (44). Furthermore, most of the economy is poorly structured and a large segment is in the non-monetized traditional sector.

Although the percentage contribution of agriculture to the gross domestic product at factor cost is declining (see Table 1.1), the role of agriculture in the Sudanese economy is still profound. Not only does agriculture contribute to food production, raw materials, local industry, foreign exchange earnings, and employment, but a large part of the value-added contribution of non-agricultural sectors can also be attributed to processing, transportation, marketing, and various services performed on agricultural products. According to provisional tabulation of the 1973 Population Census, the agricultural sector employs 72.2 percent of the people (34). Furthermore, about 89 percent of the population live in rural areas and are thus directly dependent on the agricultural sector. Agricultural exports provide 98 percent of foreign exchange earnings (27), and the government derives directly and indirectly 50 percent

TABLE 1.1 PERCENTAGE CONTRIBUTION OF AGRICULTURE IN THE SUDAN TO THE GROSS DOMESTIC PRODUCT AT FACTOR COSTS AND CURRENT PRICES, SELECTED YEARS 1955/56 TO 1982/82

Sector	1955/56[a]	1960[a]	1964[a]	1969/70[a]	1971/72[a]	1973/74[b]	1976/77[c]	1982/83[c]
1. Agriculture	61.0	57.4	47.9	40.2	38.1	47.0	39	37
a) Crop production	37.3	35.1	27.5	23.6	22.9	n.a.	n.a.	n.a.
b) Livestock	23.7	22.3	20.4	16.6	15.2	n.a.	n.a.	n.a.
2. Non-Agriculture	39.0	42.6	52.1	59.8	61.9	53.0	61	63
Total	100	100	100	100	100	100	100	100

SOURCES: Compiled from various sources

[a]ILO/UNDP Employment Mission, "Growth, Employment and Equity: A Comprehensive Strategy for the Sudan," (Geneva: International Labor Office, 1976), p. 14. Ministry of Finance and National Economy "Economic Survey, The Economic and Financial Administration, Ministry of Finance and National Economy, Sudan, 1973, in Arabic Table 1 p.10

[b]Department of Statistics, Ministry of National Planning, National Income Accounts and Supporting Tables, 1975, Table 12 pp. 34-35.

[c]Ministry of National Planning, "The Six-Year Plan for Social and Economic Development 1977/78-1982/83, Sudan, 1977 in Arabic Table 3.1 p.50.

of its revenue from the agricultural sector (34). Hence, in the foreseeable future, notwithstanding popular wishful thinking about the possibility of the discovery and extraction of oil, agriculture is likely to remain the basis for development efforts.

Sudanese agriculture is characterized by a marked dualism between a modern sector, composed of irrigated and mechanized rain-fed (dry land) agriculture, and a traditional agriculture and livestock sector. Government efforts and interests have been directed primarily towards the modern sector to the relative neglect of the traditional sector (Osman, 53). The lower risk and uncertainty associated with modern farming reinforces this attitude.

B. Public Investment in Irrigation Projects

Within the modern agricultural sector, the irrigated agriculture sub-sector receives the maximum attention of government policy makers. Historically, the government of the Sudan has financed the supply of irrigation water, land, capital and management. A number of factors help explain the government decision to assume this role. First, there are a variety of interdependencies in the construction of large irrigation projects. For example, when the government invests in large infra-structures like dams, irrigation canals, accessible roads, etc. which have investment indivisibilities, the economies of scale are gained. If

more than one firm invests in these projects, it is probable that a higher per unit cost will be created. This is illustrated by the hundreds of small irrigation schemes scattered along the Blue and White Niles which constitute the present Agrarian Reform Corporation in the Sudan. Second, irrigation projects with long gestation periods are particularly vulnerable to changes in factor prices, product prices, and systems of production, as well as distribution of ownership of rights and other political considerations. Furthermore, investment in irrigation projects produces immobile assets, coupled with limited alternatives in product-mix--given the soil, climate, and farming experience. Costs associated with selling or purchasing these factors of production may be prohibitively high. Once a dam is built, it is indispensible. For a public investment entity the cost of a dam can be considered a sunk cost (Gittinger, 23) but for a private firm such possible immobility and its associated costs scares the firm and limits its investment in the production of the commodities under consideration--irrigation water being the intermediate good. The decentralized market fails when the private firms either produce less than optimal amounts or fail to produce the good at all (Burkhead and Miner, 10). To provide this good in the public sector is primarily a political decision (Schmid, 62).

Another plausible agrument for public provision of irrigation water is found in cases where the indigenous

private sector may not be capable of undertaking the investment because of a lack of financial and managerial resources (44). In contrast, the government may be able to enlarge its opportunity set by international borrowing, which is not readily available for the private sector.

In the preceding discussion, a case for public provision of irrigation water has been demonstrated. In fact, the government of the Sudan has always attempted to develop and expand agricultural land by controlled irrigation. In the past it invested in all the gravity irrigation projects. Smaller pump irrigated schemes along the Blue and White Niles had been developed initially by the private sector, but the government nationalized them during 1968-70 (Adam, 1). Pump schemes along the Nile, with the exception of small vegetable and orchard pump schemes and the Zeidab scheme which was nationalized along with others, were originally developed by the government. In brief, all four million feddans under irrigation, except for small areas commanded by minor schemes have been owned and managed by the public sector (34). The government owns about one-quarter of the land under cultivation, which is mainly the irrigated area (See Table 1.2), and its irrigation projects produce about half the agricultural output of the country. The government is expanding the existing schemes and developing new irrigation projects. The total Six-Year Plan appropriation of LS 350 millions is designed to complete the development of Rahad I, three sugar

plantations, a kenaf plantation, the Jongeli Canal, and the consolidation and expansion of irrigated areas in the existing schemes (34, 44). Further expansion plans for the 1980s are shown in Table 1.3.

With the exception of the sugar plantations, the development of irrigated agriculture followed in the footsteps of the Gezira scheme, which first operated in 1925 and is considered a landmark. Additions to Gezira, such as Managil (1956), and Guneid (1967), new irrigation projects like New Halfa (1964), Pump Schemes (nationalized in 1968-70), Essuki (1971), and Rahad (1977) were developed with similar cropping patterns, organizational set-ups and tenant-management production relations.

C. The Need For On-Going Evaluation: Choosing the Best Project vs. Making the Project Work

An on-going evaluation aims to identify implementation constraints and to adapt the project to changing objectives and circumstances (31). Such an evaluation can critically examine decisions on major issues that affect project performance. In this context, an on-going evalution can improve project implementation and achieve project objectives.

Some kind of formal or informal evaluation in economic and/or social terms is usually done prior to project acceptance and execution. This is done to assure that the best project is chosen or that the project meets net

TABLE 1.2 THREE YEARS AVERAGE OF THE PERCENTAGE OF THE CULTIVATED AREA AND THE PERCENTAGE SHARE OF TOTAL PRODUCTION OF THE MAIN CROPS IN THE SUDAN

Type of Production	1966/67-1968/69 Average Percentage		1973/76-1975/76 Average Percentage	
	Area	Production	Area	Production
Irrigated	22.4	53.8	18.5	50.3
Non-Irrigated	77.6	46.2	81.5	49.7
Modern	47.2	69.2	45.6	71.2
Traditional	52.8	30.8	54.4	28.2
Public Sector	27.6	54.9	22.3	51.6
Private	72.4	45.1	77.7	48.4

SOURCE: Ministry of National Planning, "The Six-Year Plan for Social and Economic Development 1977/78-1982/83, Sudan, 1977 in Arabic, Table 1.9 p. 35.

TABLE 1.3 THE EXPANSION PLAN FOR IRRIGATION PROJECTS IN THE SUDAN

Project	Area in Feddans
Rahad II	500,000
Four Sugar Schemes	182,000
Expansion of Pump Schemes	380,000
Setit on Atbara River	600,000
Total	1,662,000

SOURCE: ILO/UNDP Employment Mission, "Growth, Employment, and Equity: A Comprehensive Strategy for the Sudan," (Geneva: International Labor Office, 1976), p.50

return thresholds set by the financing organization. Post evalutions of projects are subsequently used to test the extent to which a project has attained its physical objectives, benefitted the target groups, or efficiently used resources. Although useful in planning future projects, these post evaluations do not improve the productivity of the current projects. But the primary purpose of on-going evaluations is to serve as an early check on the effectiveness of projects and programs and to provide a basis for adaptive action to improve performance. Perhaps planning authorities have put too much of their analytic resources into choosing the best project and not enough into making the chosen project achieve its potential.

An on-going evaluation is needed when a project takes a long period from approval to completion. The Rahad project, for example, was appraised and finally approved in 1973. The execution of the project, however, is still in progress in 1979 and may require one or two more years to complete. During such long implementation periods many changes may have been introduced because of changing circumstances. Frequent on-the-spot management decisions, especially those of a cumulative nature, may lead to substantial changes in the project design, target group and objectives. As a project grows in complexity, the need for such interim evaluation increases.

Occasionally, projects are appraised and their anticipated economic and social impacts are identified at the

start. Yet a more detailed plan of execution may develop from knowledge gained during project implementation. In such cases, on-going evaluation helps to draw lessons from past implementation experiences, and is especially useful if similar activities are repeated periodically during implementation. In the Rahad project, for example, tenants should be selected each season and settled in to a specified area allocated for crops.

In contrast to project evaluation and post evaluation, on-going evaluation would involve all the participants. They would, perhaps, cooperate in the evaluation if its objectives and usefulness are clear, reasonably acceptable, and of relevance to them.

The conclusions drawn from an on-going evaluation could be useful not only for the restructuring of the project under execution, but also for improving other irrigation projects in the Sudan.

D. Justification for the Choice of Rahad Projects as a Case Study

The central position of irrigated agriculture in the Sudanese economy and the importance of agriculture in development lead to the choice of an irrigation project for an on-going evaluation. As shown in Table 1.3, some 1.7 million feddans are planned to come under irrigation through the 1980s. Since the Rahad project is a public sector irrigation enterprise presently under development,

an on-going evaluation would be valuable not only for later phases of the present stage of the project, but also for its future expansion. This future expansion constitutes about one-third of the overall investment program.

The Rahad project is a comprehensive program rather than a single project, and has several components: irrigation and crop production; farmer settlement; services in the fields of processing and marketing; transportation; education; health; etc. The project should provide readily available data because all parties involved could be reached with relative ease.

E. The Statement of the Problem

Experience with the development of irrigation projects, including the Gezira scheme completed in 1925 (Gaitskeil, 20), indicates that there was a large lapse of time from the perception of the project, to the commencement of work, to completion. Similarly, the Rahad project was first appraised during 1965-67, approved in 1973 after several other appraisals; but actual construction started in 1974. Despite this relatively long period and repeated economic appraisals, the adequacy of the project planning has been questionable.

A universal problem of development is the frequent failure in program implementation (8). Failures are due to time lags, cost overruns, revenue losses, and participants' dissatisfaction. Project planning should not only

be concerned with choosing the best project (based on net returns to investment), but also with making the chosen project work to achieve its potential.

Successful project performance depends on achieving the planned physical output and the desirable impact on the target group. In irrigation projects, land plots of equal size, each called a tenancy[1] and each allocated to grow the same crops in the same proportions, are distributed to tenants. With the exception of the Gezira scheme, each tenant is allotted one tenancy. Tenants are expected to exercise certain responsibilities at the crop-production level in a manner that will be explained in detail in Chapter V. In return, they are paid either a percentage share of the net revenue from crop sales or the net revenue after the deduction of all production costs. The adoption of either tenant-management relationships depends primarily on the way the production costs are handled.

If the tenant is the ultimate producer, then a crucial question is how much land the tenant should receive, given the crop mix,[2] cropping intensity[3] and system

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[1]Sugar is produced in public sector plantations, except in Guneid Scheme where the tenancy system prevails.

[2]Crop mix refers to the crops grown, area of each crop within a given rotation and the sequence of cropping.

[3]Cropping intensity, on the other hand, refers to the percentage of land annually put to production whether at the tenancy or the project level.

of production. The survey of some selected irrigation projects in the Sudan, presented in Table 1.4, showed the differences among these projects in the gross tenancy sizes, the maximum number of tenancies allowed (i.e. maximum land area), the cropping intensity, the crop mix and the system of production. The wide variations in tenancy size may lead to disparities in the expected farming returns to the tenant in the respective irrigation schemes. To determine the tenancy size in the case of each of these irrigation schemes, policy-makers must study the issue in a variety of ways. However, in the Sudan, the income criterion was not explicitly incorporated in deciding the tenancy-size of irrigation projects. Instead, after the size of the tenancy has been decided upon, studies were conducted to estimate the income from the determined tenancy. There was no case on record where the size of the tenancy was altered ex post in order to alter the expected returns to the tenant.

Evidence indicated that neither the financial returns to the tenants as the ultimate producers at the basic unit of production, nor the tenancy size in Rahad project evaluation were given due consideration. With the exception of one project appraisal (Osman, 54) known to the author, financial assessment of tenants' profits and losses followed the economic evaluation of the project. The Rahad Project-Roseires Preinvestment Survey Summary reads: "At this stage of analysis the project is considered as

TABLE 1.4 DIFFERENCES AMONG IRRIGATION PROJECTS IN GROSS TENANCY SIZE, MAXIMUM NUMBER OF TENANCIES ALLOWED PER TENANT, CROPS GROWN, CROPPING INTENSITY AND SYSTEM OF PRODUCTION IN THE SUDAN

Irrigated Agriculture Schemes	Years of Development	Gross Tenancy Size in Feddans	Maximum Number of Tenancies Allowed Per Tenant	Crops Grown	Planned[a] Cropping Intensity %	System of Production
Gezira	1925	40	2	Cotton groundnuts dura, wheat fodders	65	crop-sharing[b] on cotton
Managil (Gezira Extension)	1956	15	1	"	90	crop sharing[b] on cotton
Blue & White Nile Pump Estates	(1927-1953)	10-15	n.a.	Cotton, dura	75	crop sharing on cotton
New Halfa	1964	15	1	Cotton, wheat, groundnuts	70	Crop sharing on cotton Land & Water charge on groundnuts and wheat
Essuki	1971	10	1	Cotton, groundnuts	100	Land & Water charge
Rahad	1977	22	1	Cotton, groundnuts leguminous fodder	100	Land & Water charge

SOURCE: Compiled from various sources.

[a]Actual cropping intensity differs from planned, if only for reasons of planting failure.

[b]During 1978, the government decided to include other crops in the sharing arrangement. Later the tenants objected to the government decision. The matter is yet to be resolved satisfactorily.

one large farm and no account is taken of the size of farms and the number of farmers" (25). In subsequent evalutions, the approach was one of macro concern. The farm budget analysis was usually performed to rationalize what the appraised project had already given to the tenants.

Tenancy-size has been altered at various stages in the lengthy planning process of the Rahad project, yet in each case the underlying assumption was that tenants would follow suit. Thus it appears that tenancy size has not been considered explicitly in policy formalation, design, and evaluation of the project.

Even if the selection of the tenancy size is made on the basis of satisfying income needs of some "representative households", it ignores the heterogeneity of the would-be tenants. There is no doubt that adequate household earning is an important factor in inducing tenants to maintain and stabilize production at the farm level and consequently at the project level. The project management has the managerial advantage of retaining tenancy as the unit of production and at the same time securing parity in tenant household earnings except for disparities of extraneous nature. Furthermore, the selection of the tenancy is claimed to be related to the tenant household's expected labor supply to the cotton crop, as perceived through the experience of policy-makers (14). However, despite the heterogeneity in the potential labor supply of tenant households, the potential labor supply

received little attention in the design of the Rahad project. In all the irrigated schemes of Table 1.4., this consideration was ranked low, as evidenced by the wide variation in tenancy size.

In the course of planning and implementing the Rahad project, the size of the tenancy was changed a number of times. As late as six months before the first tenants settled in, the tenancy-size was re-examined and changed (as were crop mix and the cropping intensity). These changes in the tenancy size were made without considering the tenants' socio-economic characteristics and financial returns. Thus, the amount of land and, consequently, other resources that should be allotted to the tenant is a crucial problem which has an important bearing on project performance.

F. Objectives of the Study

The objectives of the research are as follows:

1. To study the planning of the Rahad project in historical perspective,
2. To analyse the implementation of the Rahad project,
3. To describe the socio-economic characteristics of the tenants,
4. To study the economics of tenancy size and recommend alternative tenancy sizes consistent with the needs of settlers and the objectives of the project,
5. To recommend improvement in the preparation, implementation and distribution of land in the project.

G. The Organization of the Study

Chapter II explains the method used to collect data as well as the method of analysis. Chapter III reviews the history of Rahad project planning and explores the adequacy of the project preparation. In Chapter IV a brief review of the literature of implementation, the results of the inquiry on the Rahad project implementation, the problems faced by the project and the tenants; and the likely impact of these problems on the performance are presented.

The socio-economic characteristics of the sample of tenants surveyed are analyzed in Chapter V. Also examined are the nature of the agricultural production system used in the Rahad project, the relation between the project management and the tenant, and the role of the tenant in farming decisions. In Chapter VI, a method is developed that incorporates the most important variables needed to determine tenancy area. The results of the application of this method using data from the sample of tenants survey are presented. The returns from a fixed tenancy size allocated to each tenant irrespective of his household size and composition are compared with the annual household expenditures of tenants. The labor requirements of the fixed tenancy are compared with the tenant households potential supply of labor.

Chapter VII gives a summary of the findings and draws policy implications for future planning, implementation and land allocation in irrigation projects in the Sudan.

CHAPTER II

PROJECT DESCRIPTION, SOURCES OF DATA, METHODOLOGY, AND DATA COLLECTION

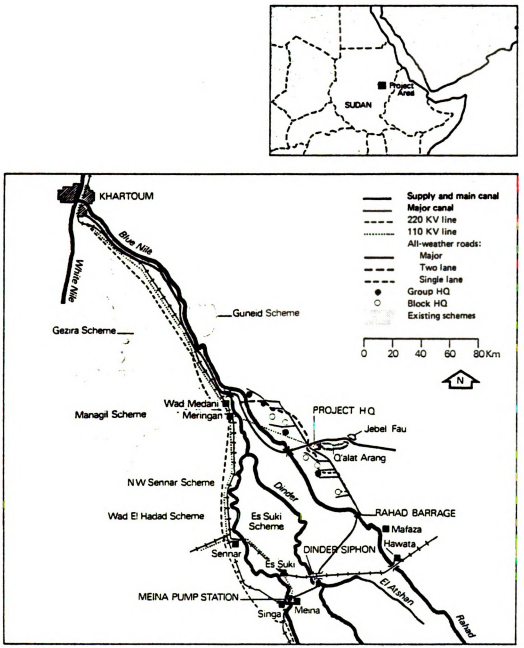
In this chapter a brief description of the Rahad project is presented. The sources of data used to analyse the planning, implementation, and tenancy size of the project are described; and sampling procedures for the selection of the tenants and the method of data collection are discussed. Included is a brief outline of the method of analysis.

A. Description of the Rahad Project

The project consists of two major components: an irrigation network; and agricultural production including support services and facilities.

1. Project Location

The project area is located on the east bank of the Rahad river and extends for 240 kilometers from near Mafaza in the south to the confluence of the Rahad river and the Blue Nile in the north, 160 kilometers south of Khartoum (see attached map). The area is a flat alluvial plain with a gentle slope from south-east to north-west of about .5 meters per kilometer (41).



Source: By courtesy of the Ministry of Irrigation (41)

FIGURE 2.1 Rahad Project Area

2. The Irrigation Network

The irrigation water is conveyed by a supply canal from Meina, on the Blue Nile, 200 kilometers north of the Roseires Dam. The capacity of the supply canal is 105 cubic meters per second. The water is pumped into the supply canal by electrically powered pumps, travels 84 kilometers from the Blue Nile and is siphoned under the Dinder river to pour into the Rahad river. A barrage and head regulator, 6 kilometers downstream from the supply canal outfall on the Rahad River, regulate the water flow into the subsequent irrigation network. The project's main canal stems from the Rahad river, skirts the eastern edge of the area, and branches into major and minor canals to command 300,000 feddans.

3. The Tenant Settlement

The population was concentrated along the Rahad river and especially at the northern segment of the project area. Traditionally the project land was utilized for either rainfed (dry-land) agriculture or grazing. There were few permanent homesteads because of lack of drinking water, especially in the south-eastern part of the project area. Those who were settled in the interior of the project were scattered and had to be resettled for irrigation purposes. The settlement administration provides village demarcation and services such as drinking water, roads, health and education. The project authorities had to

select the eligible tenants from among numerous applicants and settle them in the appropriate villages.

4. The Agricultural Production

The 300,000 feddans were distributed in units of 22 feddans for each eligible tenant. The tenancy size was reduced from 24 feddans to the current 22 feddans in 1977 to meet a field layout condition: that the tenancy size be a factor of the block of land irrigable from the terminal irrigation channel--estimated at 88 feddan in the Rahad project. The project management decided the amount of land per tenancy, the crops to be included in the rotation, the amount of irrigation water for each crop and the collection, processing, and marketing of the products. The participants in agricultural production, namely the project management representing irrigation and agricultural authorities, and the tenants would be rewarded according to a formula determined by the government.

B. Sources of Data

The data were obtained from the following sources:

1. Primary data were obtained by conducting a field survey of 125 Rahad tenants during April-May, 1978. Fourteen managers from the Rahad project and agencies involved in project implementation were also interviewed, as well as fifteen other officials from the financing agencies and the Sudanese government

2. Secondary data were obtained from the Ministry of National Planning and Rahad Agricultural Corporation archives. Rahad project appraisal reports and documents, Tambul Pilot Farm results, the Gezira scheme statistics were also collected.

C. Data Collection

A samply survey of 125 tenants was conducted at the project site during April-May 1978, and a complete sampling frame was obtained from the project management. Stratified random sampling was used to select the tenants. The stratification was based on the administrative units of the project, known as "blocks", and this procedure aimed at reducing the time and cost of data collection. At the time about 100,000 feddans of the Rahad project were completed and the sample was drawn from those tenants who were living in project villages and were farming during the 1977/78 season. There were five settlement villages in each of the four blocks; one village was selected at random from each block, i.e. four out of twenty villages. The nth tenant was selected from the rth village (Moser and Kalton, 48). As a precautionary measure against non-response a reserve list of the kth tenant was selected from each village. Around 11 percent of the tenants from the rth villages constituted the total sample size, which is about 2.5 percent of the total tenants residing in the

project. Table 2.1 provides basic data on the sample size and percentage of tenants in the block or village.

The questionnaire solicited information about various aspects of household composition, the household and hired labor required during the production season, the costs, yields, total output, annual household expenditure, problems associated with settlement, and conflicts with the project management.

In the one-shot survey, one of the two interviewers or the author visited each tenant either at his home or tenancy. Some tenants were revisited after responses to the questionnaire had been thoroughly reviewed by the author and the interviewers. Data on agricultural production activities, the contribution of household and labor, and the cost of each production activity paid by the tenant, were based on tenant recall. Tenant's answers were checked for consistency by comparing responses and revisiting them to obtain sound explanation for any inconsistency. Because it was the first year of the project, the tenants' recall of the information was generally adequate.

The annual household expenditure on food, clothing, footwear, health, education, and other needs was recorded for each tenant. Food items consumed on a daily basis such as grain, tea , cooking oil, milk, onion, okra and sugar were recorded in physical quantities. Other items such as meat were given on weekly basis. Tenant's responses

TABLE 2.1 SAMPLE OF TENANTS SURVEYED, NUMBER AND PERCENTAGE OF TENANTS TO THE BLOCK AND VILLAGE POPULATION

Block Number	Selected Village Number	Total Number of Field Crop Tenants in the Block	Total Number of Tenants In The Village	Tenants Included In The Sample Survey	% of Sample of Tenants to Block Tenants	% of Sample of Tenants to Village Tenants
1	1	1381	352	35	2.5	9.9
2	6	1375	234	29	2.1	12.4
3	11	1222	256	31	2.5	12.1
4	16	1415	253	30	2.1	11.8
Total		5393	1095	125	2.3	11.4

SOURCE: Rahad Project and Survey of Tenants

were compared with household size and composition to check for consistency. The physical quantities of these items were then priced at the prevailing prices in scattered shops in the Rahad project area, and these prices were compared to those given by the tenants. The annual clothing and footwear needs of each household member were traced, and tenants gave the total expenditure on these items in monetary terms. They also gave the typical annual expenditure on other household needs such as health, transportation, social activities in monetary terms.

In addition to the survey data, information was gathered during frequent visits to the project area before and after the survey. The author also made field observations and recorded relevant remarks. Furthermore, the management interviews, project reports and attendance of official meetings were used.

The author used two approaches in interviews with policy-makers, concerned agencies, and the Rahad management. About 15 informal interviews were conducted with senior executives of some agencies involved in the project planning and implementation. The interviewees were Sudanese government officials; the Agency for International Development (USAID); the International Bank for Reconstruction and Development (IBRD) and its specialized agency, the International Development Association (IDA); the Economic Development Institute (EDI); and Sir M. MacDonald and Partners (MMP), the project consultants. In the second

approach a management questionnaire was administered to fourteen project officials who had broad knowledge of the project management. Issues discussed included project objectives, the evolution of the project, criteria for tenancy allocation, implementation problems, coordination, etc. Discussion of the criteria for tenancy allocation focused on the amount of income that the tenant should receive from the tenancy.

D. The Method of Analysis

To analyse the planning and implementation of the project, the author drew on the formal management questionnaire, informal interviews, project documents, tenants' perspectives and field observations. To analyse the socio-economic characteristics of the tenants and the choice of the tenancy size, the author used descriptive statistics, frequencies, percentages, tables, graphs, etc., in depicting sample of tenants' characteristics, household composition, income sources, roles in decision-making and tenant-management relations. These data were obtained from the field survey, the management questionnaire and the project reports. Partial budgeting was used to calculate the net returns to the household labor by deducting from the gross receipts of agricultural production the direct costs of production incurred by the tenant, the costs of production paid by the management on behalf of

the tenant, and the cost of irrigation. A method incorporating the variables affecting tenancy size was developed to compute alternative tenancy sizes for consideration by the policy-makers.

CHAPTER III

PLANNING FOR THE RAHAD PROJECT

Upon completion of the Roseires Dam in 1966, 2086 million cubic meters of irrigation water from the Blue Nile were at the disposal of the government of the Sudan (16). Shortly thereafter a comprehensive investment survey of irrigation water resource utilization was completed and the Rahad project was proposed in the list of possible projects. The Rahad project was irrigated the first time in August/September 1977. This chapter examines the planning of the Rahad project over time in order to identify the key problems, how they were resolved, and the implications for planning future irrigation projects.

A. The Roseires Dam

Water storage behind the Roseires Dam made the development of the Rahad irrigation project possible. The Roseires Dam, completed a year ahead of schedule, in 1966, has a reservoir with a gross storage capacity of 3024 million cubic meters. Annual provisions for sedimentation are 15 million cubic meters, such that the total dead storage capacity amounts to 638 million cubic meters over the envisaged economic life of the dam. An additional 300

million cubic meters is the estimated annual evaporation allowance. Adjusting for these losses, the rate at which the dam approaches the minimum net operating storage capacity of 2086 million cubic meters depends on the annual rate of sedimentation.

