ICARDA International Center for Agricultural Research in the Dry Areas

Poverty Assessment and Mapping in Sudan Part 1

Poverty Assessment Northern Sudan

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EXECUTIVE SUMMARY

Sudan Rural Poverty Analysis

This is Part 1 of a study, presented in three reports that detail the results of a poverty assessment and mapping project in North and Southern Sudan. The study's objective was to produce a rural poverty analysis and poverty maps for North and Southern Sudan, and based on these findings, recommend agricultural interventions that can help reduce poverty.

These findings provided an input to the IFAD Sudan Country Program 2007–2012, that takes into consideration the new constitutional changes in Sudan resulting from the peace agreements with South/East/West Sudan and to support peace, security and stability in Sudan.

- Poverty assessment in Northern Sudan – Part 1
- Poverty assessment in Southern Sudan – Part 2
- Mapping of agricultural resource potential of North and Southern Sudan – Part 3.

Northern Sudan Assessment: Key findings and recommendations

The results of the Northern Sudan Poverty Assessment show higher rural than urban poverty, in the six regions studied. This rural–urban disparity was mainly due to the rural–urban differences in food compositions and food prices. However, in absolute terms the number of rural poor was greater than of urban poor. Higher poverty incidence in rural areas is a due to chronic low productivity and low income in rural areas.

A targeting procedure conducive to poverty reduction in the Sudan is proposed in a chart, which suggests priority agricultural interventions in the 10 states with both highest income poverty and human poverty levels (see the recommendation at the end of the Northern Sudan report).

Overall findings - General state of the economy and agriculture - North and South Sudan's economic structure has undergone a major shift over the past two decades (DTIS, 2008), the main drivers of this change are the discovery of oil in the early 2000s and the expansion in services dominated by telecommunications, transport, and construction.

Agriculture used to be the leading economic sector, forming typically more than 40% of GDP, but has lost much ground with a drop of its GDP share to 33% in 2007. A more dramatic trend has been the deterioration in the contribution of agriculture to the country's exports, declining to some 3% in 2007 down from an average of 74% in the 1996–1998 period. Both the relative share and the absolute value of agricultural exports has declined. Data from the Central Bank of Sudan reveals an annual trend value of $71,500.
Both income poverty and general human poverty are concerns for North and Southern

Sudan. There is considerable deprivation in education and health, and poor households are particularly disadvantaged. Yet, despite the current fragile situation of Sudan's agriculture, this study found that the countries have enormous potential to raise crop yields by bridging at least part of its current 'yield gaps' – between actual and potential food production.

These vary from 46% to as high as 56% between on-farm trials and prevailing commercial productivity. Irrigated crops can be improved by margins ranging from about 50% to > 140%. Even higher yield potential have been identified for rainfed crops – where potential margins ranged from twofold to over fivefold.

Prerequisites for achieving these levels of development and macro-economic stability require an ambitious development plan that includes: creation of a sound financial system and an efficient federal system through more decentralization, coupled with adequate financial and technical resources and participatory mechanisms, and the just income and wealth distribution.

Southern Sudan Assessment – Key findings and recommendations (Part 2)

The survey estimates income poverty incidence at 99.6% in the states of Eastern Equatoria State, 88.6% in the Lakes State, and 54.0% in Central Equatoria State. The situation was especially serious in Eastern Equatoria and Lakes States. The study also showed acute shortfalls of the required caloric intake for about a third of both Eastern Equatoria and Central Equatoria States. Some 60% of the population in Lakes State faces a shortfall in the required daily caloric food intake. This is an indication of deep poverty among a sizeable portion of the population. Lakes State had the lowest per capita income from both agricultural and non-agricultural sources. In all states, poverty was lower when expenditure estimates were used than when income estimates were used. This is a common feature in poverty analysis, and it is generally believed that expenditures are more easily recalled than incomes, but the ranking of relative poverty by province did not change.

To address this acute situation a set of 14 recommendations is proposed. The government will need to implement a long-term poverty reduction strategy that takes a broad perspective – focusing on strengthening its institutions, developing and implementing policies and legislation, investing in related areas of research and infrastructure to link rural communities to economic centers building capacity, systems, and structures for delivering services in the areas of health, education, and clean water. Actions for donors and other partners such as the private sector are also specified.

Mapping of agricultural resource potential of North and Southern Sudan (Part 3)

This section provides detailed maps of different agro-ecological, climatic, and soil indices. These have been combined into agricultural resource potential indices.

POVERTY ASSESSMENT AND MAPPING IN NORTHERN SUDAN

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1. THE SETTING

1.1 Sudan's administrative and macroeconomic view

Sudan, one of the largest countries in Africa, lies roughly within latitudes 3–22°N and longitudes 22–38°E. and is neighbor to nine countries around almost all of its borders. While Sudan's location offers a strategic economic position, it is nevertheless associated with a high influx of refugees across its borders, adding to the poverty situation that already exists in the country. The lately completed population census in the Sudan (2008) puts the country's population at about 39.154 million. No figures are yet available from the census on the growth rates or rural–urban ratios, but according to the (World Bank, 2008) the population growth rate was 2.5% in 2007, and 40% of the population lives in urban areas. Compared with an urban population share of 31.9% in 1993, the urban population grew at a relatively quick pace over the past 15 years or so. Besides normal population growth, this is partly caused by substantial migration from rural to urban areas, which is in turn partly a result of deteriorating livelihood conditions in the former and increasing poverty over time.

Administratively, the country is divided into 25 states; 15 in the north and 10 in the south (Fig. 1). The division into states came as a result of the decentralization policy implemented in 1993 prior to which the country was divided into nine regions, six in the north and three in the south. The division of former regions into current States is illustrated in the Table accompanying (Fig. 1). The identification of current states with former regions is useful since spatial poverty analyses that come in later sections are based on regions, while recent analyses are based on states.

States	Region
Northern, River Nile	Northern
Red Sea, Kassala, Gedaref	Eastern
North Kordofan, South Kordofan	Kordofan
North Darfur, West Darfur, South Darfur	Darfur
Gezira, Sennar, White Nile, Blue Nile	Central
Khartoum	Khartoum
Upper Nile, Unity, Jonglei	Upper Nile
Western Bahr el Ghazal, Northern Bahr el Ghazal, Warrab, Lakes	Bahr el Ghazal
Western Equatoria, Bahr El Jabal, Eastern Equatoria	Equatoria

Figure 1. Sudan map: States and rivers

Sudan's economic structure has undergone a major shift over the past two decades (DTIS, 2008), the main drivers being oil discovery at the turn of this century and expansion in services dominated by telecommunications, transport, and construction. Agriculture used to be the leading economic sector forming typically over 40% of the GDP, but has lost much ground with a drop of its GDP share to 33% in 2007. More dramatic is the deterioration in the contribution of agriculture to the country's exports, declining to about 3% in 2007 down from an average of 74% during 1996–1998. Not only the relative share but also the absolute value of agricultural exports has experienced a declining trend, computed from the data of the Central Bank of Sudan at an annual trend value of US$71 500.

Agriculture has almost consistently been disadvantaged in public allocations to various economic sectors (Elbashier and Faki, 2006). Its allocations are both meager and dwindling: from 3.4% to 1.6% during 2000 to 2005 (i.e. > 50%). Further, public investment expenditure, while generally low in absolute terms (254 billion Sudanese Pounds (SDG) compared to 1825 billion SDG actual grand public spending in 2006), it is particularly modest for agriculture. The actual share of agriculture in the total development expenditure, on the other hand, varied within 8–44% over the period 2000–2005, but the trend is irregularly increasing. Higher shares were allotted to agriculture within actual expenditure on the overall national development programs with range 21–46%; yet also with irregular distribution among years.

Further to the budgetary allocation by the Ministry of Finance and National Economy, the Central Bank of Sudan provides directives to the commercial banks on the credit portfolio to the various economic sectors. In 1990 the set policy was such that the agricultural sector should receive at least 50% of the credit ceiling in line with the self-sufficiency objective at the time. The year 1998 witnessed a setback in the privilege provided to agriculture when it became one among a list of so-called priority sectors that were allocated 95% of the credit portfolio. Due to reluctance of commercial banks to finance agriculture, especially its production side, credit provision to agriculture continually slumped. Another setback occurred in 2001 when credit ceilings for economic sectors were abandoned altogether. However, in 2002 there was a shift in policy towards microfinance whereby a minimum of 10% of the finance was to be directed to social development including 'productive families' and small businesses. Currently microfinance is gaining more ground and institutional structures are being established for its management; its share has recently increased from 10 to 12%. The whole situation boils down to a dramatically declining share of agriculture from the financial sector's lending portfolio: from 33% in 1998 to 8% in 2007.

It can be gleaned from the above that agriculture, if not discriminatively treated, has not been given the attention congruent with its socioeconomic importance. This is not only confined to meager investment directed to agriculture, but also involves a discouraging situation for agricultural marketing and exports. While the poor transport infrastructure of the country engenders high marketing costs, cumbersome bureaucratic procedures faced in the movement of products along the marketing and export channels induce high transaction costs (DTIS, 2008). Added to that are high production costs, excessive taxation particularly for livestock, high costs of provision of services, and charges that are not connected with the provision of any services. According to (Faki and van Holst Pellekaan, 2007) production costs formed 38–229% of the producer price for some commodities in different regions of the country, indicating losses in many situations. Further, taxes and charges can be as high as 41–50% of the price at the point of export. These conditions have led to the prevalence of domestic prices being higher or only marginally lower than export prices and have resulted in low competitiveness of Sudanese commodities in the world market. However, the high internal market prices only partly trickle down to producers who are usually compelled to sell at the low prices prevailing at harvest time when they are in need of cash.

The North–South conflict that had afflicted the whole country for decades had a more negative impact in the south. The long-term war resulted in massive destruction of most of the infrastructure there, high refugee movement out of the region, and hindered internal movement of people associated with social upheaval. Eventually, economic activities, development interventions, and commodity movement were very restricted. Under such a situation poverty would obviously be expected to escalate. Yet, the Comprehensive Peace Agreement (CPA) in 2005 that has brought the North–South war to an end holds high promise for stability in the south and the country at large. The most significant expectations from

the CPA are equitable distribution of the country's wealth and power that are to be implemented within an interim period of six years (2005–2011). Along with the more prevailing peace and stability, these developments are expected to have a tremendous impact on reducing poverty, especially since the south is known for its rich natural resources.

1.2 Goal and objectives

The goal of this project is to develop a rural poverty map for Sudan using sources of available data and limited rural household surveys for verification of the available data. The outcomes are envisaged to contribute to the development of a new IFAD country program for the period 2007–2012 that takes into consideration the new constitutional changes in Sudan resulting from the peace agreements with the South/East/West fronts and the challenge to realize the peace dividends to consolidate security and stability in Sudan. The main direct objective of the study is to undertake rural poverty analysis along with developing poverty maps for Sudan and to derive recommendations on possible agricultural interventions that would assist in poverty reduction.

1.3 Methodology

Delineation of the standard family of the three known income poverty indicators, namely incidence, depth, and severity was first undertaken. Further, human poverty was measured using the standard Human Poverty Index (HPI), which is a composite index of three combined indices that measure deprivations in knowledge, survival, and decent standard of living. Within this context it has been possible to expose a spatiotemporal dimension of poverty exhibiting the dynamics of poverty and its regional disparities. Using the mathematical property of the HPI, a distributive device that achieves regional equity was also derived. Since agriculture is the main source of livelihood for the majority of people in the Sudan, the poverty levels are largely shaped by the conditions of agriculture. In this respect the level of use of natural resources and the associated pressures on land have been illustrated within their space and time dimensions that has a close relationship to the spread of poverty. In tracing differences in the agricultural situation, detailed calculations from available data were made to estimate average per capita rural income from agriculture and to derive poverty levels related to these incomes in each of the 15 northern states, based on data available at the state level. Further, to highlight possible interventions for improvement, agricultural incomes were derived by the type of agricultural activity in different states. Moreover, the important association between the spatial distribution of agricultural incomes and land productivity of crops was manifest by the analysis of time-series crop yields in different states. Yield gap analysis between research and farmers' yields was further conducted to illustrate the potential that exists to boost productivity levels.

To verify the relationship between poverty and agriculture a focused household budget survey was conducted in four selected states based on their poverty levels. The survey methodology involved direct interviews using a structured questionnaire concerning detailed information on poverty measurement-related variables. The data was subject to analyses on poverty line construction and welfare distribution. The income decomposable poverty analysis was carried out, and allowed netting out the role of agriculture in poverty generation.

1.4 Structure of part 2 report

For organizational purposes this report is structured in two major parts. Part I deals with poverty assessment and mapping in Northern Sudan and Part II addresses the same topic in Southern Sudan. The two parts are similarly organized. Further, each part comprises three sections. Following this introductory section, sections 2 and 3 deal with food and human poverty; addressing their conceptual framework, their measurement procedures, and assessment of the poverty indicators. This is followed by Section 4 in which the interrelations between agriculture and poverty are presented within a context describing changes in the use of natural resources. "In section 5, we estimate spatial distribution of agricultural incomes and establish relationships between specific agricultural activities and income and poverty levels in different states". It also provides an account of the temporal and spatial changes in poverty levels, as well as an interface between income, agricultural, and human poverty. Crop productivity and the existing potential for its improvement are handled in Section 6. Section 7 is devoted to detailed analysis of poverty and its

correlates in four selected states, including nutritional status of children, and also again presents temporal comparisons of poverty over time including the results of the recently conducted household survey. Section 8 provides the main conclusions from the study, while recommendations are lastly presented in Section 9.

2. FOOD POVERTY

2.1 Introduction

Under any socio-political system, a citizen has three different types of entitlements. (a) His/her personal income which relates directly to his/her income-earning capabilities. This is the income entitlement that enables a citizen to attain a decent standard of living under a given goods and service market condition. (b) His/her share in public spending which relates directly to the size, quality, distribution, and accessibility of public health, education, water, and security services. (c) donations and provisions that are provided by social networks and family members. This is the public entitlement that provides public utilities and enhances human capabilities to increase income entitlement (a). Thus human development runs from entitlement (b) to entitlement (a) through enhancing human capabilities. Therefore, the key to both income and human poverty reduction is the development of human capabilities in the sense that the higher and more equally distributed is entitlement (b), the higher is social welfare (human development). Conversely, the lower and less equally distributed is entitlement (b), the higher is human deprivation (human poverty). This is why development and poverty eradication are symmetric processes, with the former being deliberately and carefully designed to speed up the latter.

Unfortunately this symmetry is often not well conceptualized, although it is well exemplified by the fact that GDP and poverty in Sudan grew apart during the 1990s. The coexistence of an acknowledged high economic growth and a little mention of growing poverty since the early 1990s would further imply that growth was being considered as synonymous to development. This, of course, is paradoxical; otherwise poverty would have been reduced with increased growth. For the poor, growth that excluded them is as disappointing as a cloudy sky that didn't rain. To translate growth into poverty reduction (i.e. make the cloudy sky rain), the capabilities of the poor should be developed [i.e. entitlement (b)] so that they simultaneously contribute to growth and increase their income entitlement (a). Such translation can only be made through the design and implementation of a national poverty reduction strategy. For this purpose, spatial poverty analysis should provide policymakers with quantitative answers to five fundamental strategic questions, namely: (1) how many are the poor? (2) How poor are the poor? (3) How are the poor unequal in being poor? (4) Where are the poor? And finally, (5) who are the poor? While quantitative answers to questions 1–3 help policymakers allocate financial and non-financial development needs, quantitative answers to questions 4 and 5 set the geographical and sectoral goals for the poverty reduction strategy.

To address the spatiotemporal distribution of poverty in Northern Sudan, two interrelated types of analyses were made. The first focused on displaying various rural and urban food poverty indicators in the six former regions of the north in 1993 as well as during 1990–1996, and human poverty indicators in the current 15 states of the north (and states in the south) for the year 2000. The second deals with agriculture where the natural resource use, spatial distribution of agricultural incomes and land productivity are subjected to spatial analysis over the current 15 states of the north and temporal assessment between the early 1970s and recent years of the current decade. The interface between the two sets of analyses helps to delineate spatial changes in the poverty situation over a wider time horizon in Northern Sudan, with adjustments made between the structure of administrative divisions, which comprised six regions that were divided into 16 states in 1994 and then 15 states in 2007. The paper sets itself the task of helping policymakers design well-articulated strategies by providing them, not only with numerical spatial views of poverty, but also with equity devices that help achieve vertical equity and consequently abort potential conflicts.

2.2 The concept of food poverty

This type of poverty is commonly known as a lack of income; and defined as income inability to attain a socially determined food basket that contains the recommended minimum calorie and protein intake per person per day. Therefore, a person whose income falls behind the money metric value of that food basket is identified as food poor, i.e. lack of income entitlement (a). It may appear at the outset that it is the lack of income that causes food poverty; but a closer look at the vicious circle of poverty will reveal that the underlying cause is the lack of development as indicated by income-earning constraints like unemployment, salaries and wages that fall behind prices, low agricultural productivity, unfavorable agricultural terms of trade, lack of agricultural finance, inaccessible social services, lack of political will, and/or lack of developmental vision. Therefore, income poverty reduction should be viewed through the wider lens of development rather than sporadic social transfer of funds to the poor using questionable targeting. Also, there is sometimes a misconception that since the rural people own assets in the form of land and cattle, they should not be counted as poor. If this were true, the people of Sudan as a whole would not be counted as poor in such a resource-rich country. The crucial issue is to bring economic life to those sorts of economically dead assets; and this is what economic development is all about. Therefore, income poverty reduction is after all a development issue. Any development strategy that enhances economic growth, improves income distribution, and reduces the cost of living will be conducive to income poverty reduction. This is why the high economic growth achieved during the 1990s was not translated into poverty reduction in Sudan either because of bad income distribution and/or economic instability (high prices) associated with that high economic growth.

