

## Chapter 6

### EVALUATION OF THE SOCIOECONOMIC PERFORMANCE OF THE RAHAD IRRIGATED SCHEME

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#### 6.1 INTRODUCTION

##### 6.1.1 The Setting

The Rahad Irrigated Scheme is approximately 25 km wide and 160 long. It is situated along the eastern bank of the Rahad River which is one of the tributaries of the Blue Nile. The first phase of the scheme was completed in 1981. At present, the total command area is about 300,000 feddans (approximately 126, 000 hectares). The net irrigated area under crops is around 280,000 feddans (approximately 117,600 hectares). The remaining area is under forestry, small scale poultry and dairy enterprises, research and seed farming plots, villages and waste land.

The irrigated area under cropping is divided into farm tenancies of three types: (i) 22 feddans for field crops; (ii) 5 feddans for horticultural crops; and (iii) 10 feddans for fodder crops. There are about 13,000 of the 22 feddans tenancies (Block 9 of the Northern Group is the only exception where the allotment is only 11 feddans or half tenancy) and 2000 of the 5 feddan tenancies and 1000 of the 10 feddan tenancies. No mortgage or any sort of land disposal is allowed.

According to the crop rotations decided by the management of the Rahad Agricultural Corporation (RAC), the location of the plots under field crops will be determined. For example, under two course rotation of say Cotton - Groundnut / Sorghum, a single tenant is to share two large plots termed as *Numbers*<sup>30</sup> with seven other tenants. In the case of the existing four course rotation, Cotton - Sorghum - Groundnut - Wheat, each tenant shares four such larger plots with 15 other tenants. In both cases his total allotment is 22 feddans.

The 16,000 tenants of the scheme have been drawn either from the project area itself or from the surrounding areas. They have been settled in 46 villages. Before they joined the scheme, they were either traditional rain-fed farmers or livestock herders. Very few used to practice other jobs like craftsmanship and trading. One of the main objective of the scheme is to change the poor peasants and nomadic habitats to a modernized agricultural society.

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<sup>30</sup>each Number / large plot has 88 feddans and it is served by one tertiary canal or Abu Ishreen.

### **6.1.2 Factors Affecting the Contribution of Tenants in the Scheme' Economic Activities**

The three factors which are considered here are the education level, the transportation facilities and the health conditions of the tenants. The extent to which these factors are affecting the economic activities have been studied by many researchers since the inception of the scheme in the early seventies.

Education is the first and important factor to be considered. Illiteracy is still high among the population in the scheme. Abdalla (1982) showed that the illiteracy rate in the age bracket of 30-41 years is 100 percent in the studied southern villages, 95.7 percent in the north and 86.7 percent in the center. He also found that those who achieved elementary schooling in the age bracket of 18 - 29 years are 8.7 percent in the south, 11.1 percent in the north and 23 percent in the center of the scheme<sup>31</sup>. These figures indicate that the center has a better access to the educational opportunities.

The second factor is related to the transport facilities available within the region. The villages of the central group are closer to the network of the paved roads in the scheme, indicating better movement opportunities for the tenants of that part.

The third factor is concerned with the status of the health conditions available in the project. In this context also, the villages in the central group were equipped with better health facilities when compared with the villages in the other two groups of the scheme. The tenants of the central groups enjoy favorable conditions over those residing in the northern and southern groups.

## **6.2 METHODOLOGY FOR EVALUATING THE SOCIOECONOMIC PERFORMANCE**

The social and economic dimensions of the resources utilization will be analyzed. Social parameters will include comparisons of different locations (North, Center, South) in relation to the crop yield indices estimated for the different segments / canal commands of the irrigation system.

Finally, the socioeconomic indicators of performance will be translated into profitability indicators: (i) profitability in terms of land; and (ii) profitability in terms of water. These are further defined as under:

and

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<sup>31</sup>the scheme is divided into three administrative units termed as northern, southern and central groups.

## 6.3 THE CHANGE IN THE RESOURCES USE AND PRODUCTIVITY

### 6.3.1 The Change in the Land Use Intensity

The Cropped area and land use intensities in the Rahad Scheme for the period 1981/82 - 1993/94 are shown in Table 6.1. The land use intensity in the area allocated for field crops varies from 84.45 percent in year 1982/83 and approaches 100 percent and more in the year 1990/91 and onwards.