The Roseires Dam stored water resource should have been utilized for agricultural development in several ways (29):

1. Intensification and diversification of already existing schemes

Intensification refers to the increase in cropping intensity, whether by increasing the area of the crops already grown or by including new crops in the rotation. The diversification of cropping had been achieved--especially in the Gezira scheme by two means. The first was the growing of temperate crops like wheat, which requires the relatively cooler temperatures prevailing during the November-March period. Such crops could not be grown without the elongation of the irrigation period which was made possible by the water stored in the Roseires Dam. After the 1959 Nile Waters Agreement[1] between the Sudan and Egypt

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[1]The Sudanese share of the Nile water amounts to 18.5 milliards (thousand millions) cubic meters measured at Aswan in Egypt. This constitutes about 25 percent. The effective amount, when measured at Roseires, rises to 20.5 milliard cubic meters, because of the reduced losses and Egypt's share amounts to 55 milliard cubic meters (Megahed, 18).

all restrictions on the withdrawal of irrigation water from the Nile and its tributaries within the Sudanese share become unnecessary (16). But, it was only due to the appreciable increase in the amount of stored water after the construction of the Roseires Dam that such crops could be grown. The second was the growing of crops like irrigated rice which requires large quantities of irrigation water in a relatively short period of time.

2. Extensions of the Gezira Scheme (Managil) and construction of new pump irrigation schemes

The utilization of the Roseires Dam for expansion has been very sluggish. The Rahad project, for example, which was a candidate for gravity irrigation from the Roseires Dam, evolved slowly during a decade of appraisals into a pump irrigation scheme; hopefully it will be completed within one or two years. When completed, it is expected to utilize from one-eight to one-quarter of the Roseires water, depending upon the use and non-use of the natural flow of the Rahad river.

These intensification, diversification and expansion efforts were supposed to take place over the final three-year period of the dam construction (29). In mid-1974, eight years after the completion of the dam, the financiers and the owners debated over the percentage utilization of the dam irrigation water resource. The financiers voiced their findings in the following remark: "...the consideration of actual monthly flows of the Blue Nile...leads

to the conclusion that in the last seven years, only during one year, 1972/73--which was exceptionally dry (one of the driest in the last 60 years)--has the dam proved to be significantly useful for irrigation purposes; in another year, 1969/70, it was marginally useful (14% of its capacity), and in the remaining five years it has not been utilized at all" (29). The Directorate General of Irrigation, on the other hand, held the position that "the actual percentage utilization of the Roseires storage (1972/73) based on the calculation of the Audit Report and excluding prewatering should be considered as more than 30% and not 15% (16). Using its own calculation procedure the Directorate General of Irrigation concluded that "the percentage of the utilization of Roseires water during the last four years would vary from 29% to 42% (16).

Pending the fulfillment of the agricultural development projects, the financiers argued that in 1980 the percentage utilization of the Roseires stored water will be 68% (29). The calculations of the Directorate General of Irrigation raised the figure to 84% (16).

3. Hydroelectric Power

The building of the hydroelectric power generators started two years after the dam and was completed in 1971. This delay was additional evidence that the Roseires Dam was underutilized. But hydroelectric power generation made available a secure and relatively cheap source of energy for pump irriation schemes such as the Rahad project.

This important factor partially tilted the decision in favor of pump irrigation rather than the originally proposed gravity irrigation for the Rahad project.

B. Rahad Project Preparation

The Rahad project passed through four stages of project preparation. The evolution through these four stages is presented in Table 3.1.

1. Preparation Stage I: Identification as part of the Roseires pre-investment survey

As revealed earlier, the Roseires irrigation project had two parts: one dealing with the dam construction and the other with the utilization of the stored water in agricultural development. The government of Sudan in October, 1964, entrusted to two British consulting firms[1] the Rahad irrigation project study as part of a Roseires pre-investment survey which identified and prepared irrigation projects. In March, 1966, the consultants submitted four volume report covering the engineering, agricultural and economic aspects of the Rahad project. Although the consultants studied other irrigation projects, they argued that the Rahad project should receive priority because of its proximity to the Gezira scheme, the relatively low rainfall and the uniform topography which was well-suited for gravity irrigation.(25).

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[1]Hunting Technical Service (HTS) and Sir M. MacDonald & Partners (MMP)--hereafter will be referred to as the consultants.

TABLE 3.1. THE DIFFERENT CHARACTERISTICS OF THE COMPETITIVE RAHAD PROJECTS EVALUATED AT THE VARIOUS STAGES OF THE PROJECT PREPARATION

Preparation Stage	Period	Total Area of Project Feddans	Method of Irrigation	Percentage of Intensity of Cropping	Crops in the Rotation	Maximum Yields Assumed of Cotton and Groundnuts	Proposed Tenancy Size Feddans	Percentage Economic Rate of Return
I: Consultants[a]	1965-1967	430,000	Gravity	83.3	Cotton Groundnuts Dura (Sorghum) Vegetables	5.5 B.K.[b] 1.25 tons	12	18.5
II: IBRD	1968	410,000	Gravity	83.3	Cotton groundnuts +vegetables	IBRD 5.0 B.K. n.a.	18	8.0
Agricultural Development Corporation (ADC)	1969	410,000	Gravity			ADC 7.0 B.K. 1.5 tons	12,24	19-23
III: IBRD	1970	410,000	Gravity	83.3[d]	Cotton groundnuts + Vegetable Tenancies	IBRD 5.5 B.K. n.a.	24	10-14
Government	1971	300,000	Pumps			Government 6.2 B.K. 1.5 tons		26-39[c]
IV: IBRD	1973	300,000	Pumps	83.3[d]	Cotton Groundnuts + Vegetable Tenancies	6.0 0.9 tons	24[d]	9-16

SOURCES: Compiled from various sources:

: Hunting Technical Service and Sir M. MacDonald and Partners "Roseires Pre-investment Survey, Report No.2, Rahad Project, Part I-IV, Ministry of Finance and Economics, 1965.

International Bank for Reconstruction and Development "Appraisal of the Rahad Irrigation Project, Sudan, 1973

Ministry of Agriculture, "A Comparison Between The Gravity and Pump Irrigation Designs of the Rahad Project: A Memorandum , Sept. 1970"

Ministry of Planning, "A Memorandum On Rahad and Kenana Projects, December 1970"

Osman, A.A. "Economic Reappraisal of the Rahad Project, Phase I, 410,000 Feddans, Agricultural Development Corporation, Khartoum, May, 1969"

[a] Hunting Technical Service and Sir M.MacDonalds and Partners,

[b] Big Kantor (B.K.) of Seed Cotton,

[c] The internal rates of return were very high because in the process of evaluation the disagreeing ministries picked least costs and maximum benefits

[d] The tenancy-size was again changed to 22 feddans during implementation and the intensity of cropping was increased to 100 percent in 1977.

The following discussion examines the major issues which influenced the selection of the Rahad project. First, the opportunity cost[1] of the irrigation water resource in agricultural production must have been perceived at the time as higher in the Rahad project than in competitive projects. This is primarily because the Rahad project is in a lower rainfall zone (400-600 mm of rain) than other competitive projects south of it (800-1000 mm of rain in the proposed Roseires project area). The higher rainfall areas in the south could be utilized economically with mechanized rainfed (dry-land) agriculture and/or livestock grazing. It was implicitly argued that the marginal productivity of the irrigation water resource in producing agricultural output increases with the decrease in intensity and duration of rainfall. Thus the marginal value productivity of irrigation water in the Rahad project area per feddan of crop mix was thought to be greater than its marginal value productivity per feddan of crop mix in the

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[1]The opportunity cost of producing one unit of commodity X is the amount of commodity Y that must be sacrificed in order to use resouce (Z) to produce X rather than Y (Ferguson and Gould, 19) In the context of this study, the resource in use is irrigation water (Z) assuming that land is not a scarce resource. Commodity X is produced in the competitive projects. Commodity Y is produced in the Rahad project.

competitive projects.[1] Since the proposed crop-mixes, in which cotton was considered the principal cash crop, were almost similar for these projects, the Rahad project looked more attractive than the competitive projects. In any case, uncertainty associated with the amount and timeliness of rainfall required the inclusion of considerable idle capacity in the irrigation network as a safeguard against dry years. Secondly, the Rahad project area had a higher population density, which had socio-economic and political implications. First, it was assumed that anticipated social problems would be fewer and financial costs of tenants' resettlement would be lower in the Rahad project than in competing projects where settlers might be drawn from other areas. Second, a more densely populated area would generally have more political clout, especially in the prevailing partisan parliamentary system at the time.

The project identified by the consultants was supposed to include 430,000 feddans of land. Gravity irrigation was proposed. The irrigation water would be

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[1]The marginal value product of an input (Z) is the change in the total value product attributable to a change of one unit of the variable input (Z) to the production process, the fixed inputs remained unchanged (Bradford and Johnson, 9, 19). Mathematically: $MVP = \frac{TVP}{Z}$

Assuming similar crop mixes for Rahad project and the competitive projects and almost similar irrigation network capacity, that is equal amount of irrigation per feddan of crop mix to accommodate for uncertainty associated with rainfall then: $MVP_{zy} > MVP_{zx}$

conveyed from the Roseires Dam by a 191-kilometer supply canal and 338 kilometers of the Rahad river course. The rotation with 83.3 percent cropping intensity included acala or sakel cotton[1], groundnuts and dura. The tenant was allotted 12 feddans and an additional 1/4 feddan back-yard vegetable garden. The benefit-cost analysis resulted in an internal rate of return of 18.5 percent[2] (25).

The government of Sudan submitted the Rahad project prepared by the consultants to the International Bank for Reconstruction and Development (IBRD), for financing around 1967.

2. Preparation Stage II: IBRD Appraisal Missions

The IBRD responded by sending a mission to appraise the project and the mission's report on the economics of the project was extremely unfavorable. The internal rate of return was estimated at 8 percent, i.e., below the IBRD acceptable level of 10 percent. From personal contacts with the chief of the 1967/68 mission, the author understands that crop yields were assumed to be lower than in

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[1]Acala cotton is a medium staple cotton. Sakel cotton is a long-staple cotton commonly known as Egyptian cotton.

[2]Internal rate of return is the discount rate which just makes the net present worth of the incremental net benefit stream or cash flow equal to zero (23). Mathematically:

$$\sum_{i=n}^{n} \frac{Bn-Cn}{(1+r)} = 0$$

where Bn = benefits each year;
Cn = costs each year;
n = number of years (economic life of project);
r = interest (discount) rate.

subsequent evalutions.[1] But yield discripancies by themselves could not explain the wide margin of difference between the consultants' 18.5 percent and the 1967/68 IBRD mission's 8 percent internal rates of return.[2] Beside the estimated low economic returns, other reasons which hampered the financing of the project were cited, including the large size of the investment, an implied capital constraint, the lack of a comprehensive national development plan, doubts about the capacity of the government to provide the required local currency funds, and unsettled political conditions (28, 29).

During the same period and in close consultation with the IBRD, the government of Sudan created the Agricultural Development Corporation (ADC).[3] The main function of the corporation was to undertake major development

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[1]The assumptions of maximum cotton yields varied from 5 Big Kantars (B.K.) of seed cotton in 1967/68 to 5.5 B.K. in 1970 and 6 B.K. in 1973; on other occasions a figure of 7 B.K. was used (Osman, 54).

[2]It was not possible to look for all the underlying assumptions that may account for the wide margin that separates the two estimates, because the author could not obtain a copy of the 1967/68 IBRD report. In fact, the author used 1967/68 because at times references were made to 1967 (28) and at other times to 1968 (29). Most likely the mission might have gone to the field in late 1967 and the report was published in 1968.

[3]Similarly, at the same time the Mechanized Farming Corporation was created and entrusted with the development of rainfed (dry-land) agriculture.

projects in the irrigated agricultural sector, including the construction of the Rahad project. The Agricultural Development Corporation issued its first economic re-appraisal of the Rahad project in May, 1969 (Osman, 54). The results were very favorable, with the internal rate of return ranging between 19 and 23 percent. The study made specific recommendations in cropping intensity, rotation and tenancy size, and undoubtedly initiated subsequent efforts with the financiers and encouraged the IBRD to reconsider its position.

Despite the implicit IBRD decision not to participate in financing the Rahad project, it agreed, in 1969 to finance Tambul Pilot Farm with funds left over from the Roseires Dam project. The purpose of the Tambul Pilot Farm was to develop intensive farming practices for the future Rahad project over a three year period. The International Land Development Consultants (ILACO) entrusted with the assignment completed their final report in October, 1972 (33).

Following the 1969 coup d' etat, some of the influential members of the May Revolution voiced strong opposition to economic activities of some foreign donors and financial agencies in the Sudan. Paradoxically, bilateral cooperation with some selected countries and their increased economic participation were advocated and sought.

At the time of the May 1969 Revolution, and IBRD mission was concluding talks on various issues in Khartoum.

The mission, facing a completely different government overnight, sought the opinion of the new regime and was given the impression that the Sudan was interested in economic cooperation with the IBRD. A second reappraisal mission was planned for June 23, 1969, but the mission was delayed until after the Council of Ministers' resolution in July, 1969. Finally, after the approval of the Council of Ministers in January, 1970, the IBRD reappraisal mission arrived in Khartoum in February, 1970. This mission found that the excavation of the supply canal from behind the Roseires Dam had already been started--a development which will be explored subsequently. The findings of the reappraisal mission were favorable and the technical aspects of the project were considered sound. The internal rate of return was estimated at between 10 and 14 percent.[1] There was every indication that the IBRD was willing to negotiate the financing of the project.

But by the end of 1969 there was much frustration due to the long delay in the use of the Roseires waters. Also, sentiments were against the lengthy negotiations with the IBRD and the alleged terms of financing--especially those concerning the use of foreign consultants.

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[1]The 1970 Appraisal report was not available to the author. The project design was changed shortly after the departure of the IBRD mission, and hence the interest in its findings was lost. These details were obtained from the Ministry of Agriculture Memorandum (38).

Something had to be done. Hence, the Minister of Irrigation at the time pledged to start the excavation of the irrigation network using available local resources. The Ministry of Irrigation mobilized its heavy equipment and moved to the site of the supply canal at the end of 1969. By the time the excavation was stopped, 2 million cubic meters of earth were already moved (43).

Though the excavation work in the supply canal was started and the chances of being financed had greatly improved after the latest IBRD mission, a drastic alteration in the method of irrigation of the Rahad project prompted the termination of the excavation work around May, 1970. The new method of irrigation which was eventually accepted by all concerned bodies led to what is presently under execution--the pump irrigated Rahad project.

3. Preparation Stage III: The Gravity-Pump Irrigation Controversy:

During the formulation of the 1970/71-1974/75 Five-Year Plan of Economic and Social Development of the Democratic Republic of the Sudan,[1] the Ministry of Irrigation was asked to submit an alternative means of irrigation that would substantially decrease the funds requested for the construction of the irrigation structures of the Rahad project (42, 43). The Ministry of Irrigation then proposed

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[1]The plan was supervised by a team of experts from the Soviet Union.

an entirely different method of irrigation, which relied on irrigation by pumps instead of gravity. The length of the supply canal was reduced from 191 kilometers to 84 kilometers, the proposed pump site being some 200 kilometers downstream from the Roseires Dam. The cultivable area of the project was reduced from 410,000 feddans to 300,000 feddans. The alternative project design was approved and appropriations were allocated in the Five-Year Plan without consulting the agricultural authorities (43).

The Ministry of Agriculture, waging strong opposition to the alternative proposals, sent a menorandum to the Ministry of Planning in mid-September, 1970 (38). The economic evaluation of the competitive projects, based on assumptions made by the Ministry of Agriculture, favored the 410,000 feddan gravity irrigation. The memorandum sparked a tug of war between the agriculture and irrigation authorities. The Ministry of Planning took the initiative to make the choice between the two alternatives. In a series of meetings extending from September to December, 1970, in which top level officials including ministers, of agriculture, irrigation and planning, participated a careful scrutiny of assumptions was undertaken.

The differences of opinion were mainly technical and related to irrigation and the flow of net benefit stream. The flow of net benefit stream in turn depended on the apportioning of costs among the stages of the Rahad project. The gravity irrigation supply canal was designed

with a capacity of 150 cubic meters per second. All parties acknowledged the excess capacity of the supply canal, but disagreed on the precise volume of the excess. The Ministry of Irrigation held the view that it would not exceed 15 percent, whereas the Ministry of Agriculture contended it would be 40 percent. Assuming that the excess capacity could be utilized for irrigating additional land, particularly the expansion of the Rahad project Stage II, the cost of the supply canal would be divided between the two stages in accordance with the percentage use of the supply canal. Furthermore the flow of the net benefit stream depended on the availability of irrigation water at the tenancy level, the water requirements of the crops in the rotation, and the duration of the water application for the crops included in the rotation. The Ministry of Planning, acknowledging lack of technial knowledge and experience (43), relied solely on the Ministry of Irrigation's technical advice to determine the cost structure of the Rahad competitive methods of irrigation, the capacity of the irrigation structures, the pace of implementation and the time flow of the cost and benefit streams. The Ministry of Planning always relied on the Ministry of Agriculture for technical advice in the field of agriculture, but such advice was not part of the controversy.

On the basis of these assumptions arrived at during the numerous high-level meetings, the Ministry of Planning supported the alternative pump irrigation project. The

Ministry of Planning reached this conclusion after discounting the highest return gravity irrigation project, because the Ministry of Irrigation did not approve the irrigation technical aspect presumed by the agricultural authorities (43). The Ministry of Planning Memorandum paved the way for the final approval of the present pump irrigation project but it also led directly to the resignation of the Minister of Agriculture.[1]

It was not the economic evaluation per se but political factors which led to the approval of the present pump irrigation Rahad project. There was every sign that that IBRD was ready to help finance the Rahad project, though the reservations stated earlier did not seem to have changed. The Soviet expert team advocated the drastic change in the project irrigation at the time the IBRD was considering the financing of the project. However, the shift to pump irrigation reduced the financial burden, which was much advocated by both the Soviet experts and the IBRD. Moreover, benefits would be obtained earlier. The Ministry of Irrigation made a commitment to construct

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[1]Paradoxically, the present author was the co-author of both the Ministry of Agriculture and the Ministry of Planning memorandums. The author was also responsible for the computations in both cases, in addition to the coordination of all the meetings and their minutes. The involvement of the author was an invaluable source of information and guaranteed an access to the project documents. The author being aware of the dangers of bias in such cases, spared no effort to be objective.

the gravity irrigation project, but without additional heavy earth-moving equipment it was difficult to execute. Hence an alternative project which would substantially reduce the volume of work to within the prevailing execution capacity of the irrigation authorities was attractive. Besides, there were antagonistic feelings against foreign consultants and investments in general. There was a proposition that the smaller, less sophisticated pump irrigation project could be financed by the local resources of the country. But even if it was to be financed from abroad, it was assumed that there would be no need for foreign consultants.

4. Preparation Stage IV: The Rahad Pump Irrigation Project

The political situation in the Sudan was very tense in early 1971. In February, three members of the Revolutionary Council were fired. The climax was reached in July when those three members staged a coup d' etat. The leader of the May Revolution was deposed and imprisioned until a counter-coup set him free three days later. The brief coup d'etat, believed to be instigated by the communist bloc, caused a major rift in the relations with that bloc and the service of the Soviet experts were terminated. Those experts who remained in compliance with contracts lost most of their influence. The Minister of Irrigation was fired on the allegation that he was sympathetic to the aborted coup. Meanwhile, the IBRD pointed out that the pump design had a number of attractive features,

including a lower capital outlay than the gravity scheme. Also, countries such as the United States and Kuwait showed willingness to help finance the project.

During 1971, the IBRD made a comparative study of the two alternative Rahad projects. The study showed that the difference between the internal rates of return for the gravity and the pump projects did not exceed 1 percent. The report concluded:

> Benefit cost analysis indicates that the margin of difference between the gravity and pump schemes is small enough that the choice between them can be made on other criteria (28, Annex 1, p.4).

The other criteria apparently favored the pump project and the economic appraisal was completed and approved in February, 1973. The internal rate of return was estimated at 9 to 16 percent, depending mainly on the future price of cotton (28).

From mid-February to the end of March, 1973, the Council of Ministers approved the Rahad project credit agreements with the Agency for International Development of the United States (USAID), the International Development Association (IDA) of the IBRD, and the Kuwait Fund for Arab Economic Development (KF). The Rahad pump irrigation project was henceforward put into implementation. The Ministry of Irrigation undertook the responsibility to construct the irrigation network. The tenants' settlement, agricultural production, and various related responsibilities were entrusted to the Rahad Agricultural

Corporation (RAC) in place of the Agricultural Development Corporation.[1]

Parallel to the changes in the design of the irrigation system, changes were noticed in the agricultural component. For example, only the acala cotton had been included in the rotation while sakel cotton was left out. The area under cotton was increased to half instead of one-third of the cropped area. The vegetables and orchards were allocated as a separate enterprise for specialized tenants, instead of backyard plots.

C. Summary

The irrigation of the Rahad project was made possible by the construction of the Roseires Dam. However, the execution of the Rahad project was started a decade after the completion of the Dam. In light of the considerable delay in the usage of the Roseires Dam water resource--not just in the case of the Rahad project--one post evaluation argued that the dam was built five years earlier than it should have been (29). A more logical conclusion would be that for some reason the dam was not timely utilized, and this should have been considered in

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[1]The dissolution of the Agricultural Development Corporation signified a major shift in policy. Instead of having a consolidated agricultural authority responsible for irrigated aggriculture development, each project would have a separate agency as appropriate.

the economic appraisal and planning of the water storage project.

The products of the dam, whether irrigation water, electric generation capacity or whatever, are intermediate and not final outputs. Thus when considering approval of dam construction, policy-makers should not rely on Say's Law that supply creates its own demand. In such a large indivisible and interdependent project, it is crucial to estimate carefully the demand for its joint-products. However, in this case there were only vague ideas about projects that would be undertaken after the completion of the dam. Hence anticipated agricultural development was seriously impaired because of poor planning in the beginning.

The case for delayed utilization was demonstrated by examining various stages of the Rahad project preparation. In the economic evaluation there were numerous difficulties and disagreements over the identification and quantification of the costs and benefits. These disagreements were reflected in the wide range of the internal rates of return at various preparation stages. Finally, the project was transformed from gravity to pump irrigation, but not without confusion and confrontation. It appears that not only the method of irrigation mattered but also the amount of work involved. The pump irrigation project has an irrigation network that could be constructed with relative ease and with the pay-off in a shorter period than the gravity irrigation project.

The persistent capital constraint, especially when foreign assistance was sought, contributed to the delay in approval of either version of the Rahad project. Moreover the capital constraint favored the pump irrigation project, which needed less investment appropriations.

Politics blended with other factors. Instability arising from the change in the regimes and differing perspective of the leaders contributed to the delay in approval and execution of the Rahad project. Relations within the Sudanese government agencies and with the interestd international agencies also influenced approval and execution of the project.

The results of the economic appraisals undertaken at various stages of the project preparations followed logically from the identification and quantification of the project costs, benefits, and the nature of their time flow. Assumptions regarding these might be manipulated to suit the dominant interest molded by the prevailing political, technical and economic factors. There is hardly a value-free economic appraisal (Chambers, 12).

The concern with the project irrigation design may have resulted in overlooking some important aspects of the project. Some are relevant to planning the implementation of the project, and others to the agricultural production at the farm level, and the tenant in particular. The tenants' productivity and well being are important to the overall performance of the project. Implementation

will be discussed in Chapter IV, while important issues concerning the tenant will be discussed in Chapters V and VI.

CHAPTER IV

LESSONS FROM THE IMPLEMENTATION OF THE RAHAD PROJECT

Projects are only as good as their implementation. Nevertheless the implementation process receives proportionately less attention from policy-makers than project choice. Such neglect would undoubtedly lead to: (1) poor project preparation, (2) erroneous economic evaluation, (3) delays in project implementation, (4) non-fulfillment of the stated project objectives, and most important, (5) failure to learn from past experiences. The need to focus more attention on the on-going evaluation of projects during implementation is crucial. This kind of evaluation would provide implementers with valuable information and enable them to make continuous adjustments as new problems are encountered and new research findings become available. The major emphasis in this chapter is to identify the constraints encountered during the implementation of the Rahad project--those which could effect the performance of the project.

The implementation of the Rahad project could not be evaluated in its entirety because of the numerous project components, and because it is still not completed.

The project outputs and impacts are yet to be fully realized. But, available data and information obtained from the sample of tenant survey, the management interview, personal contacts and the project reports and archives are used for an on-going evaluation of the Rahad project implementation.

A. Towards A Conceptual Framework For An Evaluation of the Implementation of Projects

1. Literature Review

Research on implementation has been generally confined to a mere listing of implementation problems; most of the details have remained accessible only to the implementaters and policy makers. A synthesis of these problems in a broad conceptual framework is yet to come. As Williams expressed it:

> ...the lack of concern for implementation is currently the crucial impediment to improving program operation...Nothing comes across more strongly than the great naivete about implementation. We have got to learn that implementation period for complex social programs is not a brief interlude between a bright idea and opening the door for services. (Williams, 65, p. 268).

This concern produced a literature which, with few exceptions, has concentrated on implementation failures. Moreover, normative considerations and circumstantial evidence influence the choice of projects for evaluation. Value judgements of the researcher may also influence the results of the study. Bardach (6) summarized this as

follows: "Opinions differ on whether or not L-P-S[1] has been very effective in this regard...A brief, and necessarily sketchy, personal evaluation of L-P-S is offered in..."

Exhaustive lists of implementation problems, ranging from shortages in financial and physical inputs to conflicts among participants have been sketched in the literature. Only recently have some attempts been made to put together a theoretical framework based on detailed case studies of policies undertaken in the United States during the last decade. Hargrove (24) pointed out the difficulty of defining what implementation precisely means. Although he considered Williams definition, the "...process of trying to move from a decision to program or project operations" (65) as most succinct; he was sceptical about the interdependence between the decision itself and the process of obtaining a predetermined product (24). This concept of interdependence, or the difficulty of separating policy decisions from their implementation, has led to the idea that a policy decision could be treated as an hypothesis (56) and implementation would be the process of trying to put that policy into effect (24). Some public policy analysts have developed this idea further and recommended that the analyst provide the decision-maker

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[1]Among the few exceptions in the literature is the Mental Health Reform in California (L-P-S) sponsored by the state legislator Lanterman. However, even in this case, the researcher acknowledges that some people do not agree with his view (6).

with an "implementation estimate" that would show the ease or difficulty of implementing alternatives (24).

Bardach viewed the implementation process as "an assembly process", and made an analogy between the implementation process and the operation of a machine. He argued: "Putting the machine together and making it run is, at one level, what we mean by the implementation process" (6). This definition implies that the policy maker should draw the specifications for the "machine" as well.

The annual budget of any country reflects a large number of policies and their variations relative to policy field, sector, region, nation, level of technology, physical inputs and outputs, target groups, etc. It seems logical to conclude that the implementation process would be highly specific: location specific, policy specific, implementation agency specific, etc. But as Bardach argues: "Yet, at an intermediate level of abstraction, one can see that all such machines do look rather similar" (6). There are decisions, administrative units to implement, means of financing, inputs acquisition and use, capital, labor, services, physical outputs and target groups. Within this context it is possible to make some theoretical abstraction useful for policy formulation and prediction.