2.3 Measuring food poverty

To measure food poverty two fundamental conceptual issues will need to be resolved. The first is the distribution of an observable and measurable welfare indicator (e.g. consumption expenditure) to which households and individuals are comparable. The second issue is the computation of the money metric value of the socially determined food basket that contains the recommended minimum calorie and protein intake per person per day (i.e. the food poverty line).

2.3.1 Construction of a welfare distribution

In household-budget surveys the income and consumption expenditure can only be reported at the household level because of the difficulty in determining individuals' incomes or consumption expenditure as distinct from that of the household. However, since the poor should ideally be identified and targeted as individuals rather than households, it is the distribution of per capita household consumption expenditure (income) that serves the purpose and not the distribution at the household level. However, in the distribution of per capita consumption expenditure, neither households nor individuals are comparable unless per capita consumption expenditure is adjusted for variations in household characteristics (e.g. age, sex and activities). The adjustment can easily be done by converting the head-count size of the household into adult equivalent using an adult equivalent index that reduces adolescents, children, and females into adult males. As suggested by Deaton (Deaton and Muelbauer, 1980) and applied by (Nur, 1992) to the Poverty Line Survey of 1992 (CBS, 1992), the adult equivalent ratios are generated based on the justification that nutrition is considered here as a basic need and the index is accordingly based on nutritional requirements for different sex and age.

Either household income or household consumption expenditure is used as an observable and measurable household welfare indicator. However, the distribution of either of these two indicators shall not reflect the true household welfare distribution in which households are strictly comparable unless they are adjusted for variations in family sizes (i.e. per capita household income or household consumption expenditure). Furthermore, the distribution of per capita welfare indicator is not the true household welfare distribution unless the per capita welfare indicator used is readjusted for variations in household characteristics. The adjustment for variations in household characteristics involves the conversion of the head-count size of household into male adult equivalent using the following expression:

$$A(Ci^h) = \sum a_i m_i \text{ over } i[1.2.3.4....n] \qquad (1)$$

$A(C^h)$ denotes the adult male-equivalent size of household h that has the characteristics (C^h) which is finally the deflated sum of the head-count members of household h; m_i is the head-count member i in household h who has characteristic (C_i), a_i is the factor that converts the head-count household member (mi) into adult male equivalents (i.e. a_i converts children and females into fractions of an adult male), and (Ch) is the vector of the demographic characteristics of household h. These characteristics include the following; parentheses show age in y:

C_1 = Adult male (20+)
C_2 = Adult female (20+)
C_3 = Adolescent male (10–19)
C_4 = Adolescent female (10–19)
C_5 = Child male (0–9)
C_6 = Child female (0–9)

To construct a nutrition-based adult equivalent index, we first computed the daily average energy and protein requirements for each family member with demographic characteristics C_1–C_6 using information from the energy and protein requirements of the joint FAO/WHO Experts Report (FAO, 1970 and 1971). We then constructed the adult-equivalent index by computing the average daily minimum energy and protein of persons of characteristics (C_2–C_6) as fractions of the average energy and protein requirement of a person of characteristic C_1. The adult-equivalent conversion factors aih used were:

a_{1h}=1.00, a_{2h}=0.75, a_{3h}=0.95, a_{4h}=0.79, a_{5h}=0.55 and a_{6h}= 0.48

While the elements of vector Cih are the demographic characteristics of the head-count members of household h, the elements of vectors Mi h and ai h are the corresponding head-count members of household h and the adult equivalent factors, respectively. Therefore, the inner product of vector ai h by Mi h is the adult equivalent size of household h. Dividing the household consumption expenditure or household income by the adult equivalent household size gives the per capita household expenditure, or income. The distribution of the adult equivalent per capita household expenditure was used as a welfare distribution.

Finally, the distribution of the adjusted household per capita consumption expenditure where both households and individuals are comparable was used as a welfare distribution in poverty measures.

2.3.2 Computation of a food poverty line

The poverty line is the money metric value of the socially-determined minimum standard of living. The question is how the components of the minimum standard of living can be objectively identified in terms of basic needs (e.g. food, shelter, clothes, mobility, and social relations). The start is usually with food; partly because it is the major welfare component for the poor and partly because the recommended daily minimum food intake per person can be determined objectively using the recommended daily minimum calorie intake per person. As such, the food basket that contains the recommended daily minimum calorie intake per person and remains consistent with the existing general pattern of consumption is the socially and physiologically determined daily minimum standard of living per person in terms of food items. The inner product of the vector of the prescribed food items by the prevailing food price vector is the money metric value of the minimum standard of living per person per day in terms of food (the food poverty line). Therefore, any person whose daily household adult-equivalent per capita consumption expenditure (or income) is less than the money metric value of his/her daily minimum standard of living in terms of food is counted as food-poor. Now, having resolved the two fundamental conceptual issues of constructing a welfare distribution and computing a food poverty line, poverty measurement becomes a matter of computation. Anchoring the food poverty line on the welfare distribution, the population under study is discretely divided into food-poor and food non-poor.

2.4 The aggregate measures of food poverty

The poor can easily be identified as individuals by names, addresses, telephone numbers, and other socioeconomic characteristics; however, for the purpose of geographical, sectoral, and specific group targeting poverty is always measured in aggregate terms using the following family of aggregate poverty measures:

$$P_{\alpha} = 1/n \, \Sigma \, [(Z - Y_j)/Z]^{\alpha} \quad \text{For all js that belong to q} \qquad (2)$$

Where P_{α} is a poverty index, n is total population, Z is the minimum food required per person per day in money metric value (poverty line). Yj is consumption expenditure (income) of poor person j, and q is the number of persons whose individual consumption expenditure (income) is less than the poverty line (i.e. number of the poor). Finally, α is the poverty aversion parameter. When α = 0, equation (2) is reduced to q/n as given by the following expression:

$$P_0 = q/n = H \qquad (3)$$

P_0 is the incidence of poverty measured by the number of the poor as a ratio of total population. Sometimes this measure is known as the head-count index of poverty and this is why it is denoted by H. Therefore, when α = 0, the poverty measure in equation (2) averts both the depth and severity of poverty and focuses on the head-count index of poverty.

$$P_1 = q/n \, (1 - \mu/Z) = HI \qquad (4)$$

Where (1 – μ/Z) is the income gap index denoted by I and measures the depth of poverty among the poor. Therefore, when **α = 1**, the poverty measure in equation **(2)** takes into account the incidence **H** as well as the depth (I) of poverty but averts the severity of poverty.

$$P_2 = q/n \, (1 - \mu/Z) + q/n \, (\mu/Z)G = H \, [I + (1 - I) \, G] \qquad (5)$$

While μ is the mean consumption expenditure (income) of the poor, G measures the degree of consumption expenditure (income) inequality among the poor (0 < G < 1). It is noted from equation (5) that when α = 2, the poverty measure in equation (2) captures the three dimensions of poverty: the incidence of poverty P_0, the depth of poverty P_1, and the severity of poverty P_2. It should be noted that P_2, which might be called total human deprivation in food consumption has two terms: the first is absolute deprivation and the second is relative deprivation, which is governed by the degree of inequality among the poor. If the poor are equal in being poor, the inequality index G = 0 and consequently the second term H(μ/Z)G will vanish indicating no relative deprivation in food consumption. If the poor are unequal in being poor, then G > 0 and consequently, the second term H(μ/Z)G will remain positive indicating is a degree of relative deprivation in food consumption.

$$G = 1 + 1/n - (2/n2 \, \mu) \, \Sigma riyi \, , \; 0 < G < 1 \qquad (6)$$

Where G is the inequality index among the poor, n is the population size, μ is the mean income, Yi is the income of person i, and ri is the rank of person i when incomes are ranked in descending order. When G is equal to zero, income is equally distributed, when G is greater than zero but less than one, there is a degree of income inequality, and when G is equal to one there is complete inequality. Since the extreme situations of complete equality and complete inequality do not exist in real life, the numerical value of G is always greater than zero but less than one.

The policy contents of these measures include direct transfers, increasing the share of the poor in economic growth (pro-poor growth), and a stable economic growth that exceeds population growth. For example, inequality among the poor as measured by G and consequently relative deprivation as measured by H(μ/Z)G can be reduced by a direct targeting strategy provided that the poor are well identified. A good example of direct targeting is Zakat (an Islamic levy on the wealth of the rich Muslims transferred to

their needy fellow Muslims). If Zakat is collected from the rich and distributed to the ultra poor, inequality among the poor will be reduced and consequently relative deprivation will be reduced. For a given population size and a given inflation rate, increasing the share of the poor in economic growth (i.e. making growth pro-poor) will reduce the depth of poverty as measured by $H(1 – \mu/Z)$. Sustainable and stable economic growth with improved income distribution will reduce total poverty as measured by

$H (1 – \mu/Z) + H (\mu/Z)G$.

2.5 Food poverty results

To produce food poverty results, three national surveys data were utilized; namely, the 1990 Migration and Labour Force Survey conducted by the Ministry of Manpower, the 1993 Poverty Line Survey conducted by the Social Solidarity Fund, and the 1996 Migration and Labour Force Survey conducted by the Ministry of Manpower. Unfortunately, these surveys did not reach the southern part of the country because of the war at that time and, as such, the results will obviously only apply to Northern Sudan.

2.5.1 The numerical spatial view of food poverty in Northern Sudan (1993)

Based on the 1993 Poverty Line Survey data, (Table 1) reports the numerical spatial view of food poverty in Northern Sudan over the six regions forming the administrative divisions at that time. The results pertain to the incidence P0, the depth P1, and the severity P2 of food poverty by region and the rural–urban residence of the poor. The results also include the values of the equitable regional share index by region and the rural–urban residence of the poor for each of the three food poverty indicators.

Table 1: Numerical spatial view of food poverty (1993)

Region	**Incidence of rural food poverty**			**Incidence of urban food poverty**			
	P_0	**R_i^r**	**$ERSI_i$**	**P_0**	**R_i^u**	**$ERSI_i$**	**DR_i**
Darfur	0.89	1	0.408	89	3	0.136	–2
Kordofan	0.84	2	0.204	0.91	2	0.204	0
Central	0.83	3	0.136	0.89	4	0.102	–1
Eastern	0.81	4	0.102	0.82	5	0.082	–1
Northern	0.8	5	0.082	0.91	1	0.408	4
Khartoum	0.64	6	0.068	0.75	6	0.068	0
	Depth of rural food poverty			**Depth of urban food poverty**			
Region	**P_1**	**R_i^r**	**$ERSI_i$**	**P_1**	**R_i^u**	**$ERSI_i$**	**DR_i**
Darfur	0.75	1	0.408	0.73	1	0.408	0
Kordofan	0.69	2	0.204	0.63	3	0.136	–1
Central	0.67	3	0.136	0.62	2	0.204	–1
Eastern	0.62	4	0.102	0.59	5	0.082	–1
Northern	0.6	5	0.082	0.6	4	0.102	1
Khartoum	0.43	6	0.068	0.42	6	0.068	0
	Severity of rural food poverty			**Severity of urban food poverty**			
Region	**P_2**	**R_i^r**	**$ERSI_i$**	**P_2**	**R_i^u**	**$ERSI_i$**	**DR_i**
Darfur	0.81	1	0.408	0.83	3	0.136	–2
Kordofan	0.76	2	0.204	0.85	1	0.408	1
Central	0.75	3	0.136	0.82	4	0.102	–1
Eastern	0.73	4	0.102	0.76	5	0.082	–1
Northern	0.71	5	0.082	0.84	2	0.204	3
Khartoum	0.56	6	0.068	0.7	6	0.068	0

Source: Own computation based on 1993 Social Solidarity Fund Survey Data, Note: **P_0** = the incidence of poverty; **P_1** = the depth of poverty; **P_2** = the severity of poverty; **R_i** = the descending order rank of region i; **$ERSI_i$** = the equitable regional shares in rural economic development; **DR_1** = the rural–urban difference in the rank of the region by food poverty indicator (**$R_i^r – R_i^u$**)

The six regions retained their food poverty rank positions across the board for the three rural food poverty indicators (Table 1). This implies equitable rural development shares for each of the three rural food poverty indicators.

With regard to urban food poverty, almost all six regions changed their rural poverty rank positions; except for Kordofan, which retained its incidence of food poverty rank position and Khartoum, which kept its rank as the least food-poor region for the three food poverty indicators.

For the six regions, the incidence of rural food poverty ranged from 0.89 in Darfur region to 0.64 in Khartoum region, but was smaller than the incidence of urban food poverty, which ranged from 0.91 in the Northern region to 0.75 in Khartoum region (Table 1). This regional disparity in the rural–urban incidence of food poverty was mainly due to the rural–urban differences in food compositions and food prices. However, in absolute terms the number of the rural poor was greater than the number of urban poor because rural people at that time were settling down to their rural sources of livelihood (i.e. small rates of rural–urban migration). Higher poverty incidence in rural areas is a common textbook phenomenon by virtue of low productivity and low income in rural areas. However, employees in urban areas with the same level of education as their peers in rural areas have access to moonlighting in urban areas as will be discussed later.

The depth of rural food poverty, ranging from 0.75 in Darfur region to 0.43 in Khartoum region, was higher than the depth of urban food poverty (Table 1). The reason that rural food poverty was deeper than urban food poverty is that the rural poor were squeezed between low income (mainly due to low agricultural productivity) and high cost of living (mainly due to the Economic Liberalization policy adopted in the early 1990s) thus giving a high income gap. It is true that the people of rural Sudan, though sitting on huge natural resources (in spite of their notable deterioration) in the form of vast fertile lands, underground water, heavy rainfall, livestock, and a wide range of biodiversity, are harvesting poverty. Such a development irony necessarily urges policymakers to rethink the current development policy by shifting development attention from oil to soil.

The severity of rural food poverty, ranging from 0.81 in Darfur region to 0.52 in Khartoum region, was less than the severity of urban food poverty, ranging from 0.85 in Kordofan region to 0.70 in Khartoum region (Table 1). The lower severity that characterized rural food poverty was due to the fact that rural people, beside their poverty sharing practices, had low but almost equal income-earning capabilities which resulted in low, yet almost equally distributed income. Consequent to this characterization, rural food poverty is deeper but less severe than urban food poverty.

Based on the distribution of poverty levels among the six states, the computed factor ERSI provides a policy tool by virtue of which public spending could be redistributed to ensure equity in welfare. It represents the inverse of the region's rank (for more on ERSI see Section 3.3).

2.5.2 The numerical spatial view of food poverty in Northern Sudan (1996)

To produce a spatial view (Table 2) we used the 1996 Migration and Labour Force Survey data. The results include the incidence, depth, and severity of food poverty in each of the 32 provinces of the six northern regions. The degree of income inequality within each province and the province average income are included for further poverty analysis. Province-level poverty results provide a wide spectrum of geographical targeting.

For a given food poverty line and a given state of income distribution, then the incidence of food poverty, the income gap ratio, and consequently the depth of food poverty increases (decreases) with the decreased (increased) in average income. Similarly for a given food poverty line and a given level of average income, the severity of food poverty increases (decreases) with worsened (improved) income distribution. Therefore, the wide spectrum of geographical targeting should be characterized by pro-poor stable economic growth where income is increased, income inequality is decreased, and food prices remain constant in every province.

Table 2: Spatial view of food poverty in Northern Sudan (1996)

Region	Province	Poverty Measures (%)			
		P_0	P_1	P_2	G
Northern	Marawi	95	75	61	46
	Barbar	84	72	57	53
	Shendi	86	65	53	60
Eastern	Red Sea	98	74	59	40
	Sinkat	98	87	78	52
	Atbara River	92	77	66	67
	Gedaref	92	73	61	77
Khartoum	Khartoum	75	44	31	73
	Jebel Awliya	82	52	37	76
	Khartoum Bahari	76	44	30	71
	Om-Durman	82	56	42	76
Central	Alkamlyn	87	62	46	45
	Alhasahisa	87	58	43	58
	Albutana	88	62	46	53
	Ajazira	95	74	61	59
	Almanagil	95	75	63	59
	Sinar	90	67	55	81
	Adindir	91	78	65	57
	Al-Gitaina	94	73	59	50
	Al-Diweim	98	83	71	41
	Kosty	89	75	63	63
Kordofan	Bara	98	91	83	53
	Shikan	92	69	55	61
	Om-Rwaba	93	75	62	71
	Al-Nohoud	96	83	73	57
	Kutum	96	74	62	68
Darfur	Al-Fashir	93	73	61	63
	Om-Kadada	97	85	77	64
	Al-Jineana	97	83	73	60
	Al-Da-Ein	96	90	84	82
	Niyala	94	80	70	66
	Id-Alforsan	99	83	72	49

Source: Compiled by (Mehran, 2004) from the 1996 Migration and Labour Force Survey, (Ministry of Manpower, 1996)
Notes: **P_0** = the incidence of food poverty; **P_1** = the depth of food poverty; **P_2** = the severity of food poverty; **G** = Gini coefficient

For a given food poverty line and a given state of income distribution, then the incidence of food poverty, the income gap ratio, and consequently the depth of food poverty increases (decreases) with the decreased (increased) in average income. Similarly for a given food poverty line and a given level of average income, the severity of food poverty increases (decreases) with worsened (improved) income distribution. Therefore, the wide spectrum of geographical targeting should be characterized by pro-poor stable economic growth where income is increased, income inequality is decreased, and food prices remain constant in every province.

