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Unequal Wealth Accumulation and Income Inequality in a Unimodal Agriculture: Sudan's Radad Irrigation Scheme

by Rashid M. Hassan,* Lehman B. Fletcher** and S. Ahmed***

Patterns of income, savings, and wealth accumulation of tenant farmers in the Rahad irrigation scheme of Sudan were examined. Although land and irrigation water are publicly owned and equally distributed in these schemes, unequal access to capital was found to influence strongly the distribution of family income and the saving and accumulation capacities of the tenant farmers. Analysis using Lorenz curves and Gini coefficients revealed a high positive correlation between wealth and family income. The average wealth gap between poor and rich households increased by 28 per cent over the year of the study. To reduce relative poverty, improved credit and marketing systems plus more research and extension support to enhance productivity and create higher on-farm incomes for the poorer tenants are needed. In addition, macro and sector policies that subsidise labour-saving technologies and lower incentives for export and domestic crop production need to be reformed to promote greater employment and higher off-farm earnings for the poorer households.

INTRODUCTION

Land ownership is often the primary source of economic inequality and social differentiation in rural areas, especially in countries at early stages of agricultural development [Robinson, 1956; Myrdal, 1972; Nurske, 1962; Adelman and Robinson, 1978; de Janvry, 1975 and 1981]. This cannot be the case, however, in the public irrigated schemes of Sudan, which present an example of the unimodal model of farm resource organisation. Both land and irrigation water are publicly owned and their use is administratively allocated on an equal basis among tenant farm households in the irrigated schemes. This approach suppresses access to land and water as a source of income inequality and establishes a presumption of equitable agricultural

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growth. Yet, an early study of the schemes pointed to the possibility of growing income and wealth disparities among the tenant households [Adam, 1981]. Survey data collected during 1982/83 for this research confirmed the existence of a significant and increasing degree of income inequality among tenant farmers in one of the country's largest irrigated areas [Hassan, 1983].

This article analyses the distribution of productive assets other than land and water as the key to the puzzle of rising relative inequality in this important subsector of Sudan's agriculture. Capital is an important production resource that is privately owned and allocated by the tenant households. The impact of differential access to capital assets on the distribution of net household income and end-of-year wealth in the Rahad Scheme was examined using the household survey data. Lorenz curves and Gini coefficients were used to evaluate the relationship between initial asset ownership and household income during the subsequent year. Then, consumption and savings behaviour during the year were measured. The results showed that wealthier households earned higher incomes, saved, and became wealthier while most poorer households dissaved and became relatively poorer. A rising concentration of wealth and increased income inequality resulted, a process that can be expected to continue in the future in the absence of government policies to establish a more equitable distribution of income-earning opportunities.

The first section below briefly reviews agricultural organisation in the Rahad Scheme and describes the household survey data. The next section tests access to capital as a determinant of current income distribution. Then, patterns of savings and wealth accumulation are analysed to examine the various uses of capital assets and suggest possible reasons behind the strong correlations between differential access to capital and current income and savings of tenant farmers. The final section summarises the main findings and implications for policies.

AGRICULTURAL PRODUCTION IN THE RAHAD SCHEME AND THE DATA BASE

The study was conducted in the Rahad, the second largest irrigated scheme in Sudan. A fixed rotation is imposed on the 22 feddans¹ tenancy allotted to each farmer by the scheme administration. In an intensive cropping sequence, cotton occupies half the land; groundnuts and dura (sorghum) share the other half. Dura is usually retained for home consumption and groundnuts sold by the individual tenants to private buyers. Cotton, on the other hand, is handed over to the public Rahad Corporation for ginning and marketing.

The corporation in this arrangement stands as the owner of the land and pumps, renting out these resources and providing other services to the tenant farmers. The corporation performs the critical mechanical operations and

provides most of the non-labour inputs. Cotton labour, as well as most of the production inputs for other crops, are hired or purchased privately by the tenants.