A number of writers have explored models of policy implementation during the last decade. These models depended more or less on the view that policy and implementation

fall in a continuum. Smith as quoted in (Quade, 57) presented a policy implementation model in which policy-making process and policy are linked to the complex implementation process by a feedback mechanism. He made what he termed idealized policy--i.e., the idealized pattern of interaction that those who have defined the policy are attempting to induce--the nucleus of the implementation process. Around this nucleus revolve the various participants with their patterns of behavior and relationships and the factors that shape these relationships and the environment.

Williams model considers the implementation process as part and parcel of policy. According to his model, policy has six stages which fall in a continuum. Implementation embodies two stages: policy specification and field implementation. The model provides a separate stage for operation of the policy, though many analysts do not seem to particularly acknowledge the need for such a provision.[1] To qualify his model the author warns that:

> The orderliness of the stages (of the model) and the vigor of the definitions are heuristic devices used to facilitate exposition. Implementation is too complicated, and too little is known about it to expect either orderliness or vigor when analysis and assessment are actually undertaken. (66, p. 271).

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[1]Yet it is interesting to note that the operation of some particularly vulnerable and controversial projects are being blocked after their physical completion--e.g., nuclear plants. Also in Chapter III, it was shown that the Roseires Dam remained under utilized for more than a decade after its physical completion.

Recent works by Rein and Rabinovitz (61) and Van Meter and Van Horn (68) have examined the association between policy impacts and the characteristics of variables which are thought to affect those policy impacts. In general these econometric models would take the form

$$P = f(X_i)$$

where

P = policy impacts - dependent variable

X_i = factors affecting P - Independent variables

i = 1 ... n

2. A Conceptual Framework

The implementation process could be viewed as a production process. Policy decisions commit resources to produce some specific outputs as sketched in Figure 4.1. Within such a conceptual framework stage A is crucial to the production process because the answers to major questions determine the objectives of the policy. Those answers are subject to revisions at varying degrees, depending on the feedback, pressures, compromises, loopholes and problems that might arise in the subsequent stages.

The importance of Stage B, is that in determining the policy outputs, decision-makers have to commit specific resources. In many cases resources committed fall short of the resources actually used. This is not always due to inefficiencies in production but, apart from uncertainties, might be due to an overestimation of resource productivity. Some researchers have called for the

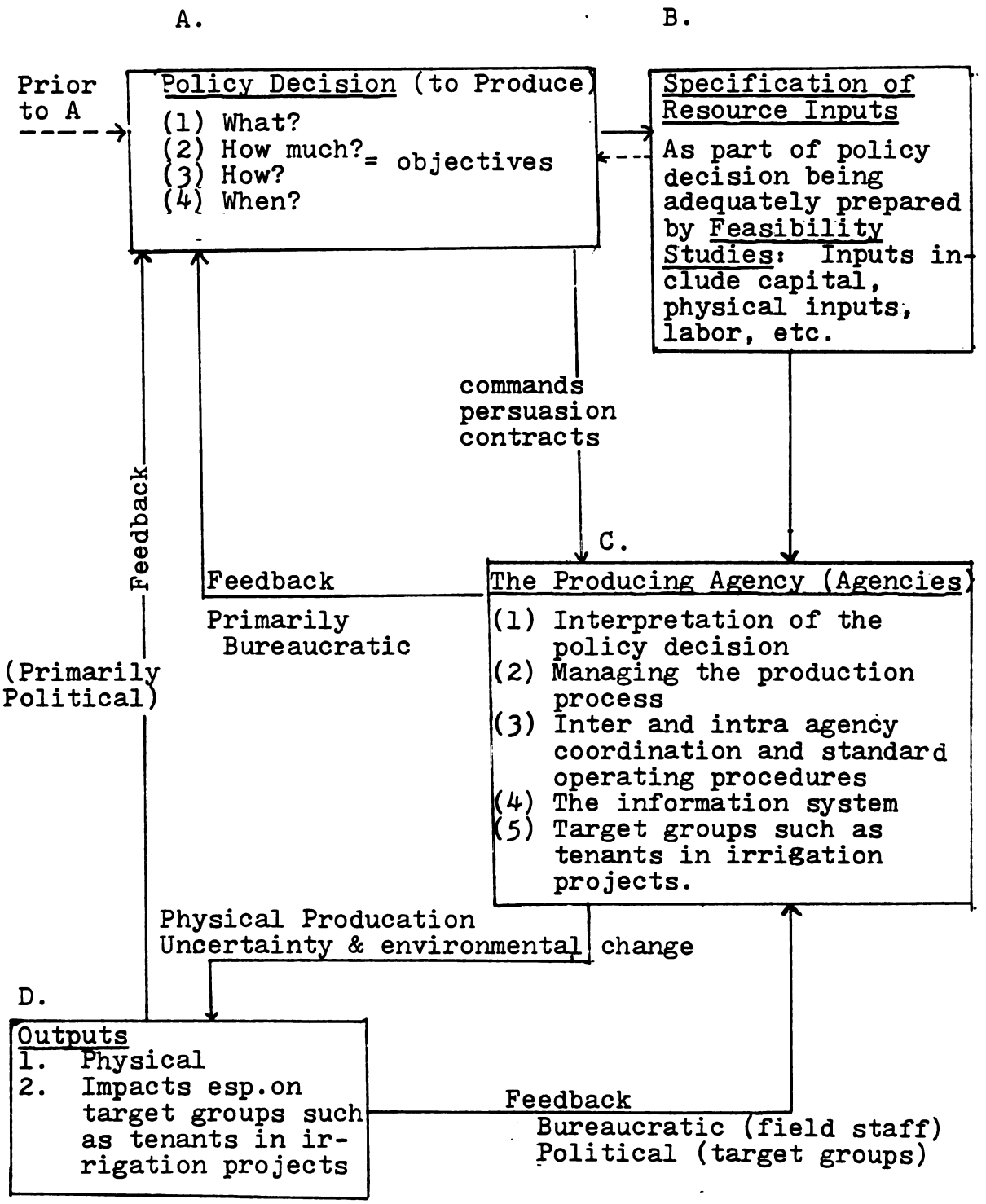


FIGURE 4.1 IMPLEMENTATION: A PRODUCTION PROCESS

inclusion of implementation estimates for policy alternatives at the policy evaluation stage (24).

Actual production commence at Stage C, where there could be substantially different and conflicting interpretations of the objectives. The struggle shifts to this stage to ensure that the particular participants' objectives are met. The bureaucracy, for example, may shape the production process in such a way as to score gains for its own bureaucratic organization as well as to serve the original planned objectives. In the case of agriculture not all of the production activity is governmental; some involves the farmers (tenants). They have their own objectives and depending on those and their view of costs and benefits, they may affect project output accordingly. This is why land allocation to tenants can affect performance.

In Stage D the physical outputs and impacts on some target goups are finally produced. These outputs are not necessarily those desired as prescribed by the policy in A or the bureaucratic organization in C. Feedback is expected from all participants, target groups, and the public at large.

The model of Figure 4.1 deals with the implementation process in the context of production function. The model permits the study of the relationship of variables within any one stage and between the various stages. This model incorporates the basic characteristics of the implementation

process as perceived from the literature. These are summarized as follows:

1. The interdependence of policy and implementation,
2. Variables which influence the implementation process including the following:
   a. the macro social, political and economic policies,
   b. the nature and availability of resources, including the funds committed and their release,
   c. the implementation agency (or agencies) and its characteristics, the behavior of the bureaucracy, the inter and intra-agency coordination, the standard operating procedures and the resources available to any parity for reaching agreement with other parties when objectives conflict,
   d. the information and feedback,
   e. the participants such as tenants in irrigation projects, and whether they perceive to gain or lose from the implementation of the policies;
3. The iterative nature of the implementation process,
4. The uncertainty and information cost associated with implementation,
5. The joint-product characteristics of the output,
6. The dynamic nature of implementation,
7. The problems of developing appropriate criteria for evaluating implementation.

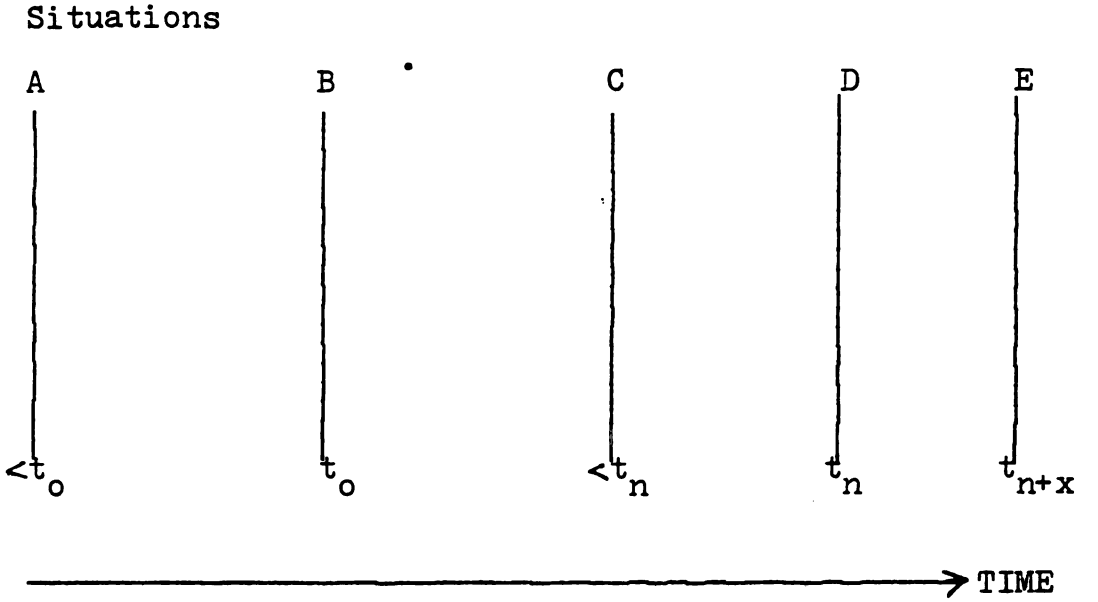
B. Evaluation of Project Implementation

1. Problems of Measuring the Evaluation of Implementation

There are three situations to be considered in measuring implementation. The first occurs prior to project approval at time $<t_o$ (situation A of Figure 4.2) when the problem or need is first identified. The second concerns the decision taken at t_o, with the period $<t_o - t_o$ used for formulating and compromising the decision to move to situation B. The third situation takes any length of time between t_o and t_{n+x} to achieve the objectives which change situation A to C, D or E; where D at t_n is the situation predicted on the introduction of the policy or project.

Failure to clearly identify which difference is being measured in the course of evaluating implementation is common. Politicans, capitalizing on gaining "favorable" perception from their constituents, frequently emphasize the hypothetical difference between situation B at t_o and projected situation D at t_n. They tend to compress the time needed and ignore the implementation process to impress their constituents with the great achievements within their reach (57). The politicans gain by maximizing the total sum of short-run positive perceptions of change as viewed by the constituents.[1] It is possible, of course,

[1] Statements such as "for local consumption" or "window-dressing" are commonly used in daily political life when giving favorable impressions to constitutents. Although policy inaguration speeches may be sincere, experiences have shown that they, too, fall far short of their promises.



A: Some "undesirable" situation which makes change necessary.

$<t_o$: Beginning of a period of time during which change of the situation is being perceived as vital.

B: The situation when the policy to change situation A has been approved. The only difference between A and B is that at B, commitment to change is made.

t_o: The time at which policy is approved.

C,D,E: Situation which may prevail after implementation, with D being originally projected.

t_o---$<t_n$, t_n, t_{n+x} : Represent the period of the implementation process.

n: Number of units of time to complete the policy.

x: Unknown number of units of time; $x \lesseqgtr n$.

FIGURE 4.2. A Diagram Explaining the Various Measurable Differences in Implementation

though very rare, that the implemented policy resembles the planned policy. But for purposes of research much care should be exercised to distinguish which difference is measured, if it is measurable at all.

The comparison of two snap-shots, one at the time of the policy decision and another upon project completion, is conceptually deficient. This approach ignores what may have taken place during the implementation-production-process, including changes in policy stemming from the field feedback.

Besides the conventional approach, which measures the changes in outputs and impacts produced by the implemented policy, the literature suggests an evaluation procedure by which the alternative policy formulations can be compared (24). In the first place it is extremely doubtful that such formulation exists other than in hypothetical terms. Whereas one policy formulation would be put to field implementation, hypothetical processes of implementation of the other alternatives should be simulated for comparison purposes. It is, of course, possible to compare the theoretical underpinnings of these alternatives. Yet apart from that, one may be comparing two groups of different things: apples and citruses. Whereas the apple is the implemented policy, the citruses refer to all other alternatives.

For any one policy the rate of implementation, its success , and failure depend on the period in which the

evaluation is undertaken and the participants' valuation of the outputs and impacts at the time. Determining the end of implementation poses another difficulty, since the outputs and impacts may vary with the time at which they are recorded. Completion of the physical structures--the irrigation network, the land preparation and the tenant settlement in the Rahad project, for example--is considered the beginning of the end of implementation. The precise time is arbitrarily determined.

To further complicate the situation, the participants normally have their own perspectives in evaluating the project implementation. If the perspectives of all participants are compatible, no theoretical or practical problems of measurement arise. However, the common situation is for them to be incompatible in whole or in part. For this reason the question of tenancy size is singled out for emphasis in Chapter VI. In the Rahad project, for example, the tenants as a group, the management, and the government had their own perspectives. Incompatibilities were evident when the interviewed tenants pointed out that the shortage of dura (sorghum), their staple diet, was adversely affecting their well-being. With this perspective, they argued strongly for the introduction of dura in the crop rotation, in spite of government assurances of an ample supply of dura from the adjacent mechanized rainfed (dry-land) agricultural region. From the perspective of the management the inclusion of dura in

the rotation creates technical and managerial problems and furthermore it could be produced at lower costs in rainfed (dry-land) agriculture.

While none of the participant groups are homogeneous in composition and/or aspirations, the tenants of irrigation projects are traditionally considered a single homogeneous group for the purposes of economic appraisal and project choice. Aggregation can be detrimental to the success of field implementation in terms of physical output and positive change in the welfare of the individual tenant households constituting the group. The policy expected outputs and impacts may be reduced if the individual tenants' output and gains are perceived as inadequate.

2. Criteria for Evaluating Implementation

In project evaluation a statement certifying the technical, economic and political feasibility of the project precedes its approval. In reality projects so described, frequently encounter technical, economic and political problems. Whereas in some cases these problems are constraints which might be overcome, in other cases these are symptoms of theoretical deficiencies.

A fundamental theoretical deficiency arises when some objectives are mutually exclusive. This is often the case when objectives are decided upon after hard bargaining and compromising among the interest groups during the policy formulation stage. Any of the interest groups may have accepted (or been forced to accept) the

policy, hoping that the implemented policy version would be in its favor. Issues that were unwillingly accepted during policy formulation or later identified as undesirable by the interest group will be contested during subsequent stages.

The most important criterion for evaluating implementation is measuring the degree to which some selected policy objectives have been met. The quantity of physical outputs such as the area of land developed and the total and per unit resource output are recorded and compared with the total and unit resource productivity before the policy implementation and/or with the policy objectives. The monetary equivalents of these physical quantities can be obtained by pricing the resources used and the products. Financial and economic comparisons of individual incomes, returns to public investments, foreign exchange earnings, etc. can be made between the implemented policy and the originally planned policy objectives, and between the former and the situation without adopting that policy. Assumptions can be made and weighting systems can be used to compare the qualitative aspects of individuals and group in the same manner as outlined above.

The use of benefit-costs analysis as a method of evaluation has a number of perils. First, aggregation over-simplifies the comparison, especially with the validation of interpersonal comparisons. Secondly, if benefit-cost analysis covers a number of future periods (usually

years), necessary assumptions are needed about future implementation performance, and these may be mere speculations. Therefore policy-makers should attempt to control the implementation variable and make the project work instead of spending all their time trying to guess the future outcome. Thirdly, in benefit-cost analysis, projects are evaluated according to the life-span of the physical assets, which may have little relevance to the impacts of the project on the target groups and their time preference. A benefit-cost analysis comparing the performance of the implemented Rahad project with the approved project may not be meaningful, because the project was in early stages of implementation when this study was started in 1978. At the time only 20 percent of the planned area was under agricultural production. Comments on the rate of implementation and the relative change in the status of the tenants may prove useful here.

C. The Implementation of the Rahad Project

1. Project Objectives

If implementation is viewed as a production activity then the questions of what, how much, how and when must be addressed. Whereas the answer to how may be of a technical nature, the answers to the other questions should be embodied in the policy objectives. Unfortunately, the 1973 Rahad project appraisal (28), does not state explicitly the objectives of the project. The implicit objectives

could only be obtained from the project description of how much land would be cultivated, how much production would be obtained and how much tenants would be settled. The appraisal study has only given indications of the planned time framework, implementation and productivity targets, and project costs.

In order to classify the objectives, the author interviewed numerous implementation executives, identified a long list of objectives, and reclassified them into a list of twelve (See Table 4.1). Some of these objectives relate only indirectly to project implementation; most are extremely difficult to put in measurable terms.

During the interviews some of the project implementers reported that when they joined the project, they were obsessed by the fact that there was no statement of project objectives. In September 1973, six months after the project was approved, the Rahad project management tried to define the project objectives, and implementers apparently were not aware of this. In May, 1978, a report written by a senior implementation executive mentioned only four broad objectives (58). Some implementers stated they were aware of only three; the maximum reported was seven. Generally implementers reported that project objectives they mentioned could be achieved simultaneously. On the other hand, in response to a consistency question and discussion, seven of the twelve executives acknowledged that some of the objectives could be conflicting; examples

TABLE 4.1 RAHAD PROJECT OBJECTIVES AS REPORTED BY THE IMPLEMENTATION EXECUTIVES INTERVIEWED.

	Objectives	Number of Executives Who Reported the Objective
1.	Socio-economic development of the project area	11
2.	Utilization of land and water for the expansion of irrigated agriculture	8
3.	Increase in national income	8
4.	Contribution to foreign reserves	8
5.	Settlement of nomads	8
6.	Increase of tenants' incomes	5
7.	Generation of employment opportunities	4
8.	Integration of animals in irrigated agriculture	4
9.	Increase in vegetable production	3
10.	Introduction of new technology and mechanization	1
11.	Development of cooperatives	1
12.	Help in developing future projects	1

SOURCE: Rahad Project Management Interviews By The Author

included the issues of employment versus introduction of large-scale mechanization, and the introduction of animals in an agricultural system not designed for them versus the planned total crop production.

At the project preparation stage, only five of the executives interviewed were fully involved, three were partially involved and those remaining did not contribute to project preparation. Of all the implementers only five studied the appraisal report carefully, seven studied it partially to familiarize themselves with their specific area, and two had not read it.

Thus, with no explicit statement of the project objectives, limited participation of the management staff at the project preparation stage, and little access to the appraisal study, there were bound to be different interpretations of perceived objectives. Such misinterpretations frequently occur, even in cases where objectives are clearly defined. But poorly defined objectives can severely hinder any efforts to evaluate the implementation of a project. Lack of detailed studies contributed to the ambiguity of the Rahad project objectives. If the numerous studies--undertaken after project approval and during implementation--had been made prior to the final decision, a better project with well defined objectives could have been prepared. Table 4.2 lists important studies undertaken after the approval of the Rahad porject. An informed IBRD staff member mentioned in retrospect that a further detailed

TABLE 4.2 LIST OF STUDIES UNDERTAKEN AFTER THE APPROVAL AND DURING THE IMPLEMENTATION OF THE RAHAD PROJECT

	The Study	Date Month/Year	Comment
1.	Transportation study of Rahad Project	April/1974	A comparison between tarmac roads and light railways
2.	Location of groundnuts decortication plants in the Rahad project	/1975	A comparative location study
3.	Fruit and vegetable growing in the Rahad project.	Feb/1974	Recommended decreasing the fruit and vegetable area, to 7,000 feddans for local industrial & foreign demand from a proposed 20,000 feddans
4.	Production relations for horticultural tenancies	Aug/1975	
5.	The human factor in the Rahad project Area Phase 1: Results of population & Socioeconomic survey	Dec/1975	
6.	Revised farm budget	Aug/1976	
7.	Report on Rahad project site planning	n.a.	A report prepared by Shankland Cox
8.	Report on impact of revised cropping pattern with livestock integration	Jan/1977	The most important report which rationalized change of tenancy size from 24 feddans to 22 feddans & studied livestock integration.
9.	Land and water charge in the Rahad project	June/1977	
10.	Design note on sewage disposal at project and group headquarters	Feb/1978	
11.	Cotton picking		Committee formed in Feb/1978 to study the feasibility of mechanical picking

SOURCE: Rahad Project Data

project preparation was needed prior to project approval; but it was thought that such a line of action would be completely unacceptable to the government of the Sudan.

2. Coordination of Project Implementation

It is difficult to find in the literature the unqualified use of the term "coordination". The idea is more commonly perceived as the "problem of coordination". But it may be more useful to think of coordination as a prerequisite for all phases of project implementation. Coordination should be considered at the time the policy decisions are made.

a. The Need for Coordination in the Rahad Project.

The implementation of the Rahad project presents a classic example of the need for coordination. A number of factors make it a crucial task.

(1) The scarcity of resources places the Sudan in the poorest quartile of the world's nations. A severe form of resource scarcity is the lack of excess capacity in the economy.[1]

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[1]To describe lack of excess capacity positively, Caiden and Wildavsky used the term functional redundancy, which they defined as "A certain amount of redundancy (duplication of resources) on which depends the probability that a given function will be performed" (11).

For the most recent and thorough infrastructural, labor, and financial resources of the Sudan consult (34).

(2) The complexity of the Rahad project, with diverse physical, labor, and capital resources (as shown by the chart of Figure 4.3) requires a carefully managed, coordinated, and monitored program to finally produce the desired physical output and impact on target groups.

(3) The large number and diverse composition of the participants lead to conflicting interests and the need to resolve them. There are at least seven groups of participants:

(a) The political leadership;

(b) The central government agencies participating at the policy decision level,

(c) A minimum of thirteen government agencies responsible for project implementation--with Irrigation, the Rahad Agricultural Corporation, Central Electricity and the Water Corporation entrusted with implementation of the key components,

(d) Five international agencies and a food grant organization financing the foreign component, and the Sudan government financing the local component,

(e) The consulting firms, of which one is responsible for aiding in and monitoring implementation, and the others for purchasing and changing designs as needs arise,

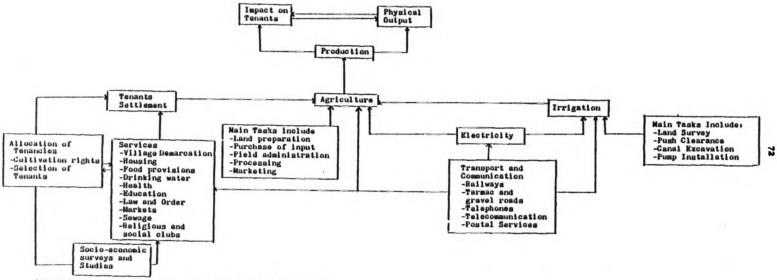

FIGURE 4.) Agricultural Input-Output Flow of the Rahad Project

(f) National and international construction companies,

(g) The tenants, who usually join at a later stage, but whose welfare is affected by the action and performance of the other groups.

b. The Effort to Coordinate The Implementation of the Rahad Project.

Efforts to coordinate the project implementation started in August, 1973, immediately after the agreements between the Sudan and the financing agencies were ratified and became effective. The first Coordination Committee, formed under the auspices of the Planning Commission, met for the first time in December, 1973. But, the work of that committee could not coordinate effectively because of: large membership; discontinuity of participation by designated members; a high degree of absenteeism; and lack of power to command the implementation agencies or to enforce procedures.

In June, 1974, the Supreme Planning Council (SPC), a ministerial committee headed by the Minister of Finance and National Economy, acknowledged the ineffectiveness of the first Coordination Committee. The SPC ordered the restructuring of the Coordination Committee and called for continuity in membership. The membership was limited to the Ministry of Irrigation; Rahad Agricultural Corporation, including the Commissioner; Ministry of Construction and Public Works. The SPC also gave the committee discretionary powers to coordinate the work of different agencies,

but did not specify clearly the nature of these powers, so the same situation prevailed after the restructuring and the formulation of the second Coordination Committee. In a meeting between the financiers and the implementation agencies six months later in December, 1974, one financing agency representative was quoted as saying:

> The project coordination is a concern to the Bank as it affects every aspect of the project. He hopes that this question (of project coordination) is resolved as minor details may arise, and if not solved in time, affect development (sic) (implementation). He believes that a body responsible to do this work is to be set up. This body should have financial powers, as well as decision making powers to speed development (sic) (implementation). (58).

The Director General of Planning maintained the position that "the Coordination and Follow-Up Committee solves problems that arise, but is only an advisory committee" (58).

The second Coordination Committee could not gain discretionary powers, they had them in name only and the powers were not specified. In April, 1975, apparently because of the surmounting implementation problems and the year-long delay in project irrigation, the Council of Ministers took over the matter and appointed an executive director at the level of Deputy Minister. The Council also formed the third Coordinating and Follow-Up Committee headed by the Executive Director.

The third Coordination Committee and its successive chairmen did a lot of trouble-shooting but achieved only

limited success in project implementation. Irrespective of how much land was prepared for irrigation or how many tenants were settled during 1977/78, the actual land cultivated was 60,000 feddans, or only 40 percent of the projected 150,000 feddans. The land cultivated in 1978/79 was 120,000 feddans--again about 40 percent--instead of the planned 300,000 feddans. The project settlement and cultivation should have been completed in 1978/79.

"Extremely high rates of settlement have been achieved on previous irrigation schemes, averaging 95,000 feddans per year from 1966 to 1971" (28). The rates of settlement and irrigation achieved so far in the Rahad project were much lower than the previous record--whichever definition is adopted.[1] This implies that even though the coordination authority had been elevated to an unprecendented level, the achievements in Rahad project implementation were moderate. The reasons for this do not lie in coordination per se; other factors hindered the efforts of the coordination and implementation authorities.

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[1]The rate of settlement may refer to the amount of irrigated land brought under production and settlement by the relevant implementation agencies in any one year. Alternatively it may refer to the total amount of irrigated land brought under production in a particular irrigation project, divided by the number of years of implementation. For example, if Rahad project is completed in 6 years, then the rate will be $\frac{300,000}{6}$ = 50,000 feddans. A third alternative will be the land brought under production and settlement after the completion of irrigation infrastructure. In this case it will be about 60,000 feddans for 1977/78 and 1978/79.

Coordination should have focused on the smooth functioning among implementation agencies and the timely sequencing of tasks to produce the physical output and impact on target groups. Instead the coordination committee concentrated most of its efforts in securing a "most favored" position for the project in its competition for the extremely limited resources.

Members of the Coordination Committee and implementation staff pointed to the shortage of both local currency and foreign assistance as the most important resource constraint. There is some evidence to support their claim. For example, out of an increase of $143 million in foreign assistance to the Rahad project during 1975, approximately $60 million (42%) were available to cover a $43.5 million cost increase in irrigation works, building, electrification, etc. Cost increases were due to changes in design and quantities, the underestimation of project costs, and an additional $16.5 million needed for project improvements. Added to these were the increase in contigencies of $49.2 million, and world-wide price increases of $34 million, primarily after October, 1973 (30). The 1975 cost adjustment were not enough. Subsequently the project costs had to be increased to cope with international price increases and domestic inflation.