In 1996 poverty was particularly high in Kordofan and Darfur States. The incidence of poverty P0 in each of the 11 provinces of Kordofan and Darfur was > 90% and it was particularly high (99%) in Idelforsan Province of Darfur Region. The depth of poverty P1 in each of the 11 provinces of Kordofan and Darfur regions was > 70%, except for Shikan Province of Kordofan region where the depth of poverty was 69%, and was particularly high in Bara Province where the depth of poverty was 91%. The incidence of poverty was similarly high in the Eastern region where its level in each of the five provinces was > 90%, except for Kassala Province where the incidence was 87%, and was particularly high in the Red Sea Province at 98%. Poverty was also high in the Northern region where its incidence ranged from 84% in Barbar Province to 97% in Eldamar Province. In five of the 10 provinces of the Central region the incidence of poverty was > 90% and particularly high in Eldiewaim Province reaching 98%. In the remaining five provinces of this region the incidence of poverty ranged from 87% in Elhasahisa Province to 90% in Sinar Province. In 1996, Khartoum region was relatively the least poor with the lowest incidence of poverty (75%) in the country but with the highest degrees of income inequality.

One possible explanation for this gloomy picture is that the stringent Structural Adjustment Program (1978) and the Economic Liberalization (1992) policies perpetuated, in a rather combined way, the three causes of food poverty: low growth, bad income distribution, and high cost of living. The compounded negative effect of these policies paved its way rather cumulatively into 1996 and resulted in rising and widely increasing poverty in Sudan. The most important direct policy effects include cuts in public spending, devaluation of local currency without due consideration to the responsiveness of exports and imports of the country, and increasing government revenue through taxation.

2.5.3 The spatiotemporal views of food poverty (1990–1996)

Based on data of the 1990 and 1996 Migration and Labour Force Surveys, this subsection investigates the trend and profile of food poverty in Northern Sudan over the period 1990–1996. The spatiotemporal distribution of food poverty and its correlates over that period is reported in (Table 3).

(Table 3) contains multidimensional quantitative knowledge about food poverty in Northern Sudan. At each of the two points in time (1990 and 1996), results pertaining to each of the three food poverty indicators: incidence, depth, and severity of food poverty are reported by region and in each region by rural urban location. This numerical picture is useful for geographical targeting. At another dimension the three food poverty indicators are individually reported by male and female-headed households (gender) by rural–urban locations. Furthermore, the results for the three food poverty indicators are individually reported by eight sectors of employment of the head of household in the rural and urban location. These sectors of employment include agriculture, mining, industry, construction, electricity, commerce, transport, and service. Moreover, the same food poverty indicators results are reported by six levels of education of the head of household. These levels of education include illiterate, read and write, elementary education, intermediate education, secondary education, and university education. Thus, with this multidimensional quantitative knowledge of food poverty, (Table 3) provides a much wider spectrum of targeting. Since a poverty reduction strategy is all about setting targets and directions, the results can help setting three different targets: incidence, depth, and severity of food poverty in 16 different directions. For example, we can target the depth of food poverty among the female-headed households in the rural areas of the Red Sea State. Similarly, we can target the incidence of food poverty among households whose heads are employed in the agricultural sector in rural Kordofan (geographical targeting). We can also target the severity of food poverty among households whose heads are illiterate in urban Khartoum State (characteristic targeting). Moreover, the points in time (1990 and 1996) provide an opportunity to analyze the trend of food poverty by poverty correlates.

Table 3: Spatiotemporal food poverty by poverty correlates in Northern Sudan (1990–1996)

Character	1990						1996					
	P0		P1		P2		P0		P1		P2	
Region	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**
Northern	88.6	56.1	62.42	32.23	49.02	18.02	90	92.7	60.72	67.48	45.52	53.65
Eastern	89	60.4	59.58	34.45	44.68	20.87	88.4	94.3	60.07	71.5	46.26	58.05
Khartoum	83.7	56.1	55.56	29.27	41.61	19.47	76.9	80	50.72	50.43	37.08	37.4
Central	87.7	66.5	61.07	38.62	47.07	26.81	93.1	91.2	61.39	66.36	46.28	52.32
Kordofan	91.1	76.5	67.76	45.59	54.59	32.1	86.5	96	62.03	76.81	48.09	65.13
Darfur	87	55	61.3	25.94	47.8	18.28	89.1	97	67.78	72.81	56.73	69.49
Gender												
Male	88.4	65.3	61.32	34.67	47.78	23.80	84.5	94.3	58.00	72.79	44.39	60.29
Female	83.7	82.8	51.81	27.52	38.51	18.39	85.2	89.9	57.11	68.50	43.16	
Sector												
Agric.	86.4	63.8	66.60	33.11	43.10	22.60	88.9	94.9	60.36	74.13	45.34	62.35
Mining	–	–	59.30	29.99	45.84	17.99	–	–	–	–	–	–
Industry	89.6	69.0	63.07	37.85	49.2	25.86	86.0	91.8	60.68	67.34	47.75	53.63
Construct	–	–	66.38	38.66	54.11	28.37	–	–	78.55	40.80	63.53	23.18
Electricity	–	–	58.23	34.26	43.11	23.93	–	–	63.60	61.10	49.53	47.37
Commerce	–	–	61.44	37.69	47.43	25.68	–	–	55.34	66.58	42.49	53.55
Transport	–	–	63.15	33.84	49.49	23.71	–	–	61.75	68.64	49.10	54.87
Services	87.9	66.2	53.24	52.28	40.08	36.80	84.2	92.0	56.10	76.28	42.15	60.86
Education												
Illiterate	88.1	67.4	61.22	35.67	47.31	24.46	89.9	94.9	64.13	76.00	49.77	64.56
Read & write	88.8	64.7	63.90	35.85	50.26	24.92	84.3	94.1	60.46	71.59	47.70	58.79
Primary	89.4	65.6	63.52	34.06	49.69	22.85	88.1	92.9	62.14	65.53	47.91	50.59
Intermediate	86.7	56.6	59.89	29.91	46.40	20.73	84.6	91.0	56.19	62.28	42.34	47.39
Secondary	87.2	50.9	59.93	84.83	45.63	15.14	80.1	87.0	52.42	56.43	39.20	41.42
University	79.2	58.8	49.62	24.83	35.99	22.33	74.7	72.2	40.86	41.91	27.3	28.34

Source: Compiled by (Mahran, 2004) from the 1996 Migration and Labour Force Survey, (Ministry of Manpower, 1996)
Notes: P0 = incidence of food poverty; P1 = depth of food poverty; P2 = severity of food poverty

a) Food poverty: a rural–urban profile

There was a dramatic increase in rural poverty in almost all regions over the period 1990–1996 (Table 3). For example, while the incidence P0 of rural poverty in Khartoum region increased from 56% in 1990 to 80% in 1996, the incidence of rural poverty in the Northern, Eastern, Central, Kordofan, and Darfur regions increased from 56, 60.4, 66.5, 76.5, and 55% in 1990 to 92.7, 94.3, 91.2, 96, and 97% in 1996, respectively. Other poverty measures also exhibit a rising trend over the same period. For instance, while the depth P1 and severity P2 of rural poverty in the Northern region increased from 32 and 18% in 1990 to 67 and 54%, respectively; the same poverty measures in rural Darfur increased from 25 and 18% in 1990 to 73 and 69.5% in 1996, respectively. These dramatic increases in rural poverty support the contention that the negative impact of adjustment and liberalization policies has reached the rural areas and hit them hard.

b) Food poverty by gender of the head of household

Female headship is not a useful gender concept that measures the poverty gender inequality unless researchers make a clear distinction between a de facto and a de jour female headship. Since it is the only available concept, we are going to use it in measuring the difference in poverty between male-headed and female-headed households. The results show no significant difference in poverty as a result of a difference

in household headship and poverty among both female-headed households and male-headed households increased dramatically over the period 1990–1996, but in urban areas the increase in poverty was not as large as in the rural areas. For rural areas, while the incidence of poverty among male-headed households increased from 65.3% in 1990 to 94% in 1996, the incidence of poverty among female-headed households increased from 83% in 1990 to 90% in 1996. For the urban areas, the incidence of poverty among male-headed households decreased from 88.4% in 1990 to 84.5% in 1996, but that among female-headed households increased slightly from 83.7% in 1990 to 85.2% in 1996. One possible explanation of such a rural–urban difference in poverty trends is that in urban areas there is room for the poor to cope with poverty in the informal sector while such coping facilities are not available for the rural poor and that the male coping activities are more rewarding than the female coping activities.

c) Food poverty by sector of employment of the head of household

(Mahran, 2005) noted that according to the Ministry of Manpower the distribution of employment over the different sectors suggests that 55.5% of the total employed were in agriculture (1.4% in urban and 54.5% in rural areas). It is a typical characteristic of an underdeveloped economy that the majority of the labor force is engaged in agriculture, particularly in rural areas. The ratio of males to females in agricultural employment was 8.5 in urban areas and 1.7 in rural areas, indicating the important role of women in agricultural activities in rural areas relative to their counterparts in urban areas. Regardless of the economic sector in which the head of household is working, rural poverty increased at a higher rate than urban poverty during 1990–1996 (Table 3), and the hardest hit in rural areas were the households with heads working in the agricultural sector. For instance, the incidence of poverty among households with heads of households working in urban agriculture increased from 86.4% in 1990 to 88.9% in 1996; however, among households with heads of households working in rural agriculture the increase was from 65.3% in 1990 to 94.3% in 1996.

d) Food poverty by level of education of the head of household

There were no significant differences in poverty resulting from differences in the levels of education of heads of households (Table 3), i.e. there was one-to-one mapping between levels of poverty and levels of education of heads of households. For example, in 1990 while the incidence of poverty among households with illiterate heads was 88.1%, the incidence of poverty among households with heads with secondary and university education was 87.2 and 79.2%, respectively. This was mainly due to the liberalization policy, which in fact liberalized all the sectors including the public-services sector (health and education) except the public employment sector where > 90% of educated people were employed. Thus, the educated people who eked out a living in a non-liberalized public employment sector, and received limited salaries and wages that fell behind prices in the liberalized sectors, including the public service sector (health and education), were squeezed between low payments and high cost of living that rendered them unable to attain the prevailing minimum standard of living.

In the urban areas the incidence of poverty among households whose heads received secondary and university education decreased from 87.2 and 79.2% in 1990 to 80.1 and 74.7% in 1996, respectively. For the rural areas the incidence of poverty among households whose heads had received secondary and university education increased from 50.9 and 58.8% in 1990 to 87 and 72.2% in 1996, respectively. One possible explanation of this rural–urban reversed poverty trend is that, while most of the poor public-sector employees in urban areas can moonlight in order to adjust to adversity, their counterparts in rural areas have no access to such facilities. Another observation is that the incidence of poverty among households headed by illiterate persons in urban and rural areas increased from 88.1 and 67.4% in 1990 to 88.9 and 94.9% in 1996, respectively. Thus, while in urban areas the incidence of poverty among households headed by illiterate persons increased by 1.8 percentage points over the six-year period, the same poverty measure among the same group of households in rural areas increased by 27.5 percentage points over the same period. The reason that poverty among households headed by illiterate persons in rural areas exhibited a rising trend while poverty among the same group of households in urban areas had an almost constant trend is that the illiterates in the urban areas have opportunities to adopt all sorts of coping practices in the informal sector, while their counterparts in the rural areas remain on their returns from traditional agriculture and the sporadic transfers of income from relatives.

3. HUMAN POVERTY

3.1 The concept of human poverty

"Poverty is a broad concept which encompasses different aspects of human welfare, capabilities and dignity and the provisions of all types of services that ensure socially acceptable level of welfare". As such it has been subjected to different interpretations. Whatever effort we make to capture the broad concept of human poverty, unanswered questions remain. To avoid missing major parts of this broad concept, we shall view poverty through the wider lens of the human development paradigm. It is true that upon hearing the word 'poverty' the immediate concept that jumps to mind is income poverty. However, in the perspective of human development, poverty is more than a lack of income because income is not the total sum of wellbeing and consequently, lack of income is not the total sum of poverty.
The rediscovery of the human development paradigm, though late, has been revolutionary in placing a human dimension in the economic development process. At the cost of stating the obvious, the ultimate goal of development is to enlarge human choices no matter how infinite, diverse, and dynamic they are. In this respect, the difference in concept and emphasis between traditional economic models and the rediscovered human development paradigm is that while the former is confined to the enlargement of only one human choice (income), the latter embraces the enlargement of all human choices in the economic, social, cultural, and political spheres.

Does this distinction necessarily imply that the human development paradigm accuses traditional economic thinking of not being concerned with the non-income human dimensions of development? The immediate answer is no. The human development paradigm is not rejecting the important role of economic growth in achieving human development but is questioning the automatic trickling down effect of growth through the market mechanism, which was assumed by the traditional economic models. In the view of the human development paradigm, growth is necessary for human development but not sufficient as there is evidence that market failure as well as government failure render the presumed automatic link between growth and human development ineffective. Since it is the use of income rather than its generation that matters for human development, the human development paradigm is revolutionary in identifying conscious and deliberate public actions that help enhance growth and translate it into human lives instead of leaving the job to the market mechanism where the poor are further marginalized. The end result of such public actions is what we might call people-centered development where there is equity in opportunities rather than results, where people are empowered both as agents and beneficiaries of development, and where resources are developed – not preserved – for future livelihoods (sustainability of development).

As such, what is new in the human development paradigm is that while it retains all economic issues, it carefully relates them to what is human in us for both present and future generations. Accordingly, economic growth and human development are not mutually exclusive. In fact they are mutually interrelated in the sense that while growth finances human development, the latter enhances growth through human and social capital formation. Therefore, in the context of the human development paradigm, development can be measured not only in terms of what we have economically achieved (economic growth) but ultimately in terms of what has happened to all of us (economically, culturally, socially, and politically) as a result of what we have achieved, such that the present progress should not jeopardize the wellbeing of future generations. Such a comprehensive measure of development should imply a shift of emphasis from the national income accounting system (i.e. the flow measure of economic activities) to the national social accounting system (i.e. the stock measure of human capital). In this context, the Gross National Product (GNP) in real terms should be the nominal GNP, firstly, adjusted for a rise in the general price level and secondly, adjusted for reductions in the quantity and quality of the national stock of human capital (i.e. adjusted for human poverty).

Is human development measurable? The first Human Development Report (UNDP, 1990) took a major step towards measuring human development. Three observable and measurable human choices were selected and used as indicators of human development. These selected human choices included the desire to live long (longevity), the desire to acquire knowledge (knowledge ability), and the desire to have a comfortable standard of living (decency of living). These choices are indicated by life expectancy, adult literacy, and

GNP per capita adjusted for purchasing power parity. These indicators, though measured in different units, are aggregated in one composite index known as the human development index (HDI).
If human development is about human choices being enlarged (conglomeration), then what is human poverty about? Human poverty is about human choices being denied (deprivation). Therefore, progress in development can be evaluated from two perspectives. The first and the most politically popular perspective of evaluating development is the advances made in enlarging human choices as measured by the HDI. The second perspective of evaluating development, which is in most cases regarded as a political stigma, is the degree of human deprivation among those who are left behind by the development process as measured by the HPI. It is true that interest in development concerns both perspectives but, for the advances made by the better-off not to overshadow the disadvantages of the deprived, development should start with human poverty reduction especially in underdeveloped countries where the development backlogs are huge and politicians invariably sing to the advances made but do not cry for those who are deprived.

3.2 Measuring human poverty

Since poverty in the human development perspective manifests itself in the deprivation of lives that people can lead, we identified three main aspects of human deprivation that are contrary to the three human choices (longevity, knowledge ability, and a decent standard of living) used in the measurement of human development. These aspects of human deprivation include: deprivation in survival, deprivation in knowledge, and deprivation in material well-being (UNDP, 1997). The methodology involves the identification and measurement of human poverty indicators that are directly related to each aspect of human deprivation. Since we do not have readily available poverty data specifically collected for the purpose of measuring human poverty in Sudan, the methodology also involves the search for relevant data from previous surveys.

3.2.1 Identifying human poverty indicators

Here we need to identify measurable human poverty indicators that are closely related to the three identified aspects of human deprivation. These indicators and their aggregations in combined human poverty indices are described in the following way:

a) Deprivation in survival combined index (P_1)

This is a combined HPI of the following three human poverty indicators, which are directly related to human deprivation in longevity (Equation 7).