Households lack access to public institutional credit except for small loans advanced by the corporation to support the hiring of cotton labour. The absence of alternative marketing and credit institutions has forced poor farmers to resort to liquidation of physical assets (animal wealth), farm and non-farm wage labour, and other non-farm income, as well as borrowing in the informal money market, to finance the remaining production and marketing activities. Differential access to the necessary financial resources also implies differential on- and off-farm investment opportunities and an unequal status of farmers participating in the capital and labour markets as money lenders or borrowers and buyers or sellers of labour services. Access to capital is therefore hypothesised to have a large impact on the distribution of net income accruing to households.

Survey information was collection from a multi-stage stratified random sample of 100 tenant farmers during the 1982/83 season. The following variables were defined:

Initial Wealth (W_0) – measured as the stock of physical and financial assets controlled by each of the farmers at the beginning of the year. The wealth variable comprised the value of the stock of producing and work animals, the value of farm tools and implements, and non-farm income-generating assets (commercial capital). Debt was not measured so W_0 was treated as non-negative.

Disposable Household Income (Y) – net returns from field crops, livestock production, wage labour, non-farm activities, and transfers.

Consumption Expenditures (C) – consumption expenditures on food, clothing, health, and other personal items plus consumption from own crop production and animal inventory.

Household Savings (S) – measured as a residual:

$$S = Y - C \quad (1)$$

Terminal Wealth (W_1) – measured as the level of wealth at the end of the season defined as:

$$W_1 = W_0 + S \quad (2)$$

Sample households were classified into three wealth groups on the basis of W_0 : poorest 30 per cent (poor), middle 40 per cent (middle), and richest 30 per cent (rich).

ACCESS TO PRODUCTIVE ASSETS AND DISTRIBUTION OF HOUSEHOLD INCOME

The central thesis of this article is that the initial stock of productive assets (W_0) influences the scope of economic activities in which farmers are engaged and thus determines to a large extent the level of current disposable income (Y). Household consumption spending (C), on the other hand, is assumed to be a function of disposable family income (Y) and the wealth position (W_0) of the tenant farmers. Accordingly, the relationship given in equations (1) and (2) above can be rewritten as functions of initial wealth (W_0):

$$S(W_0) = Y(W_0) - C(Y, W_0) \quad (3)$$

$$W_1(W_0) = W_0 + S(W_0) \quad (4)$$

Unequal access to productive assets (W_0) is therefore expected to result in differential saving and accumulation abilities and create growing inequalities in wealth and income among the tenant population.

Relative income inequality among tenant farm households is estimated in this section. The impact of the initially skewed pattern of family ownership of capital assets on income distribution is also examined.

The Model

The procedure developed by Fei, Ranis and Kuo [1979] to disaggregate overall inequality in income distribution among groups was utilised to test the hypothesis that better access to capital leads to higher incomes. Specifically, initial wealth distribution (W_0) was related to inequality in the distribution of current net family income (Y).

The previous classification of the sampled households into three wealth groups was maintained. The groups were ordinaly ranked according to their income earning potential (W_0). Incomes of families within each group were arranged in a monotonically non-decreasing order. Lexicographic ranking was then assigned to the (N) families such that members of the first group ranked first and so on:

$$W_0^1 \leq W_0^2 \leq W_0^3 \quad \text{ordinal (group) ranking} \quad (5)$$

$$Y_1^i \leq Y_2^i \leq \dots \leq Y_{n_i}^i \quad \text{for } i = 1, 2, 3 \quad (6)$$

n_i = no. of families in group i .

The hypothesis that better access to capital assets leads to higher income is supported when the income ranking conforms with the ordinal ranking (ranking by the quality characteristic W_0), that is, no member of a given group receives an income higher than any member of a group with a higher ranking. On the other hand, the hypothesis is contradicted when the ordinal

ranking fails to preserve the income ranking. In this case the Gini coefficient (G_y) for the distribution of net family income (Y) is defined by:

$$G_y = s^+ + s^- \quad (7)$$

where:

$$s^+ = \frac{\sum_{i \geq r} \sum_{j \geq v} (Y_i^j - Y_v^j)}{N \sum_i \sum_j Y_j^i} \quad \begin{array}{l} i, r = 1, 2, \dots, M \\ j, v = 1, 2, \dots, N \end{array} \quad (8)$$

Where M is the number of wealth groups (3 in our case).

and s^- is defined by (8) for all $i < r$, where s^+ (s^-) measures the average of the income gaps that support (contradict) the hypothesis.