The local and foreign capital constraints were accompanied by other shortages in labor, energy, machinery, building materials, cement, farm inputs, consumer goods,

etc. Implementation agencies and the successive coordination committees devoted most of their time and energy coping with these waves of resource constraints.

The scarcity of resources and the shortage in the supply of services were not the only reasons for the ineffectiveness of the coordination efforts. These coordination committees did not develop and adopt a clear set of operational guidelines, i.e., standard operating procedures for their conduct. Even if operational guidelines were available, some of the coordination committees had limited persuasion power to enforce them.

In addition to problems of getting agreement among agencies, there were information and conceptual problems. Given the complexity of the project, the large number of agencies involved in implementation, and the chain of dependent tasks, modern analytical management techniques such as network analysis[1] should have been used. Whereas implementation schedules used in planning the Rahad project were designed for independent work programs, the techniques of network analysis such as the Program Evaluation and Review Technique (PERT) and the Critical Path Method (CPM) are used to relate the time framework of each activity, the

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[1]The two most known techniques are the Program Evaluation and Review Technique (PERT) developed by U.S. Navy in 1958 and the Critical Path Method (CPM) of DuPont. For an excellent review of the technique consult (48,49).

critical time relative to other dependent activities, and the sequence of the activities within the available resources and time. This schedule is used as a tool for controlling and monitoring the progress of the work.

3. Interdependence of the Project Components

A brief review of the implementation process illustrates the interlocking nature of the project components. The excavation of the large supply canals for irrigation could only be done with heavy excavation equipment, namely caterpillars. However, as they are not usually stock items, they were only obtainable on order or as second-hand equipment and to purchase them from either source required a waiver (of purchase rules) from the financing agency--USAID. Because of this and related obstacles, it was clear from the beginning, in 1973, that it would be difficult to finish the excavation of the canals by April of 1976. Letters exchanged between the Irrigation Authorities, Planning Commission, IBRD, and USAID during late 1973 and early 1974 expressed that concern (58).

Electric power was needed for pumping the irrigation water from the Blue Nile; the responsibility was given to Central Electricity and Water Corporation (CEWC). But because of difficult technical questions, the financiers insisted on appointing a consultant firm to assist in installing the equipment. Ambiguity in the selection procedure, dissillusion on the part of the implementing agency, and delays in decision-making decreased the chances

of timely execution of the electrification program. This situation prevailed for more than a year after project approval.

Finally, around November, 1974, the Director General of Planning who headed the second Coordination Committee wrote a memorandum to the Commissioner of Planning and the Minister of Finance and National Economy; he recommended a de facto one year delay in project implementation. The recommendation was accepted and it was agreed that 150,000 feddans would be brought into production during each of the last two years, instead of 100,000 feddans for each of the last three years. But the financiers thought the proposed higher rate of implementation was unrealistic, and their reservation was warranted (58).

The preparation of the agricultural land for cultivation and distribution to tenants was the responsibilty of the Rahad Agricultural Corporation. The irrigation authorities were to clear the land and hand it over to the agricultural authorities for land preparation and tenancy demarcation. In preparing the land for cultivation the Rahad management was confronted with numerous difficulties, including energy shortages, vehicle shortages, problems of purchasing and transporting farm machinery, and non-response to building contracts. In settling tenants in the project area, the management faced two main difficulties. First, the provision of adequate housing, drinking water, health, education, transport and marketing

services had to be carefully syncronized with the movement of the settlers into the project. Secondly, in moving the settlers during the March-May period (immediately after settlers had harvested their rainfed crops), the Rahad management had to be highly certain that the irrigation water, land, and other inputs would be readily available for production. Otherwise the settlers would risk losing the opportunity to produce by irrigation, after having given up their previous method of rain-fed production.

Despite this delicate situation, tenants were asked to settle on the project site, even if their families couldn't accompany them, in May, 1977. At that time, with no certainty of the provision of water for irrigation, the project management decided to take the risk and planted cotton on dry land. This proved successful. The project could operate at least partially, and 40 percent of the target area (of the 1974-75 change in implementation schedule) was cultivated. This decision to plant prevented a full year delay.

The factors in favor of the decision to plant cotton on dry land were:

1. The area to be cultivated was in the southeastern part of the project, which is in a higher isohyte (rainfall),
2. There were enough assurances and indications that the irrigation water would be available before the end of the rainy season, which in fact occurred in August-September, 1977,

3. The agriculture and irrigation authorities developed a working relationship and were able to avoid confrontations experienced at the project preparation stages,
4. Seemingly a desirable degree of competition and challenge had developed between the two authorities at the field implementation level,
5. The implementers' strategy, which gave the Rahad project a "favored" position, alleviated bottlenecks--especially in allocation of resources.

D. The Main Factors Contributing to Delays in Project Implementation

The factors which have played a major role in delaying the implementation of the project are identifiable, but it is difficult to rank these factors because they are interrelated and the data are incomplete. The factors are as follows:

1. Project preparation was inadequate.
2. Resource limitations were considered by most of the implementers as the major cause of delay. The project was approved and implementation commenced during a period of high international inflation, as a result, the estimated cost of the project had to be adjusted through lengthy negotiations. Foreign aid funds necessary for purchases in the international markets were often slow in coming. The financing rules and regulations

of the lending agencies are based on the reimbursement principle, i.e. the country pays from its own foreign reserve resources and presents the necessary documents for reimbursement. With extremely limited foreign reserves, the purchases of capital equipment might be given lower priority. The lending agencies sometimes paid directly for market purchases. However, in cases where a letter of credit had to be opened by the recipient country the problem prevailed. Even though the foreign financing was available the problem was insolvable (46).

Shortages of physical inputs such as building materials, energy, machinery and equipment, skilled manpower were mentioned by the implementers as important factors in the delay. Another was the limited transportation capacity in the country. Considering these resource limitations, it seems that the Rahad project could not have been implemented faster. Perhaps it would have been more appropriate that the implementation estimates be adjusted accordingly.

3. Coordination was properly handled only at a later stage of the implementation process, and coordination efforts were concentrated primarily in solving the problem of input shortages. An example of coordination failure was the electrification component. One function of the hydroelectric power from the Roseires Dam was to provide electricity for the irrigation pumps and the

ginning factories. The electrification process encountered many technical and logistical problems, however, and only partial electricity was provided for the ginning factories by the end of April, 1978. About three to four months of the ginning season were lost and a large part of the Rahad cotton was transported to Gezira ginning facilities. Some of the cotton had to be stored for ginning after the rainy season.

4. Uncertainty was an important contributor to the delay. According to the 1975 revisions of the Rahad project costs, about a quarter of the expected rise in cost ($34 millions) was the result of price increases since the project appraisal. Furthermore about a third of the expected rise in cost were due to increases in contingencies to hedge against future uncertainties (30). By 1978, since the project management was faced with price increases and changes in designs and quantities, the government sought to secure increased funding through parallel financing[1] or national sources.

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[1]Parallel financing is a procedure by which funds are loaned by one of the donor agencies on a bilateral basis outside the original financing agreement. These additional funds could be complementary or allocated for some specific sub-component of the project.

E. The Tenant as the Producer

The tenant is the ultimate producer in the irrigation projects in the Sudan. Hence, to attain the project objectives an account must be made of the problems which confronted the tenants.

They were selected for settlement in the Rahad project by the following criteria:

1. Sudanese nationality was required,
2. Tenants who owned land or had cultivation or grazing rights on project land or surroundings were preferred,
3. Preference was given to tenants with larger households.

The tenants interviewed ranked application for tenancy and the selection procedures as the least difficult problems. The result presented in Table 4.3, however, reflects an obvious bias because the tenants included in the sample were already chosen. Those who ranked the process as difficult were those on the waiting list. The settlement of nomads in the Rahad project was difficult because they lacked interest and knowledge of settled life, and establishing their previous grazing rights was difficult.

Although the survey of tenants was conducted in the project's first year of partial operation, common problems were already visible. For example, 88 percent of the tenants sampled experienced difficulty in obtaining

TABLE 4.3 TENANTS RANKING OF SELECTED PROBLEMS IN THE RAHAD PROJECT

Problematic Area	Missing or No Response		No Problem		Minor		Difficult		Very Difficult	
	No.	Per-centage	No.	Per-centage	No.	Per-centage	No.	Per-centage	No.	Per-centage
1. Application for tenancy and selection	1	1	90	72	27	21	5	4	2	2
2. Movement to the project	2	2	3	2	24	19	41	33	55	44
3. Village location	2	2	3	2	6	5	39	31	75	60
4. Irrigated agric. production	2	2	16	13	27	21	61	49	19	15
5. New cultural practices	4	3	50	40	15	12	25	20	31	25
6. Water application	1	1	32	26	15	12	30	24	47	37
7. Labor supply	2	2	3	2	11	9	20	16	89	71
8. Dissatisfaction with the management in farming	1	1	45	36	12	9	31	25	36	29

SOURCE: The Survey of Tenants

Percentage figures were rounded to nearest whole number

hired labor.[1] Similarly, 90 percent of the tenants sampled did not like the location of their villages for various reasons.

Sample tenants were specifically asked to explain the basic reasons for late settlement of their families into the project area (near the end of the first production season). Their answers, presented in Table 4.4, implied that 87 percent of those who moved in late were not given ample notification. Fifty-four percent of those who settled late thought that the facilities provided by the project were not adequate at the time. Another 25 percent expressed doubts about the provision of irrigation and drinking water.

These tenants were also asked to list the most important difficulties they had encountered. Their response is presented in Table 4.5. Over the years many of these problems will be resolved, but by that time both the physical output and target groups might be adversely affected.

During the first crop year, it was too early to determine if tenant income was adequate, so tenant response on this question must be supplemented by a comparison of their expected income from agricultural production

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[1]The survey was conducted during cotton picking. Both tenants and management were in a tense situation because of shortages in the supply of labor for cotton picking.

TABLE 4.4 TENANTS RANKING OF REASONS FOR LATE SETTLEMENT IN THE RAHAD PROJECT AREA

Reasons Cited by Sample Tenants	Number	Percentage Of The Sample	Percentage of the Tenants Who Report Delay
1. Late notification	59	47	87
2. Inadequate facilities of new village sites	37	30	54
3. Doubts about irrigation and drinking water	17	14	25
4. Children at school	10	8	15
5. Involved in other activities	9	7	13
6. Busy in managing the tenancy at the Rahad project	4	3	6
7. Proximity of his original village	4	3	6
8. Other reasons	3	2	4

SOURCE: The Survey of Tenants

TABLE 4.5 TENANTS RANKING OF SETTLEMENT DIFFICULTIES IN THE RAHAD PROJECT

Difficulties Faced	Number	Percentage
1. Lack of healthy drinking water	74	59
2. Education facilities	60	48
3. Shortage of cash flow	58	46
4. Inconveniencies created by settlement and irrigation authorities[a]	58	46
5. Shortages in supportive services[b]	56	45
6. Shortages in grain--the staple diet	49	39
7. Health facilities	45	36

SOURCE: The Survey of Tenants

[a]These include: allocation of housing space; claims that housing loans were not given, crossing bridges were lacking or remote, etc.

[b]These include: lack of flour mills, transport, building materials, firewood, etc.

with their annual household expenditures. Project performance, considered in terms of tenant productivity, overall project output, and impact on tenant well-being, depends on the income derived from the tenancy. The rule adopted for tenancy allocation is to give each tenant equal tenancy, irrespective of his household size. This principle might have adverse effects on project performance. Hence, the question of tenancy size must be carefully studied. Chapter V examines the characteristics of the tenant household sampled. Chapter VI, using findings of the previous chapter, focuses on both the appropriate procedures for determining tenancy size and the adequacy of the tenants return from the tenancy. In Chapter VII, some policy implications will be drawn.

F. Summary

Most of the implementation studies concentrated on the problems. The approach followed here has considered implementation problems as symptoms of more fundamental shortcomings in the design and specification of projects. Implementation is a production process where decisions involve questions of what, how much, how and when to produce; setting objectives; and committing specific resources to meet these objectives. The products of the process are of two types: physical outputs and impact on target groups. There are conceptual problems in measuring the outputs of the implementation process. If the evaluation

of implementation is to become an empirical question, there should be a precise definition of what is being measured and what level and quality of outputs should be compared. Evaluations should focus on the chances of attaining the predicted outcome of implementing a policy or project.

The objectives of the Rahad project were not explicitly stated. The agencies responsible for implementation of different project components had specified different sets of project objectives, some of which were competitive.

In the beginning, the project lacked coordination, but as implementation progressed, more effective coordination was achieved, even though efforts were oriented towards trouble-shooting. Modern techniques of coordinating and monitoring implementation were not applied, despite the need to cope with the complexity of the project and the interdependence of its components. Coordination, inadequate project preparation, resource limitations, and uncertainty were considered the most important factors in the delay of project implementation.

While settling in, the tenants faced shortages of drinking water, staple diet, and vital social services such as health and education. As a result, the productivity of the tenants and the overall project performance were affected. Furthermore, tenant households were considered a homogenous group, and accordingly, each tenant was allocated a uniform tenancy. If the tenant household is proved to be heterogeneous in size and composition, then

the allocation of uniform tenancy could also affect tenant productivity and overall project performance. Chapters V and VI examine this problem.

CHAPTER V

ROLE AND RELATIONSHIP OF THE TENANT WITH THE PROJECT MANAGEMENT AND SOCIO-ECONOMIC CHARACTERISTICS OF THE TENANTS

In irrigated agricultural projects in the Sudan, the project management sets forth rules and guidelines for the tenant that encompass all aspects of production and marketing--from seed variety selection to the market price of the produce. But the tenant, as a decision unit and in his individual or group capacities, affects output both at the tenancy and project levels. Thus there is a need to focus on the tenant's decision-making role and his relationship with the project management.

The administrative rules, and especially the guidelines for tenancy eligibility, imply a total dependence of the tenant on the income generated from his tenancy. To achieve higher productivity it follows that the income needs of the tenant should be reasonaly met. These needs are partially determined by the size and composition of the tenant's household. In addition, the tenant's household supplies labor at the tenancy level. Hence, it becomes necessary to examine the socio-economic characteristics of the tenant and his household.

A. The Role of the Tenant and the Project Management in Decision-making

Decisions are made by a complex body of policy-makers including the government, the financing agencies, the Rahad project management, and the tenants. Their decisions affect all aspects of production: the financial and physical resources allocated for production, crops, processing, marketing, etc. The organization chart of Figure 5.1 depicts the various participants in the decision-making process.

The role of the tenant, restricted to supplying labor at the tenancy level, has been determined by a number of factors: (1) the hierarchy of agricultural production within the project, (2) the tenancy agreement, and (3) the impact of the role played by the different participants in adjacent irrigation projects. For example, most of the field staff responsible for project implementation and supervision of crop production is either seconded by the Gezira Board or trained in the Gezira scheme.

At the production level: mechanical units prepare the land, tenants provide labor, field officers supervise work and handle supplies, and irrigation officers manage the water. Tenants do not participate in contract negotiations for reaching tenancy agreements nor are they supposed to dispute them. But in fact, a would-be tenant is not legally a tenancy holder until he signs this written agreement, which is usually based on the tenant agreements

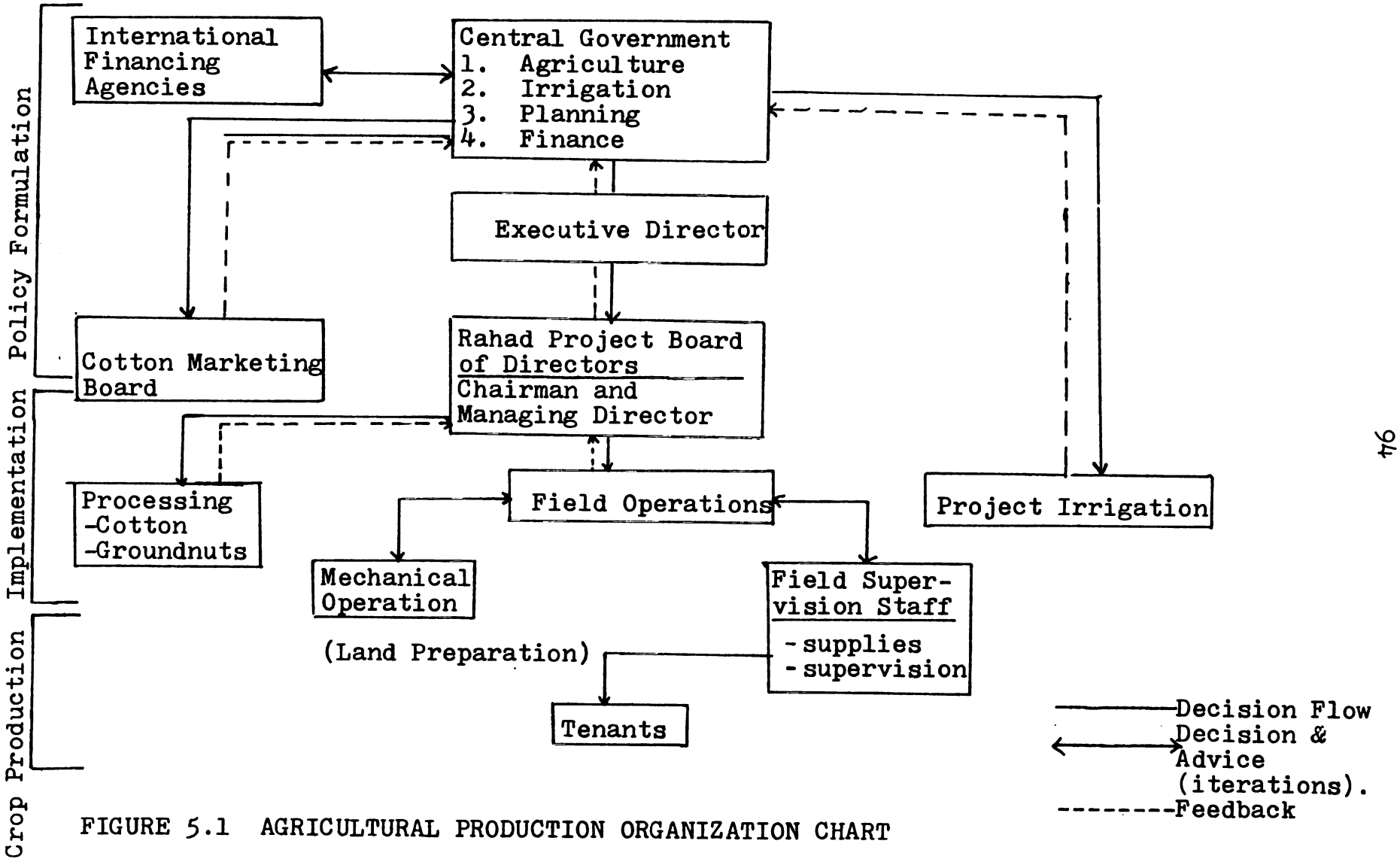

FIGURE 5.1 AGRICULTURAL PRODUCTION ORGANIZATION CHART

and traditions of the Gezira scheme. Tenants are expected to cultivate the land according to the crop rotation and cultural practices as laid out by the project management (Barnett, 8).

The role of the project management and the tenant vis-a-vis the different policies and activities of the project are discussed in the following:

1. The System of Payment for the Use of Irrigation Water, Land and Other Resources

Two systems of payment are used in Sudanese irrigation schemes to pay for irrigation water, land preparation, cultivation, management, processing and marketing: (1) crop-sharing for cotton--while other crops are considered the property of the tenant[1]--as in the Gezira scheme; and (2) land and water charges, where all costs from land preparation to marketing, are deducted from the tenant's gross revenue from all crops--adopted for the Rahad project. Crop-sharing is advocated because risk and uncertainty are shared among the partners; the land and water charge is favored as more efficient in resource use. The decision to adopt either system is the responsibility of the

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[1]During the 1977/78 season, the government introduced a new sharing arrangement which aimed to extend the sharing to other cash crops but dura, as a subsistence crop, remains a tenant property. The Gezira Tenant Union waged a strong opposition to these measures.

government policy-makers and the project management; tenants have never shared in making this decision, even though it directly affects their productivity and returns.

2. Irrigation Control

Depending on the amount of water available in the irrigation canals and the amount and frequency of rainfall, the project management determines the frequency (and hence number) of irrigations that each crop should receive according to the economic priority it enjoys and within the optimum level specified by researchers. The optimum depends on numerous factors, but in the Rahad project, it was observed that the field staff advocated different numbers of applications. Some believed that it was more appropriate to continually apply water to the cotton crop while others believed that water stress towards the end of the growing season induces polling and water would be wasted at this stage.

Number and frequency of irrigations to cotton and groundnuts depend on the level of technology used in crop harvesting. In the event of mechanical harvesting, water should be withheld to induce uniform maturation and to enable machinery to get into the field. The tenant does not control the amount of the irrigation water or the amount of rainfall nor does he decide the optimum number of irrigations, the economic importance of the crop, or the level of technology in harvesting. The role of the tenant is extremely weak in the Rahad project. Maas and

Anderson recently commented:

> The technological characteristics of irrigation agriculture - especially the flow, stochasticity and singularity of water supplies - create special problems of control to which there are two polar responses, with a relatively small number of alternatives between them: a single leader or leadership group, which may be from outside the irrigated area, can operate the control structures and procedures; or all the irrigators of a water course who live within a defined service area can create and support a users organization with authority to operate the structures and procedures of water control.
>
> Wittfogel and like-mined scholars believe that the typical response is the first- control from outside and from on top, which can lead to despotic power in an agronomical bureaucracy that tends towards totalitarian control over water users. (35, p. 366).

The tenant role is to inform the agricultural field officer either directly or through the water canal superintendent (Ghaffir) that irrigation water is needed. If there is enough water in the canal and in accordance to a scheduled program, the agricultural field officer commands the Ghaffir to release water to the whole set of tenancies. If water is not in the canal, the agricultural field officers turn in their constituents' needs at the block level and so on, until finally the total requirements of the project are available to the irrigation authorities. The irrigation authorities then dispatch the required amount of water from the irrigation network head to the specified canals in the system.

The tenants most important decision concerns applying water to his tenancy. Since each tenancy cannot be policed--

except at extremely high costs--tenants are known to over-irrigate. It is not uncommon for the spillover of irrigation water to cause roads to become impassable. Although water lost in such a manner is not charged at cost to the tenant, the agricultural field officer, if aware of the situation, could record it, and the tenant may be fined.

3. Choice of Crops and Crop Mix

The tenant exercises no role in the choice of crops to be grown in the project. Neither does he have a say, except marginally, on the selection of area for each crop. These are usually determined--and changed whenever it appears appropriate to the project management--and specified outside the contractual agreement. In fact, in the tenant contractual agreement, the crops are left out intentionally. For Gezira "The Standard Conditions of Tenancy 1936" states: The tenants shall cultivate the land in proper manner and according to the scheme of crop rotation laid down by and to the satisfaction of the (Sudan Plantation) Syndicate--(a British company responsible for managing the Gezira scheme then)...(Gaitskell, 20).

The Rahad Project 1973 appraisal states that: "The tenants shall hand over to the (Rahad) Corporation their prescribed crops in clean condition at the collection centers..." (28, Annex 12 p. 35).

The project management does not like to be legally bound by specifying the crops. Furthermore, the tenants

whether as individuals or as a group, cannot alter the cropping pattern. Tenants are part of a complex system and do not seem to be the most important.

Historically crop rotations have been changed over time in irrigated agirculture in the Sudan. Decisions on crop rotations are made by the government and dictated by national objectives. But, in at least one case the national and the tenant interests matched: the introduction of dura (sorghum), the staple diet, in the Gezira scheme rotation. In the early days of the scheme, the project management noticed that tenants would leave cotton, the partnership cash crop, and devote more of their time to the dura grown outside the rotation area. Hence, dura was included in the rotation in order to provide food security to the tenant and save him the trekking time to distant dura parcels (Tothill, 64). But to safeguard against the tenant's bias toward husbanding his subsistence crop, the Standard Conditions of Tenancy (1936) read:

> The said scheme of crop rotation shall allow the growth by rain cultivation and subject to the prior requirements of the cotton crop by irrigation water on a portion of the said land of a crop of dura sufficient for and restricted to the tenant's own requirements. Provided that the tenant shall not sell any part of the said crop and shall in no way neglect the cultivation of the cotton crop for the sake of the dura crop (20).

In the course of planning the Rahad project, the central government has retained the right to determine the

crop rotation and mix. The policy-makers have always focused on a rotation of two crops: medium staple cotton and groundnuts. But since livestock was a major enterprise of many farmers before they joined the Rahad project, the project management decided to allow the tenant to determine whether to keep livestock and include leguminous fodder in his rotation, or to concentrate on producing groundnuts and cotton.

4. Production and Marketing

In production and marketing decision, the power lies with the project management. Annex 12, Article 5 of the 1973 Rahad project apprisal is a good example:

> The (Rahad) Corporation may also undertake the following operations on behalf of the tenant whenever it is considered by the Corporation to be advantageous or convenient to do so. The cost of such operations together with interest at a rate to be fixed by the Corporation taking into consideration the current bank rate shall be a charge on the tenants. Such operations shall include the following:
>
> (a) Land preparation (including ploughing, smoothing, and ridging), mechanical planting and harvesting,
>
> (b) Supply of improved seeds and cost of seed treatment,
>
> (c) Supply of fertilizers,
>
> (d) Supply of chemicals and crop spraying to control pests and diseases,
>
> (e) Ginning of the cotton crops,
>
> (f) Hulling of groundnuts
>
> (g) Transport of the crop,
>
> (h) Crop insurance,

(i) Crop storage,

(j) Marketing,

(k) Construction of Abu VI canals,

(l) Supply of Abu VI pipes,

(m) Any operations done by the Corporation on behalf of any tenant due to the negligence or failure of the tenant to fulfill his obligations (28, Annex 12, p.3).

The analysis of cotton production costs in the sample of 125 tenants revealed that the tenant commanded on the average only 2 percent of the costs per fedden (See Appendix B). A large part of these costs were advanced as loans by the project management to the tenants. Even though cost allocation does not reflect day-to-day decision making in the field, the tenants' share in cost allocation must be viewed as an important means of control and an indicator of decision-making.

Unlike the adjacent Gezira scheme where cotton is the only joint-venture crop, in the Rahad project both cotton and groundnut are produced and marketed under the joint auspices of the project management and the tenant. Article 35 of Annex 12, of the 1973 Rahad project appraisals addresses marketing procedures:

> The tenants shall hand over to the (Rahad) Corporation their prescribed crops in clean condition at the collection centers established by the Corporation. The Corporation shall market such crops on behalf of the tenants to give the tenants the benefit of economies of marketing on a large scale. The tenants shall market on their own their vegetables, fruits and livestock. The Corporation shall extend to them advisory services in the marketing of these products (28, Annex 12, p.3).

The rationale for project management control over production and marketing of cotton and groundnuts is stated as economies of scale. But this is not the whole story. In August, 1975, a committee set up to determine the relations between the project management and the fruit and vegetable tenants reported that: It is extremely difficult to secure the repayment of the land and water charge and costs of services and inputs provided in cash by the (Rahad) Corporation to the fruit and vegetable tenants (59).