P_{11}: the probability that a child will die before their fifth birthday (%)
P_{12}: the probability that an infant will die before their first birthday (%)
P_{13}: the underweight prevalence among children (%)

$$P_1 = (1/3)\ \Sigma P_{1j} \qquad (7)$$

b) Deprivation in knowledge combined index (P_2)

This is a combined HPI of the following three human poverty indicators that are directly related to the deprivation in knowledge (Equation 8):

P_{21}: adults (aged 15+) who are unable to read and write (%)
P_{22}: children at the age of basic education who never attended and /or dropout of basic education (%)
P_{23}: adolescents at the age of secondary education who never attended and/or dropout of secondary education (%)

$$P_2 = (1/3)\ \Sigma P_{2j} \qquad (8)$$

c) Deprivation in economic provisioning combined index (P_3)

This is a combined index, which is closely related to income inability to attain the required material components of a decent standard of living. It is a proxy for income poverty and it combines the following

human poverty indicators (Equation 9):

P_{31}: people with no access to electricity (%)
P_{32}: people with no access to safe drinking water (%)
P_{33}: people with poor sanitation, i.e. no toilets (%)
P_{34}: people dependent on biomass energy (%)

$$P_3 = (1/4)\,\Sigma P_{3j} \qquad (9)$$

We quickly note that, while the 10 individual poverty indicators p_{11}–p_{34} are head-count indices, the combined poverty indices p_1, p_2, and p_3 are not, by virtue of being the arithmetic means of their relevant individual indicators. Instead, each combined index can be interpreted as the proportion of people under the combined effect of the relevant poverty indicators used.

d) The human poverty index (HPI)

Poverty must be measured and addressed in all its dimensions, not income alone; however, the human needs are great and the sum total of poverty is equivalent to the total denial of all human needs such as leading a long, healthy, creative life and enjoying a decent standard of living, freedom, dignity, self-esteem, and the respect of others. However, due to lack of data, the HPI combines only three basic dimensions of human deprivations; namely, a short life as indicated by P_1, lack of knowledge indicated by P_2, and lack of access to public and private resources indicated by P_3. Therefore, the HPI like any measure has its weaknesses in concept and data and thus does not capture the totality of human suffering. However, the novelty is that the HPI combines 10 different indicators representing 10 different dimensions of human deprivations p_{11}–p_{34} in one composite index. The general form of this composite index is a weighted mean of the three combined indices P_1, P_2, and P_3 of order α given by the following expression

$$P_\alpha = [(1/\Sigma W_j)\,\Sigma\, W_j P_j^{\alpha}]^{1/\alpha} \qquad (10)$$

While P_j is poverty indicator j, and W_j is the weight attached to poverty indicator j, and α is the order of the mean. The HPI Pα has the following desirable properties. (1) By virtue of being a mean, Pα lies between the highest and the lowest poverty indicators used in its calculation. (2) It is monotonic increasing in a representative poverty indicator Pj in the sense that the rate of change of Pα with respect to Pj is positive. In a more technical term, $(\partial P_\alpha/\partial P_j) = (1/\Sigma W_j)[P_j/P_\alpha]^{\alpha-1} > 0$. (3) It is homogeneous of degree one in the individual poverty indicators in the sense that doubling the values of the individual indicator will double the human poverty index. (4) As the order α approaches infinity, the human poverty index approaches the highest poverty indicator used in calculating it.

For our purpose we attached unity weights to each of the combined indices of human poverty P_1, P_2 and P_3 such that $W_1 = W_2 = W_3 = 1$. This is so because the poor are almost equally affected by the three dimensions of human deprivation. Governed by properties (1) and (4), listed above, and in order not to overestimate the HPI we assigned α = 3. With these two restrictions, the HPI is given by:

$$HPI = [(1/3)\,(P13 + P23 + P33)]1/37) \qquad (11)$$

While P_1, P_2 and P_3 are the combined human poverty indices that represent human deprivation in survival, knowledge, and decent living conditions, respectively, the number '3' happened to be both the order of the mean α and the sum of the unity weights attached to each of the three combined poverty indices (UNDP, 1997).

3.3 Equity devices

It is true that the numerical spatial and sectoral views of human poverty are important building blocks in the design of a workable poverty reduction strategy. However, for equity purposes the spatial analysis of poverty should provide further implementation guidance with the view to help policymakers design a corresponding development map with a one-to-one mapping to regional and sectoral intensities of human poverty. The use of the following implementation guidance is recommended:

3.3.1 Equitable regional share index (ERSI)

For implementation purposes the poverty reduction strategy should ultimately be translated into development projects based on the corresponding spatial distribution of natural resources and based on the relative need to ensure that development is equitable across regions. Therefore, planners would eventually need to know the effective and equitable regional allocation of these development projects so that they ultimately lessen regional disparities and reduce national poverty within the set time-bounds. Spatial poverty analysis should provide this knowledge by mapping regional development projects intensities with the corresponding regional poverty intensities. Such careful and equitable allocation of development projects among the different regions will serve the double purpose of achieving vertical equity among regions (dealing with unequal regions unequally) and speeding up the process of national poverty reduction. One possible way of constructing a one-to-one mapping between the intensity of regional poverty and the intensity of regional development is formulated in this study by constructing an ERSIi as given by the following expression.

$$ERSI_i = R_i^{-1} / \Sigma R_i^{-1} \qquad (12)$$

Where R_i^{-1} is the inverse of the descending order rank of region i by the HPI. Thus, to derive ERSI, the contribution of a region to total HPI was used as weight for resource allocation.

3.3.2 Equitable sectoral share index (ESSI)

Equitable sharing of development among regions is a necessary step towards achieving vertical equity but by no means sufficient unless the development share of each region is in turn distributed equitably among the public service sectors: health, education, water, and other public provisioning sectors. We can easily meet this sufficient condition of achieving vertical equity among sectors by computing the ESSI. Given the mathematical properties of the HPI that it is monotonic increasing in each of the combined human deprivation indices P_j and a homogeneous of degree one in the individual poverty indicator (in the sense that doubling the values of the individual indicator will double the human poverty index), the ESSI will be given by the following expression:

$$ESSIj = 1/k\ (Pj/P\alpha)\alpha \qquad (13)$$

Where K is the number of the combined human deprivation indices (K = 3); namely the deprivation in survival P_1, the deprivation in knowledge P_2, and the deprivation in the decent standard of living P_3, Pα is the human poverty index, and α is the order of Pα. The ESSI is a useful tool in endeavors to pursue equitable development objective, but it obviously requires that good data monitoring be in place.

3.4 Human poverty results

To produce the human poverty results we utilized data from two national surveys; namely the 2000 Multiple Indicators Clusters Survey (MICS) and the 2006 Health Survey. Fortunately, the 2006 Health Survey covered the whole country. The MICS results are reported in (Table 4) and the Health Survey in (Table 5). In (Table 4) are reported a numerical rural–urban profile of human poverty in Northern Sudan by State; the rural–urban values of the Gini coefficients with the view to assessing the rural–urban difference in poverty inequality; and ERSI for each State and ESSI within each State. A numerical spatial view of human poverty in the whole of Sudan, including ERSI for each State and ESSI within each State is shown in (Table 5).

3.4.1 Human poverty in Northern Sudan (2000): a rural–urban profile

Human poverty was particularly high among the rural people (Table 4). While rural HPI ranged from 70.8 in North Kordofan State to 29.8 in Northern State, urban HPI ranged from 39.1 in West Darfur State to 14.3 in Gezira State. The results also indicated that the state-level human poverty indices were not only individually high but almost similar in rural and urban areas as indicated by the Gini coefficients of 0.128 and 0.152 in rural and urban areas, respectively. For Northern Sudan as a whole, rural HPI = 51.3 and urban HPI = 24.9. The difference in magnitude between rural and urban human poverty at the state level showed that the rural HPI in every state was significantly greater than urban HPI. For instance, in North Kordofan while the rural HPI = 70.8 the urban HPI = 27.5. Thus, in North Kordofan, while 70.8% of rural

people were suffering the combined effect of deprivations in survival, knowledge, and decent standards of living, only 27.5% of urban people were similarly affected.

It is interesting to note that in almost every State, both rural and urban, HPIs were more responsive to deprivation in the decent standard of living combined index P_3 than the deprivation in survival and in knowledge indexes, i.e. P_1 and P_2. This is indicated by the results that the third equitable sectoral share index ($ESSI_3$), which measures the responsiveness of HPI to P_3, was greater than the remaining two ESSIs (i.e. $ESSI_1$ and $ESSI_2$) throughout the States, except for rural Khartoum and urban Northern State where $ESSI_2 > ESSI_3$. Moreover, the results showed that the rural $ESSI_3$ (which measures responsiveness of HPI to deprivation in decent standard of living index, P3) was greater than the urban $ESSI_3$.

As a one sentence summary, the human poverty in Northern Sudan (in the year 2000) was primarily a rural phenomenon dominated by deprivation in the decent standard of living. An obvious recommendation is agriculture-led rural development.

3.4.2 Numerical spatial views of human poverty in Sudan (2006)

For simplicity, the results in (Table 5) are divided into five groups of States with the view to identify the most deprived regions in the country. The striking character of the results was that despite what seemed to be an over-estimation of the health data as indicated by the small values of the ESSI1, human poverty in Sudan remained high and maintained clear geographical differences in welfare, as indicated by the huge disparities between States and between regions (groups of States). For example, HPI ranged from 75.3 in the Lakes State to only 14.3 in Khartoum State, implying that the population proportion in the Lakes State who experienced the triple effect of deprivations in survival, knowledge, and economic provisioning was five times that in Khartoum State.

In terms of regions, the most deprived people, especially in knowledge as indicated by the high values of ESSI2, were those in the five States of Lakes, Eastern, Equatoria, Unity, Northern Bahr el Ghazal, and Warrab where HPI ranged from 75.3 in Lakes to 67 in Warrab; the large group average of 69.7 and small standard deviation of 2.7 indicated that people in the most deprived five States of the first group were almost equal in being highly deprived. It is worth noting that human deprivation in the most deprived five States in group one was dominated by deprivation in knowledge as indicated by the high values of ESSI2. On the other hand, the least deprived people in the country were those in group five which includes Sennar, River Nile, Northern, Gezira, and Khartoum States where HPI ranged from 33.9 in Sennar to 14.3 in Khartoum; the small group average of 23.2 and relatively large standard deviation of 7.4 indicated that the people of the least deprived region were not equal in deprivation. The human deprivation in the least deprived five states of group five, particularly River Nile and the Northern states, was dominated by deprivation in decent standards of living as indicated by high $ESSI_3$ values.

The remaining middle three regions that fell between the most deprived (group one) and the least deprived region (group five) rank as follows. The region that ranked second to the most deprived region included Jonglei, Western Bahr el Ghazal, Upper Nile, West Darfur, and Central Equatoria States where HPI ranged from 65.9 in Jonglei to 53.8 in Central Equatoria, with a regional mean of 61.1 and standard deviation of 5.2. Human deprivation in this region, particularly in Jonglei, Western Bahr El Ghazal, and Upper Nile States was dominated by deprivation in knowledge as indicated by high $ESSI_2$ values. The region that ranked third to the most deprived region included South Kordofan, Western Equatoria, South Darfur, Blue Nile, and North Darfur States, where HPI ranged from 52 in South Kordofan to 45.3 in North Darfur with regional average of 49.8 and standard deviation 2.7. Human deprivation in this region was predominantly deprivation in decent standards of living as indicated by high $ESSI_3$ values. The region that ranked fourth to the most deprived region included Kassala, Gedaref, North Kordofan, Red Sea, and White Nile States where the HPI ranged from 44.7 in Kassala to 35 in White Nile with regional average of 41.4 and standard deviation 3.9. Again the deprivation in the decent standard of living dominated the human poverty as indicated by high $ESSI_3$ values.

Table 4: Spatial views of human poverty in Northern Sudan (2000): A rural–urban profile

	Rural human poverty in Northern Sudan (2000)						
State	**(HPI)i**	**Rir**	**ERSIi**	**ESSI1**	**ESSI2**	**ESSI3**	
N. Kordofan	70.8	1	0.2958	0.002	0.369	0.629	
W. Darfur	67.5	2	0.1479	0.003	0.376	0.621	
Blue Nile	65.9	3	0.0986	0.009	0.431	0.560	
Red Sea	62.9	4	0.0739	0.013	0.124	0.863	
W. Nile	57.5	5	0.0592	0.005	0.157	0.838	
N. Darfur	56.6	6	0.0493	0.006	0.427	0.567	
S. Darfur	55.9	7	0.0423	0.005	0.368	0.627	
Kassala	55.0	8	0.0370	0.014	0.281	0.705	
Gedaref	54.9	9	0.0329	0.006	0.258	0.736	
W. Kordofan	53.4	10	0.0296	0.005	0.492	0.503	
S. Kordofan	50.0	11	0.0269	0.014	0.453	0.533	
Sennar	43.6	12	0.0246	0.012	0.381	0.607	
Gezira	39.6	13	0.0228	0.003	0.275	0.722	
Khartoum	37.1	14	0.0211	0.016	0.779	0.205	
River Nile	34.8	15	0.0197	0.010	0.250	0.740	
Northern	29.8	16	0.0185	0.015	0.171	0.814	
Gini Coefficient	0.128						
ALL	51.3	ALL	RHDF	0.008	0.338	0.654	
	Urban human poverty in Northern Sudan (2000)						
State	**HPI**	**Riu**	**ERSIi**	**ESSI1**	**ESSI2**	**ESSI3**	**DRi**
W. Darfur	39.1	1	0.2958	0.01	0.34	0.65	1
Blue Nile	36.6	2	0.1479	0.04	0.31	0.65	2
Gedaref	33.4	3	0.0986	0.01	0.36	0.63	6
S. Kordofan	33.0	4	0.0739	0.04	0.16	0.80	7
Kassala	31.2	5	0.0592	0.04	0.52	0.44	3
S. Darfur	31.1	6	0.0493	0.01	0.48	0.50	1
N. Kordofan	27.5	7	0.0423	0.02	0.32	0.66	- 6
W. Kordofan	26.5	8	0.0370	0.03	0.56	0.41	2
Sennar	25.1	9	0.0329	0.05	0.46	0.49	3
N. Darfur	24.6	10	0.0296	0.03	0.29	0.69	- 4
W. Nile	23.7	11	0.0269	0.04	0.20	0.76	- 6
Red Sea	23.4	12	0.0246	0.12	0.24	0.64	- 8
Northern	21.4	13	0.0228	0.03	0.75	0.22	3
River Nile	16.7	14	0.0211	0.04	0.51	0.45	1
Khartoum	16.1	15	0.0197	0.15	0.48	0.38	- 1
Gezira	14.3	16	0.0185	0.01	0.32	0.68	- 3
Gini coefficient	0152						
ALL	24.9	ALL	UHDF	0.03	0.12	0.84	All

Source: own computation based on 2000 MICS survey data

Note: HPI = Human Poverty Index; R_i^r = the rural ranking of State i by HPI; R_i^u = the urban ranking of Statei by HPI; $ERSI_i$ = the equitable regional share of State I; $ESSI_j$ = the equitable sectoral share of sectorj

RHDF = rural human development fund; UHDF = urban human development fund

DRi = the difference in States ranking by rural and urban poverty ($R_i^r - R_i^u$); G = Gini coefficient.

Table 5: Human poverty in Sudan: magnitude and distribution

State	HPI	R	$ERSI_i$	$ESSI_1$	$ESSI_2$	SSI_3
Group1						
Lakes	73.5	1	0.2621	0.0009	0.5382	0.4609
E. Equatoria	71.1	2	0.1310	0.0033	0.4865	0.5102
Unity	69.6	3	0.0874	0.0049	0.7411	0.2540
N. Bar el Ghazal	67.4	4	0.0655	0.0081	0.7109	0.2810
Warrab	67.0	5	0.0524	0.0057	0.7270	0.2673
Group2						
Jonglei	65.9	6	0.0437	0.0056	0.7070	0.2874
W. Bar el Ghazal	65.2	7	0.0374	0.0059	0.7473	0.2468
Upper Nile	62.7	8	0.0328	0.0051	0.5507	0.4442
W. Darfur	57.7	9	0.0291	0.0147	0.2864	0.6989
Central Equatoria	53.8	10	0.0262	0.0050	0.2970	0.6980
Group3						
S. Kordofan	52.0	11	0.0238	0.0128	0.3035	0.6837
W. Equatoria	51.8	12	0.0218	0.0064	0.2678	0.7258
S. Darfur	50.3	13	0.0202	0.0119	0.2552	0.7329
Blue Nile	49.4	14	0.0187	0.0270	0.3289	0.6440
N. Darfur	45.3	15	0.0175	0.0233	0.1571	0.8196
Group4						
Kassala	44.7	16	0.0164	0.0196	0.3400	0.6404
Gedaref	44.4	17	0.0154	0.0249	0.2307	0.7444
N. Kordofan	42.7	18	0.0146	0.0198	0.2465	0.7338
Red Sea	40.9	19	0.0138	0.0258	0.2696	0.7045
White Nile	35.0	20	0.0131	0.0283	0.2184	0.7534
Group5						
Sennar	33.9	21	0.0125	0.0293	0.4900	0.4808
River Nile	25.6	22	0.0119	0.0587	0.1151	0.8262
Northern	23.2	23	0.0114	0.0779	0.2008	0.7213
Gezira	19.2	24	0.0109	0.0794	0.5144	0.4063
Khartoum	14.3	25	0.0105	0.2081	0.4924	0.2995

Source: own computation based on (2006) MOH survey data.
Note: HPIi = Human Poverty Index; R = the rank of the States vis-à-vis poverty in a descending order.
ESSIj = the equitable sectoral share in development. For j = [1, 2, 3]; ERSIi = the equitable development share of State i

Finally, from the above analysis we can glean two important development policies for human poverty reduction in Sudan: (a) Since the deprivation in decent standards of living was the dominant component of HPI as indicated by high $ESSI_3$ values, human poverty reduction in Sudan will quickly respond to pro-poor economic growth, and (b) vertical equity in development can easily be achieved by application of the ERSI. For example, while Lakes State should have 26.2% of the development basket (Table 5), given the political will then Khartoum State should have only 1.1%. The geographical view of (Table 5) is given in (Fig. 2).