From the year 1981/82 to the year 1989/90, when the two course rotation was prevailing, the planned area under cotton was 50 percent of the scheme i.e., 130,000 feddans. The cotton related use of the land varied from 89.3 percent to 96.7 percent. Starting from the year 1990/91, a four course crop-rotation was adopted. Under the new rotation, cotton was planned to cover 25 percent of the cropped area. In this case, the land use under cotton varied from 82.2 percent to 104.58 percent. The land use for other crops varied as follows: (i) 93 to 101 percent for wheat; (ii) 80 percent to 113.8 percent for groundnut; and (iii) 115.7 percent to 129.1 percent for sorghum.

Table 6.1. *Cropped areas and land use intensity in the Rahad Irrigated Scheme.*

Season	Cotton	Wheat	G/nuts	Sorghum	Total <sup>32</sup>	Land use intensity %
81/82	124,656	-	73,843	29,728	228,227	87.78
82/83	116,052	-	46,550	56,980	219,582	84.45
83/84	125,767	-	56,376	60,345	242,488	93.26
84/85	1,166,804	-	59,640	69,558	246,002	94.62
85/86	117,268	-	39,136	88,436	244,840	94.17
86/87	124,652	-	57,237	71,543	253,432	97.47
87/88	116,041	-	65,335	62,928	244,304	93.96
88/89	118,879	-	60,981	67,701	247,561	95.22
89/90	120,911	8,053	53,982	71,658	254,604	97.92
90/91	67,977	63,359	51,970	83,922	267,228	102.78
91/92	55,799	65,595	62,485	79,782	263,659	101.41
92/93	55,912	62,228	73,980	75,958	268,078	103.10
93/94	53,445	60,410	71,028	75,209	260,092	100.03

Source: Department of Planning and Agricultural Economics, Rahad Agricultural Corporation.

<sup>32</sup>Based on the total of the field crops tenancies amounting to 260 thousands feddans at 100% cropping intensity.

### 6.3.2 The Change in the Productivity

The levels of crop yields are shown in Table 6.2. During the period 1981/82 to 1989/90, when the scheme was following the 2 course rotation, Cotton maintained a reasonable yield of 6.15 Kantars per Feddan. In the following four years, when the four course rotation had been adopted, the yield dropped to 5.16 kantars, about 16 percent reduction. Contrary to the cotton situation, the yields of the food crops went up. Both Groundnut and Sorghum achieved growth of 29.3 percent and 20.9 percent, respectively. The Wheat crop shared the land of Cotton with the adoption of the four course rotation. Wheat showed a remarkable yield level in the second year, but dropped drastically in the following two years.

*Table 6.2. Crop yields in the Rahad Irrigated Scheme.*

Season	Cotton kantar/fed	Wheat sacks/fed	G/nuts sacks/fed	Sorghum sacks/fed
81/82	5.9		19.7	6.88
82/83	7.21		18.4	6.0
83/84	6.86		14.0	8.0
84/85	6.50		14.0	5.1
85/86	5.31		10.0	5.2
86/87	6.71		14.0	7.1
87/88	6.16		16.0	5.0
88/89	5.65		16.0	4.0
89/90	5.13	6.40	17.1	4.0
90/91	5.77	4.31	17.0	3.5
91/92	6.13	9.53	21.0	7.0
92/93	4.44	4.81	17.0	7.0
93/94	4.29	3.42	25.0	8.0

*Source:* Department of Planning and Agricultural Economics, Rahad Agricultural Corporation.

### 6.3.3. The Change in the Demand for Water

With the change in the crop rotation, it is obvious to have changes in the demand for water. The new rotation helped to reduce the area under crop during October - a peak demand period. However, the addition of wheat prolonged the irrigation season to the middle of March - an increase of about 2 to 3 months. Thus, the change in the crop-rotation changed the water demand pattern in a significant way.

In order to understand the variation in water demand, the average areas for the crops grown under each crop rotation are estimated as follows (Table 6.3):

*Table 6.3. Estimated cropped area under two and four course rotations.*

Crops	Area under two course rotation (Feddan)	Area under four course rotation (Feddan)
Cotton	120,114	58,283
Wheat	-	62,898
Groundnut	57,009	64,866
Sorghum	64,320	78,718

By using the above estimated areas, the water demand based on the recommended crop - water requirement as given in Appendix 6.1, is calculated and presented in Table 6.4.

*Table 6.4. The changes in the demand for water (,000 M<sup>3</sup>).*

Rotation	Cotton	Wheat	G/nuts	Sorghum	Total
Two Course	492,467	-	233,908	197,269	923,644
Four Course	238,960	155,547	266,145	241,428	902,080

It is clear that there is a change in the demand for water, but on a very limited scale, not affecting significantly the overall water regime.