Earlier suggestions for repayment, which arose in one of the meetings of the Rahad Agricultural Corporation Board of Directors, called for either of two solutions: that the (Rahad) Corporation receives a mandate from the Board to collect the dry Haricot beans and market that crop for its advances and debts on fruit and vegetable tenants; or alternatively that the tenant should sign an injunction to pay these debts at the end of the season, and that he may be legally evicted in case of his failure to do so. (58). The Committee did not go so far as giving the marketing responsibility to the Corporation; instead, it recommended formation of cooperatives to handle the marketing of fruits and vegetables. It also recommended that a tenant be evicted if he did not repay the loans advanced for these crops. The Committee's final recommendations state that: (1) the tenant should not dispose of onions, Haricot beans and fruits privately, since these crops are suitable for cooperative marketing and the

returns which accure from them should be enough to repay the Corporation advances; (2) the tenant should repay his debts on a strict timetable to be agreed upon with the Corporation; and (3) if the tenant failed to meet his obligations as stated in the agreement, the Corporation would be free to undertake the necessary steps to safeguard its interests. In the occasion of tenant evication, the Corporation would determine the best use of the fruit and vegetable tenancy, in accordance with the rules and regulations (59).

The repayment of loans, advances, and production costs has always been the primary concern of the project management.

5. Non-Farm Occupations

Traditionally, in irrigation projects in the Sudan, tenants have been strongly encouraged not to pursue off-farm jobs. For example, field officers monitor tenants, frequently make note of the absence of tenants in their tenancies, and examine the condition of the tenancy for weed control, drainage, and the flow of water. In the Rahad project the approach is the same--except where occupations, such as trading, are perceived to be of vital importance to the tenants. Thus, the tenancy remains the most important, if not the only, source of income for the tenant.

6. Provision of Services

Services such as health, drinking water, education, electricity, paved roads, etc. affect production at all

levels. An adequate supply and fair distribution of these goods are not only important for the social welfare of the tenants but also essential for the utilization of resources. In the Sudan most of these services are provided free of charge by the public sector. Three of them, education, health care, and drinking water, are of special interest in this investigation. Whereas in the assumed perfectly competitive model they would be considered private goods, in Sudanese irrigated agriculture they are at best "impure" public goods. First, the market fails to provide these services at market prices which the majority of consumers could afford. Secondly, there are high costs of exclusion associated with the use of these goods (62). Although the demand for these services is expanding, the supply is failing to keep pace because the cost of producing these goods is very high.

Tenants may be aware of the stalemate which the government faces as a producer of these goods, but they generally do not appreciate the preferential distribution of these services. That is, these services may be provided for some of them and not others. During the field work for this study many tenants reported that they were apprehensive about the inadequate production and unfair distribution of these goods. For example, about 60 percent of the tenants surveyed ranked the shortage of drinking water as their most serious problem, followed by problems in health and education.

B. Socio-Economic Characteristics of the Tenants

1. Household Composition

Household composition is important in many respects for the proper operation of the production system. In the context of this study, the household is of interest both as a source of labor and as a consumption unit. The basic assumption is that the tenant and his household will supply the needed labor, at least to cultivate a certain acreage of cotton, the principal cash crop, in the rotation (39). On the other hand, the project management makes sure that the tenant devotes full time to the tenancy. Since there are few, if any, alternative income opportunities, the tenant and his household must rely on the tenancy for their sustenance.

The dependency rate is obtained by calculating the ratio of persons below 15 years of age plus persons above 64 years of age to the active population between 15 and 64 years of age. The dependency rate in the tenant household sampled was 1.2 However, field observations indicated that children in the 10-14 years age bracket were active participants in agricultural production; when these children were included the dependency rate dropped to 0.7. The results of this sample tenant survey (See Table 5.1) were within the range of dependency rates found in a survey of the total population conducted in the area during 1974-75 for the would-be tenants in Rahad project (Galal Eldin,21).

TABLE 5.1 TENANT HOUSEHOLD COMPOSITION BY AGE-GROUP, ABSOLUTE AND PERCENTAGE DISTRIBUTION

Age Group (Years)	Total Number in the Sample	Percentage	Cumulative Percentage
1-9	297	36	36
10-14	123	15	51
15-19	88	11	61
20-64	286	34	96
65 & above	35	4	100
TOTAL	829	100	

SOURCE: The Survey of Tenants

A micro level examination is needed of household characteristics and composition, and of the individual tenants in the sample. In subsequent analysis, it was contended that household composition is an important variable in tenancy size determination and hence in all policies that follow, such as tenancy allocations, production decisions, settlement, and services provision.

Table 5.2 indicates that tenancies were distributed predominantly to males, who were usually the heads of households. The 4 percent females represent widows who lost their husbands and either did not have sons in their immediate families or had sons who were not adults at the time of tenancy distributions. That tenancy holders were selected predominantly from among males and females with families is reinforced by the results shown in Table 5.3. Even the 2.4 percent unmarried males and the 4 percent widows were selected because they were heads of families.

Table 5.2 further reveals that 72 percent of the tenants were between 20 and 50 years of age, which suggests a large variability in household size and composition. This, in turn, implies a large variation in the household labor potential and in per capita (or per consumer equivalent) income derived from tenancy farming. Considering the underlying assumption that the tenant is expected to supply the needed labor for the tenancy, the adequate supply of household labor is most critical in times of peak demand for labor--especially for weeding in the Rahad project farming system.

TABLE 5.2 AGE, SEX AND PERCENTAGE DISTRIBUTION OF SAMPLE OF TENANTS

Age Group	Sex Distribution					
	Absolute Numbers			Percentages		
	Male	Female	Total	Male	Female	Total
15-19	1	0	1	0.8	0	0.8
20-29	29	0	29	23.2	0	23.2
30-39	32	0	32	25.6	0	25.6
40-49	29	3	32	23.2	2.4	25.6
50-64	18	1	19	14.4	0.8	15.2
65 & above	11	1	12	8.8	0.8	9.6
Total	120	5	125	96.0	4.0	100.0

SOURCE: The Survey of Tenants

TABLE 5.3 MARITAL STATUS OF SAMPLE OF TENANTS, NUMBER AND PERCENTAGE DISTRIBUTION

Status	Number of Tenants	Percentage Distribution
Un-married (males)	3	2.4
Married (males)	117	93.6
Widows (females)	5	4.0
TOTAL	125	100.0

SOURCE: The Survey of Tenants

The tenant selection procedure favors tenants with larger households. But it allows unweighted "equal" access to the land and other resources by distributing a uniform tenancy size to each tenant irrespective of the size and composition of his household. This could eventually lead to unequal income opportunities. Furthermore, if there are no internal correction devices responsive to the size and changing needs of the family living on tenancy incomes, then skewed distribution could prevail in the future, if not already.

It is also clear from a joint interpretation of Tables 5.2 and 5.3 that the age groups of 30-39 and 40-49 were the most eligibe cultivators and accounted for half the holdings. Table 5.4 depicts the relationship of all sample tenant household members to each other, and their age and sex. In the survey there were 415 males and 414 females. The ratio between girls and boys in the 1-9 year age category was equal, but changed to about 40 percent girls and 60 percent boys in the 10-14 year age group. The prospect of marriage for girls, as early as 13-14 years, offers a possible explanation for this ratio change (Mohammed, 47). Some of these ratios are already recorded in Table 5.4 Early marriage may also explain why there were only 2 female dependents in the 15-19 age group. The average age of tenant wives was 11 years younger than that of married male tenants.

Researchers have observed that in the irrigation projects in the Sudan, the system of production promotes

TABLE 5.4 SAMPLE OF TENANT HOUSEHOLD, AGE, SEX, COMPOSITION AND DISTRIBUTION BY RELATIONSHIP

Age Group	Absolute Numbers						Percentage Distribution					
	Tenant	Wives	Sons	Daughters	Male Depen-dents	Female Depen-dents	Tenants	Wives	Sons	Daughters	Male Depen-dents	Female Depen-dents
1-9	0	0	139	138	7	13	0	0	17.7	16.6	0.8	1.6
10-14	0	3	64	45	5	6	0	.4	7.7	5.4	0.6	0.7
15-19	1	17	38	20	9	2	.1	2.0	4.6	2.4	1.1	0.2
20-29	29	45	17	5	4	5	3.5	5.4	2.0	0.6	0.5	0.6
30-39	32	40	0	0	0	4	3.9	4.8	0	0.0	0	0.5
40-49	32	15	1	1	0	8	3.9	1.8	0.1	0.1	0	1.0
50-64	19	7	0	0	5	18	2.3	0.8	0	0	0.6	2.2
65 & above	12	0	0	0	6	17	1.5	0	0	0	0.7	2.1
TOTAL	125	127	259	209	36	73	15	15	31	25	4	9

SOURCE: The Survey of Tenants

nuclear rather than extended families (8). In this case, however, the shift to the nuclear family proceeds gradually because the analysis of the tenant survey conducted in the first year of Rahad project settlement revealed that there were still 13 percent male and female dependents. Around 40 percent of these dependents were not at the productive age: 22 percent were above 65 years of age and 18 percent were less than 10 years old (see Table 5.4). The age at which family members are considered active producers in the labor force is estimated in this study to be between 10 and 64 years.

The variations in the size and composition of the tenant households should be a pivotal factor in determining the tenancy size. Yet tenants have a limited opportunity to change their tenancy size which is mandated by the project authorities.

2. Previous Occupations of Tenants

The would-be tenants were slected from among area inhabitants who showed that they had established land rights by the use of the project land over the years. It is important to identify the occupations these tenants had prior to the construction of the project for several reasons. First, farming experience, in general, whether as a farmer or a livestock rearer whether nomadic or settled, has an important bearing on productivity both at the farm and project level. Secondly, experience with irrigated farming and cotton production also affects the performance of the

tenant. Thirdly, the tenants previous income can be used as a guide to project future income of the tenants.

From Table 5.5 it is clear that the primary occupation prior to the construction of the project was rain cultivation. Statistical surveys in the area had shown that dura (sorghum), the staple grain in the Sudan, was grown on 97 percent of the area under rain cultivation (dry-land farming) (15).

Though raising animals was a subsidiary occupation for about 40 percent of the sample of tenants, it was the major previous occupation for only 3 percent of the sample of tenants. This low percentage did not reflect the importance of animals in the project area, however, because the full-time animal rearers were nomads, who were the least aware of and the least interested in settled life. As a result they were most likely to be under-represented in the total number of settlers; although after the project began they applied by the thousands.

3. Occupations Outside the Tenancy

The management of the irrigation projects in the Sudan aims at keeping the tenant fully occupied with his tenancy. The tenant finds little time to take care of other activities, even those that seem complementary by nature. Most of the tenants were originally rain cultivators in the same area now occupied by the project (See Table 5.5). With rain cultivation still existing on land adjacent to the project, tenants who might find tenancy work to be less than their management and labor capacity,

TABLE 5.5 OCCUPATION, NUMBER AND PERCENTAGE DISTRIBUTION OF SAMPLE OF TENANTS

Occupation	Number	Percent to Number of Households
Rain Cultivation	121	96.8
Coal and Firewood Production	51	40.8
Livestock rearing	48	38.4
Dura Harvesting	30	24.0
Daily Paid Labor	23	18.4
Cotton Picking	22	17.6
Trading	17	13.6

SOURCE: The Survey of Tenants

or who might place high value on securing their staple diet grain, might try to keep their rain cultivation plot. When interveiwed, however, only 3 percent of the sample tenants were determined to pursue some rain cultivation on areas adjacent to the project.

About one-third of the sample of tenants were still operating their previous businesses. Some of these occupations, like trading (8 percent), hut construction, bedmaking, and coal and firewood production (only 2 percent), were vital for the functioning of the project.

Animal rearing is of special interest. There is no doubt that animal products, namely milk and meat, are important for the nutrition of the population. However, at the beginning the project management promoted total dependence on the cash crops--cotton and groundnuts--and no plans were made to integrate animals into the rotation. Sensing the importance of animals (for example, about one-third of the sample tenant households kept animals for domestic milk and meat consumption), the project management made plans to integrate livestock into the rotation.

4. Experience in Irrigated Farming

It is extremely difficult to determine the amount of previous irrigated farming experience of tenants, but it appears that most of the tenants' experience was limited. All but 3 percent of the tenants had practiced rain cultivation--primarily the production of dura. For off-season employment, about 41 percent of the tenants interviewed had

engaged in cooking coal and firewood production, 24 percent in grain harvesting in commercial schemes, and 18 percent in daily paid labor. Cotton picking, the only activity from which the would-be tenants might have benefited in irrigated farming, was the least favored, with 18 percent of the sample of tenants involved.

This limited exposure to irrigated farming and to the crops grown in the project is further reflected in tenant's response to problems they were experiencing. Sixty-four percent of the sample of tenants considered that their inexperience with crops grown in the project posed difficult problems. Moreover, 77 percent of the sample of tenants encountered problems in irrigation.

C. Summary

This examination of tenant and management responsibilities in the Rahad project has shown that the management is in control of the farming decision on irrigation, choice of crops, rotation, production activities, processing, marketing, and payment arrangements for the use of the resources. The tenant role is restricted to supplying labor, particularly that of his household. The sample survey of 125 tenants in 1978 revealed that the tenant was responsible for only about 2 percent of the total cotton production costs in the 1977/78 season. Hence, the role of the tenant in the Rahad project was extremely weak.

The analysis of the socio-economic characteristics of 125 tenants included in the sample survey revealed that

tenant's household size and composition were heterogenous; the size of the tenant household varied between 1 and 16. This has important implications for the current tenancy allocation policy of the Rahad project where each tenant had been allotted one tenancy irrespective of household size and composition.

The results of the sample of tenant survey showed that the tenant and his household had limited off-farm employment opportunities. The work on the tenancy was given priority by the project management such that the tenant was left with virtually no time to allocate for off-farm occupations which would bring in additional income. Therefore, the tenants' returns from the tenancies should be sufficient at least to meet the annual expenditures by each tenant household, which vary with each household size and composition. This could be achieved by replacing current fixed tenancy size with a variable tenancy size. In Chapter VI, the variable tenancy size will be otained by using the tenants' returns from farming, the annual household expenditures, and the size of the tenant household.

CHAPTER VI

ANALYSIS OF TENANCY SIZE

In the previous chapter the analysis of the tenant sample identified uniform tenancy size as an important problem which should be addressed by the policy-makers. Tenancy sizes vary from 10 in Essuki to 40 feddans in the Gezira main schemes. For the Rahad project tenancy size is fixed at 22 feddans, distributed to each tenant irrespective of the size and composition of his household. This chapter will focus on tenancy size. First, a method for generating alternative tenancy sizes will be presented for policy makers consideration. Second, the consequences of fixed tenancy size will be examined.

A. Evolution of the Tenancy Size in the Rahad Project

In 1967, the Roseires Preinvestment Survey (25) chose 12 feddans as the optimum tenancy size for each Rahad project tenant. The study states:

> The final evaluation revealed that a self-contained family holding (in which its labor demand can be supplied primarily by the family labor) of 12 feddans was the optimum size, having due regard to the cropping pattern envisaged, labor inputs, mechanization, the availability of casual labor and the level

> of income which the tenant would anticipate. (25, Part 1, p.2).

In 1969, the Agricultural Development Corporation proposed two tenancy sizes: 12 and 24 feddans which could tap all available household labor from small and large families.

> Holdings of 12 feddans are alloted to small families supplying labour equivalent of 200 man-days per year. Holdings of 24 feddans are alloted to large families supplying labor equivalent of 300 man-days per year. (54, p.8).

The distinction among households on the basis of size and household labor supply was an extremely important development, because it pointed up the heterogeneity in the size of tenants' household and the need for variable tenancy sizes. The study further asserted that larger tenancies would provide incentives for full time farming.

> The level of income to be realized by a tenant is more or less a function of both yield and the size of holding as the main factor. Hence the larger the size of holding, the higher the level of income, and hence the incentive for people to be settled as permanent farmers. The smaller the size of holding the more would be the incentive for people to look for part-time employment to subsidize their income (54, pp 8-9)

In 1970, an IBRD mission for the appraisal of Rahad project suggested a tenancy size of 18 feddans, and the 1973 study for the Rahad project (28) suggested a 24 feddan tenancy size for each tenant. In both cases, the 1969 suggestion of variable tenancies was not considered. The government of the Sudan approved the 1973 study and the project implementation began in October, 1973.

In January 1977, for field layout convenience, the project management decided to reduce the tenancy size from 24 to 22 feddans so that the 88 feddan area to be irrigated from the terminal channel could be more easily subdivided. To compensate for this reduction in tenancy size, cropping intensity was increased from 83 percent to 100 percent.

Evaluation revealed that the Rahad project policy-makers repeatedly changed the size of tenancy, yet gave no consideration to the heterogeneity of the tenants' households. Their decision was much simplified by aggregating the would-be tenants into a "representative" tenant household.

B. Change of Crop-mix and Rotation

The choice of crop-mix and rotation must take the following factors into account:

1. The productivity of land and other resources,
2. The recommended sequence of the rotation which determines the amount of land that can be allotted to the respective crops;
3. The choice of any one crop or rotation which ultimately influences the cost of production, the gross revenues, and the net economic and financial returns.

These factors--yield, area, and net returns per unit of output--are the determinants of benefit streams which are then discounted to obtain the net present worth.

Alternatively, the present worth of the cost and revenue streams are discounted to finally calculate a cost-benefit ratio or to find the internal rate that would equate the value of the two streams. The returns to the tenant are usually calculated for "representative" tenants.

The choice of crop mix and rotation was made on the basis of recommendations of the Agricultural Research Corporation (ARC). Since it was believed, until recently, that there was an abundant supply of irrigation water for expansion of irrigated agriculture, crop water requirements had but a limited impact on the choice of crops at the planning stage. But once the irrigation network and control system were designed, the insufficient supply of irrigation water imposed a constraint on the crop mix and the rotation.

In analyzing the tenancy size to determine possible alternative tenancy sizes for the consideration of the policy-makers, the choice of the crop-mix and rotation must be taken as given, with the clear understanding that the returns to each individual tenant are affected by the policy-maker choice on what, how much and how to produce.

C. A Method For Generating Policy Options on Tenancy Size

The policy maker needs guidance in determining tenancy size acceptable to the tenants, the project management and the society at large. Rather than allowing each

tenant a different tenancy size, the policy maker should be provided with reasonable number of options from which to choose. Obviously, some degree of aggregation is inevitable and should be based on a classification scheme that accounts for the tenant's household characteristics which vary widely in the Rahad project.

1. Assumptions About Sudan Government Policies Concerning Irrigated Agriculture

The question of tenancy size must be analysed in the context of the policy environment guiding irrigated projects in the Sudan. The following assumptions are made about the government policies in irrigation projects:

1. The government will continue to prefer tenancies of equal size,
2. The project management will decide the crops to be grown, the area under each crop, and the rotation,
3. The project management will perform a variety of production activities on behalf of the tenant and deduct the costs from crop proceeds,
4. The project management will provide irrigation water and decide the frequency of application. In return for irrigation water and agricultural management, the tenant will pay a fixed cash rent known as the land and water charge.
5. Tenants and their families will be responsible for all production activities that need direct labor input,
6. Tenants and their families will be urged to derive their living premarily from farming.

2. Variables Affecting Tenancy Size

Considering the previous discussion and the policy constraints, the following variables are the most relevant in determining tenancy size:

1. Tenant household size and composition, the household being a source of labor and a consumption unit,
2. The income from the tenancy, obtained by computing the net returns to household labor and reflected in the explicit income choice,
3. The crop mix and rotation and their impact on both labor requirements and net returns to labor.

The relationship between the three variables is depicted in Figure 6.1.

3. Tenancy-Size Computation Formulae

In the analysis which follows, a method is developed to determine the amount of land (area of tenancy), given the tenant household size, the tenancy returns, and the crop mix and rotations. This relationship is computed using the following formulae:

$$(1) \quad A_{ij} = \frac{Y_{ij}}{\sum_{j=1}^{k} R_j . C_j}$$

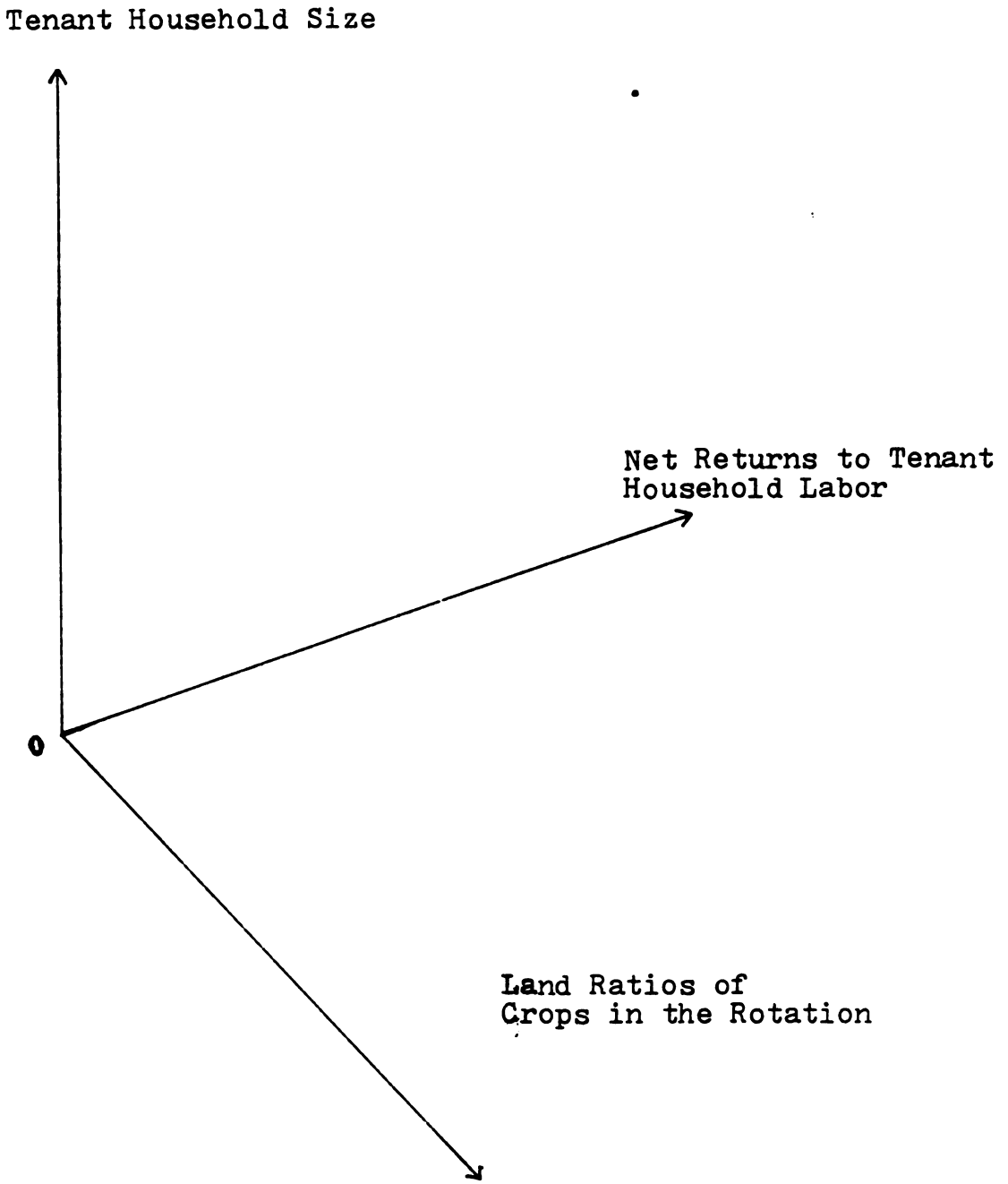

FIGURE 6.1 THE RELATIONSHIP BETWEEN LAND RATIOS OF CROPS GROWN, THE NET RETURN TO TENANT HOUSEHOLD LABOR, AND THE HOUSEHOLD SIZE

where: A_{ij} = Area of Tenancy

Y_{ij} = Exogenously given target income based on annual household expenditure which varies with the consumer equivalent of the tenant's household

R_j = group mean(s) of net returns to household labor per unit area of jth crop

C_j = Land ratio under the jth crop, the relative weight for a given rotation

i = 1...m associated with consumer equivalent household size.

1 group mean of (1.0-3.0) consumer equivalent household size.

2 group mean of (3.1-4.4) consumer equivalent household size etc.

j = 1..k associated with income level as generated by net returns to household labor per feddan of the jth crop, R_{ij}

The net returns to household labor per feddan of jth crop, R_{nj}, $\bar{R}_j$. are computed using the formula:

$$(2) \quad R_{nj} = G_{nj} - (1 + \frac{r}{2}) \quad (T_{nj} + F_j + U_{nj} + L_j)$$

where: j = 1...k associated with the crops included in the rotation C_j

n = 1...125 number of cases in the sample of tenants surveyed

$$G_{nj} = \frac{O_{nj} \cdot P_{wj}}{A_{nj}}$$

O_{nj} = total output per feddan for nth tenant growing jth crop

p_{wj} = weighted price calculated for joint products, e.g., cotton (lint, seed and scarto). It is the same price offered for all tenants' output.

A_{nj} = Area of the jth crop of the nth tenant.

r = The current rate of interest estimated at 10 percent, since the production season is 6 months, it is divided by 2.

T_{nj} = cost of production activities paid by the tenant either from his own resources or through advances from the project management. These could be per crop area or output. The total costs incurred are divided by area under the jth crop for the tenant, A_{nj}.

F_j = costs of production activities per unit area of the jth crop paid by the product management on behalf of the tenant. It is the same cost per feddan.

U_{nj} = costs of production per unit of output (post-harvest operations) of jth crop produced by nth tenant, paid by the project management on behalf of the tenant. It is transformed to per feddan cost by multiplying unit cost by $\frac{O_{nj}}{A_{nj}}$.

L_j = land and water charge per unit area of the jth crop. It is the same cost per unit area of the jth crop, irrespective of actual use of irrigation water.

4. Labor Requirements Compulation Formulae

Two categories of production activities in which the tenant has some responsibility and provides labor are identified: crop establishment, and harvest and post-harvest activities.

To obtain the total labor requirements for the crop establishment activities, the following relationships were used:

$$(1)\quad L_{nk} = FL_{nj} + HL_{n}$$

Where: L_{nk} = total labor inputs per cotton production activity

$n = 1.....125$ number of cases

k = crop establishment activities (See Table 6.8)

FL_{nj} = family labor in hours of work

j = 1, 2, 3

1 = adult male labor

2 = adult female labor

3 = child labor

FL_{n} = daily work hours x days per activities

HL_{n} = hired labor in hours of work

To resolve the problem of common denominator, all labor inputs will be converted into adult male labor. If f and c are the transformation coefficients for female and child labor respectively then:

$$(2)\quad FL_{nj} = FL_{n1} + FL_{n2} \cdot f + FL_{n3} - C$$

Assuming that the work done by hired labor is of the same type and quality as household labor, then hired labor can be expressed in terms of household labor as follows:

$$(3)\quad HL = \left(\frac{P_{nk}}{100 - P_{nk}}\right) \cdot FL_{nj}$$

where: P_{nk} = percentage of work done by hired labor per kth activity in nth case

Hence, equation (1) becomes (2) + (3) or

$$(4)\quad L_{nk} = FL_{n1} + FL_{n2} \cdot f + FL_{n3} \cdot C + (FL_{n1} + FL_{n2} \cdot f + FL_{n3} \cdot C)\left(\frac{P_{nk}}{100-P_{nk}}\right)$$

or

$$(5)\quad L_{nk} = (FL_{n1} + FL_{n2} \cdot f + FL_{n3} \cdot C)\left(1 + \frac{P_{nk}}{100 - P_{nk}}\right)$$

The reduced form is:

$$(6)\quad L_{nk} = FL_{nj}\left(1 + \frac{P_{nk}}{100 - P_{nk}}\right)$$

The second category of production activities includes harvest and post-harvest activities where sample tenants have depended to a large extent on hired labor. For example, more than 75 percent of cotton picking, 90 percent of packing and weighing, almost all cotton transportation to collection centers, and 60 percent of stalk cleaning are done by hired labor. Hence, in the analysis of peak demand for labor for the various tenancy sizes; it will be assumed that most of the harvest and post-harvest activities are done by hired labor. (See Appendix D)

5. Potential Supply of Household Labor Computation Formulae

The mean labor requirement for the crop establishment activities in tenancies under various crop rotations will be compared with the maximum potential household

labor available on a month by month basis using the following formula:

$$(7) \quad S_F = (FL_1 + FL_2 \cdot f + FL_3 \cdot C) \cdot d$$

where: FL_1 = adult male labor

FL_2 = adult female labor

FL_3 = child labor

f = transformation coefficients from adult female labor to adult male labor equivalent

C = transformation coefficient from child labor to adult male labor equivalent

d = annual days of work

D. The Computation of Alternative Tenancy Sizes

1. Calculation of the Financial Net Returns Per Feddan of Crop

The net returns per household per feddan of cotton are computed using partial capital budgeting and applying the formula:

$$R_{nj} = G_{nj} - (1 + \frac{r}{2}) \quad (T_{nj} + F_j + U_{nj} + L_j)$$

The results are depicted in Appendix A. There are five types of tenant production costs:

1. Tenants pay the interest on operating capital for a utilization period of six months. The annual simple rate which is currently charged by the commercial banks is 10 percent.