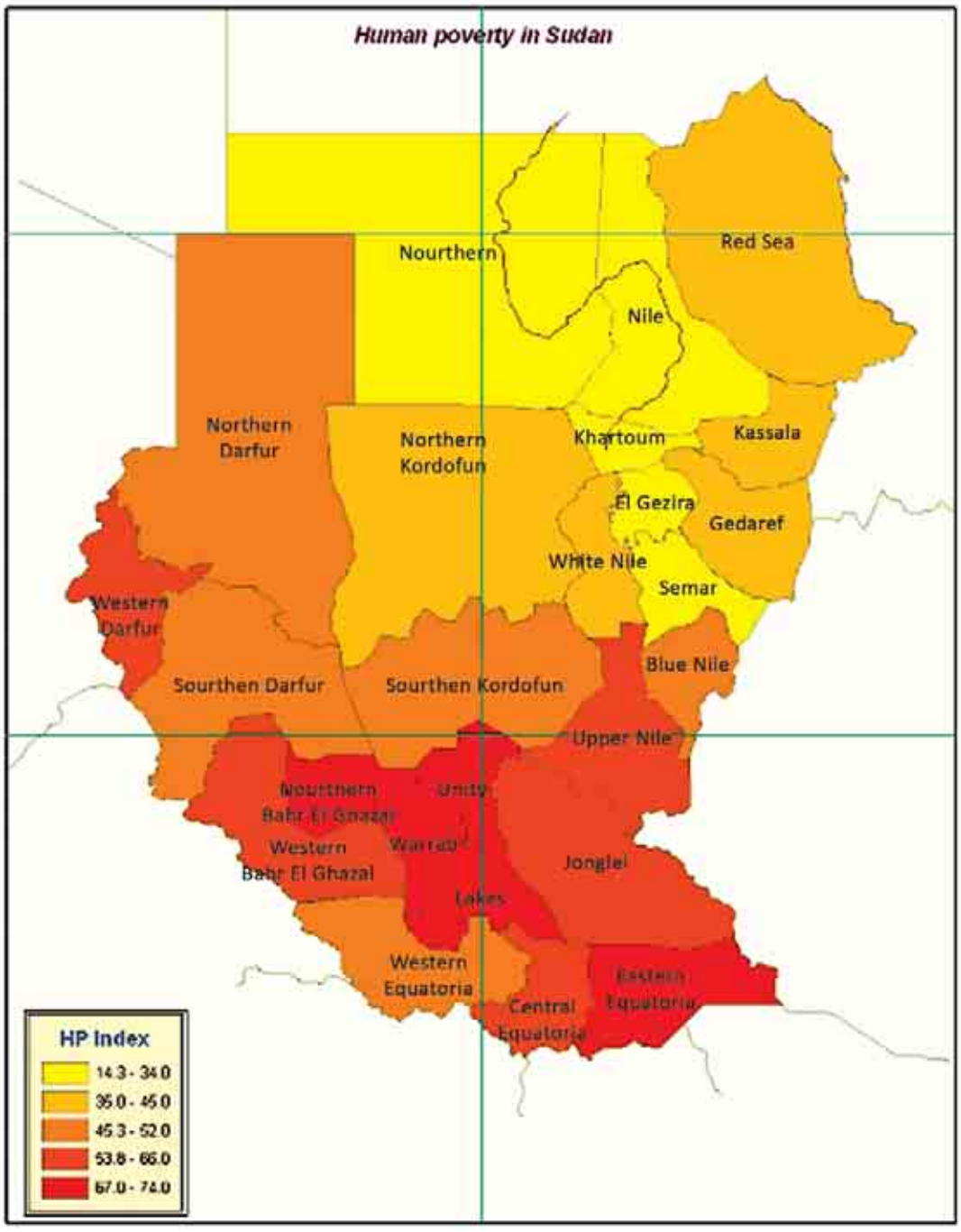


Figure 2. Magnitude and distribution of human poverty in Sudan

4. INTERRELATIONS BETWEEN AGRICULTURE AND POVERTY DISTRIBUTION

4.1 Sudan's natural resource base

Sudan, with its large land expanses extending over about 2.5 million km^2 is bestowed with diverse natural resources. Agricultural activities, forming the main source of livelihood in the country, are basically geared by the magnitude of natural resources. This is particularly so on account of the low level of use of modern agricultural inputs such as fertilizers and pesticides. While soil types vary across the country, agro-ecological characteristics are largely shaped by climatic variation along its north–south axis. With latitude 3°N roughly forming a tangent to its southern borders, Sudan's territory crosses over 18 degrees of latitude, providing an extremely diverse environment ranging from arid desert in the north to tropical forests in the south (UNEP, 2007).

Rainfall is the single major component influencing natural resources and their use patterns. Rainfall increases along the north–south axis from almost nil at the northern borders to > 1400 mm in the south-western part of the country (Fig. 3). The belt stretching across the central part of the country hosts most of the agricultural crop and livestock activities in Northern Sudan. Rainfall there ranges from about 125 mm to a little over 700 mm. Most of the administrative regions fall within rainfall zones characterized by the north–south rainfall decrease (Fig. 3). All their southern parts enjoy reasonable amounts of rainfall with approximate range 300–700 mm.

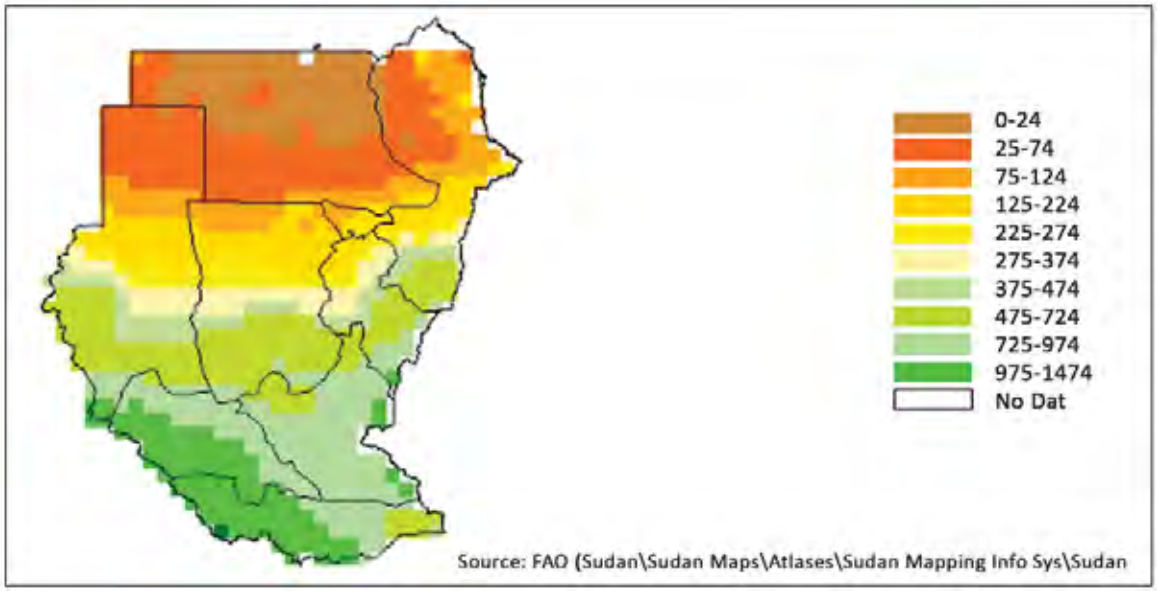


Figure 3: Sudan's average rainfall distribution

The variability of Sudan's agro-ecological resources was reflected by (Purnell and Venema, 1976), who identified 16 mapping units with different agricultural potential, and based on the interplay of soils and climate were further divided into 38 sub-classes across the country. These units extend from a desert type in the north through the 'qoz' soils and the Central and Southern Clay Plains up to the Marches, Green Belt and Southeastern Uplands in the far south. Yet Sudan's climatic zones are commonly simplified into five major categories, namely (running from north to south), Desert, Semi-desert, Woodland Savanna, Flood Region, and Montane Vegetation (El Wakeel, 2005). The desert (with < 75 mm of annual rainfall) and semi-desert (with maximum rainfall of 300 mm) together cover almost half (49%) of the area of the country. Soils differ in their characteristics; however, it can be generalized that most of Sudan's soil types do not face unmanageable constraints that impair agricultural production such as high water tables or presence of salinity (Ali, 1996). Rainfall is generally variable, reflected in annual variations of 45% in northern Sudan and 15% in the south and south-east (Eltom, 1996).

In addition to rainfall, variable as it is, Sudan's water resources are augmented by flows from the Nile and its tributaries, annual flows from many seasonal rivers and streams and groundwater. The surface water from rivers and streams is primarily confined to the northern, central and eastern parts of the country as well as most of Southern Sudan. Western Sudan is mainly dependent on rainfall and groundwater in addition to seasonal streams that dry out shortly after the rainy season. The Nile system provides 22.5 billion m^3 of water measured in the central part of the country according to the 1959 Nile Waters Agreement between Egypt and Sudan. The total annual average flow of non-Nile surface water is 6–7 billion m^3 depending on rainfall intensity and distribution (FAO, 1997). Renewable groundwater sources, which cover about half of Sudan's area, are estimated at 2.6 billion m^3 (Eltom, 1996), but other estimates are of 4 billion m^3 (FAO, 1997). The total theoretical water endowments of the country are not accurately determined, yet an estimated figure of about 30 billion m^3 is given by (Farah, 1998). Utilization of most of this water is bound with high costs due to the diverse geography and variable nature of water flows among and within years (Eltom, 1996). Despite this, there is considerable potential to develop Sudan's water resources to expand irrigated areas and employ water-harvesting techniques to improve agricultural productivity; a situation congruent with the objective of poverty reduction.

4.2 Farming systems

Sudan's farming systems are commonly classified into three major categories, namely irrigated, mechanized rainfed, and traditional rainfed systems. Livestock as a system is actually intermingled within the three cropping systems, but is predominantly spread within the traditional rainfed agriculture in the form of pastoral grazing with an over-riding transhumance mode of livestock keeping. However, many sub-systems exist within these major systems. Irrigated agriculture comprises three sub-categories: (1) The large parastatals of Gezira, Rahad, New Halfa, and Suki; (2) pump irrigation along the Blue Nile, White Nile, and the main Nile in the northern parts; and (3) flush irrigation in Gash and Tokar Deltas in eastern Sudan, as well as many small basins in Northern Sudan and other parts of the country. Traditional rainfed agriculture is also diverse, with large areas under clay soils across central and southern Sudan and others under sandy '*qoz*' soils in the western parts. Further, a diversity of scattered cultivation is practiced in '*wadis*' that capture rain water in drier areas of the country.

With a total arable land of about 84 million ha, the average area under cropping during the period 2004–2006 amounted to close to 17 million ha (Table 6) representing some 20% of the total arable land. The distribution of crop cultivation over the three main farming systems (Table 6) indicates wide prevalence of traditional agriculture (58%) and sizeable mechanized cropping (33%). Irrigated farming, although smaller in area, is very important in total value of production and contribution to the country's GDP relative to the other two sectors (Table 6).

Table 6: Shares of main agriculture sub-sectors in area and GDP (average 2004–2006)

Agriculture sub-sector	Area (million ha)	% Share in Area	% Share in GDP
Irrigated (2 sub-sector)	1.537	9	11.3
Traditional rainfed	9.812	58	6.3
Mechanized rainfed	5.513	33	1.4
Total	16.861	100	19.0

Source: Calculated from the Economic Survey 2006, Ministry of Finance and National Economy.

In general terms, the main crops grown in the irrigated sector are cotton, wheat, sorghum, and groundnuts. The traditional rainfed sector is dominated by sorghum in the central clay soils where sesame, sunflower, and limited amounts of cotton are produced. In the sandy soils of western Sudan the major crops are millet, sesame, and groundnuts, but there are notable areas of other crops such as roselle (karkadeh) and water melon as a water source. In areas of mechanized agriculture in eastern, central, and western Sudan, sorghum and sesame are the major crops, but sunflower production is of increasing importance and cotton is also produced. Vegetables and fruits are found in almost all parts of the country, although they are more important in the north, which is also the hub of production of cool-season food legumes such as faba bean, chickpea, and lentil.

Livestock production, which contributes about 20% to the total GDP, prevails all over the country under three main sub-systems. The most prevalent is transhumant animal keeping within an agro-pastoral system characterized by presence of arable farming and livestock migration in part of the season in search for feed and water. Sedentary livestock keeping is also widely spread and is more obvious under irrigated farming; the most intensive type is the relatively modern dairy farming in urban and peri-urban locations in most parts of the country. Nomadic livestock keeping is also found in all parts of northern Sudan, but is decreasing in importance as nomads represented 3.4% of the total population in 1993 compared with about 14% in 1956 (Zarroug, 1996).

Southern Sudan enjoys a relatively rich and abundant resource base but its utilization has been impaired by the decades-long civil war. The growing season, which varies from 130 to 300 days from north to south, provides variable agricultural potential. While at least two consecutive harvests can be gained in the greenbelt located from Tambura (Western Equatoria) to Kajo-Keji (Central Equatoria), crop failures can be experienced in the marginal areas of Eastern Equatoria and Northern Bahr el Ghazal (FAO/WFP, 2008). Crop production is practiced on small hand-cultivated units mostly by women-headed households. Sorghum is widely grown in addition to minor crops of maize, bulrush millet, finger millet, and upland rice according to location. In the northern parts cropping activities include groundnuts, which make a significant contribution to the household food economy, and a diversity of other crops such as green gram, cowpeas, beans, sesame, pumpkins, and tobacco. In the south and central areas, cassava is the most important contributor to the household food economy, but other minor crops of sweet potatoes, yams, coffee, mangoes, papayas, and teak are also grown for home and some localized commercial use.

Agriculture in Southern Sudan is labor intensive and livelihood generally depends highly on cattle-raising (except in areas infested with tsetse fly), in addition to other activities such as crop production, fishing, hunting, collection of honey and other wild foods, and trade (SSCCSE,undated; FAO/WFP, 2008). Region-wise, pastoralism dominates in the far south-east and crop production in the southwest. Fish and wild foods are more prominent along the Nile and its tributaries, supplementing cattle products and crops. Cattle, thriving on the rich floodplains, provide the fundamental basis for wealth, status, and social linkages. The rich resource setup and seasonal variability allows people to utilize food availability in different seasons and areas, but this depends on ability of people to move, trade, and feed their livestock. Accordingly food problems exist only when such movement is hindered due to security problems. Yet, as mentioned above, agro-climatic conditions induce high variability from bumper harvests to crop failure.

4.3 Developments in use of natural resources

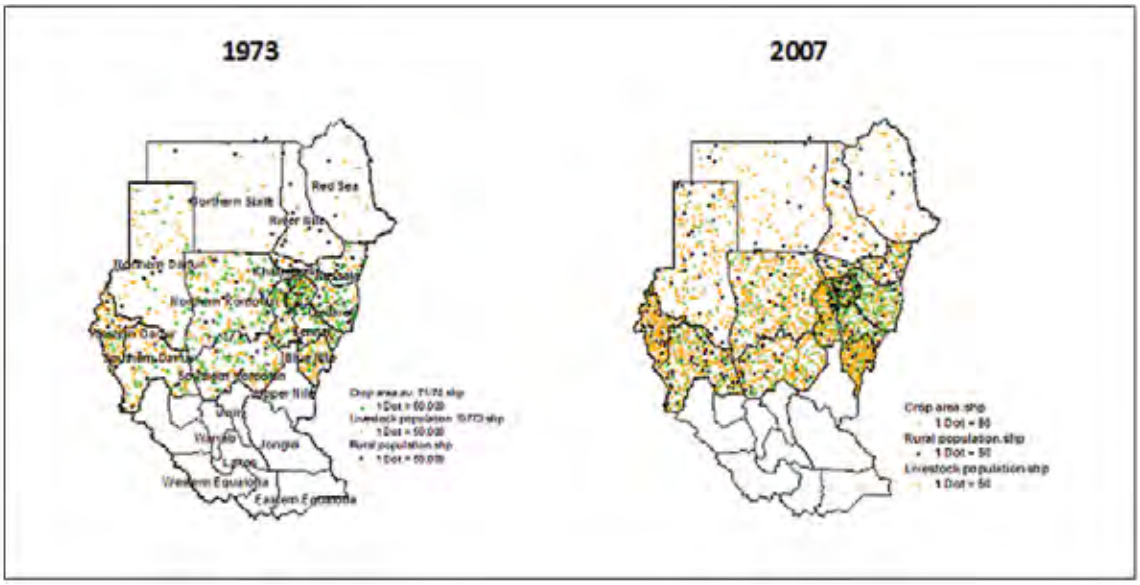
While yield-enhancing inputs and technologies have been fairly applied in Sudan's irrigated agriculture, production in the vast rainfed sector has mainly depended on the natural base of available land and natural water sources from rainfall and seasonal rivers and streams. Enormous pressures have been exerted on those natural resources over time. Some 50 years ago, land was generally far in excess of demand and natural resources were capable of sustaining the livelihood of people even under problematic land use patterns (Tothill, 1948). Hinging on the prevailing problematic land tenure system, such pressures have mounted since then and developments in human and livestock populations and arable cropping (Table 7), as well as deforestation have been largely behind degradation of the natural resource base.