### 6.3.4 The Changes in the Demand for Labor

The labor requirement for each crop is shown in Appendix 6.1. The changes in the demand for labor was calculated with the change in the crop rotations. If the total labor requirement is compared under the two rotations, it is clear that the reduction in the cotton areas created the less demanding situation under the four course rotation as shown in Table 6.5.

**Table 6.5. The Changes in the demand for labor (,000 Mandays).**

Rotation	Cotton	Wheat	G/nut	Sorghum	Total
Two Course	7,807	-	2,776	2,103	12,686
Four Course	3,788	409	3,159	2,574	9,930

## **6.4 CROP YIELD INDICES AND THE PROFITABILITY INDICATORS**

### **6.4.1 Crop Yield Indices**

The 1993/94 crop yields of Rahad Irrigated Scheme were studied based on the crop cutting survey results for Sorghum and Groundnut along Major 2 (South) and Major 7 (North), interview-based data of both crops for Major 5 (Center), beside the accounts data for Cotton and Wheat along the three major canals. Each major canal is represented by three minor canals selected at head, middle and tail locations. Table 6.6 gives the estimated crop yields. For each major and each minor, the mean is calculated and the overall mean is indicated by the bottom figure in the last column.

**Table 6.6A. Cotton yields during 1993/94 in the Rahad Scheme (kantar/feddan).**

Minors	Major 2	Major 5	Major 7	Mean
Minor 1	5.20	6.36	4.92	5.83
Minor 2	3.31	4.52	3.54	3.79
Minor 3	3.10	4.46	-	3.78
Mean	4.20	5.11	4.23	4.47

**Table 6.6B. Wheat yields during 1993/94 in the Rahad Scheme (sacks/feddan).**

Minors	Major 2	Major 5	Major 7	Mean
Minor 1	3.70	2.80	3.87	3.46
Minor 2	3.82	3.74	2.48	3.35
Minor 3	-	2.77	2.12	2.45
Mean	3.76	3.10	2.82	3.09

**Table 6.6C. Groundnut yields during 1993/94 in the Rahad Scheme (sacks/feddan).**

Minors	Major 2	Major 5	Major 7	Mean
Minor 1	15.6	31.18	28.70	25.16
Minor 2	11.0	26.89	29.90	22.60
Minor 3	10.0	11.89	22.40	14.76
Mean	12.2	23.32	27.00	20.84

**Table 6.6D. Sorghum yield during 1993/94 in the Rahad Scheme (sacks/feddan).**

Minors	Major 2	Major 5	Major 7	Mean
Minor 1	8.70	11.41	6.70	8.94
Minor 2	4.10	11.69	6.30	7.36
Minor 3	4.10	5.33	3.60	4.34
Mean	5.63	9.48	5.53	6.88

Crop yield data at each segment (major canal command) of the irrigation system was related to the overall mean of that crop to get a crop yield index representing performance of the selected unit / segment. The layout of the crop yield indices is illustrated in Table 6.7. The comparison / ranking of the performance of the crops associated with different canal commands / segments is presented in Table 6.8:

**Table 6.7A. Cotton yield index along different major canal commands.**

Minors	Major 2	Major 5	Major 7
Minor 1	1.39	1.42	1.30
Minor 2	0.74	1.01	0.85
Minor 3	0.69	-	0.85
Mean	0.94	1.14	0.95

**Table 6.7B. Wheat yield index along different major canal commands.**

Minors	Major 2	Major 5	Major 7
Minor 1	1.20	0.91	1.25
Minor 2	1.24	1.21	1.08
Minor 3	-	0.90	0.79
Mean	0.94	1.00	0.91

**Table 6.7C. Groundnut yield index along different major canal commands.**

Minors	Major 2	Major 5	Major 7
Minor 1	0.75	1.50	1.21
Minor 2			
Minor 3	0.48	0.57	0.71
Mean	0.59	1.12	1.30

**Table 6.7D. Sorghum yield index along different major canal commands.**

Minors	Major 2	Major 5	Major 7
Minor 1	1.26	1.66	1.30
Minor 2	0.60	1.70	1.07
Minor 3	0.60	0.77	0.63
Mean	0.82	1.38	0.8

Source: Calculated from Table 6.6 (A-D).