2. The tenant incurs expenditures from past savings, borrowings, or credit advances from the project management (T_{nj}) to pay for production activities under his supervision,
3. The project management undertakes, on the tenant's behalf, per feddan expenditure (F_j), for large operations where economies of scale are experienced (or assumed), such as agricultural aviation for pest and disease control or land preparation. Over and above the realization of scale economies, the project management may be opting for certain standards such as variety selection and treatment of seeds for planting, and planting to attain a certain population per hole or per unit area. The total cost of these operations are "socialized" by dividing them equally per feddan of crop irrespective of the specific costs incurred in a specific area or tenancy. This procedure is acceptable because the random allocation of resources with variable qualities gives rise to cost variations. Cost variations are evened out through this procedure but there is no evidence that output variations are evened out as well.
4. There are per unit of output expenditures on post-harvest operations, including marketing (U_{nj}) where, in addition to realizing scale

economies, the project management collects the sales proceeds to deduct the land and water charge, production and management costs incurred and loans, Again the total costs are divided to obtain a per unit output cost which will then be charged uniformly.

5. The land and water charge (L_j) is a flat rate per feddan of crop, by the project management on a "socialized cost" basis. That is, the charge per total crop area of each tenant is deducted irrespective of the amount of water applied by the tenant. Whether water is available or not, the number of applications is subject to the discretion and approval of the agricultural field officer (inspector) and not the tenant. The intensity of each application is essentially left to the tenant because of the high costs of extension and policing. On the other hand, a tenant may be limited by the availability of water in the canal, his tenancy location relative to the water flow, and the adequacy of his tenancy leveling to receive irrigation and drainage.

2. Test of Variation in Net Returns to Household Labor Per Feddan of Cotton

a. Labor Equivalents and Classifiction of Tenant Households

To test the variation of the net returns to household labor, the household labor equivalents of the sample

of tenants need to be calculated. In order to compute them the common denominator for expressing the different male, female and child labor units must be determined. The weighting of the household labor presented in Table 6.1 is based on the following assumptions:

1. Physical labor productivity is initially positively correlated with age and then negatively correlated with age (Norman, 52).
2. The weights are assigned to age groups because it is not practical to assign them for each age.
3. Children participate in agricultural production in irrigation projects in the Sudan as early as 10 years old. Children from ages 10 to 14 play an important role in water application, resowing and weeding.
4. From ages 15 to 64, both men and women are fully productive.
5. The productivity of females ages 15 to 64 is equal to that of same age group of males in some agricultural activities such as weeding, sowing and picking, but lower than that of males in other activities such as the tilling of soil and construction of ridges. Field observation indicates that the weeding activity, in which females equal males in productivity, is of the greatest importance, and hence, women are given higher weights than those given to them by Norman (52).

TABLE 6.1 ADULT-MALE LABOR EQUIVALENT
Weights by Sex and Age

	Sex	
Age Group	Male	Female
0-9	0.0	0.0
10-14	0.5	0.5
15-65	1.0	0.9
65	0.0	0.0

SOURCE: Based on the Survey of Tenants and Field Observations

The male labor equivalents of the sample of tenants are obtained by applying these weights to the following relationship.

$$FL_{nj} = FL_{n1} + FL_{n2} \cdot 0.9 + FL_{n3} \cdot 0.5$$

1 = adult males with a weight of unity

2 = adult females with a weight of 0.9

3 = children with a weight of 0.5

The labor equivalents of the tenant households are given in Appendix C. .

In order to test for the variation in net returns per feddan of cotton, the tenant household are divided according to their labor equivalence into three equal groups of small, medium and large households. Then the means of the net returns to household labor per feddan of cotton $\bar{R}_{ij}$ are obtained for each of the three groups (See Table 6.2).

b. A Statistical Test of the Variations in Net Returns Per Feddan of Cotton.

To determine whether the net returns to household labor per feddan of cotton for the group means are significantly different from each other and from that of the entire sample, a multiple test, or F-test of variance, is conducted.

The Null hypothesis is:

$$H_1: \quad U_1 = U_2 = U_3$$

The alternative hypothesis is:

$$H_0: \quad U_1 = U_2 = U_3$$

TABLE 6.2 CLASSIFICATION OF HOUSEHOLDS ACCORDING TO ADULT-MALE LABOR EQUIVALENTS AND THE NET RETURNS TO HOUSEHOLD LABOR PER FEDDAN OF COTTON

Group	Household Groups By Adult-Male Labor Equivalents[a]	Percentage of Sample Households	Group Mean Net Return to Household Labor/ Feddan of Cotton Ls
Small	1 - 2.3[b]	32	75.474
Medium	2.4 - 3.8	35.2	71.660
Large	3.9 - 8.3[c]	32.8	72.308
Mean	3.4	100	74.693

SOURCE: The Survey of Tenants

[a]The classifiction is made around the mean household, with approximately one-third of the sample tenant households in each group.

[b]The mode of the observations (1.9) falls within this group. It comprises about 83% of this group and 26% of all observations.

[c]The effective class interval of this group is 3.9 - 6.9 since only two observations (8.2 and 8.3) have higher values.

where:

U_1 = group mean #1 net returns to household labor per feddan of cotton.

U_2 = group mean #2 net returns to household labor per feddan of cotton.

U_3 = group mean #3 net returns to household labor per feddan of cotton.

To test the null hypothesis an analysis of variance was performed. The results of the analysis of variance were as follows:

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	Probability
Between Groups	2	404.5	202.3	0.07	0.93
Within Groups	122	347703.9	2850.0		
Total	124	348108.4			

Thus, with 0.93 probability, there are no variations between the means of the three groups of net returns to household labor per feddan of cotton. Alternatively there is a probability of 0.93 that type one error will be committed by rejecting the null hypothesis (H_0: $U_1 = U_2 = U_3$) while it is in fact true. Consequently the entire sample tenant mean of net returns to household labor per feddan of cotton can be substituted for any one of the group means.

Furthermore, the variations amongst the three group means and between the three of them on one side and the sample mean on the other side are very small. In absolute terms, the maximum difference is about ls4 between the first two group means, while the maximum

difference between any group mean and the sample mean is around 1s3.

Some of the reasons for such uniformity in net returns to household labor per feddan of cotton are:

1. The project management undertakes, on behalf of the tenant, all the production activities and post-harvest operations which may exhibit economies of scale.
2. The project management further reduces variation in net returns per feddan by collecting equal charges per feddan or unit of output in return for conducting these activities on the tenant's behalf. The land and water charge is also levied on the same principle.
3. The tenant's share--whether in terms of direct household labor or hired labor--in performing production activities is very meager, as revealed in earlier discussions.
4. The prices of inputs and outputs are the same, since the purchasing of inputs and the marketing of outputs are carried out by the project management.
5. In the Rahad project, the production of all crops is based on similar farming practices and production relations. Groundnuts, like cotton, is a cash crop, and the project management assumes the lion's share in production and marketing. Although the author could not obtain data on groundnuts production in Rahad project, it could be hypothesized that the net returns per feddan of crop are neutral to scale,

whether of household or tenancy. The net returns to the tenant household per feddan of all crops are presented in Table 6.3

TABLE 6.3 NET RETURNS TO TENANT HOUSEHOLD PER FEDDAN OF ALL CROPS

CROPS	MEAN NET RETURNS ($\bar{R}_j$) ls
Cotton [a]	74.693
Groundnuts [b]	31.705
Leguminous Fodder [b]	22.520
Fallow	0.0

SOURCE: [a]The Survey of Tenants

[b]Ahmed, M.A., The Revised Farm Budget: Rahad Corporation (Ministry of Agriculture, Food and Natural Resources, May 1975).

3. Tenant Household Annual Expenditures: A Basis For Tenant Target Incomes.

a. Variations in Tenant Household Annual Expenditures

In Chapter II it was pointed out that a survey of 125 tenants provided information for estimating tenant household annual expenditures for 1977/78. The results of the survey, presented in Appendix E , showed large variation among the tenant household annual expenditures. These variations arise partially from difference in the size, age, and sex composition of the tenant households.

b. Consumer Equivalents and Classification of Tenant Households

To find a common denominator for expressing the consumer units of tenant households, a weighting procedure suggested by the Food and Agriculture Organization (FAO) of the United Nations (18) was used (See Table 6.4). Its

TABLE 6.4 CONSUMER EQUIVALENT WEIGHTS

Age/Sex Group	Male	Female
0-4	.2	.2
5-9	.5	.5
10-14	.75	.7
15+	1.0	.9

SOURCE: Food and Agriculture Organization (FAO) of the United Nations, Calorie Requirements: Report of the Second Committee on Calorie Requirements, Nutritional Studies, No. 15, (Rome: F.A.O. 1957).

use was justified inspite of the problems of standardization and comparison of the consumption scale pointed out by Woodbury (67) and Prais and Houthakker (55). According to the FAO weighting procedures, the consumption requirements of individuals are positively correlated with age. While they do not vary with sex for children in the (0-4) and (5-9) age groups, they vary with sex in higher age groups and the consumption requirements of males become

larger than that of females. The consumer equivalent weights were used to compute the tenant household consumer equivalents (See Appendix C).

As a result of these large variation in annual household expenditures, the sample of tenants was divided into five consumer equivalent groups: two groups smaller than the mean (average) tenant household; two groups larger than the mean; and one group representing the mean. These consumer equivalent groups are shown in Column 1 of Table 6.5

c. Tenant Target Incomes

The average annual household expenditures of each of the five groups were obtained from the field survey and are shown in Column 3 of Table 6.5. Columns 4 and 5 of Table 6.5 illustrate to the policy-maker the projected level of expenditures by consumer equivalent groups when the 1977/78 level of annual household expenditures is increased by 10 and 20 percent. These percentages were chosen because the interviewed managers' response, when asked about the level of income that should be adopted as a target for the tenants, ranged from Ls600 to Ls1600, and hence was not useful in determing the target income for the tenants. The procedure adopted in this study is in agreement with the Rahad project managing director at the time who proposed in his response a target income of cost-of-living-plus.

TABLE 6.5 APPROXIMATIONS OF ANNUAL HOUSEHOLD EXPENDITURES BY CONSUMER EQUIVALENT TENANT GROUPS

1	2	3	4	5
Group #	Sample of Tenants Household Consumer Equivalent Groups[a]	Annual Household Expenditure L s	Annual Household Expenditure +10% L s	Annual Household Expenditure +20% L s
1	1 - 3.0 (2.3)	637	701	765
2	3.1 - 4.4 (3.8)	823	905	988
3	4.5 - 6.0 (5.0)	994	1093	1192
4	6.1 - 8.0 (7.0)	1014	1115	1217
5	8.1 -10.7 (9.3)	1611	1772	2053
	Mean 4.7	913	1005	1096

SOURCE: The Survey of Tenants

[a]The figures in the brackets represent the group means of the consumer equivalents.

In determining target incomes of tenants, the author decided to use the 1978 survey results of approximate annual household expenditures for the previous twelve month period. The tenants reported annual household expenditures ranging from Ls637 to Ls1611. Although the 1978 annual household expenditure survey was very crude, it does illustrate the wide range of annual household expenditures and the need for flexible tenancy sizes in order that the declared policy objective -- providing a decent living to the tenant household--be achieved. The 10 and 20 percent increases above the tenant household annual expenditures were chosen to illustrate alternative income target choices which the policy-makers might select.

4. Crop Land Ratios for Different Rotations

The ratio of land under each crop in a given rotation affects the net returns of the tenancy. The average returns per feddan of crop weighted by the ratio of land under each crop included in the rotation will reveal the total income from the tenancy.

Rotation 1 has equal land under cotton and groundnuts. Rotation 2 has half-tenancy under cotton, one-third under groundnuts and one-sixth under leguminous fodder. Rotation 3 has half the tenancy under cotton, one-third under groundnuts and one-sixth fallow, and was the basis on which the project was evaluated and financed. The crop land ratios are given in Table 6.6. Depending on the resources available to him, his management abilities, the

TABLE 6.6 CROP LAND RATIOS FOR VARIOUS CROP ROTATIONS

Crops \ Rotations	Rotation 1[a]	Rotation 2[a]	Rotation 3[b]
Cotton	0.5	0.5	0.5
Groundnuts	0.5	0.333	0.333
Leguminous Fodder	0.0	0.167	0.0
Fallow	0.0	0.0	0.167
Total	1.0	1.0	1.0

SOURCE: [a]M. MacDonald and Partners: Report on Impact of Revised Cropping Pattern with Livestock Integration, Rahad Irrigation Project, Ministry of Irrigation and Hydro-Electric Energy, January 1977

[b]International Bank for Reconstruction and Development. Appraisal of the Rahad Irrigation Project, Sudan, 1973

amount of animals he possesses and their marketability, the tenant can choose either Rotation 1 or 2. At present it seems that tenants strongly prefer Rotation 1. This is positively reinforced by the project management for a variety of reasons, the most important and obvious being the problems associated with keeping animals inside the project and the low to negative returns anticipated from the fodder enterprise (45).

5. Results and Analysis of Tenancy Sizes

Using the information in Tables 6.3, 6.5 and 6.6, and applying the tenancy-size formula:

$$A_{ij} = \frac{Y_{ij}}{\sum_{j=1}^{k} R_j . C_j}$$

the tenancy sizes obtained are presented in Table 6.7.

The following observations emerged from the results of the preceding computations.

1. The differences in the consumer equivalents of the sample of tenant households are the main cause of the differences in the required tenancy sizes. In Table 6.7, the largest consumer equivalent household group required a tenancy size from 140 to 180 percent larger than the one required for the smallest consumer equivalent household group.
2. On the other hand, using alternative income targets in the computations, the highest target income requires a 20 percent larger tenancy size than the lowest income choice as compared with the 140 to 180 percent of the consumer equivalent of tenant households.

TABLE 6.7 COMPUTATION OF TENANCY SIZES IN FEDDANS[a]

Sample of Tenant Household Consumer Equivalent Groups	CROP ROTATION 1			CROP ROTATION 2			CROP ROTATION 3		
	Annual Household Ex-penditure	Annual Household Expen-diture +10%	Annual Household Expen-diture +20%	Annual Household Ex-penditure	Annual Household Expen-diture +10%	Annual Household Expen-diture +20%	Annual Household Ex-penditure	Annual Household Expen-diture +10%	Annual Household Expen-diture +20%
1.0 - 3.0	12	13	14	12	14	15	13	15	16
3.1 - 4.4	15	17	19	16	18	19	17	19	21
4.5 - 6.0	19	21	22	19	21	23	21	23	25
6.1 - 8.0	19	21	23	21	22	24	21	23	25
8.1 -10.7	30	33	39	31	34	40	34	37	43
Mean 4.7	17	19	21	18	19	21	19	21	23

SOURCE: Computed using Tables 6.3, 6.5, 6.5 and Tenancy Size Formula

$$A_{ij} = \frac{Y_{ij}}{\sum_{j=1}^{k} R_j . C_j}$$

[a]Tenancy-sizes are approximated to the nearest whole number

3. The changes in crop rotation have the least effect on tenancy size; for example, the tenancy of the least intensive crop rotation ranges 10 percent larger in area than the tenancy of the most intensive crop rotation.
4. On the basis of the average consumer equivalent tenant household, the tenancy size is between 17 and 23 feddans, depending on the expenditure level and the crop rotation. The Rahad project current tenancy of 22 feddans falls within this range.

E. Comparison of Monthly Labor Requirements For A 22 Feddan Tenancy With The Potential Household Supply of Labor

1. Monthly Labor Requirements (Demand) For A 22 Feddan Tenancy.

The subsequent analysis of labor requirements is made on the basis of peak demand. To satisfy the conditions of peak demand for labor, the calculations were made using crop Rotation 1 which is half cotton, half groundnut, and the most intensive option at present in the Rahad project. The average of the actual cultural activities recorded by the sample of tenants was used.

For the cotton crop, the labor requirements of each production activity were obtained by applying the following formula to the crop establishment activities:

$$L_{nk} = FL_{nj} \left(1 + \frac{P_{nk}}{100 - P_{nk}}\right)$$

Table 6.8 gives the average labor requirements per feddan of production activity actually carried out in the field in adult male labor equivalents, the contributions of households and hired labor and the time of the year in which the production activity was performed. The time flow of the production activities was constructed by using the sequence of the standard practices and not the individual tenants' actual timing because major field operations such as land preparation and sowing are undertaken by the project management. However, for the timing of these production activities, the Tambul Pilot Farm--Final Report (33) was consulted and followed with due consideration for the large-scale field production conditions.

For groundnuts, adult male labor requirements per production activity were taken from the results of Tambul Pilot Farm (33). Similarly, the timing of the production activities was based on the same source. This was chosen because in adjacent schemes like Gezira, groundnut production was not mechanized and the produce was solely the property of the tenant until the 1977/78 season--factors which had a tremendous impact on the quantity of labor demanded and supplied. The labor requirements of groundnuts per feddan of production activity in hours of labor, their equivalents in adult male equivalent days, and the suggested timing of the activity are presented in Table 6.9.

From the suggested timing of the crop establishment activities of cotton and production activities of

TABLE 6.8 TIME-FLOW OF CROP ESTABLISHMENT ACTIVITIES OF COTTON AND THEIR LABOR REQUIREMENTS PER FEDDAN IN ADULT MALE LABOR DAYS

Crop Establishment Production Activity		Time of the Activity	Labor Requirements per feddan in Adult Male Labor Day Equivalents[a]		
			Household Labor	Hired Labor	Total Labor[b]
Preparation of Tenancy for Irrigation		June-July August	0.4	0.9	1.3
Hand Application of Fertilizer		June	0.01	0.09	0.1
Manual Replanting		Aug.-Sept.	0.3	0.7	1.0
Manual Reconstruction of Ridges After Green-Ridging		Aug- Sept.	0.07	0.43	0.5
Irrigation	1	July-Aug.	0.64	0.03	0.7
	2	Aug.	0.84	0.0	0.9
	3	Sept.	0.47	0.0	0.5
	4	Sept-Oct	0.74	0.0	0.8
	5	Oct.	0.47	0.0	0.5
	6	Nov.	0.51	0.0	0.5
	7	Nov-Dec.	0.13	0.0	0.1
	8	Dec.	0.06	0.0	0.1
Weeding	1	July-Aug.	2.24	3.5	5.3
	2	Aug-Sept.	1.68	1.73	3.4
	3	Sept.	1.16	0.72	1.9
	4	Sept-Oct	0.21	0.05	0.3
	5	Oct.	0.03	0.00	0.1

SOURCE: The Survey of Tenants

[a]A day of work is defined as 7 hours of work, usually from 6 a.m. to 11 a.m. and from 3 p.m. to 6 p.m. with half-hour rest for each period.

[b]The total labor requirements are approximated to the first decimal place.

TABLE 6.9 TIME FLOW OF PRODUCTION ACTIVITIES OF GROUNDNUTS AND THEIR LABOR REQUIREMENTS PER FEDDAN IN ADULT-MALE LABOR DAYS

Production Activity	Time of the Activity	Hours Per Feddan		Adult-Male Equivalent Days
		Labor Hours (excl.Tractor Operator)	Machine Hours	
Land Preparation (including re-ridging	March-April-May		1.3	
Pre-irrigation	May-June	6.0	-	0.9
Planting	June-July	7.0	0.4	1.0
Irrigations (6-8)	June-Nov.	24.0		3.5
Weeding (3-4)	June-Sept.	30.0		4.3
Green-ridging	June-July-Aug.		0.6	
Harvesting				
Lifting, Collecting & Stripping	Oct-Nov-Dec	6.5	1.1	0.9
On farm Transport	Oct-Nov-Dec	2.5	0.5	0.4
Drying & bagging	Nov-Dec-Jan	15.0		2.2
Land Cleaning				
Post-Crop ridging	Feb.		0.2	
Post-Crop irrigation	Feb.	3.0		0.4
General Activities	esp. Sept., March-April-May	20.0		2.9

SOURCE: Adapted from International Land Development Consultants (ILACO) Management of Tambul Pilot-Farm. Rahad Development Project, Final Report, The Agricultural Development Corporation, October, 1972, Table 14, p.35

groundnuts, a half-year schedule of demand for labor was drawn up and presented in Table 6.10.

2. Maximum Potential Household Supply of Labor

On the supply side, the maximum potential household supply of labor was obtained using the formula:

$$SF = (FL_1 + FL_2 \cdot f + FL_3 \cdot c) \cdot d$$

The averages of the adult male labor equivalent household groups given in Table 6.2 were calculated. The maximum potential household supply of labor was obtained by assuming that on the average, field work days during the period of peak demand for labor number 25 days per month. The results are shown in Table 6.11

3. A Comparison of the Peak Demand for Labor in Cotton Crop-establishment and Groundnuts Production Activities With the Potential Household Supply of Labor.

A graphical comparison of June-November monthly labor requirements for cotton and groundnuts with the potential household supply of labor for a 22 feddan tenancy under these crops is depicted in Figure 6.2. It is clear that two-thirds of the tenant households would have to resort to hired labor at the period of peak field activities, even if all household members are part of the labor force. The demand for hired labor peaked during August-September because of the labor intensity of the weeding operation. The only group of tenant households which could supply the needed labor during the peak period and still exhibit some surplus, if all household members worked would be large labor equivalent tenant household group. Thus, with

TABLE 6.10 MONTHLY CALCULATIONS OF ADULT MALE DAY EQUIVALENTS PER FEDDAN OF COTTON AND GROUNDNUTS

Month	Cotton Adult Male Equivalent Days	Groundnuts Adult Male Equivalent Days	Total Adult Male Equivalent Days
January	x[a]	0.2	--
February	x	0.4	--
March	x	0.7	--
April	n.a.[b]	0.8	--
May	n.a.	0.9	--
June	0.6	2.5	3.1
July	1.9	2.5	4.4
August	8.0	2.2	10.2
September	5.6	1.5	7.1
October	1.2	1.1	3.3
November	0.5	2.1	2.6
December	x	1.6	--

SOURCE: Computations based on Tables 6.8 and 6.9

[a]x stands for the second category of production activities which was not included in this analysis of peak demand for labor. Cotton picking is the most important of these activities and usually begins in December.

[b]n.a. means data were not available.

TABLE 6.11 THE MAXIMUM POTENTIAL HOUSEHOLD SUPPLY OF LABOR PER MONTH BY HOUSEHOLD LABOR EQUIVALENT GROUPS

Adult Male Labor Equivalent Household Groups	Weighted Average	Monthly Maximum Potential Household Labor Supply (Adult Male Days)
(1 - 2.3) Small	1.84	46
(2.4 - 3.8) Medium	3.0	75
(3.9 - 8.3) Large	5.13	128

SOURCE: The Survey of Tenants

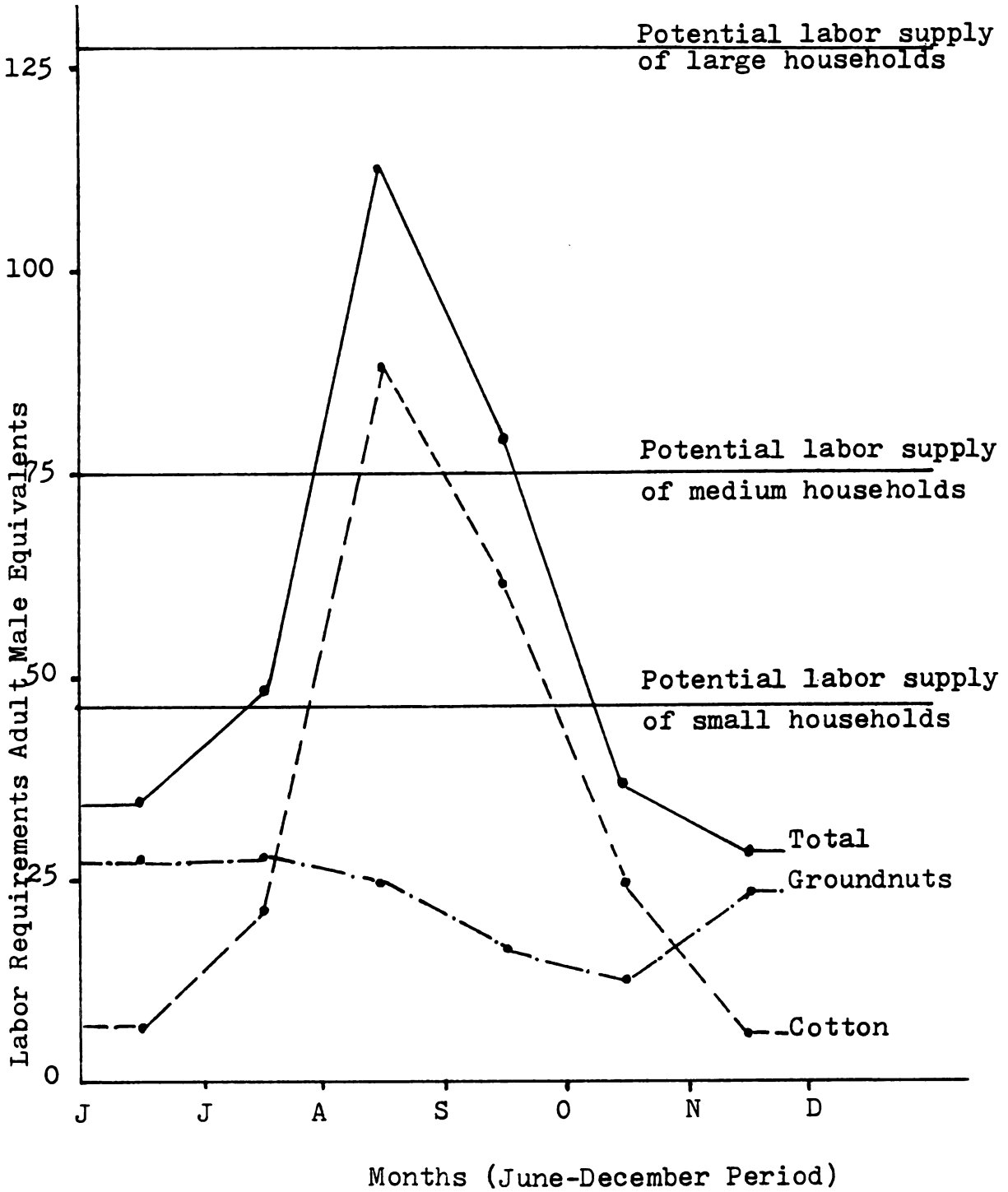

FIGURE 6.2 A Graph Comparing The Tenant Household Potential Supply of Labor With The Labor Requirements of Cotton Crop Establishment and Groundnuts Production Activities.

a fixed tenancy distribution policy, the marked differences in seasonal labor requirements require that the smaller tenant households purchase labor while the larger tenant households seek employment outside the tenancy.