There have been tremendous increases in rural population, livestock population and copped area (Table 7) and shown spatially in (Fig. 4). Noticeable are the high livestock growth rates, substantially surpassing those of the rural population and reflecting rising per capita livestock numbers in rural areas that increased annually by an average of 1.66%. The per capita growth rates were variable among regions; highest in Khartoum (3.3%) despite its low importance, and the north (3.2%). Relatively high growth rates were also derived for the Central and Kordofan Regions (2.7 and 2.2%, respectively). Rates were relatively lower in the Eastern Region (1.5%) and negative in Darfur due to migration influxes. Growth rates in terms of Tropical Livestock Units have been slower in all regions (except the Central Region where they increased to 4.2%), indicating a shift towards small ruminants (Faki et al., 2008).

Table 7: Growth in rural human and livestock population and crop areas, 1973–2007

Region	Rural Population (million)		Livestock Population (million)		Crop Areas (million feddans*)	
	1973	2007	1973	2007	Average 1971–1975	Average 2003–2007
North	0.753	1.177	1.003	4.877	0.102	0.512
Khartoum	0.899	0.731	0.506	1.310	0.014	0.185
Central	2.971	5.241	7.031	31.603	3.915	8.272
Eastern	1.228	2.605	2.472	8.955	2.544	6.819
Kordofan	1.720	2.848	6.819	24.529	6.117	9.299
Darfur	1.703	5.673	11.039	30.374	2.242	7.692
Total	9.273	18.275	28.869	101.647	14.933	32.779
Growth (%)**	1.94		3.60		2.25	

* 1 feddan = 0.42 ha (total area of major crops).
**Average Annual Growth (%) – exponential growth.
Source: adapted from (Faki et al., 2008) based on computations from statistics of the Central Bureau of Statistics, Ministry of Agriculture & Forests, Ministry of Animal Resources & Fisheries, Sudan.



Source: Compiled by authors, Rural and livestock population (dots) are in thousands; crop areas (dots) in thousand feddans
Crop areas are averages of 1970/71–1974/75 in the first period, and 2002/2003–2006/2007 in the second period

Figure 4. Rural population, livestock population and total crop areas by State – 1973 and 2007

Deforestation has been significant. The FAO data shows that total forests have been reduced by 8.247 million ha, or 11.6%, between 1990 and 2005. (UNEP, 2007) estimated the increase in deforestation at an annual rate of over 0.84% at the national level, while at the regional level, two-thirds of the forests in north, central, and eastern Sudan disappeared during 1972–2001. In Darfur, one-third of the forest cover was lost during 1973–2006. UNEP indicates that forest cover could decline by > 10% per decade, with total loss expected within the next 10 years in high pressure areas.

The land tenure system has been a major underlying factor behind use of natural resources. Under the Land Resettlement and Registration Ordinance of 1925, which is still largely in force (De Wit, 2001), all unregistered land belongs to the government while community rights are recognized over its use under customary rules. Individual land registration is limited, while long land lease applies in public irrigation schemes and in large semi-mechanized rainfed private holdings. Communal land use provides incentives

to irrationally increase livestock herds and encourages crop expansion with almost no soil conservation measures, leading to soil mining under continual relaxation of the shifting cultivation system that was previously followed.

Fairly balanced management of natural resources had been practiced by the traditional leadership system till its dismantling in the early 1970s. The control over natural resource management has therefore undergone profound relaxation, resulting in misuse through deforestation and over-grazing (De Wit, 2001). The land issue has strongly emerged within the Comprehensive Peace Agreement (CPA) of 2005 that ended the long-running South–North war. National and regional land commissions are to be set under the CPA terms to consider, among others, mechanisms that would allow transfer of current land use rights to long-term lease rights. This will convey additional value to the lease holders (Faki and van Holst Pellekaan, 2007), but more importantly would encourage more rational use of natural resources.

5. INCOME FROM AGRICULTURAL ACTIVITIES

5.1 Methodology for estimating agricultural income distribution

An attempt was made to estimate average per capita rural income from agriculture in each of the 15 northern states, using detailed calculations based on data available at the state level. The estimates were inspired by similar income assessments in Syria based on gross income calculations (Szönyi et al., 2005). However, income derivation here was based on gross returns from crops and livestock less intermediate inputs that mainly constituted machinery use, fuel (for machinery and water provision), and agricultural chemicals. The following procedure and assumptions were adopted in the computations:

- Crop and livestock production data available from official statistics, mainly the Ministry of Agriculture and Forests (MAF), the Ministry of Animal Resources and Fisheries (MARF), and Ministries of Agriculture (in some states), were compiled as disaggregated by state for Northern Sudan. Areas and production for each crop are taken as the average of the most recent five-year period (2002/2003–2006/2007) to accommodate the annual fluctuations that usually apply to crop production in the country. However, for a few crops, such as sweet potatoes, *karkadeh*, and melon seed, most recent and best-bet estimates used were based on recorded data. For many horticultural crops, state-level data were available only for 2002/2003. Disaggregation by state was derived from the ratios in that season and the annual totals already reported for the whole country. The livestock data were for the year 2007, which represents the current situation based on the fact that livestock population has a positive exponential trend of growth.
- The most recent prices were used; predominantly those prevailing in 2007 but prices of some products, especially horticultural crops and livestock were estimates based on the ruling general market prices. Farm-gate prices are used as far as available data permitted where for some crops resort was made to the FAO producer prices reported on the web-based FAOSTAT (http://faostat.fao.org/default.aspx).
- Computations were made for each crop or livestock product for each state, from which the total returns per activity (production × price) costs of intermediate inputs were deducted to arrive at total income per activity per state. The values of byproducts, mainly crop residues, were added as percentages of gross returns based on estimates that depended on the crop type. Labor costs were not included in the cost calculations, on the assumption that they represented income transfers to family labor or agricultural labor in the state.
- The range of crop products included in the assessment were as follows:
  - Field crops: sorghum, millet, and wheat.
  - Oil crops: sesame, groundnuts, and sunflower.
  - Winter legumes: faba bean, beans, and chickpea.
  - Fibers: cotton.
  - Tree crops: gum Arabic.
  - Vegetables and spices: onion, tomato, okra, eggplant, leafy vegetables, cucurbits, potato, sweet potato, and spices (*karkadeh* is included in this group).
  - Fruits: mango, banana, grape fruit, orange, lemon, and dates.

- Sugar was not included since its production is predominantly private business-oriented or state-owned using direct labor. Also forestry products other than gum Arabic were not included due to the difficulty of sourcing or estimating state-level data. Pastures were assumed to be consumed by livestock and were hence excluded from computations.
- Livestock incomes (from cattle, sheep, goats, and camels) were derived as those accruing from sales of live animals and milk. Live animal sales were computed by distributing the total off-take numbers reported by MARF for the states according to their shares of animal numbers and multiplication by an estimated average price, which was based on (Faki and Van Holst Pellekaan, 2007) and authors' estimates. Quantities of milk produced were estimated according to assumptions on the ratios of females in the herds of various animal types, lactating females, lactation periods, and milk production per head. However, due to the fact that livestock was primarily raised under pastoral systems in remote areas, the amount of milk available for sale was much less than that produced. Deflating factors have been introduced by state taking into consideration the location effect with respect to urban consumption centers and access to markets. In a similar manner, milk prices were estimated according to such criteria, with lower levels in remote rural areas.
- Total income was derived by state and, using the state-level rural population given by the Central Bureau of Statistics (CBS), average per capita income was derived for each of the crop and livestock categories as well as for all agricultural activities under consideration.

The estimated total and average per capita income by state for crops, livestock and the total for agriculture are presented in (Table 8). Aggregate total income might be compared with the GDP calculated for the whole country. According to CBS data, the average national agricultural GDP or AgGDP for the period 2002–2006, excluding forestry and fisheries, was computed to amount to SDG 23,740 million. The estimated AgGDP of SDG 15,646 million (Table 8) represents about 66% of the CBS reported total. In the absence of information of disaggregated GDP for northern and southern parts of the country, this figure looks reasonable for the Northern States, especially that some agricultural activities, e.g. sugar and probably some minor crops were not included in the calculations.

Table 8: Estimated total and annual per capita income from agriculture by state and per capita-income ranking

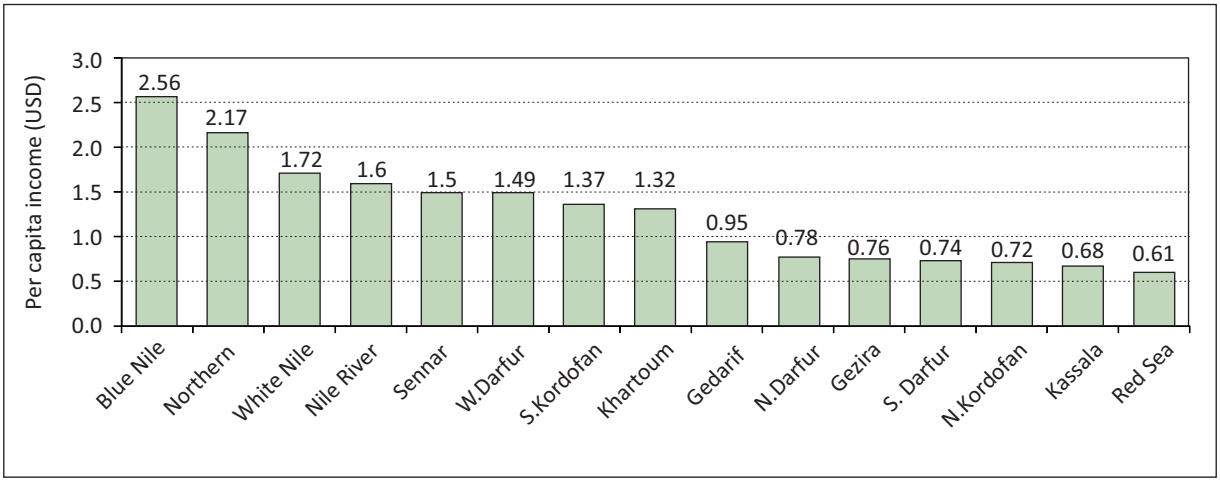
State	Total Income (SDG '000)			Average per capita (SDG)			Per Capita Income Rank		
	Crops	Livestock	Total	Crops	Livestock	Total	Crops	Livestock	Total
Northern	653,446	215,515	868,961	1215	401	1,616	1	5	2
River Nile	580,985	181,482	762,467	909	284	1,193	2	10	4
Khartoum	585,701	129,017	714,718	809	178	987	3	15	8
Sennar	747,158	312,930	1,060,088	788	330	1,117	4	8	5
West Darfur	1,021,603	703,258	1,724,861	657	453	1,110	5	3	6
South Kordofan	1,013,351	722,638	1,735,989	595	424	1,019	6	4	7
Blue Nile	241,469	784,983	1,026,452	450	1,463	1,913	7	1	1
Gedaref	492,383	301,786	794,169	440	270	710	8	11	9
White Nile	273,566	705,848	979,414	359	925	1,284	9	2	3
Gezira	1,002,936	723,043	1,725,978	331	238	569	10	13	11
Kassala	372,267	219,155	591,422	317	187	504	11	14	14
South Darfur	778,159	664,928	1,443,087	300	256	556	12	12	12
North Darfur	355,072	449,459	804,531	256	324	579	13	9	10
North Kordofan	473,507	820,138	1,293,645	195	338	534	14	7	13
Red Sea	26,582	94,023	120,606	100	353	453	15	6	15
Total	8,618,186	7,028,203	15,646,389	444	362	806			

Source: Authors' estimates

Income disparities (Table 8) reveal annual per capita (in SGD) of 100–1215 for crops, 178–1463 for livestock and 453–1913 for all agriculture. The corresponding averages for Sudan were SDG 444, 362, and 806. Ranking of states indicated that North, River Nile, and Khartoum enjoyed the highest per capita income from crops, while North Darfur, North Kordofan, and Red Sea States had the lowest. With regard to livestock, Blue Nile, White Nile, and West Darfur States had the highest per capita income; while Gezira, Kassala, and Khartoum had the least. It is generally true that states with high income from crops had irrigation facilities and those with high income from livestock enjoy substantial rainfall under the pastoral system of animal keeping.

5.2 Agricultural-income levels

The aggregate per capita income per day was derived at US$1.08 at an exchange rate of SDG 2.05 per US$. While acknowledging variation among states, the country is as a whole is close to the edge of poverty according to the average cost of the food basket computed in Section 7 at an equivalent US$1.1.
The array of per capita income per day in US$ for the 15 Northern States (Fig. 5) and range from US$2.56 (Blue Nile) to US$0.61 (Red Sea). Seven states fell below the poverty line on the basis of agricultural incomes, most likely as agriculture provides the main livelihood source in rural Sudan.



Source: authors' calculations based on statistics of the Ministry of Agriculture and Forests, Ministry of Animal Resources and Fisheries, various data from some states, records of irrigation schemes (Gezira and Rahad).

*Figure 5. Estimated average per capita agricultural income (US$) * in rural areas in different states at average yields in the period (2006/2007) and current prices*
** Derived at an exchange rate of SDG2.05/US$*

Despite this, presence of other income sources was highly likely, such as small businesses and remittances. However, the analysis did not allow any type of inter-state disaggregation to identify agricultural income poverty levels among various population groups who possibly undertake different agricultural activities. For instance, in almost all states with irrigation facilities, rainfed agriculture is also practiced to varying degrees. Evidence shows that yields under the latter system are poor, but the farm size could matter as far as per capita income levels are concerned. Likewise, gender disparities could not be articulated, but they have been considered within the earlier-presented human poverty analysis.

It should be noted that, while the low-income states include those that are usually reported to have high poverty levels, namely North Kordofan, Kassala, Red Sea, and North and South Darfur, estimates also reveal income poverty in the rural areas of Gedaref and Gezira States, which until now have been considered outside the poverty zone. In Gezira State, this is likely a result of the enormous restructuring challenges that have been facing the Gezira Scheme in recent years, which is the major source of agricultural income in the State. Gedaref, even with its known lead in producing sorghum and sesame, has been prone to low and deteriorating crop productivity and low prices of the crops produced. Income poverty in Gedaref may be higher than indicated by the figures if it is considered that the state is highly dominated by semi-mechanized crop production in the hands of big investors, with limited spill-over

income effect to small rural households. It is also worth noting that Khartoum, which might be considered a relatively favored state, has rural part is not far from the fringes of poverty. The whole situation may indicate temporal spread of poverty in Sudan's rural areas.

It is also worth noting that the estimates confirmed that the frequently mentioned problems in the Blue Nile, West Darfur, and South Kordofan are in fact a product of instability due to civil conflict rather than poor resource productivity; a situation also evident from the earlier-displayed analysis of human poverty indicators. These areas are relatively rich in land and water resources and accommodate sizeable crop and livestock activities that provide decent incomes relative to the size of their rural population. The Blue Nile State is favored with high rainfall and rich land cover. It hosts a variety of crops and forestry resources while it boasts considerable livestock wealth. West Darfur, with its reasonable rainfall, its mild weather as influenced by the Jebel Marra Plateau and its land abundance hosts a range of agricultural activities including horticultural crops that provide satisfactory incomes. However, the area has been negatively affected by a high influx of people moving from neighboring countries, encouraged by abundant land and relatively rich resource endowments and putting high pressure on its natural resources (van Hollst Pellekaan, 2007). South Kordofan also enjoys rich natural resources and the estimated figures of per capita income were most likely reduced by the effect of joining part of the former West Kordofan State to South Kordofan in 2007, while the other part went to North Kordofan.

It is yet to be mentioned that these states, especially South Kordofan and Blue Nile, in addition to Gedaref, Sennar, and White Nile accommodate large expanses of mechanized farming with big holdings in which mostly sorghum and sesame are grown. The income distribution would therefore be highly affected by that from these large holdings, resulting in high income skewness. Accordingly, per capita incomes derived in these states might hide more widespread poverty.

5.3 Spatial poverty changes over time

The poverty analyses displayed earlier showed spatial rural poverty distribution and its ranking in 1990 and 1996 over the six administrative regions of Northern Sudan at that time. Aggregation of agricultural income and its ranking according to these divisions allowed wider temporal fair-comparison of poverty distribution, but taking into consideration that ranking in the latter year was confined to agricultural income while the analysis in the former two years was based on rural income. This is illustrated in Figure 6, which displays in discrete categories the changes in regions' ranks from 1990 to 2007. The regions' sequence was set according to the 2007 ranking, while the ranks are reversed in the sense that small numbers in the scale indicate poorer regions and vice versa (Fig. 5).