The Gini coefficient (G_y) was calculated to be 0.457, where G_y is the usual measure of overall inequality in the distribution of current disposable income. The average supporting gap ($s^+ = 0.3998$) represents that part of the total variation in Y explained by the introduction of the ordinal characteristic W_0 , which amounted to 87.4 per cent of G_y . This supports the hypothesis that wealth is a major determinant of current household income.

In Figure 1, the actual Lorenz curve describes the actual degree of inequality when families are arranged in a monotonically increasing order of income irrespective of the wealth group to which they belong. The Gini coefficient (G_y) is equal to the area between the actual Lorenz curve and the perfect equality line (total inequality in Y). The pseudo Lorenz curve, on the other hand, show the distribution of income when ranking was based on the wealth position. The pseudo Gini coefficient (\tilde{G}_y) measures the area between the perfect-equality line and pseudo Lorenz curve and is defined as:

$$\tilde{G}_y = s^+ - s^- \quad (\text{the net supporting gap}) \quad (9)$$

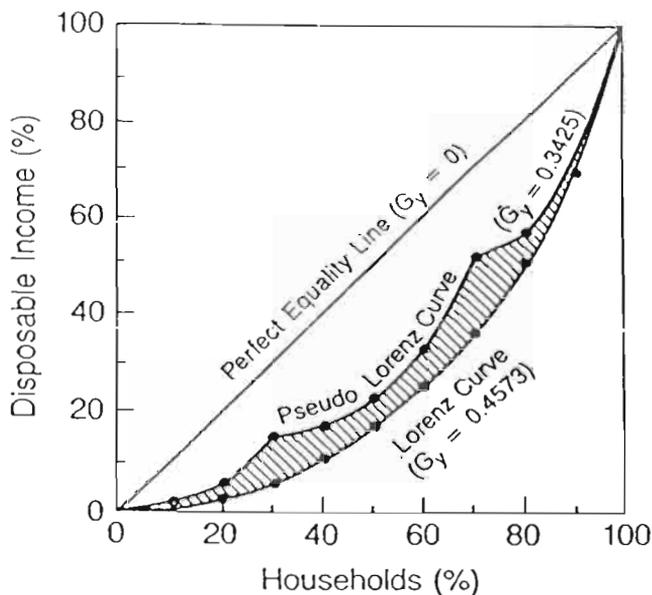
The pseudo Gini coefficient was calculated to be 0.343. Its positive value implies that the average supporting gap (s^+) is greater than the average contradicting gap (s^-) and favours the hypothesis.

PATTERNS OF SAVINGS AND INTERNAL ACCUMULATION

The discussion in the previous section showed the positive correlation between the pattern of ownership of capital assets and the unequal distribution of disposable household income. Accordingly, farmers abilities to save and accumulate capital are likely to vary and worsen the wealth distribution. This section explores savings and accumulation patterns and examines the changes that occurred in the distribution of wealth during the year of investigation.

The basic descriptive data on the wealth, income, expenditure, and savings

FIGURE 1
INCOME DISTRIBUTION CURVES



variables, grouped by the distribution of initial wealth (W_0), are summarised in Table 1. The data demonstrate that the larger initial wealth holdings of the middle and rich households were associated with higher farm and non-farm incomes and higher savings by those households. On the average, households in both the middle and rich classes became wealthier while poor households ended the year as net debtors.

The Spearman rank correlation coefficient for the distribution of initial (W_0) and terminal wealth (W_1) was calculated to be 0.81, which shows that the terminal wealth ranking was very much the same as the initial ranking for the households in this sample. Few households changed positions in the two rankings, providing further support for the importance of wealth to the households' ability to earn, save, and accumulate additional wealth.

The fact that 37 per cent of the farmers ended their year with deficit wealth balances made straight-forward calculation of Gini coefficient to measure changes in relative wealth shares impossible. Two alternative approaches were utilised, termed the normalised Gini coefficient and the zero option.