F. Comparison of Net Returns From A 22 Feddan Tenancy With Annual Household Expenditure by Consumer Equivalent Household Groups

It was shown earlier that there were no significant variations in the net returns to tenants per feddan of cotton with the labor equivalent household groups. Similar assumptions were made for other crops for the same reasons. To simplify the comparison, the net returns to the tenant household labor per feddan of cotton and groundnuts (See Table 6.3) for crop rotation 1, were adopted. The annual household expenditures were shown to vary with the consumer equivalent household groups, while the tenancy returns did not vary by household size.

The results of the computation, presented in Table 6.12, showed that four out of five tenant household groups are meeting their approximate annual household expenditures and that the large tenant household group will fall short of income needs under the 22 feddan tenancy. The fixed tenancy size favors smaller tenant households at the expense of large tenant households.

TABLE 6.12 A COMPARISON OF A 22 FEDDAN TENANCY RETURNS WITH THE ANNUAL HOUSEHOLD EXPENDITURES OF TENANT HOUSEHOLDS CONSUMER EQUIVALENT GROUPS

Sample of Tenant Household Consumer Groups[a]	Returns From a 22 Feddans Tenancy[a] ls	Annual Household Expenditures[b] ls	Surplus + Deficit - ls
1.0 - 3.0	1170	637	+533
3.1 - 4.4	1170	823	+357
4.5 - 6.0	1170	994	+176
6.1 - 8.0	1170	1014	+156
8.1 -10.7	1170	1611	-441

SOURCE: The Survey of Tenants

[a]Table 6.3

[b]Table 6.5

G. Summary

The review of the evolution of Rahad tenancy size revealed that during project planning five different tenancy sizes were purposed. Even though a number of factors were considered in making these proposals, the heterogeneity of the tenant household, the expected variation in households income needs, and the changes in crop mix and rotation were somewhat overlooked. A method for computing appropriate tenancy sizes must incorporate the tenant household size and composition, the tenancy net returns, the annual household expenditures (as a basis for tenant target income), and the land ratio of crops included in the different rotations.

The net returns per feddan of cotton were found to have no variation with the labor equivalent household groups, primarily because of the production system adopted in the Rahad project. Hence it was assumed that net returns per feddan of other crops, mainly groundnuts, also do not vary with the tenant household groups. Therefore the average net returns of cotton, obtained from the survey of tenants, and of groundnuts and leguminous fodder, obtained from the project reports, were utilized in the computation of tenancy sizes. In contrast, the survey of tenants revealed that there were variations in the annual household expenditures of the consumer equivalent household groups. These annual household expenditures were used to determine target incomes for tenants.

The computation of tenancy size showed that tenancies for the different consumer equivalent household groups ranged from 12 to 43 feddans, depending on the household group, the tenant target income, and the crop rotation. The variation in the tenant income needs of the various household groups accounted for most of the variations in the tenancy size.

The labor requirements for establishing cotton and producing groundnuts in crop rotation 1 of a 22 feddan tenancy were compared with the maximum potential household supply of labor. The results of the comparison revealed that a fixed tenancy of 22 feddans will require that smaller tenant households purchase labor and that larger tenant households seek employment outside the tenancy. The comparison of the net returns of the fixed tenancy of 22 feddans revealed that while most of the tenants are meeting their approximate annual household expenditures, larger tenant households are not. Thus the fixed tenancy size is in favor of smaller tenant households and disadvantageous for larger tenant households. Therefore, variable tenancy sizes were advocated to replace the current fixed tenancy size. In Chapter VII, specific suggestions will be made for variable tenancy sizes.

CHAPTER VII

SUMMARY, POLICY IMPLICATIONS, AND SUGGUESTIONS FOR FUTURE RESEARCH

A. Summary

The Rahad project is an irrigation scheme currently under construction in the Sudan along the east bank of the Rahad river. It extends for 240 kilometers along the Rahad river to its confluence with the Blue Nile about 160 kilometers south of Khartoum. The project is financed by an international loan from IBRD-IDA, USAID, KF, SFD and AF, and by funding from the government of the Sudan. It is irrigated by pumps installed at the Blue Nile to draw from waters stored behind the Roseires Dam, the project is designed to promote agricultural production and the development of the area at large.

The total area of the project is 300,000 feddans, which is divided into tenancies of 22 feddans each. These tenancies are allocated to tenants who are selected for settlement primarily from among people in the project site and the surrounding area. Each tenant was allocated a single tenancy irrespective of the size and compotision of his household. All tenants are required to grow the same crops in pre-determined proportions and rotation.

Medium staple Acala 442 cotton was planted in half the tenancy area, while the other half was devoted to groundnuts and leguminous fodder.

The objectives of this study are: to analyze from an historical perspective the planning and implementation of the Rahad project; to study selected tenants to determine their socio-economic characteristics, their net returns from agricultural production, and their annual household expenditure; and to determine whether the size of tenancy should be changed from the fixed 22 feddans to a variable size. In order to pursue these objectives, the project documents and reports were thoroughly reviewed, and a management questionnaire was administered to understand the project implementation process. In addition, a field survey of 125 tenants was conducted in 1978 to determine socio-economic characteristics of the tenants, and to calculate both their net returns from agricultural production and their annual household expenditures.

The review of Rahad project planning revealed that during a decade of planning prior to the launching of the project in 1973, the main concern was with macro aspects. The project design and the choice of irrigation system--gravity or pump--were controversial. Selecting the type of irrigation system and the overall project design which met the minimum benefit-cost ratios required by the financing agencies were major concerns. Valuable time and effort were spent in securing project financing from donor agencies.

Besides the technical and financial factors, the political instability of the late 1960's and early 1970's contributed to the delay in project approval.

Although the project was appraised several times before construction began in 1973, important issues were either overlooked or not adequately treated--for example, the amount of land allocated for the tenant and his household, and the tenant's role in farming decisions. In this case it is a factor affecting equity and realization of production goals.

To study the implementation process, a management questionnaire was administered to fourteen project officials who had broad knowledge of the project implementation and management. In addition, the author interviewed another fifteen officials from the IBRD, project-consultants, and the Sudan government who participated in the planning and monitoring of the project at the implementation stage. Numerous documents and reports were examined.

The review of the literature on implementation revealed that there has been a general lack of concern for the implementation of development projects. The primary concern of planners has usually been to choose the best project on the basis of an economic analysis procedure which gives little attention to implementation. As a production process, implementation should respond to questions of what, how much, how and when to produce; these should be included in the statement of project objectives.

Unfortunately, in the Rahad project the objectives were not stated clearly.

Four main factors contributed to implementation delay in the Rahad project: inadequate project preparation; resource limitations; lack of coordination in the initial stages of implementation; and uncertainty. In chosing the best project, mechanisms to handle these widely recognized problems should be adopted before the project is approved. The Rahad project was a relatively large undertaking and other projects in the Sudan competed with it for the limited financial, physical, and human resources, for instance, local funds, transportation, energy and building materials. In complex irrigation-settlement projects like the Rahad project, the need for coordination was evident from the beginning; lack of it prevented the timely execution of the project. As implementation progressed, coordination became effective in trouble-shooting and in reducing the shortages of construction materials. Overall, more appropriate techniques could have been adopted to monitor the implementation of the project and adjust to new information as it became available.

The final outputs of the implementation process are the physical products and the impacts on the tenants, the target group. In this case the problems of implementation directly affected the level and flow of agricultural production. The field survey of 125 tenants revealed that the tenants were experiencing a number of implementation

problems. Not only did they face shortages in health and education services, drinking water, and the staple diet, but many of them were also dissatisfied with the location and accessibility of the villages.

Tenants have a modest role in decision-making in irrigated farming in the Sudan, and particularly in the Rahad project, where the land allotted for the tenant, the crops and their intensity, the planting dates, the cultural operations, the number of irrigations, the degree of mechanization, the marketing, and the production relations are all decreed by the project management. The tenant participates mainly by supplying household labor. Within this framework of decision-making, the tenant as a decision-maker has a limited effect on the returns from his tenancy. Since the project management either invests directly in agricultural production or provides the necessary capital for the tenants, the tenant is in many ways a "paid laborer". Deducting the cost of hired labor (also largely financed through loans advanced by the project management), the remainder of the returns from the tenancy will be the net returns to the tenant household labor.

The policy in the Rahad project (and to a large extent in some other irrigated agricultural projects in the Sudan) is to distribute a single tenancy for each tenant irrespective of his household size and composition. The field survey of 125 Rahad project tenants conducted by the author during April-May, 1978, revealed that the tenant

households were heterogenous. Their absolute, labor, and consumer equivalents ranged betweel 1 and 16, 1 and 8.3 and 1 and 10.7 respectively. These variations were indeed large enough to question the wisdom of assuming a "representative" five member household and allocating a single tenancy for all tenants accordingly. Since the tenants depend on their living on the income derived from the tenancy, and since the managements of irrigated schemes in the Sudan, including the Rahad project, generally do not permit tenants to take off-farm jobs during the crop production season (which extends almost the entire year), the income which accrues to the tenant from the tenancy should, under these circumstances, at least satisfy the tenant's household needs. Therefore, if tenants are to meet their needs, maintain their productivity, and continue in the project, an explicit target income based on size and composition of the tenant household should be the starting point from which to determine the appropriate tenancy size for each tenant household. Beyond physical survival, the question of need is a matter for public choice. Nevertheless, some reference point from actual experience would be useful. The current annual household expenditures obtained from the field survey were used as that reference point.

The sample of tenant households was divided into five consumer equivalent household groups after assigning weights based on sex and age composition to find the common

denominator. Then three target income choices were made for each household group on the basis of the tenant annual household expenditure. Subsequently, the net returns to the tenant household labor per feddan of crop in the rotation were computed from the field survey and the project data. The costs of production for cotton were recorded from actual expenses incurred by the tenants and the project management, and the gross returns from cotton were computed from the agricultural output data of the field survey and the estimated prices of lint and cotton seed of 1978/79. The net returns from cotton were found to have no significant variation with the size of household labor equivalent groups. The net returns for the other crops in the rotation, groundnuts and leguminous fodders, were taken from the most recent project reports. The weighted net returns per feddan included in the three rotations varied according to the ratio of land devoted to each of the three crops or left fallow.

Tenancy sizes were computed using the net returns to tenant household's labor, and the land ratio of crops included in the rotation to meet alternative target incomes (based on the current annual household expenditure) for five groups of tenant households. The analysis of the matrices of tenancy areas revealed wide variations in the required tenancy size for each tenant household group. Tenancy sizes ranged between 12 feddans and 43 feddans. Therefore, the current policy of fixed tenancy sizes for all tenants may lead to inequity in the tenancy returns.

To further investigate the distributional impacts of the current policy, the 22 feddan tenancy returns were compared with the current annual household expenditures obtained from the field survey. The results showed that the fixed tenancy size policy is in favor of smaller tenant household groups. The larger tenant household groups could be forced to find sources of income outside the Rahad project--a problem the project management would like to avoid in their desire that tenants work full time in their tenancies.

Policy-makers usually claim that the potential tenant's household labor will be sufficient to meet the tenancy labor requirements. The labor requirements of the 22 feddan tenancy currently used in the Rahad project were computed on the needs of crop rotation 1, which is most intensive. The potential labor supply of the sample of tenant households was calculated. During the period of peak demand for labor in cotton crop establishment activities and groundnut production activities for crop rotation 1, the small and medium tenant household groups could not supply adequate labor and as a result would have had to hire labor. In contrast, the largest tenant household group had surplus labor and hence needed more land or off-farm employment opportunities. Large labor equivalent tenant households also exhibit large consumer equivalence. Thus a fixed tenancy size for each tenant is unjustifiable, whether in terms of the tenant's household needs or labor potential supply. This in turn affects the chances of attaining the project objectives of

maximum physical output and the desired impact on the tenants as the target group, which are optimum tenant productivity, and equity in income distribution.

B. Policy Implications

1. Planning of Irrigation Projects

Although the Rahad project was given a high priority in the national investment plan, it had no clearly stated set of objectives. There is an obvious need to clarify project objectives, whether in terms of the physical outputs or the impacts on the target groups, the tenants. Clearly planning and implementation cannot be taken seriously if there is lack of agreement on what the project is supposed to achieve.

In planning irrigation projects, planners must realize that irrigation water, agricultural land, and other resources are intermediate inputs; and that irrigation water storage, provision of irrigation water, preparation of agricultural land, settlement and resettlement of tenants, and transport, storage and processing of agricultural prodcuts are complementary investments. Each one of these components has to be identified within the context of joint intermediate inputs.

In the government effort to secure financing of the Rahad project from donor agencies during the project preparation more concern was given to the macro aspects than to the completeness and soundness of the individual project

components. Most of the micro problems did not receive attention or detailed study until after financing was secured and the project implementation was started in 1973. If micro studies had been conducted prior to project approval and during the policy formulation phase, less delays would have occurred. Tambul Pilot Farm was an exception. The pilot farm was financed by savings from the IBRD loan to the Roseires Dam and it generated technical data for the field irrigation and agricultural practices of the Rahad project. Because technical data were required in other areas for the timely execution of the project, and considering the substantial delays in the project implementation, more detailed micro and macro studies should have been included in the project preparation stage. The financing source, whether local or foreign, should have extended financial support to undertake pilot studies which would generate physical coefficients and identify likely human, physical, and institutional bottlenecks that could greatly affect overall project implementation. This step could have been more important than the complex analysis for ranking the competing project designs which only provided weak input-output data.

The complexity of irrigation projects such as Rahad points to the need for special analysis of institutions of planning and implementation. Valuable time and effort were spent in trying to resolve conflicting technical and economic aspects of the two competing project versions--gravity and pump irrigation. The economic evaluations of

the competing irrigation systems were the product of differing assumptions about technical coefficients. These could not be independently verified by the Ministry of Planning because it lacked technical expertise. It is the author's judgment, based on experience, that to effectively undertake this role in the economic evaluation of projects, the staff of the Ministry of Planning should command at least modest technical knowledge of the issues disputed. Hence, it is recommended that the Ministry of Planning strengthen its technical staff to effectively fulfill its prescribed role.

2. Implementation of Irrigation Projects

This study has examined the decisions taken by the policy-makers that would lead to the timely completion of the project and achievement of its objective. The issues discussed include the implementation estimates, the commitment of resources to the project, the impact of the implementation problems on timely execution of the project and on the tenants, and the coordination among the various agencies involved in implementing the project.

These agencies provide implementation estimates which are accurate only if certain conditions are met. For example, the canal excavation program could not be carried out expeditiously without procuring heavy earth moving equipment on time, increasing the financial resources to meet the price escalation, and training the technicians to operate this machinery. But analysts often provide implementation

estimates only for the purposes of economic appraisals and project choice. If, in the process, project conditions have not been projected accurately, the project will fall short of its estimated performance. The implementation agency has hedged against being held responsible for failures in meeting these estimates; but if the decision-maker has not taken the necessary steps to accurately access and avoid the probable future impediments, then the subsequent policy decision will be based on non-realistic implementation estimates. The irrigation and the electrification programs of the Rahad project are cases in point. Hence, it is recommended that policy decisions be based on realistic estimates.

The completion of the project on schedule depends on the commitment of adequate physical, financial, and manpower resources. For example, many times during the implementation of the Rahad project, the cost of equipment vital for timely project execution exceeded the budget provisions, which came largely from foreign donors. One line of action could have been to ask for a second bid, but because of price escalation in this case, costs ended up higher than they were in the first bid. Another line of action could have been to decrease the amount of equipment, which, if approved by the policy-makers, would lead to a slower implementation rate, though that might not be acknowledged. A third line of action could have been to ask for additional provisions, which would require even more time for approval because of the complex financing plan of the Rahad project. Thus, to avoid these difficulties

it is recommended that policy-makers not only assure adequate allocation of funds from the beginning, but also adopt flexible arrangements to handle future uncertainties in financing, procurement of equipment, etc.

Coordination is a prerequisite for the implementation of all activities. While the need for coordination varies from one activity to another, it increases with the scarcity of resources, the complexity of the project, and the diversity of the participants. The Rahad project faced just this situation. Coordination of the project was lacking from the start, and although efforts to coordinate improved after the implementation process was well underway, they were focused on trouble-shooting. No modern techniques of coordination and monitoring were applied. Hence, it is recommended that a detailed coordination plan be drawn up and approved from the beginning. The coordination body should adopt appropriate techniques to monitor project implementation so that new information can be utilized as it becomes available.

Problems which tenants encountered during settlement in the project area affected the individual tenant productivity and ultimately the total agricultural output of the project. These problems included lack of health and education facilities, lack of hygienic water for domestic use, and inadequate nutrition especially the staple diets and daily rations, etc. It is therefore recommended that policy-makers and implementers not overlook the importance

of these services and that special efforts be made to secure adequate provisions.

3. Tenancy (Farm) Size

In irrigated schemes in the Sudan, land is divided traditionally into tenancy units of equal area, where tenants grow the same crop mix and follow the same rotation. The project management determines the area of the tenancy, the number of tenancies each household can possess, the crops and cropping intensity, the irrigation method and frequency, the cultural practices, and the marketing of the most important crops. With the exception of the Gezira scheme the government policy for irrigation schemes has been based on the distribution of one tenancy for each tenant. But, the policy of uniform tenancies does not recognize the heterogeneity in size and composition of households. The present policy, for example, assumes that the size of the average household is five and uses this figure when determining the size of the tenancy. The results of the sample of tenants survey in the Rahad project revealed that tenant household size varies from 1 to 16. Adjusting for age and sex differences, the labor equivalence and the consumer equivalence of the size of the tenant households vary from 1.0 to 8.3 and from 1.0 to 10.7 respectively. Consequently, the present policy in the Rahad project of allocating one uniform 22 feddan tenancy per tenant household, irrespective of its size and composition, cannot be justified because it is inequitable and inefficient.

Thus it is recommended that variable land areas should be allotted according to each tenant's household size.

The results of this study emphasized the need for the policy-maker to select an explicit income for tenants and to gear the decision on tenancy size accordingly. Since the tenant and his household are expected to live primarily on the income earned from the tenancy, the size of the tenancy is critical for both the tenant and the project performance.

To facilitate field management of irrigated agricultural projects in the Sudan, the government policy calls for the allocation of land in tenancy units. Tenancy size is constrained by the area of land irrigable from the terminal irrigation channel. In the Rahad project this area is 88 feddans. Consequently, to facilitate field layout, management, and tenancy consolidation, the 88 feddans were necessarily a multiple of the tenancy size.

The results of the computation showed that for the smallest tenant household group the tenancy size ranges between 12 and 15 feddans depending on the level of income and the crop rotation (1 or 2) chosen. The nearest whole number to satisfy the field layout constraint would be a tenancy size of 11 feddans, which is recommended for the smallest tenant household group. The land area for the second group of tenant households ranges between 15 and 19 feddans; for the third and fourth groups it ranges between 19 and 24 feddans, depending on the choice of the target

income and the crop rotation (1 or 2). It is recommended that these three groups (which include the average tenant household), be allotted two tenancy units for a total area of 22 feddans (which is the current tenancy area distributed to all tenant households in the Rahad project). For the largest tenant household group the land area ranges between 30 and 40 feddans depending on the choice of the target income and the crop rotation (1 or 2). At least three (and sometimes up to four) tenancy units for a total area of 33 feddans may be allotted to tenants in this group. This recommendation for tenancy distribution (or one that is based on similar principles) realizes the heterogenity of the tenant households and hence is more equitable than the present policy.

Since tenancies have been distributed to 40 percent of the tenants in the Rahad project there will be some difficulty in re-allocating tenancies on the basis of these proposals. However, there is a precedent in the Gezira scheme where in 1931-33, the size of the tenancy was increased from 30 to 40 feddans. It is recommended that immediate steps be taken in the Rahad project to allocate variable tenancies of 11, 22 and 33 feddans for tenants with small, medium and large households respectively. If this system is adopted, about one-fourth of the present tenants will have to give up land, while about one-tenth will receive more land. After the original number of tenants are established, the land available for distribution will increase by about 15 percent.

Within the present tenancy allocation policy, there are means by which more land can be allocated to larger tenant households. It was mentioned earlier that the unit of irrigable land from an irrigation channel is around 88 feddans. Due to the topography of land, this area varies widely, and further division into tenancies also produces significant variations. For example, in the sample survey, about 15 percent of the Rahad project tenancies were less than 22 feddans in the range of 18 to 20 feddans; 3 percent were more than 22 feddans--ranging from 24 to 28 feddans. Rahad project data revealed that the size of tenancies varies from 14 to 34 feddans.

In addition to field crop production, the Rahad project has other production components. It is proposed that 7,000 feddans be divided into 5-feddan plots for vegetable and fruit production. (Again the 5-feddan plot was arbitrarily determined.) These are to be given to tenants who have experience in and prefer vegetable production over crop production. There is yet a third component, where tenants with a certain minimum number of cattle or sheep will be allotted land, capital, equipment and technical advice for the production of milk and milk products to supply the growing centers in the project area. Tenants with large households could be given priority in the allocation of land for fruit and vegetable production as well as for livestock.

At present the tenants' participation in decision-making in the Rahad project is limited to the supply of

household labor. The tenant has no voice in how much land to put into production, which crops to grow, the type and level of inputs to apply and where to market the produce, etc. Individual tenants should be encouraged to make tenancy-level decisions on the use of the following resource: (1) the number and duration of irrigation water application (the total irrigation charges would vary with the number of applications), (2) the use of labor or mechanical power for planting their crops, and (3) the hiring of agricultural machinery from the project management or from other cooperative or private sources. At the policy level tenant representatives should be allowed to share in the overall decision making for the project. This should increase the chances of meeting project goals in physical output as well as improve tenant productivity and well being.

C. Suggestions for Future Research

To improve the planning, implementation and future expansion of the Rahad project and other irrigated agricultural projects in the Sudan there is a need for research in the following areas:

1. The optimum use of resources at the farm level. Analyses are needed of the socio-economic characteristics of the tenant households, including the size and composition, supply of household labor, attitudes toward farm work, level of education, managerial abilities,

the opportunity cost, etc. Analyses are also needed of other resources, particularly land, irrigation water, the demand for and the supply of hired labor, agricultural machinery, chemical fertilizers and insecticides, etc.

2. Comparative economic studies of hand and machine cultivation under various field conditions. In the Rahad project, agricultural machinery has been widely used in field operations which were traditionally the responsibility of the tenant. At the farm level, the extensive use of agricultural machinery leads to the displacement of labor and a decrease in returns to the tenant. At the project level, large appropriations are needed for the procurement of the agricultural machinery, equipment and spart parts, and for the management, operation and maintenance of the fleet.
3. The role of tenants in decision-making. In this study, it has been observed that the Rahad project tenants have a modest role in decision-making as compared to other irrigated agricultural projects in the Sudan. There is a need to determine the impact of alternative decision-making arrangements, where tenants may exercise a greater control over variable farm inputs such as the application of irrigation water, fertilizer and insecticides, the use of hand labor or machines, etc.
4. The organization of the field operations. The management of the Rahad project determines the field operations, the optimum time for each operation, and whether

the operation should be done mechanically or by hand labor. The project management supplies the agricultural machinery on the assumption that economies of scale will be realized from large scale field operations. However, diseconomies of scale may arise as the fleet of agricultural machinery grows larger because of management problems and the decrease in flexibility. Research is needed to determine the most economical size of the agricultural machinery fleet. Another aspect of this issue which requires research is whether the project management should remain the sole supplier of the agricultural machinery services in the project, or whether alternative supply sources (private or cooperative) should compete with the project management. This issue is closely related to that of increasing the tenants' role in decision-making.

5. The tenant-management relationship. In theory the system of paying cash for the use of resources in farming is more efficient than sharing the crop or crop revenue. But the hypothesized efficiency of the cash system is based on the assumptions of the competitive economic model. The land and water charge system currently applied in the Rahad project does not operate under these assumptions. For example, most of the resources are supplied and their use is controlled by the project management. Tenants have no access to the inputs and products markets. Hence there is a need for a comparative

study between the crop-sharing system which is practiced in the Gezira Scheme and the land and water charge system practiced in the Rahad project.

6. Institutional research to compare the performance of the different agencies and the coordinating committees involved in the planning and implementation of the Rahad project.
7. The importance of the resource constraints and the impact of competition among the projects within the agricultural sector and other sectors for these limited resources.

APPENDICES

APPENDIX A

DETAILED COMPUTATIONS OF THE FINANCIAL NET RETURNS TO TENANT HOUSEHOLD LABOR PER FEDDAN OF COTTON

TABLE A.1 COMPUTATION OF WEIGHTED PRICE OF ACALA 442 COTTON

Ginning Output Term	A Big Kantar of Seed Cotton Yields	Estimated Price/Unit Ls	Weighted Price Ls
40% Lint	1.26 Kantars	19.0	23.94
58% Seed	.083 M.Ton	50.0	4.15
1.2% Scarto	3.78 lbs.	.05	0.19
0.8% Imputirites	2.52 lbs.	0.0	0.00
100.0			28.23

SOURCE: Author's Inquiry During 1977/78

TABLE A.2 COST OF PRODUCTION ACTIVITIES AND SUPPLIES UNDERTAKEN BY THE PROJECT-MANAGEMENT ON BEHALF OF THE TENANT ON PER FEDDAN BASIS

Production Activity	Cost per Feddan Ls
A. Land Preparation[a]	
-Disc Harrowing and Land Levelling	3.542
-Ridging	1.090
-Fertilizer Application	1.150
-Planting	1.000
-Interrow Cultivation and green ridging	1.350
-Mechanical Pulling of Cotton stalks[b]	1.000
Sub Total	9.132
B. Supplies	
-Seed[c]	1.900
-Fertilizers[d]	11.093
-Insecticides and Aerial Spraying[e]	19.312
-Miscellaneous Supplies to the tenant[b]	1.00
Sub Total	33.305
TOTAL	42.437

SOURCE: Compiled from Various Sources

[a]Hassan, M., Costs of Mechanical Field Operations, Rahad Agricultural Corporation, draft computations, (April, 1978).

[b]Estimated by the author from discussions with the project authorities and the tenants

[c]Ibrahim, A.M. and Berkoff, J. "An Economic Evaluation of the Rahad Irrigation Project" Sudan Committee, International Commission on Irrigation and Drainage (ICID), (May, 1978)

[d]AGRAR-UND, New Halfa Rehabilitation Project, Phase 1. Project Preparation Unit, Ministry of National Planning, (1978) (Actual Costs for 1977/78 season).

TABLE A.2 (Cont)

[e]Rahad Agricultural Corporation, The Rahad Project Documents (1978) (Actual Contract Costs of Insecticides and Aerial Application).