**Table 6.8. The ranking of performance.**

The crop	(A)	(B)	(C)
Cotton	Minor 1 Major 5	Minor 1 Major 2	Minor 1 Major 7
Wheat	Minor 1 Major 7	Minor 2 Major 2	Minor 2 Major 7
Groundnut	Minor 1 Major 5	Minor 2 Major 5	Minor 1 Major 7
Sorghum	Minor 2 Major 5	Minor 1 major 5	Minor 1 Major 7



The ranking of performance is higher for the following cases: (i) Minor 1 of Major 5 for cotton and groundnut; (ii) Minor 2 of Major 5 for sorghum; and (iii) Minor 1 of Major 7 for Wheat. On the other hand, the comparison of the mean of the major canals to the overall mean indicates that Major 5 is leading in Cotton and Sorghum, Major 7 is leading in Groundnut and Major 2 is leading in Wheat. The Wheat crop is the least attractive crop in all the studied segments / canal commands of the Rahad Irrigation System.

Crop yield indices are calculated based on targets yields set in the scheme. These estimated targets are as follows: (i) 6.5 kantar per feddan for cotton; (ii) 8 sacks for wheat; (iii) 25 sacks for Groundnut; and (iv) 10 sacks for Sorghum. The ratios of actual versus targets yields are presented in Table 6.9.

*Table 6.9. Crop yield indices based on targets.*

Majors	Cotton	Wheat	G/nut	Sorghum
Major 2	0.65	0.47	0.49	0.56
Major 5	0.79	0.39	0.93	0.95
Major 7	0.65	0.35	1.08	0.55
Mean	0.69	0.39	0.83	0.69

The only irrigation canal command which exceeds the target is that of Major 7 for Groundnut and the canal command which approaches the target is Major 5 for both Groundnut and Sorghum. All the canal commands for wheat are far below the target set in the scheme.

#### **6.4.2 The Profitability Indicators**

Using the costs and prices in Appendix 6.1, the increment benefits are calculated for the four crops in the studied segments of the irrigation system. The costs exclude the Water Charges applied as Irrigation Service Fees as indicated in Appendix 6.1. Based on the calculated estimates of the incremental benefits Table 6.10, the Area Based Profitability and the Water Based Profitability were calculated.

*Table 6.10A. During 1993/94, cotton related area-based incremental benefits (LS./feddan).*

Minors	Major 2	Major 5	Major 7	Total
Minor 1	13,400	14,200	7,000	11,550
Minor 2	1,050	5,000	100	1,900
Minor 3	2,100	4,700	--	1,300
Mean	3,400	7,950	3,550	4,750

**Table 6.10B. During 1993/94, wheat related area-based incremental benefits (LS./feddan).**

Minors	Major 2	Major 5	Major 7	Total
Minor 1	1,047	- 1,203	1,472	447
Minor 2	1,347	1,147	- 2,003	172
Minor 3	--	- 1,278	- 2,903	- 2,078
Mean	1,197	- 453	- 1,153	- 478

**Table 6.10C. During 1993/94, Groundnut related area-based incremental benefits (LS./feddan).**

Minors	Major 2	Major 5	Major 7	Total
Minor 1	1,811	10,692	9,278	7,260
Minor 2	- 811	8,246	9,962	5,801
Minor 3	- 1,381	- 304	4,687	1,332
Mean	- 127	6,211	8,309	4,798

**Table 6.10D. During 1993/94, sorghum related area-based incremental benefits (LS./ feddan).**

Minors	Major 2	Major 5	Major 7	Total
Minor 1	3,359	5,798	1,559	3,575
Minor 2	- 784	6,050	1,199	2,153
Minor 3	- 781	326	- 1,231	- 565
Mean	596	4,061	506	1,721

#### **6.4.3 The Area Based Profitability**

The area based profitability is calculated using Equation 1. The figures in Table 6.7 are used to calculate the area based profitability. It is estimated as follows (Table 6.11):

**Table 6.11. Area based profitability for different crops.**

	Cotton	Wheat	Groundnut	Sorghum
Major 2	2.69	1.20	- 0.13	0.60
Major 5	6.11	- 0.45	6.21	4.06
Major 7	2.73	- 1.15	8.31	0.51
Total	3.65	0.48	4.80	1.72

#### 6.4.4 THE WATER BASED PROFITABILITY

The water based profitability is calculated by using Equation 2. The increment benefits per unit water were calculated as shown in Table 6.12 These are related to the irrigation service fee per unit of water estimated as follows:

$$\text{Cotton } 1300 / 4100 = 0.32 \text{ L.S./M}^3$$

$$\text{Wheat } 1000 / 2473 = 0.40 \text{ L.S./M}^3$$

*Table 6.12A. During 1993/94, cotton related water-based incremental benefits (LS./ m<sup>3</sup> of water).*