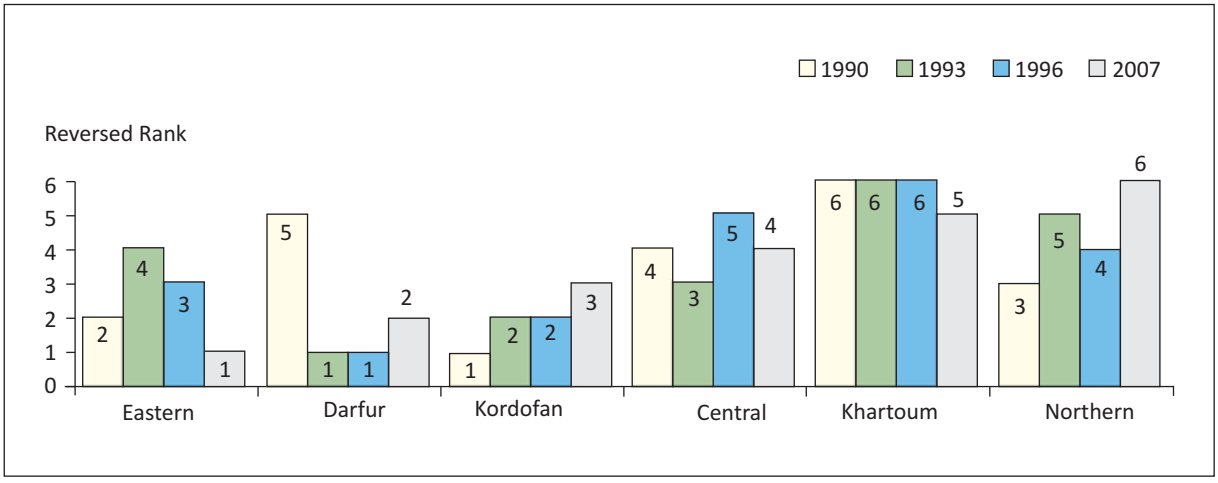


Figure 6. Temporal changes in rural income poverty ranking by region in Northern Sudan

Khartoum generally kept its front position in spite of a set-back in 2007, while distinguishable improvements are evident for the Northern region. The Central Region had some fluctuations but was more on the advanced side, also with a set-back similar to Khartoum in 2007. The situation in the Eastern and Darfur regions deteriorated in general. Kordofan witnessed successive slow improvements, with its rank always at the lower level of the scale, yet its division into North and South parts (Fig. 6) displayed a different picture with North Kordofan on the poorer side. The three regions of Eastern, Darfur, and Kordofan exchanged generally low positions except for the exceptionally advanced rank of Darfur and the modest one for the Eastern Region in 1993. In essence, and as mentioned earlier, resource endowments and their management made the difference between the poor and relatively better regions. The three poorer regions are largely rainfed, encountering irrational management, poor investment [as revealed by the human poverty calculations and by (Elbashier and Faki, 2008)], deteriorating resources, and decreasing productivity (as discussed later). The relatively better ones were largely irrigated, with generally rising productivity but the management and policy issues also posed problems as indicated by the lower ranks in the Central Region, and especially Gezira, in 2007.

5.4 Interface between income, agricultural, and human poverty

Straight-forward delineation of the income, agricultural, and human poverty status per state was faced with the difficulty that the latest figures on income poverty (1996) were on a per region basis while those of agriculture (2007) and human (2006) were analyzed per state. To bring the three indicators together required computations per region as a common denominator. (Table 9) gives the ranking of the six northern regions according to each indicator.

Table 9: Ranking of regions in Northern Sudan according to income, agricultural, and human poverty indicators

Region	Income (1996)		Agricultural (2007)		Human (2006)	
	Indicator[1]	Rank	Indicator[2]	Rank	Indicator[3]	Rank
Darfur	97	1	1.0	2	51.1	1
Kordofan	96	2	1.0	3	47.4	2
Eastern	94	3	0.7	1	43.3	3
Northern	93	4	1.9	6	24.4	5
Central	91	5	1.6	5	34.4	4
Khartoum	80	6	1.3	4	14.3	6

1 = poverty incidence; 2 = per capita agricultural income; 3 = HPI

Income and human poverty seemed to go together, except for the slight reversal in the Central and Northern Regions. Agricultural poverty was in line with both income and human poverty, where Darfur, Kordofan, and Eastern Regions were poorer than the remaining regions. On the other hand, Khartoum was more disadvantaged from the agricultural side, while the Eastern Region was the most agriculturally disadvantaged region as compared with its somehow better position in human and income gains.

Generalization over regions is not accurate, since for example in the Eastern Region it can be argued that Gedaref State was agriculturally better-off than Kassala, which was in turn better-off than Red Sea State. Yet overall, it is evident that high interactions exist among the three poverty components, indicating that integrated development is essential if poverty in all its measurable indicators is to be reduced.
State-wise comparisons were made with respect to agricultural and human poverty indicators (Table 10), in which ranking according to incomes from agriculture were superimposed on the ranking with respect to human poverty in descending order.

Four states (lightly shaded) had a relatively lower position on the basis of both agricultural and human poverty indices (Table 10): South and North Darfur, Kassala, and Gedaref. In these states both human and agricultural income developments are needed. Another four states (shaded darker) encountered relatively less deprivation in both measures (Table 10): White Nile, Sennar, River Nile, and the Northern States and may have a delayed priority in interventions. Other states had variable rankings. West Darfur, South

Kordofan, and Blue Nile had higher human deprivation and accordingly require more inputs in this area. North Kordofan, Red Sea, and Gezira States suffered more from agricultural poverty although their human poverty status was somehow moderate, except for Gezira where human deprivation was relatively low. In those states promotion of agriculture is more urgent. Khartoum is a special case where agriculture needs some emphasis. The nature of agricultural interventions is highlighted in the following section, based on contribution of various agricultural activities to agricultural incomes.

Table 10: State-wise human and agricultural income poverty and their ranking

State	HPI		Agricultural Income	
	Level	Rank	Level	Rank
W. Darfur	57.7	1	1.49	10
S. Kordofan	52	2	1.37	9
S. Darfur	50.3	3	0.74	4
Blue Nile	49.4	4	2.56	15
N. Darfur	45.3	5	0.78	6
Kassala	44.7	6	0.68	2
Gedaref	44.4	7	0.95	7
N. Kordofan	42.7	8	0.72	3
Red Sea	40.9	9	0.61	1
White Nile	35	10	1.72	13
Sennar	33.9	11	1.5	11
River Nile	25.6	12	1.6	12
Northern	23.2	13	2.17	14
Gezira	19.2	14	0.76	5
Khartoum	14.3	15	1.32	8

5.5 Contribution of various activities to agricultural incomes

To highlight possible interventions for improvement, it was useful to delineate agricultural income by the type of agricultural activity in different states; eight groups of such activities were identified and associated with their relative contribution to incomes (Table 11). States were sorted according to per capita income in a descending order in line with (Fig. 5) where the shaded area identifies states below the poverty line (US$1.1/d).

One striking feature was the dominance of livestock in contributing to total income from agriculture in most states. Especially high contributions were evident for the Red Sea, Blue Nile, White Nile, and North Kordofan States, with range 78–63%. On the other hand, such contributions were relatively low in Northern, River Nile, Khartoum, and Sennar States with range 18 to about 30%. Of the states with per capita income per day higher than US$1, dependence on livestock was high in Blue Nile and White Nile States, and on horticultural crops and legumes in North and River Nile States, although cereals had a notable contribution in River Nile state. In the remaining states in this group, livestock contributions were tangible in the western states of West Darfur and South Kordofan, but along with Sennar and Khartoum, horticultural crops had generally significant shares.

Except for North Darfur and Red Sea States, the bulk of income in the states below the US$1.1 threshold was generated from cereal and oil crops, in contrast to the higher-income group of states where these sources had lower contributions. The share of horticultural crops was sizeable within this group, especially in Kassala (both vegetables and fruits) and in North Darfur (for vegetables where relatively high production of cucurbits, tomatoes, and okra was reported). It can therefore be argued that horticultural crops and cool-season food legumes, in addition to a well-managed livestock production could form important options to raise incomes in these states.

Table 11: Distribution of values of produced crops within each of the northern States (%)[*]

State	Cereals	Oil Crops	Cotton	Gum Arabic	Legumes	Vegetables (including spices and *karkadeh*	Fruits (including dates)	Livestock
Blue Nile	4.7	3.3	0.1	0.2	0.3	5.0	9.9	76.5
Northern	14.5				12.4	6.9	41.3	24.8
White Nile	11.2	6.6	0.5	0.1	0.5	6.3	2.7	72.1
River Nile	12.6				9.4	32.3	21.9	23.8
Sennar	9.5	6.6	1.4	0.1	0.4	7.0	45.3	29.5
W. Darfur	3.0	0.8		0.2	0.4	24.4	30.8	40.8
S. Kordofan	13.5	5.6		0.5		15.4	23.2	41.6
Khartoum	0.6				1.0	37.1	43.1	18.1
Gedaref	24.2	12.9	2.0	0.7	1.0	9.5	11.5	38.0
N. Darfur	4.7	3.0		0.3		33.9	2.1	55.9
Gezira	14.1	5.4	7.6		0.7	17.3	13.0	41.9
S. Darfur	15.1	9.2		0.2		15.7	13.7	46.1
N. Kordofan	7.3	13.3		1.1		15.0		63.4
Kassala	17.7	4.8	1.7		1.0	19.1	18.6	37.1
Red Sea	4.3		2.7			10.4	4.6	78.0

[*]*Sorted in descending order according to average per capita income from Figure 5. Shaded area denotes states with average per capita income less than US$1 per day.*
Source: authors' calculations.

All these activities require a good market structure that enables efficient movement of products to consumption centers. Further, and except for Gezira, the low-income states were characterized by lower availability of water resources compared with the high-income states; a situation implying the importance of providing higher investments in sourcing water for agriculture. This is a well-recognized challenge that gained a leading priority in Sudan's recently developed Executive Program for Agricultural Revival (2008). An amount of SDG 486 million has been budgeted for water harvesting and as much as SDG 1485 million for irrigation facilities, representing respective shares of 10 and 31% of the Program's budget over the 2008–2011 period.

6. CROP PRODUCTIVITY

6.1 Crop yield levels and changes over time

Land productivity of crops forms an important factor influencing spatial distribution of incomes and poverty in various states. Obviously, the farm size and production costs are another two components closely related to productivity that shape incomes and poverty levels. Since spatial data on livestock productivity was scanty, focus was made on crop productivity in terms of crop yields, while agricultural income distribution will be considered in the next section.

(Table 12) shows comparisons of yields per unit area of the major crops in various states over two five-year time periods (1970/71–1974/75 and 2002/03–2006/07) listed according to the poverty ranks shown earlier (see Fig. 5). Comparison was limited to cases where yield data was available simultaneously for the two periods, since there were changes in the crop mix in some situations and data limitations in a few others.

The average figures showed clearly declining yields for sorghum, millet, sesame, and groundnuts, which are either fully or largely rainfed. Yields of irrigated crops (wheat and cotton) had a rising mode due to higher certainty of soil moisture and use of better technology. Tremendous improvements evident for wheat were attributed to strong government backing.

Sorghum yields were lower in the second period in all states, except in Northern and River Nile, while millet yields declined across the board. Sesame yield improvements were noticeable in North Kordofan, North Darfur, and South Darfur States; however, yields were originally low there. Yields also slightly increased in West Darfur. There were increases in groundnut yields in Kassala (New Halfa irrigated scheme) and North and South Kordofan, stable yields in West Kordofan and Gezira States, and deterioration in all others. In the case of cotton, yields increased in five states: highest in Gedaref due to developments in the Rahad Irrigation Scheme, and substantial improvements in Red Sea (Tokar Delta). Increases in the other three states (North Kordofan, South Kordofan, and Sennar) were only modest. There were notable yield deteriorations in Gezira, Kassala (New Halfa Scheme), White Nile, and Sennar States in which the crop is produced under irrigation.

Relative changes in yields over the two periods in the 15 states are depicted in (Fig. 7) (also listed in the same order of agricultural income levels). Averages yield changes for the different crops in each state were weighted by their respective area averages over the two periods.

Table 12: Comparisons of yields[*] (kg/ha) of major crops by state over two five-year periods: 1970/71–1974/75 and 2002/03–2006/07

State	Sorghum		Millet		Wheat		Sesame		Groundnut		Cotton	
	70/71–74/75	02/03–06/07	70/71–74/75	02/03–06/07	70/71–74/75	02/03–06/07	70/71–74/75	02/03–06/07	70/71–74/75	02/03–06/07	70/71–74/75	02/03–06/07
Blue Nile	350	312	213	135			240	98	433	250	250	248
Northern	361	811			774	1247						
White Nile	345	236	201	200	297	773	200	186	409	218	481	455
River Nile	456	521			549	960						
Sennar	323	243	211	149			219	88			534	342
West Darfur	326	295	667	219			165	174	434	323		
South Kordofan	295	207	219	135			183	92	204	249	114	127
Khartoum	140	105										
Gedaref	295	200					143	96			147	685
North Darfur	164	118	372	76			40	70	239	186		
Gezira	544	429	150	102	539	841			1000	993	694	675
South Darfur	317	234	260	159			96	101	357	261		
North Kordofan	407	286	303	187			253	127	281	345	157	176
Kassala	314	268			453	394			703	1230	540	456
Red Sea	531	240	368	233							184	295
Average[*]	345	300	297	160	522	843	171	115	451	451	345	384

[*]Yields are area-weighted averages for the three farming systems (irrigated, mechanized rainfed, and traditional rainfed). It should be noted that West Kordofan State was dissolved as from 2007 and its yield allocated between North and South Kordofan States.

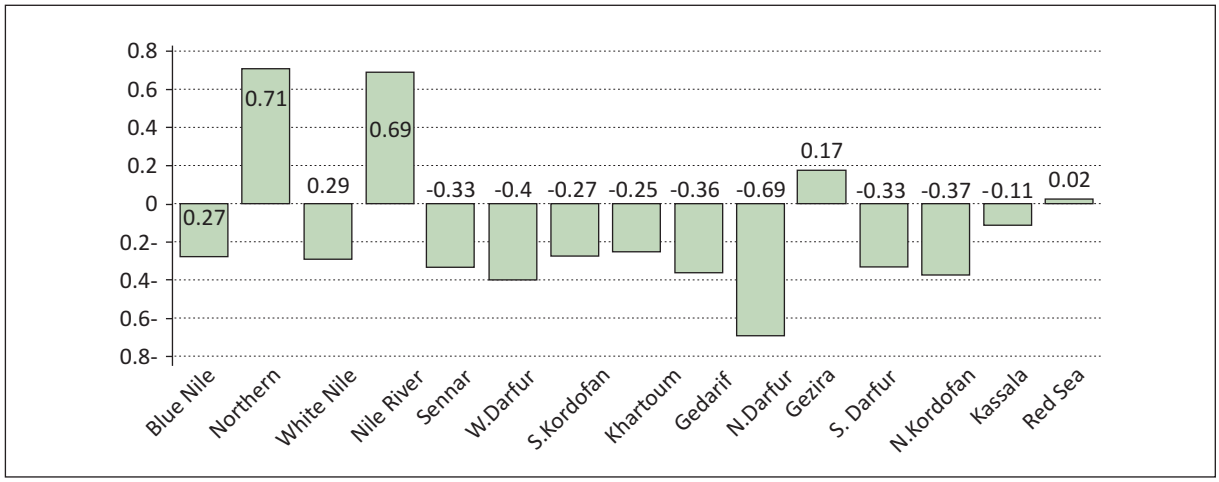


Figure 7. Average (weighted) changes (ratio) in crop yields by state over the periods 1970/71–1974/75 and 2002/03–2006/07

The productivity pattern can be argued to match the order of incomes, with some justifiable exceptions. The negative yield change for the Blue Nile and White Nile States were compensated for by high incomes from livestock as mentioned earlier, while the positive, but negligible yield rise in the Red Sea was most likely confined to the limited areas of Tokar Delta. On the other hand, North Darfur encountered the highest yield reduction, but again it had a relatively better rank with respect to livestock. Gezira's modest yield improvement was mainly due to improvement in sorghum and wheat yields but probably the interaction of high production costs and lower yields of cotton and groundnuts resulted in an under-proportional income shift. Further, all states from Gedaref to the Red Sea fall within the low income category (< US$1.1/d; Fig. 5). In essence, the statuses of crop yields, which are largely a function of deterioration in natural resources, are major factors contributing to poverty.

Current yield levels of two major crop groups (cereals and oil crops), as represented by the average of the 2003–2007 period (Fig. 8a and 8b, respectively) again in the same order of per capita income levels. Taking the income effect of livestock into account, congruence of crop yield with the estimated income levels can be verified from the figures. With regard to cereals (Fig. 8a), both wheat and sorghum yields showed a declining trend over the income-ranked spectrum of states, except for the lower wheat yields in the White Nile and the small increase in sorghum yields in Gezira. Millet yields were generally low, but generally lower in low-income states except for Red Sea where the crop was grown in limited areas in Tokar Delta. For oil seeds (including cotton; Fig. 8b), sesame yields were generally low and variable among states but in low-income states they were somewhat lower than or similar to high-income states. Groundnuts and cotton yields, on the other hand were higher in low-income states, especially under irrigation in Gezira and Kassala, although rainfed cotton in Gedaref revealed relatively high yields albeit in small areas. Overall, higher yields were clearly realized under irrigation for both crop groups but their levels were probably not sufficiently high to offset high production costs. Accordingly, yield improvements are imperative in low-income states to increase levels of incomes and reduce those of poverty.