TABLE A.3 SUMMARY OF THE TOTAL COSTS OF PRODUCTION UNDERTAKEN BY THE PROJECT MANAGEMENT ON BEHALF OF THE TENANT

Per Feddan Costs[a]	L s 42.437
Per Kantar Costs[b]	L s 4.536
Land and Water Charge[c]	L s 34.200

SOURCE: Compiled from various sources

[a]See Table A. 2

[b]Based on the Figures of the Farm Budget, Ahmed M.A. "The Revised Farm Budget - 1975" Rahad Corporation, Ministry of Agriculture, Food and Natural Resources, Revised (Aug, 1976)

[c]Ahmed, M.A. "Estimation of the Land and Water Charge in the Rahad Project" Rahad Agricultural Corporation (June 1977)

TABLE A.4 COMPUTATION OF THE FINANCIAL NET RETURNS TO TENANT HOUSEHOLD LABOR PER FEDDAN OF COTTON[a]

Case No.	Gross Returns Per Feddan Ls	Tenant Direct Costs Ls	Tenant Direct Cost Per Feddan Ls	Total Cost of Production Per Feddan Ls	Net Return Per Feddan Ls
1	183.817	20.537	1.867	108.029	70.386
2	205.587	23.652	2.365	112.024	87.962
3	127.593	18.137	1.649	98.780	23.874
4	171.982	23.322	2.332	106.593	60.058
5	202.198	21.962	2.196	111,311	85.322
6	216.421	20.077	1.825	113.224	97.535
7	201.531	22.332	2.030	111.038	84.941
8	130.417	14.732	1.339	98.924	26.547
9	139.403	26.482	2.407	101.436	32.895
10	180.993	20.152	1.832	107.541	68.075
11	180.993	30.667	2.788	108.497	67.071
12	189.721	26.212	2.383	109.494	74.753
13	195.626	36.457	3.314	111.373	78.684
14	201.531	25.777	2.343	111.351	84.612
15	142.227	23.832	2.167	101.648	35.496
16	112.703	18.032	1.639	96.379	11.505
17	142.227	15.917	1.447	100.929	36.252
18	118.608	19.357	1.760	97.448	16.298
19	237.216	16.172	1.470	116.210	115.196
20	273.928	13.995	1.399	122.036	145.791
21	172.007	14.282	1.298	105.564	61.165
22	290.615	20.667	1.879	125.195	159.160
23	320.139	42.532	3.867	131.925	181.617
24	240.040	40.762	2.912	118.105	116.030
25	77.769	18.097	1.392	90.521	-17.278
26	142.227	16.127	1.466	100.948	36.231
27	172.007	24.002	2.182	106.447	60.238
28	243.121	37.411	3.401	119.089	118.077
29	136.322	20.687	1.881	100.414	30.887
30	148.388	11.127	1.012	101.483	41.831
31	124.513	19.992	1.817	98.454	21.136
32	145.308	14.935	1.358	101.335	38.906
33	213.597	24.232	2.203	113.149	94.791
34	159.838	11.792	1.179	103.490	51.174
35	133.498	22.680	2.062	100.142	28.349
36	239.099	34.322	2.860	117.902	115.302
37	269,820	34.137	3.103	123.080	140.587
38	124.513	9.852	.986	97.532	22.104
39	188.951	14.537	1.322	108.309	75.227
40	128.620	6.512	.592	97.888	25.838
41	225.407	7.007	.637	113.480	106.253

TABLE A.4 (Cont)

Case No.	Gross Returns Per Feddan Ls	Tenant Direct Costs Ls	Tenant Direct Cost Per Feddan Ls	Total Cost of Production Per Feddan Ls	Net Return Per Feddan Ls
42	254.930	19.247	1.750	119.334	129.629
43	244.558	22.889	2.289	118.208	120.440
44	237.216	28.532	2.594	117.333	114.016
45	178.477	9.892	.989	106.294	66.860
46	136.964	10.512	1.051	99.688	32.292
47	88.109	11.497	1.150	91.939	-8.427
48	204.612	17.312	1.574	111.076	87.982
49	186.897	17.357	1.578	108.235	73.251
50	139.403	12.452	1.132	100.160	34.235
51	273.415	24.757	2.251	122.804	144.470
52	237.216	21.747	1.977	116.716	114.664
53	225.407	23.862	2.169	115.012	104.644
54	163.022	16.522	1.502	104.324	53.482
55	124.513	16.222	1.475	98.111	21.496
56	176.218	16.762	1.676	106.618	64.269
57	177.912	23.072	2.097	107.311	65.235
58	193.059	9.882	.898	108.545	79.087
59	280.423	20.167	2.017	123.696	150.542
60	302.168	30.732	3.073	128.245	167.510
61	320.053	45.697	3.808	131.853	181.608
62	174.831	15.502	1.409	106.128	63.397
63	186.897	23.142	2.104	108.761	72.699
64	123.315	14.743	1.638	98.082	20.328
65	91.908	6.812	.619	92.019	-4.711
66	166.103	5.687	.517	103.834	57.077
67	198.707	17.872	1.625	110.179	83.019
68	154.293	26.735	2.430	103.851	49.250
69	215.651	35.742	3.249	114.525	95.400
70	207.692	24.807	2.255	112.252	89.827
71	141.765	20.460	2.046	101.454	35.238
72	82.923	13.652	1.241	91.197	-12.834
73	100.894	15.367	1.397	94.240	1.942
74	145.308	23.817	2.165	102.142	38.059
75	179.324	16.937	1.694	107.134	66.833
76	106.799	12.907	1.173	94.965	7.086
77	103.718	14.587	1.326	94.623	4.364
78	130.417	9.457	.860	98.445	27.050
79	139.403	14.047	1.277	100.305	34.082
80	166.103	18.457	1.678	104.995	55.358
81	142.227	26.762	2.433	101.915	35.216
82	198.707	20.107	1.828	110.382	82.806
83	71.113	20.472	1.861	89.921	-23.303
84	71.627	12.087	1.099	89.241	-22.076

TABLE A.4 (Cont)

Case No.	Gross Returns Per Feddan Ls	Tenant Direct Costs Ls	Tenant Direct Cost per Feddan Ls	Total Cost of Production Per Feddan Ls	Net Return Per Feddan Ls
85	121.689	18.737	1.703	97.886	18.908
86	100.894	19.932	1.812	94.655	1.506
87	124.513	14.267	1.297	97.934	21.682
88	128.620	22.492	2.045	99.341	24.312
89	84.720	15.142	1.514	91.759	-11.627
90	103.718	13.922	1.266	94.562	4.428
91	103.718	18.497	1.682	94.978	3.991
92	133.498	13.602	1.237	99.316	29.216
93	189.978	33.392	3.036	110.188	74.281
94	128.364	19.137	1.740	98.995	24.419
95	241.067	7.262	.660	116.018	119.248
96	228.462	30.297	3.030	116.363	106.281
97	195.113	9.907	.901	108.877	80.792
98	311.581	27.701	3.078	129.762	175.331
99	229.601	40.037	3.640	128.400	164.781
100	163.022	19.667	1.788	104.610	53.181
101	323.220	35.607	3.237	131.791	184.840
102	207.436	31.562	2.869	112.825	88.969
103	216.421	26.317	2.392	113.792	96.940
104	195.626	25.553	2.323	110.382	79.725
105	272.901	24.852	2.259	122.731	144.034
106	177.912	25.810	2.346	107.560	64.974
107	269.820	26.402	2.400	122.377	141.325
108	195.626	31.802	2.891	110.950	79.128
109	92.486	34.602	2.882	94.376	-6.609
110	201.531	32.592	2.963	111.970	83.962
111	272.901	35.752	3.250	123.721	142.994
112	234.135	31.072	2.825	117.069	111.213
113	349.919	48.912	4.447	137.289	205.766
114	264.429	48.822	4.428	123.549	134.703
115	332.205	36.277	3.298	133.295	192.246
116	205.382	28.557	2.596	112.222	87.549
117	156.450	22.762	2.276	104.043	47.205
118	241.324	18.832	1.712	117.111	118.357
119	154.036	18.832	1.712	103.091	45.791
120	231.311	33.128	3.012	116.803	108.669
121	183.303	30.102	2.737	108.816	69.046
122	225.407	24.503	2.228	115.070	104.583
123	266.996	22.912	2.083	121.606	139.310
124	222.326	26.637	2.422	114.769	101.818
125	340.934	47.837	4.349	135.748	198.399

SOURCE: The Survey of Tenants and Rahad Project Data

TABLE A.4 (Cont)

[a]Net Returns to tenant household labor are calculated using the formula

$$R_{nj} = G_{nj} - (1+\frac{r}{2}) (T_{nj} + F_j + U_{nj} + L_j)$$

Where: G_{nj} (Column 2) is obtained from the survey of tenants and weighted price Ls28.23 is obtained from Table A.1

r = 10 percent

T_{nj} = (Column 3) is obtained from the Survey of Tenants

F_j = Ls42.437 per feddan of cotton

U_{nj} = Ls 4.536 per unit of output (Kantar) of cotton

L_j = Ls34.200 per feddan of cotton (See Table A.3)

To obtain column 6 - the net returns per feddan, Column 5 - the total costs of production is multiplied by 1.05 (a 10% rate of interest for an investment period of six months); and then subtracted from Column 2 - the gross returns per feddan.

APPENDIX B

THE PERCENTAGE OF THE PRODUCTION COSTS PAID DIRECTLY BY THE TENANT

TABLE B.1 THE PERCENTAGE OF THE DIRECT COSTS INCURRED BY THE SAMPLE OF TENANTS TO TOTAL COSTS OF PRODUCTION

Case No.	Percentage of Tenant Direct Cost of Total Cost of Production Per Feddan
1	1.7
2	2.0
3	1.6
4	2.2
5	1.9
6	1.6
7	1.8
8	1.3
9	2.3
10	1.7
11	2.6
12	2.2
13	3.0
14	2.1
15	2.1
16	1.7
17	1.4
18	1.8
19	1.3
20	1.1
21	1.2
22	1.5
23	2.9
24	2.5
25	1.5
26	1.5
27	2.0
28	2.8
29	1.9
30	1.0
31	1.8
32	1.3
33	1.9
34	1.1
35	2.0
36	2.4
37	2.5
38	1.0
39	1.2
40	0.6
41	0.6
42	1.5
43	1.9
44	2.2

TABLE B.1 (Cont)

Case No.	Percentage of Tenant Direct Cost of Total Cost of Production Per Feddan
45	1.0
46	1.0
47	1.3
48	1.4
49	1.5
50	1.1
51	1.8
52	1.7
53	1.9
54	1.4
55	1.5
56	1.6
57	2.0
58	1.0
59	1.6
60	2.4
61	2.9
62	1.3
63	1.9
64	1.7
65	0.7
66	0.5
67	1.5
68	2.3
69	2.8
70	2.0
71	2.0
72	1.4
73	1.5
74	2.1
75	1.6
76	1.2
77	1.4
78	0.9
79	1.3
80	1.6
81	2.4
82	1.7
83	2.1
84	1.2
85	1.7
86	1.9
87	1.3
88	2.1

TABLE B.1 (Cont)

Case No.	Percentage of Tenant Direct Cost of Total Cost of Production Per Feddan
89	1.6
90	1.3
91	1.8
92	1.2
93	2.8
94	1.8
95	0.6
96	2.6
97	0.8
98	2.4
99	2.8
100	1.7
101	2.5
102	2.5
103	2.1
104	2.1
105	1.8
106	2.2
107	2.0
108	2.6
109	3.1
110	2.6
111	2.6
112	2.4
113	3.2
114	3.6
115	2.5
116	2.3
117	2.2
118	1.5
119	1.7
120	2.6
121	2.5
122	1.9
123	1.7
124	2.1
125	3.2

SOURCE: The Survey of Tenants

APPENDIX C

THE LABOR AND CONSUMER EQUIVALENTS OF TENANT HOUSEHOLDS

TABLE C.1 ABSOLUTE, LABOR AND CONSUMER EQUIVALENTS OF TENANT HOUSEHOLDS

Case No.	Absolute Household Size	Labor Equivalent	Consumer Equivalent
1	5	1.4	3.10
2	7	1.9	3.80
3	9	3.8	5.40
4	7	4.2	5.40
5	6	4.7	5.60
6	11	2.9	6.30
7	10	4.8	6.70
8	3	1.9	2.10
9	5	1.9	4.20
10	2	1.4	1.90
11	3	1.9	2.10
12	4	1.9	2.60
13	9	6.7	7.65
14	2	1.9	1.90
15	3	1.9	2.10
16	8	3.9	5.30
17	7	2.9	4.25
18	5	2.9	4.55
19	12	4.9	7.45
20	8	6.8	7.30
21	8	5.4	6.65
22	12	5.9	9.45
23	3	1.9	2.10
24	6	1.9	3.70
25	4	2.9	3.80
26	5	1.9	2.80
27	3	1.9	2.10
28	2	1.9	1.90
29	4	2.5	3.20
30	3	2.4	2.65
31	3	1.9	2.40
32	9	5.3	7.15
33	3	1.9	2.10
34	11	5.2	7.30
35	3	2.3	2.70
36	4	1.9	2.30
37	4	1.9	2.60
38	9	3.9	5.80
39	9	4.8	6.50
40	5	1.9	2.80
41	10	3.4	5.90
42	8	2.9	4.75
43	3	1.9	2.10
44	7	2.4	4.05
45	7	2.4	4.30

TABLE C.1 (Cont)

Case No.	Absolute Household Size	Labor Equivalent	Consumer Equivalent
46	8	4.4	6.00
47	3	1.9	2.10
48	8	3.9	6.10
49	9	5.1	6.95
50	7	2.9	4.60
51	9	3.3	5.45
52	10	3.9	5.80
53	6	3.3	4.55
54	6	1.9	3.39
55	7	3.8	5.00
56	8	3.8	5.50
57	6	3.8	4.50
58	5	2.8	4.00
59	5	4.8	4.80
60	7	3.4	4.80
61	5	3.8	4.00
62	10	6.2	8.40
63	4	2.8	3.00
64	6	2.8	4.20
65	10	6.6	7.80
66	8	4.4	6.10
67	5	3.4	4.15
68	6	3.3	4.50
69	16	5.7	9.80
70	3	1.9	2.10
71	5	1.9	2.80
72	4	2.4	3.55
73	7	4.3	4.90
74	6	2.8	3.70
75	6	3.4	4.00
76	4	2.4	3.15
77	7	4.8	5.70
78	8	4.8	5.70
79	5	1.9	2.80
80	4	2.4	3.30
81	3	1.9	2.10
82	7	3.3	4.70
83	14	5.7	9.30
84	13	8.3	10.65
85	8	1.9	4.55
86	7	2.9	4.20
87	13	5.2	8.30
88	9	3.3	5.70
89	6	1.9	3.30
90	6	5.7	5.70
91	2	1.9	1.90
92	5	1.9	3.10
93	16	6.6	9.85

TABLE C.1 (Cont)

Case No.	Absolute Household Size	Labor Equivalent	Consumer Equivalent
94	5	2.4	3.30
95	9	5.3	7.40
96	5	3.3	4.20
97	9	4.8	6.45
98	7	4.2	5.15
99	13	5.6	8.95
100	5	1.9	2.80
101	7	4.3	5.20
102	10	6.7	7.85
103	2	1.9	1.90
104	2	2.0	2.00
105	8	4.3	5.95
106	6	2.9	4.20
107	6	2.8	4.00
108	3	1.4	2.15
109	14	6.7	9.60
110	6	2.9	4.10
111	8	4.3	5.75
112	5	2.4	3.60
113	5	1.9	3.10
114	4	1.9	3.00
115	1	1.0	1.00
116	5	1.5	4.25
117	7	2.9	4.55
118	13	3.4	7.60
119	11	8.2	9.05
120	8	2.8	4.70
121	6	2.4	3.85
122	9	4.9	6.90
123	7	3.4	4.80
124	7	3.9	5.35
125	3	1.9	2.10

SOURCE: The Survey of Tenants

APPENDIX D

THE PERCENTAGE SHARE OF HIRED LABOR IN HARVESTING AND POST-HARVEST ACTIVITIES OF COTTON UNDER THE RESPONSIBILITY OF THE TENANT

TABLE D.1 THE PERCENTAGE SHARE OF HIRED LABOR, HARVESTING AND POST-HARVEST ACTIVITIES OF COTTON

PERCENTAGE SHARE OF HIRED LABOR PER ACTIVITY

Case No.	Cotton Picking	Cotton Packing	Transportation To Collection Centers	Cotton Weighing
1	87	100	0	100
2	90	100	100	-
3	95	56	100	0
4	86	80	100	33
5	64	100	100	100
6	96	96	100	0
7	56	100	100	0
8	80	100	100	-
9	80	100	100	100
10	92	100	100	100
11	100	100	100	100
12	94	100	100	100
13	100	100	100	0
14	66	100	100	100
15	83	100	100	100
16	61	100	100	100
17	96	88	100	100
18	75	100	100	100
19	59	100	100	40
20	61	100	100	0
21	88	100	100	100
22	73	100	100	25
23	89	100	100	100
24	97	100	100	100
25	74	100	100	100
26	100	0	100	100
27	100	57	74	100
28	96	100	100	100
29	93	100	100	53
30	73	100	100	0
31	98	100	100	100
32	84	100	100	100
33	93	100	100	100
34	55	100	100	50
35	67	100	100	100
36	97	100	100	100
37	78	100	100	100
38	0	100	100	100
39	76	100	100	0
40	45	0	100	100

TABLE D.1 (Cont)

Case No.	PERCENTAGE SHARE OF HIRED LABOR PER ACTIVITY			
	Cotton Picking	Cotton Packing	Transportation To Collection Centers	Cotton Weighing
41	13	100	100	100
42	40	87	100	100
43	75	87	100	0
44	88	100	100	100
45	60	85	100	0
46	48	71	100	100
47	74	59	76	0
48	44	100	100	100
49	59	100	100	100
50	68	0	100	0
51	84	100	100	100
52	78	95	100	0
53	57	100	100	100
54	55	53	100	100
55	38	48	100	100
56	41	100	100	100
57	80	67	100	100
58	32	73	100	100
59	69	100	100	78
60	83	100	100	100
61	100	100	100	0
62	58	92	100	100
63	81	87	100	0
64	88	100	100	100
65	68	68	100	0
66	9	100	100	0
67	94	100	100	10
68	60	100	100	0
69	91	100	100	0
70	96	86	100	0
71	86	53	100	0
72	71	71	100	0
73	91	100	100	0
74	63	100	100	0
75	82	82	100	0
76	47	100	100	0
77	86	100	100	0
78	68	100	100	-
79	89	100	100	0
80	73	100	100	0
81	100	100	100	94
82	40	100	100	0

TABLE D.1 (Cont)

PERCENTAGE SHARE OF HIRED LABOR PER ACTIVITY

Case No.	Cotton Picking	Cotton Packing	Transportation to Collection Centers	Cotton Weighing
83	75	40	100	0
84	40	100	100	0
85	100	100	100	0
86	71	100	100	0
87	38	100	100	0
88	52	100	100	25
89	88	100	100	100
90	77	62	100	35
91	91	71	100	50
92	70	71	100	100
93	92	88	100	0
94	79	100	100	67
95	5	76	100	0
96	81	100	100	0
97	48	100	100	0
98	100	48	100	100
99	90	100	100	0
100	99	95	100	100
101	94	100	100	0
102	61	100	100	0
103	95	100	100	0
104	100	73	100	0
105	96	100	100	0
106	90	98	100	0
107	56	67	100	0
108	85	92	100	100
109	100	100	100	0
110	78	100	100	0
111	100	63	100	100
112	91	100	100	0
113	93	100	100	100
114	92	100	100	0
115	85	78	100	0
116	89	100	100	0
117	83	100	100	0
118	62	100	100	50
119	100	100	100	0
120	85	100	100	0
121	89	96	100	0
122	91	100	100	0
123	67	100	100	0
124	100	67	100	0
125	100	100	100	100

SOURCE: The Survey of Tenants

APPENDIX E

APPROXIMATIONS OF ANNUAL HOUSEHOLD EXPENDITURES OF TENANTS

TABLE E.1 APPROXIMATION OF ANNUAL HOUSEHOLD EXPENDITURES OF TENANTS

Case No.	Cost of Maintaining Farm Animals Ls	Cost Of Food Ls	Cost of Clothing & Footwear Ls	Cost of Other Items Ls	Total Annual Household Expenditures Ls
1	00	566.11	63.50	117.35	746.96
2	45.63	790.95	128.50	68.50	1033.58
3	91.25	774.89	295.00	194.00	1355.14
4	91.25	661.13	160.40	107.25	1020.03
5	00	554.07	109.50	110.50	774.07
6	00	616.30	92.70	106.00	815.00
7	00	595.98	93.50	95.00	784.48
8	00	485.82	28.50	59.25	573.57
9	45.63	525.96	101.00	112.00	784.59
10	45.63	546.04	23.00	50.00	664.67
11	182.50	419.57	71.25	69.50	742.82
12	00	465.74	89.75	90.80	646.29
13	182.50	931.48	233.60	292.35	1639.93
14	00	550.06	46.20	81.00	677.26
15	54.75	750.81	159.90	115.00	1080.46
16	146.00	750.81	188.00	168.00	1252.81
17	73.00	706.64	158.00	107.30	1044.94
18	45.63	790.96	98.40	60.00	994.99
19	91.25	690.58	171.00	120.70	1073.53
20	45.63	457.71	32.15	70.25	605.74
21	45.63	801.00	101.85	101.00	1049.48
22	68.44	790.96	162.00	207.50	1228.90
23	45.63	485.82	136.00	50.00	717.45
24	45.63	803.00	155.00	77.00	1080.63
25	73.00	650.43	97.00	84.00	904.43
26	00	423.59	48.10	55.50	527.19
27	45.63	429.61	36,30	70.50	582.04
28	00	345.29	42.50	118.00	505.79
29	00	345.29	44.00	86.00	475.29
30	00	501.87	102.00	80.50	684.37
31	00	347.30	53.50	65.00	465.80
32	00	489.83	42.50	70.30	602.63
33	00	385.44	58.00	85.50	528.94
34	45.63	586.19	110.00	100.00	841.82
35	00	411.54	70.00	79.00	560.54
36	00	353.32	112.00	106.00	571.32
37	00	529.98	93.00	114.00	736.98
38	45.63	630.36	201.00	340.00	1216.99
39	91.25	646.42	176.50	171.00	1085.17
40	00	345.29	29.00	37.00	411.29

TABLE E.1 (Cont)

Case No.	Cost of Maintaining Farm Animals Ls	Cost Of Food Ls	Cost of Clothing & Footwear Ls	Cost of Other Items Ls	Total Annual Household Expenditures Ls
41	182.50	809.03	171.00	132.00	1294.53
42	00	489.83	83.50	85.00	658.33
43	00	540.02	77.40	172.30	789.72
44	36.50	534.00	116.50	132.00	819.00
45	00	485.82	77.50	55.00	618.32
46	195.63	648.82	66.85	83.00	994.30
47	00	429.61	72.00	72.00	573.61
48	182.50	730.73	116.00	70.00	1099.23
49	00	632.37	169.00	132.00	933.37
50	00	525.97	125.00	105.80	756.77
51	00	588.60	228.00	108.25	924.85
52	00	578.16	170.50	233.80	982.46
53	00	485.82	97.00	91.00	673.82
54	00	548.45	102.00	124.30	774.75
55	54.75	630.36	354.00	279.00	1318.11
56	00	770.88	84.50	84.00	939.38
57	00	546.04	66.00	103.00	715.04
58	116.80	521.95	104.00	49.00	791.75
59	45.63	525.97	127.00	161.50	860.10
60	00	568.13	130.00	298.50	996.63
61	00	475.78	104.00	125.60	705.38
62	00	529.98	201.00	150.30	881.28
63	00	365.37	96.50	140.30	602.17
64	68.44	576.16	104.50	122.00	871.10
65	60.83	789.35	89.00	124.00	1063.18
66	91.25	606.27	194.00	157.00	1048.52
67	91.25	525.97	140.00	152.00	909.22
68	91.25	546.04	130.00	162.00	929.29
69	91.25	1027.84	350.00	253.50	1722.59
70	45.63	385.44	75.00	127.00	633.07
71	36.50	365.37	64.00	57.00	522.87
72	91.25	505.89	95.00	86.50	778.64
73	45.63	445.67	107.00	102.00	700.30
74	91.25	529.98	249.00	156.00	1026.23
75	91.25	620.32	212.00	230.00	1153.57
76	45.63	574.15	118.00	110.00	847.78
77	00	694.60	97.00	79.00	870.60
78	00	570.13	145.00	105.00	820.13
79	00	546.04	109.00	108.00	763.04
80	182.50	489.83	144.00	120.00	936.33
81	45.63	385.44	73.00	94.00	598.07
82	54.75	790.96	217.00	295.00	1357.71

TABLE E.1 (Cont)

Case No.	Cost of Maintaining Farm Animals Ls	Cost Of Food Ls	Cost of Clothing & Footwear Ls	Cost of Other Items Ls	Total Annual Household Expenditures Ls
83	91.25	911.41	305.00	105.70	1413.36
84	241.25	1180.41	211.00	203.00	1835.66
85	135.05	634.37	104.00	163.00	1036.42
86	91.25	654.45	134.00	145.30	1025.00
87	58.40	730.73	305.00	152.50	1246.63
88	228.13	734.75	317.00	266.00	1545.88
89	45.63	650.43	132.00	194.00	1022.06
90	91.25	610.28	195.00	202.00	1098.53
91	226.30	397.49	97.00	136.10	856.89
92	00	485.82	145.50	112.00	743.32
93	273.75	1538.64	418.50	372.00	2602.89
94	45.63	485.82	142.40	123.00	796.85
95	273.75	768.88	119.50	88.00	1250.13
96	00	670.50	109.50	113.45	893.45
97	60.83	707.85	125.50	110.00	1004.18
98	43.80	--	--	--	--
99	00	995.72	266.00	270.00	1531.72
100	00	568.13	81.00	106.00	755.13
101	136.88	538.01	171.50	175.70	1022.09
102	45.63	698.61	94.00	190.00	1028.24
103	45.63	348.16	81.00	72.00	545.79
104	54.75	388.26	76.00	127.00	646.01
105	00	491.04	209.00	170.50	870.54
106	91.25	418.90	99.00	138.00	747.15
107	60.85	536.01	104.00	133.30	834.16
108	00	343.69	73.00	96.50	513.19
109	91.25	1031.85	395.00	263.00	1781.10
110	91.25	430.81	135.50	118.50	776.06
111	00	--	--	--	--
112	00	385.44	128.50	93.00	606.94
113	36.50	365.37	99.00	121.74	622.61
114	30.42	405.52	62.00	116.00	613.94
115	54.75	445.67	68.00	101.40	669.82
116	00	301.13	00	136.00	437.13
117	00	566.12	248.00	210.00	1024.12
118	00	730.73	241.00	145.00	1116.73
119	54.75	943.13	375.00	490.00	1862.88
120	00	831.11	127.00	128.00	1086.11
121	45.63	470.96	102.00	86.00	704.59
122	73.00	746.78	238.00	195.60	1253.38
123	36.50	479.80	107.00	150.00	773.30
124	47.45	586.19	171.00	125.00	929.64
125	00	--	--	--	--

SOURCE: The Survey of Tenants

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