

*Nighisty Ghezae*

# Irrigation. Water Management

A Performance Study of the Rahad Scheme  
in Sudan, 1977–1996



Uppsala 1998

# Contents

Acknowledgements .....	13
<b>PART ONE: Introduction.....</b>	<b>15</b>
I.1. The Problem .....	15
I.2. Objectives of the Study .....	16
I.3. Conceptual Framework and the Methodology of Performance Assessment..	16
I.3.1. Approach to Assess the Performance of the Rahad Scheme .....	17
I.3.2. Assessment and Improvement of the Performance of Water Management Activities.....	20
I.3.2.1. Main System Management.....	22
I.3.2.2. On-Farm Water Management and Farmers' Participation .....	27
I.3.2.3. Water Pricing: Cost Recovery and Irrigation Financing .....	30
I.3.2.4. Water Rights and Markets in Water .....	34
I.3.2.5. Technological Issues .....	36
I.3.2.6 Concluding Remarks .....	37
I.3.2.7 Research Questions .....	38
I.4. The State of Research on Rahad .....	39
I.5. Methods of Data Collection .....	40
I.5.1. Choosing Data Collection Methods .....	40
I.5.2. Sampling Framework .....	41
I.5.3. Data Gathering Procedures and Source Criticism .....	45
I.6. The Structure of the Study .....	47
<b>PART TWO: The Context of the Rahad Irrigation Management .....</b>	<b>49</b>
<b>CHAPTER ONE: Agro-ecological and Technical Context.....</b>	<b>50</b>
1.1. Agro-ecological Factors .....	50
1.1.1. The Location and Climate of the Rahad Scheme .....	51
1.1.2. The Topography and Soils of the Scheme.....	54
1.2. The Technical Design and Characteristics of the Rahad Scheme.....	54
1.2.1. The Source of Water for the Rahad Scheme .....	55
1.2.2. The Physical Structure of the Scheme .....	58
1.2.2.1. The Rahad Canalization System .....	58

1.2.2.2. Division and Control Structures of the Scheme .....	61
1.2.2.3. The Rahad Drainage System .....	62
1.2.3. Operational Schedules and Water Delivery.....	63
<b>CHAPTER TWO: Historical and Socio-economic Context.....</b>	<b>69</b>
2.1. The Evolution and Importance of Irrigation Schemes in Sudan.....	69
2.2. Features of Large-scale Irrigated Schemes in Sudan.....	74
2.3. The History of Planning and Design of the Rahad Scheme .....	76
2.4. Objectives of the Rahad Scheme .....	78
2.5. The Financing the Rahad Scheme .....	79
2.5.1. Initial Investment.....	80
2.5.2. Resources for Operation and Maintenance.....	80
2.6. Land Tenure and Cropping Patterns.....	82
2.6.1. Land Tenure .....	83
2.6.2. Crop Mix .....	84
2.6.3. Crop Rotation and Size of Tenancy.....	84
2.7. Labour Supply .....	86
2.8. Socio-economic Characteristics of the Population .....	87
2.8.1. Type of the Farming Population.....	87
2.8.2. Economic Activities .....	90
2.9. Administrative Resources and Legal Context .....	91
2.10. Macro Context of the Scheme .....	92
2.11 Conclusion.....	93
<b>PART THREE: Assessing the Performance of the Rahad Irrigation Project... 94</b>	
<b>CHAPTER THREE: Productivity .....</b>	<b>96</b>
3.1. Productivity of Water .....	96
3.2. Production: Yield Performance .....	98
3.2.1. Cotton Yield Performance.....	99
3.2.2. Dura Yield Performance.....	100
3.2.3. Groundnut Yield Performance .....	100
3.2.4. Wheat Yield Performance .....	101
3.3. Cultivated Area.....	103
3.4 Conclusion.....	106
<b>CHAPTER FOUR: Equity and Irrigation Cost Recovery .....</b>	<b>107</b>
4.1. Assessment of Equity .....	107
4.2. Irrigation Cost Recovery .....	111
4.2.1. Basis and Levels of Water Charges in Rahad.....	112
4.2.2. Collection Rates of Water Charges.....	116
4.3 Conclusion.....	119
<b>CHAPTER FIVE: Environmental Stability.....</b>	<b>121</b>
5.1. Environmental Issues in Rahad .....	121
5.2. The Impact of the Management of Agricultural Chemicals .....	122