The normalised Gini coefficient, suggested by Chen, *et al.* [1982], is appropriate when negative and positive wealth shares do not sum to zero,

TABLE 1
STRUCTURE AND DISTRIBUTION OF INITIAL AND TERMINAL WEALTH, DISPOSABLE
FAMILY INCOME, CONSUMPTION AND SAVINGS AMONG WEALTH CLASSES OF RAHAD
TENANTS
(SUDANESE POUNDS, LS.)

| | Wealth Class (W_0) | | |
|---|------------------------|------------|----------|
| | Poor 30% | Middle 40% | Rich 30% |
| 1. Average level of initial wealth (W_0) | 120 | 962 | 5209 |
| Non-farm assets ^a | 0.0 | 138 | 918 |
| as % of W_0 | 0.0 | 14.4 | 17.6 |
| 2. Average disposable family income (Y) | 1236 | 2135 | 3476 |
| Non-farm income | 231 | 368 | 1183 |
| as % of Y | 18.7 | 17.2 | 34 |
| 3. Average consumption expenditures (C) | 1952 | 1971 | 2308 |
| 4. Average Savings (S) | -716 | 164 | 1169 |
| 5. Average level of terminal wealth (W_1) | -596 | 1126 | 6577 |
| 6. Composition of non-farm income | | | |
| a. Average return on non-farm assets | 0.0 | 159.0 | 1028.0 |
| as % of non-farm income | 0.0 | 43.2 | 86.9 |
| b. Average wage income | 128.8 | 74.0 | 85.0 |
| as % of non-farm income | 55.8 | 20.1 | 7.2 |
| c. Average transfers | 102.0 | 156.0 | 69.8 |
| as % of non-farm income | 44.2 | 36.7 | 5.9 |

(a) Non-farm assets represent mainly investments in trade and money lending, the major farm assets are farm implements and producing and work animals.

Source: Hassan [1983].

which is the case here. The normalised coefficient (G^*_w) is obtained from:

$$G^*_w = \frac{1 + \frac{2k}{n} - \sum_{j=1}^n jw_j - \frac{1}{n} \sum_{j=1}^n w_j (1 + 2(n-j))}{1 + \frac{2k}{n} - \sum_{j=1}^n jw_j} \quad (10)$$

Where w_j is the wealth share of the j th family and k is the subset of the n families for which wealth shares sum to zero.

$$w_j = \frac{W_j}{\sum_{j=1}^n W_j} \quad j = 1, \dots, n. \quad (11)$$

and k is defined such that:

$$\sum_{j=1}^k w_j = 0 \tag{12}$$

FIGURE 2
WEALTH DISTRIBUTION CURVES

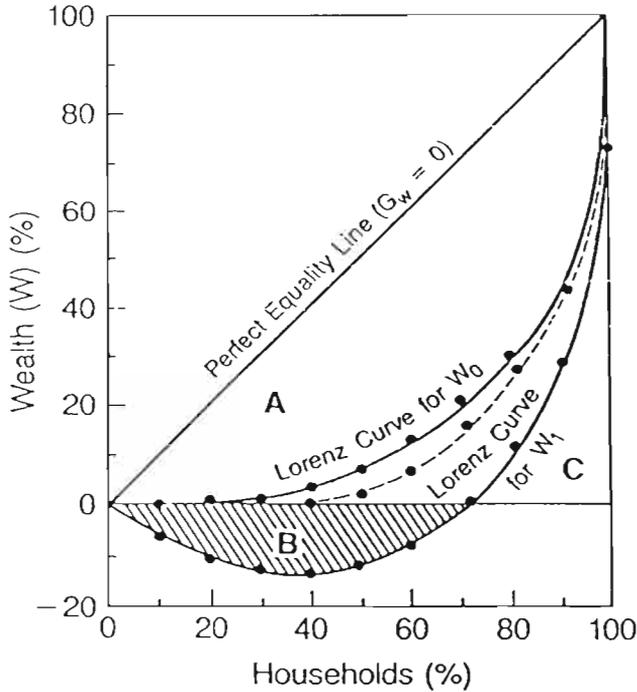


Figure (2) depicts the wealth distribution curves for W_0 and W_1 . Geometrically, $G_{W_1}^*$, the normalised coefficient for the distribution of terminal wealth (W_1), is given by:

$$G_{W_1}^* = \frac{A + B}{A + B + C} \tag{13}$$

where A, B and C refer to the area between the perfect equality line and terminal wealth Lorenz curve (W_1), area under the horizontal axis (shaded area), and the area below the Lorenz curve W_1 in Figure 2, respectively. The usual formulation to portray G_{W_1} is

$$G_{w_1} = \frac{A + B}{A + C} \quad (14)$$

which can lead to overestimation ($G > 1$) if B (shaded area) is larger than C. The normalised coefficient defined in (13) sets an upper bound for G^*_w such that

$$G^*_w \leq 1$$

The degree of inequality in wealth distribution at the beginning ($G^*_{w_0}$) and the end of the year ($G^*_{w_1}$) were estimated to be 0.67 and 0.86, respectively. This indicates that inequality in wealth distribution increased by more than 28 per cent from the beginning to the end of the year.

A 'zero option' approach was also used to provide for the possibility that negative wealth balances, though not reported, existed at the beginning of the year, that is, some of the initial wealth shares (W_0) may have been negative. In this case the above measure of the change in wealth distribution will not be precise. An alternative method was employed where all negative values of W_1 were set equal to zero. The dotted Lorenz curve in Figure 2 represents the 'zero option' curve for the distribution of W_1 . The usual concentration ratio was then calculated for W_1 under the zero option and found to be 0.76, indicating an increase of more than 13 per cent increase in wealth inequality.

The results of both methods support the same conclusion: the pattern of wealth distribution among the sampled tenant farm households became more unequal over the year. The outcome was more concentration of wealth and sharper economic differences.

Table 1 also shows the structure of household assets and the contributions of assets to disposable family income across wealth groups. The rich invest more than 17 per cent of their capital in non-farm activities (trade and money lending), which generated 87 per cent of their non-farm income. The poor, on the other hand, owned no commercial assets and non-farm activities contributed less than 19 per cent of their total net income.

According to Table 1 the shares of wage labour and transfers in non-farm income are inversely correlated with wealth. The plight of the impoverished group was only partially relieved by off-farm work and outmigration of family members to earn wages from other occupations. Conversely, rich farmers control substantial stocks of productive assets in various farm and non-farm activities. These diversified sources of income place them in a better financial position whereby they can survive bad seasons and afford to purchase farm inputs for cash.

Options for the poorer groups, on the other hand, are limited due to their low access to the necessary financial assets. They can hardly tolerate crop failures and price breaks. Their inability to pay for critical inputs prevents timely performance of sensitive farming operations and contributes to lower yields, higher costs, and reduced revenue from farming. Their income status

also stems from the unattractive alternatives open to them, such as borrowing at high rates of interest or selling their labour services cheaply. At the same time their lack of remunerative alternatives represents additional income opportunities for the rich through money lending and hiring of low-wage labour for farm production.

SUMMARY AND CONCLUSIONS

The study examined the pattern of income, savings, and capital formation in the irrigated sector of the Sudan. The distributional impacts of unequal access to capital assets were evaluated. Results obtained from the Lorenz curves and Gini coefficients revealed a high positive correlation between initial wealth and current family income. Gini coefficients were also calculated to measure changes in the wealth gap between the rich and the poor in the Rahad scheme. Inequality in wealth distribution increased by 28 per cent (14 per cent) during the year of investigation according to the normalised (zero option).

Richer farmers were observed to accumulate more wealth and concentrate resources over the year, whereas the poor suffered negative wealth changes on average. A Spearman rank correlation coefficient of 0.81 further supported the strong positive correlation between initial (W_0) and terminal (W_1) wealth rankings. Recurrence of this process will intensify concentration of resources and stratification of the farming population into differentiated social classes. What might retard the increase in inequality, or even reduce income disparities, in Sudan's irrigated agriculture? Improved credit and marketing systems are needed to permit poorer farmers to increase the incomes they earn from the land and water resources they have access to. More research and extension support to accelerate growth in their productivity and income could contribute. Reform of macro and sector policies that subsidise mechanization and lower incentives for export and domestic crop production would help to raise the demand for labour and increase off-farm earnings of the poorer tenant households.

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NOTE

1. One feddan equals 0.41 hectares.

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