Minors	Major 2	Major 5	Major 7	Total
Minor 1	3.27	3.46	1.71	2.82
Minor 2	- 0.25	1.22	0.02	0.46
Minor 3	- 0.51	1.15	--	0.32
	0.83	1.94	0.87	1.16

*Table 6.12B. During 1993/94, wheat related water-based incremental benefits (LS./ m<sup>3</sup> of water).*

Minors	Major 2	Major 5	Major 7	Total
Minor 1	0.42	- 0.49	0.60	0.18
Minor 2	0.54	0.46	- 0.81	0.07
Minor 3	--	- 0.52	- 1.17	- 0.84
Mean	0.48	- 0.18	- 0.47	- 0.19

*Table 6.12C. During 1993/94, Groundnut related water-based incremental benefits (LS./ m<sup>3</sup> of water).*

Minors	Major 2	Major 5	Major 7	Total
Minor 1	0.44	2.61	2.26	1.77
Minor 2	- 0.20	2.01	2.43	1.27
Minor 3	- 0.34	- 0.08	1.14	0.32
Mean	- 0.03	- 0.03	2.03	1.17

**Table 6.12D. During 1993/94, sorghum related water-based incremental benefits (L.S./ m<sup>3</sup> of water).**

Minors	Major 2	Major 5	Major 7	Total
Minor 1	1.11	1.89	0.51	1.16
Minor 2	- 0.25	1.97	0.39	0.70
Minor 3	- 0.26	0.11	- 0.40	- 0.18
Mean	0.19	1.32	0.16	0.56

Groundnut 1,000/4,103 = 0.24 L.S./M<sup>3</sup>

Sorghum 1,000/3,067 = 0.33 L.S./M<sup>3</sup>

Using the above estimates, the water based profitability is calculated as follows (Table 6.13):

**Table 6.13. Water profitability for different crops.**

Majors	Cotton	Wheat	G/nut	Sorghum
Major 2	2.59	1.20	- 0.13	0.58
Major 5	6.06	- 0.45	6.29	4.00
Major 7	2.72	- 1.18	4.86	0.48
	3.63	- 0.48	4.88	1.70

## 6.5 INTERPRETATION OF THE RESULTS

The profitability indicators of the different irrigation segments do not qualify the tenants to be able to pay the irrigation service fee for the Wheat crop. The performance is also weak for the Sorghum crop except in Major 5. The situation is encouraging for both Cotton and Groundnut. These are the two crops selected from the beginning to be included in the cropping plans and on which the financial and economic profitability of the project was established. Another factor to be considered is that the groundnut crop has the highest return for unit of water and land resources, and it is the crop in which management achieved the highest level of performance when compared with the yield targets.

The conclusion one can derive is that the improvement opportunities are great for all crops. Maximizing the return to water and land could easily be achieved by adoption of the appropriate improvement technologies, including better management of the resources.

## 6.6 REFERENCES

1. Abdalla, A.H. 1982. Some Socioeconomic factors which have negatively affected the Participation of Family Labor in the Rahad Scheme, M.Sc Thesis.
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## APPENDIX 6.1

### THE FARM BUSINESS COEFFICIENTS THE RAHAD IRRIGATED SCHEME

Crops	(A) Water <sup>33</sup> (m <sup>3</sup> /feddan)	(B) Labor <sup>34</sup> (mandays)	(C) Costs <sup>35</sup> (LS/feddan)	(D) Producers <sup>36</sup> Prices <sup>37</sup>	(E) Water <sup>38</sup> Charges
M. S. Cotton	4,100	65.0	18,900	5,000	1,300
Wheat	2,473	6.5	9,203	2,500	1,000
Groundnut	4,103	48.7	8,081	570	1,000
Sorghum	3,067	32.7	5,471	900	1,000

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<sup>33</sup>Data Source: Agricultural Research Corporation, Wad Medani.

<sup>34</sup>Data Source: Estimates of the Sudan Gezira Board.

<sup>35</sup>Data Source: Rahad Agricultural Corporation (1992/93 estimates).

<sup>36</sup>Data Source: Estimates adjusted to market values by the authors (1992/93 estimates).

<sup>37</sup>LS/Kantar for cotton & LS/Sack for other crops.

<sup>38</sup>Data Source: Ministry of Irrigation (1992/93 estimates).