5.3. The Impact of the Irrigation System on Health .....	128
5.3.1. Water-Borne Diseases .....	128
5.3.1.1. Malaria.....	129
5.3.1.2. Schistosomiasis.....	130
5.3.2. Domestic Water Supply.....	132
5.4. The Impacts of the Poor Maintenance of Physical Works.....	134
5.5 Conclusion.....	137
<b>PART FOUR: Assessment of Project Management Organization, Functions and Activities.....</b>	<b>138</b>
<b>CHAPTER SIX: Effects of Organisational Structure on Management Performance .....</b>	<b>140</b>
6.1. Division of Responsibility and Levels of Organisational Structure .....	140
6.1.1. National Level .....	141
6.1.2. Project Level.....	143
6.1.2.1. The Rahad Irrigation Department.....	144
6.1.2.2. The Mechanical and Electrical Department .....	146
6.1.2.3. The Earth-Moving Corporation Unit.....	146
6.1.2.4. The Rahad Agricultural Corporation (RAC) .....	146
6.2. The Allocation of Personnel and Competence .....	150
6.2.1. The Personnel of the Ministry of Irrigation at the Project Level.....	150
6.2.2. Personnel at the Rahad Agricultural Corporation.....	153
6.3. The Allocation of Tasks and Responsibilities .....	156
6.3.1. Between Farmers and Officials .....	156
6.3.2. Within the Official Organisations.....	157
6.4. Horizontal Co-ordination.....	159
6.5. Conclusion.....	163
<b>CHAPTER SEVEN: Performance of Overall Project Management Functions.....</b>	<b>164</b>
7.1. Internal Constraints and the Scope of Managers' Power.....	164
7.2. Performance of Project Management Functions.....	165
7.2.1. Objectives Setting.....	165
7.2.2. Planning.....	167
7.2.3. Information and Monitoring Systems.....	173
7.3. Conclusion.....	175
<b>CHAPTER EIGHT: Assessment of Water Supply Service Activities.....</b>	<b>176</b>
8.1. Assessing the Performance of Water Distribution Activities .....	176
8.1.1. Assessing Management Performance of Water Distribution.....	177
8.1.1.1. The Planning of Water Distribution .....	177
8.1.1.2. Implementation.....	179
8.1.1.3. Monitoring.....	181
8.1.3. Assessing Actual Performance from a Social and Political Dimension .....	183

8.2. Assessment of System Maintenance.....	186
8.2.1. Civil Maintenance .....	186
8.2.2. Electrical Maintenance .....	191
8.2.3. Mechanical Maintenance.....	192
8.2.4 Conclusion.....	193
8.3. Irrigation Financing.....	194
8.4. Conclusion.....	197
<b>PART FIVE: Farmers' Participation in Irrigation Management.....</b>	<b>198</b>
<b>CHAPTER NINE: Assessment of the Agricultural Extension Service .....</b>	<b>200</b>
9.1. Historical Review of Agricultural Extension Service Systems in the Rahad.....	201
9.1.1. The Inspectorate System.....	201
9.1.2. The Training and Visit (T&V) System.....	202
9.2. Assessing the Performance of the Training and Visit System.....	206
9.2.1. The Diffusion of Messages.....	206
9.2.2. Adoption of Recommended Messages .....	208
9.3. The Reasons for the Performance of the T&V System .....	214
9.4. Conclusion.....	219
<b>CHAPTER TEN: Assessment of On-farm Water Management.....</b>	<b>220</b>
10.1. Farmers' Field Level Activities and Responsibilities.....	220
10.1.1. Field Level Irrigation System and Farmers' Role .....	220
10.1.2. Farmers' Organization.....	222
10.2. Actual Farmers' Water Management Practices .....	223
10.2.1. Major Canal 2 .....	224
10.2.2. Major Canal 5 .....	228
10.2.3. Major Canal 7 .....	230
10.3. Reasons for On-Farm Performance .....	232
10.3.1. Technical Factors and Quality of Agencies' Services.....	232
10.3.2. Farmers' Skill in Irrigation Management.....	235
10.3.3. Farmers' Motivation.....	236
10.3.4. Farmers' Organizational Structure .....	238
10.4. Conclusion.....	241
<b>PART SIX: Summary of Findings and Improvement Suggestions .....</b>	<b>242</b>
VI.1. Findings.....	242
VI.1.1. The Setting .....	242
VI.1.2. Scheme Performance.....	243
VI.1.3. Organizational Structure .....	246
VI.1.3.1. Horizontal Structure .....	246
VI.1.3.2. Vertical Structure .....	247
VI.1.3.3. Number and Qualifications of Personnel .....	249
VI.1.4. Overall Project Management Functions .....	250
VI.1.5. Water Supply Service Activities .....	251

VI.1.6. Agricultural Extension Service .....	253
VI.1.7. On-farm Water Management .....	255
VI.2. Improvement Suggestions .....	257
VI.2.1. Physical Rehabilitation.....	257
VI.2.2. Changes in Organizational Structure.....	258
VI.2.3. The Need for Well-Designed Operational Procedures .....	261
VI.2.4. Education and Training .....	262
VI.2.5. Financial Autonomy .....	265
VI.2.6. Creating Motivation .....	266
Appendix A: Interview Guide .....	269
Appendix B: Percentage of Farmers' Response to Questionnaire-survey in 1992 .....	274
Appendix C: List of Names of Interviewed and Contacted Persons .....	280
List of Tables and Figures .....	283
Bibliography.....	285