6.2 Productivity improvement potential

While the physical productivity levels illustrated above reflect the resource potential under the prevailing management practices, such potential can be better exploited by technological improvements. Evidence has shown that improved technology is conducive to substantial yield improvements under different regions and production systems. Using research data, (Samar Shams Elddin, 2008) evaluated yield gaps between yields realized at different stages of technology testing and those obtained by farmers for a number of crops in different states. (Fig. 9) shows average yield gaps (marginal percentage increase) between on-farm trials and actual average farmers' yields over the 1985/1986–2004/2005 for a number of crops in some of the states that are reflected by the above analysis to have low per capita income from agriculture. There is enormous potential to raise crop yields by bridging at least part of the gaps that vary from 46% to as high as 56%. Irrigated crops in the Gezira can be improved by respective margins of about 50% for wheat and

groundnuts and by > 140% for cotton and sorghum. There is even higher potential for crops under rainfed farming where potential margins are around 100% in Gedaref and vary from 1.27 to over 5-fold in North Kordofan. Exploitation of technological opportunities provides plausible means to reduce poverty.

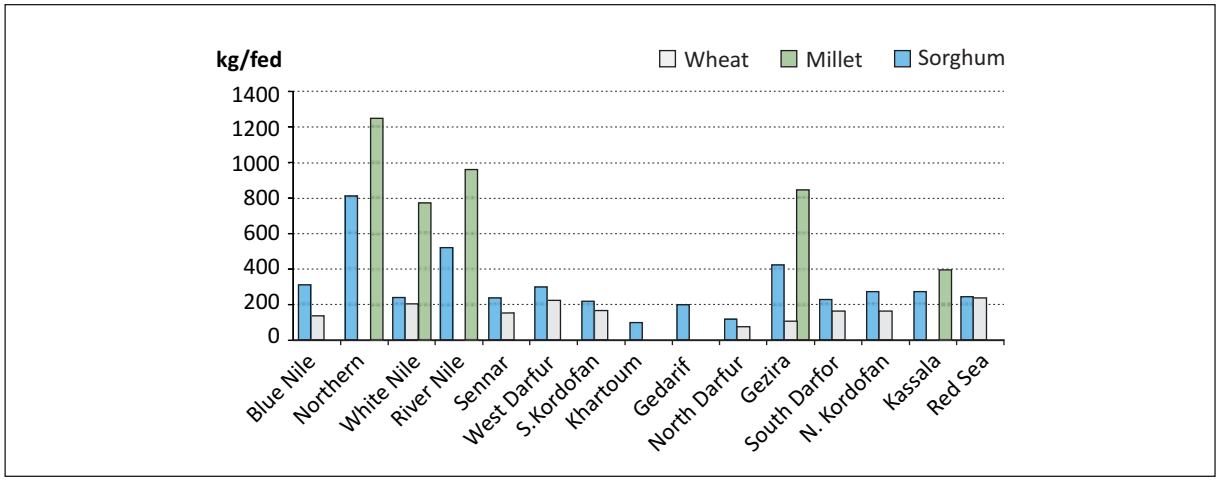


Figure 8(a). Average yields of cereal crops by state in the period 2002/03–2006/07

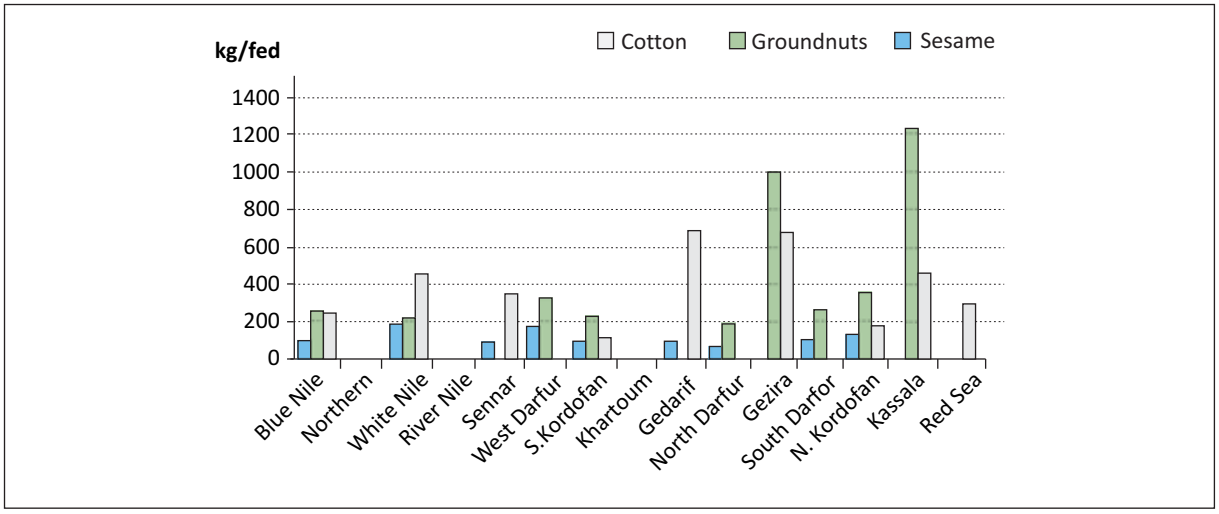
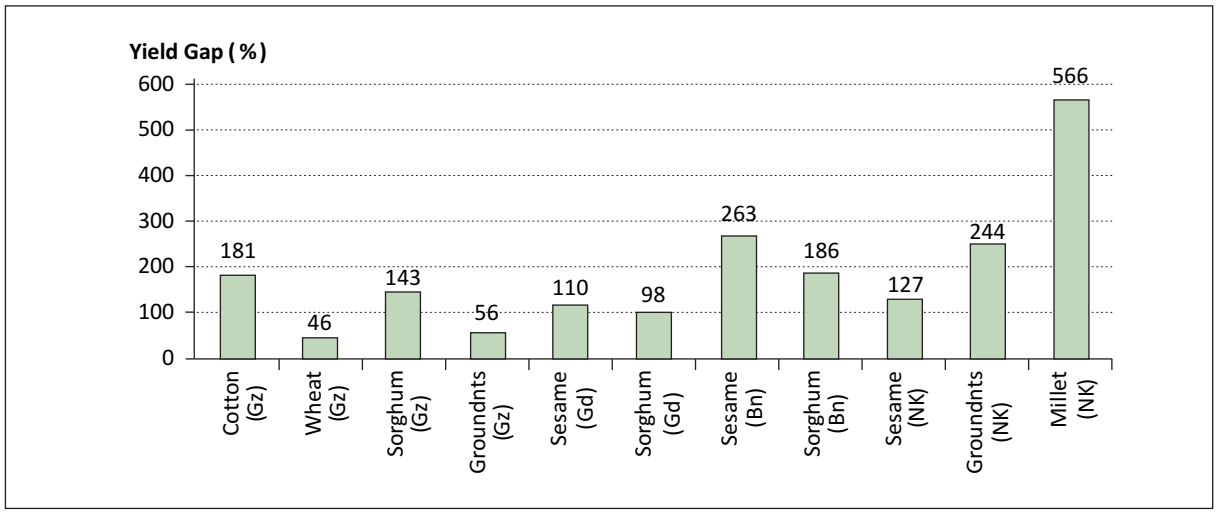


Figure 8(b). Average yields of oil crops by state in the period 2002/03–2006/07



Gz = Gezira; Gd = Gedaref; Bn = Blue Nile; NK = North Kordofan
Source: (Samar Shams Elddin, 2008)

Figure 9. Yield gaps of major crops in some states, averages in the period 1985/86–2004/2005

7. FOOD POVERTY IN SELECTED STATES IN NORTHERN SUDAN

Food poverty is the sufficient condition for food insecurity in the sense that if food is available for all the people all the time but budget constraints (incomes and prices) renders that available food inaccessible to the majority of households, then there is food insecurity in spite of food availability. Therefore, in a free trade economy, food security is mainly an issue of accessibility rather than availability, because availability or unavailability of food is the characteristic of a 'Robinson Crusoe' economy rather than an open economy. In a market economy, when incomes fall behind prices, there is always a degree of income inability to buy enough food even if food is abundantly available. This degree of income inability is a sort of food insecurity that requires a set of policies different from the production and trade policies that are usually designed to make food more available. When this set of policies is absent or not well-enacted, the few rich people will be food-secure because they have access to available food, while a growing majority of the population will remain without access to available food (food insecurity). This type of food insecurity is harsher than that characterized by unavailability of food, because it has the connotation of relative deprivation.

7.1 Methodology

7.1.1 Identifying food-poor people

The success of a poverty reduction strategy involves targeting the well-identified poor. The identification of the poor provides strategic answers to strategic questions such as follow. Who are the poor? Where are the poor? What are the poor? How poor are the poor? How are the poor unequal in being poor? Answers to these strategic questions will help planners to set geographical, characteristic, direct, and sectoral targets. Without setting these targets, a poverty reduction strategy will remain a vaguely worded document and achieve nothing at the end of its time bound. To provide answers to the above strategic questions we need a definition of food poverty. Food poverty is defined as an income inability to attain a socially determined food basket that contains the recommended daily minimum nutritional intake measured in terms of kilo calories. Thus any person whose daily income (or daily consumption expenditure) runs short of attaining that food basket is identified as food poor. For operational purposes we need to prescribe that socially determined food basket for each of the four selected States and buy it from the local markets in these states. The money metric value of the prescribed food basket is known as the food poverty line and denoted by Z. The costs of the food baskets were computed according to the varied prices of food items included in the basket for each state, and that cost was used to determine the poverty line for the sampled households (Table 13).

Table 13: Total costs of poverty food basket (poverty line) in selected states, 2008 (SDG/average adult equivalent/d)

State	Rural	Urban
North Kordofan	2.60	3.66
Kassala	2.18	2.42
Northern	2.16	3.03
River Nile	2.13	2.91

So far we have taken an important step towards the identification of the poor. Ideally, the poor should be identified and targeted as individuals, rather than households, because the former will give more room to identify the characteristics of the poor than the latter. Thus we need to construct the distribution of the actual money metric values of the individual levels of welfare which are usually indicated by household per capita income (or household per capita consumption expenditure). Given the share-alike ethic that prevails in Sudan, the household per capita income (expenditure) taken as a welfare indicator is not gender biased. To allow for strict comparability of individuals and households in the welfare distribution, we needed to adjust the distribution of the household per capita income (expenditure) for variation in household characteristics. This adjustment was done by converting the head-count family size into adult male equivalent using an adult equivalent index that converts adolescents, children, and females into fractions of an adult male. Now, having constructed a food poverty line based on a definition of

poverty, and a welfare distribution in which individuals and families were comparable, the identification of the poor becomes as easy as anchoring the poverty line Z on the welfare distribution as a cut-off point that splits the sample population discretely into poor and non-poor. Now, the poor can be identified individually by name, address, telephone number, age, sex, level of education, type of occupation, and any other characteristics a survey can provide. However, it would be handier if we measure poverty in aggregate terms.

Aggregate measures of poverty are computed using the methodology and equations already outlined in the review chapter (Section 2.3) where the poverty incidence (P0), poverty depth (P1), and poverty severity (P_2) along with the inequality index (G) were computed. Moreover, in an economy that is gradually emerging from a subsistence mode of living to a pre-capitalist mode of living, household income is generated from different sources. The idea of decomposing food poverty by sources of income is anchored on this fact of life and is in this case based on survey data where household income is reported by source. The policy purpose of the decomposition exercise is to identify the source of income that reduces food poverty most and assess the potentials of the remaining ones. The method of attributing a change in food poverty to income from any source involves the following steps: (a) measure food poverty using incomes from a source only, say agriculture; (b) augment income from agriculture by income from another source, say livestock; (c) measure food poverty using the augmented income; and (d) the change in poverty from step (a) to step (c) is attributed to income from livestock. This process of family income augmentation will cover all sources of income for which we have data.

Our 2009 survey provided us with data pertaining to household incomes from four sources: agriculture, livestock, off-farm economic activities, and remittances. We first measured food poverty using income from agriculture as the main source of income in the country (as insisted by agronomists and agricultural economists) and then gradually added incomes from other sources in a cumulative way with the view to net out individual impact on poverty of each source. If what agronomist and agricultural economists kept telling us stays true, then we would expect that the poverty results in the first round of measurements to be small and continue to fall with cumulative addition of incomes from other sources. It goes even without empirical investigation that if poverty is measured starting with income from agriculture, then addition of income from any source will eventually increase the mean income of the poor and consequently reduce the income ratio, the depth of poverty, and if the incomes of some of the poor surpass the poverty line, the additional income reduces the incidence of poverty. What is important is the distribution effect of the additional income in the sense that it goes to the ultra poor, then income inequality among the poor will be reduced and consequently the severity of poverty will be reduced.

7.1.2 Survey methodology

a) Household survey

Socio-economic surveys were carried out in four states in northern Sudan (Kassala, Kordofan, Northern and River Nile States), which were selected on two grounds. One is that they had good geographical coverage: North Kordofan in the west, Kassala in the east, and Northern and River Nile in the north. The other is that two of the states, namely Kordofan and Kassala are believed to be among leading states in poverty levels, while in the other two poverty levels are thought to lie within the low range of poverty spectrum in the country as discerned from discussion in the foregoing literature review. The household survey in these states, while aimed to verify and consolidate the results reported in the review chapter, it had a strong focus on good measurements of income (food) poverty and its correlates based on primary household-level data, a situation that was not adequately covered in earlier studies. Data was collected using a structured questionnaire with the fieldwork for data collection taking place in June–July 2008. The questionnaire elicited information on household characteristics, housing characteristics, household assets, household income by source, and household expenditures.

Within each State, a sample of households was randomly selected. This was done by random selection of villages from each region, followed by random selection of households in each village within a multi-stage type of sampling. (Table 14) shows the sample size and distribution of the number of households in different regions.

Table 14: Distribution of surveyed households in each region

State	No. of selected villages	Total selected households
North Kordofan	10	200
Kassala	11	206
Northern	8	204
River Nile	10	213
Total	39	823

b) Nutritional status of children

Income poverty, particularly food poverty correlates with and has consequences for nutritional status of children who are members of households. The nutritional status of children has significant effect on their health and development. The food offered for nourishing a growing child must supply enough energy and nutrients to meet the need of maintenance, activity, and growth as well as suiting children's taste. The best indicator that a child is receiving adequate nourishment, neither too little nor too much, is a normal growth pattern. The reference standard most commonly used to standardize measurement was developed by the US National Center for Health Statistics and was recommended for international use by the World Health Organization (WHO). Malnutrition is any condition resulting from an energy or nutrient intake either above or below that which is optimal. In developing countries, malnutrition is a major health problem.

Along with the household data collection, anthropometric measures were made and recorded by trained field workers for children of ages five years or less within each of the selected households. The measures comprised sex, age, height, and weight.

Two nutritional indices were used to estimate the degree of malnutrition based on weight and height:

1. Gomez nutritional index (Gomez et al., 1955) was used to classify malnutrition for children < 24 months of age. The reference was used to standardize a child measurement with the median or average measure for children of the same age and sex. Taking age and sex into consideration, differences in measurements were expressed in percentage of the median according to the Gomez system for classification of malnutrition as shown below:

Table 15: Gomez classification

Percent of reference weight for age*	Interpretation
90–110	Normal
75–89	Grade I: mild malnutrition
60–74	Grade II: moderate malnutrition
<60	Grade III: severe malnutrition

** Percent of median = (Child weight/weight of normal child of same age) × 100*

2. The Body Mass Index (BMI) (Park and Park, 1989) was computed for children of 24–60 months of age for both males and females using the formula:

$$BMI = Weight\ (kg) / Height\ (m)^2 \qquad (14)$$

The BMI-for-age growth chart was used for assessment of nutritional status among children of 24–60 months of age. Children who fall below the fifth percentile of the BMI-for-age distribution are considered underweight. Children are considered overweight or obese when their BMI falls at or above the 95th percentile, and at risk of being overweight when BMI is greater than or equal to the 85th percentile.

7.2 Results

Using descriptive statistics, the poverty incidence (head count) was derived and in a later section the two other poverty indicators, namely poverty depth and its severity were computed. Then households were disaggregated in relation to their poverty status (poor versus non-poor) according to the household's major characteristics, their total income, income sources, per capita income and expenditure, level of use of modern technology, and access to credit. In the mentioned latter section food poverty (incidence, depth and severity) was decomposed by the relative contribution of the main groups of income source. Further, the nutritional indicators of children were derived in relation to the poverty status.

Measured by incidence, poverty was widely prevalent among the sampled households (Table 16). In Kordofan State more than three-quarters of the households (78%) and 83% of household members fell below the poverty line. However, it is worth mentioning that the cost of the food basket in Kordofan was about 20% higher than in other states. In Northern State 65% of the members were identified as poor, while River Nile, at 48%, had the lowest poverty among the surveyed states, followed by Kassala with 54% people under the poverty line. The differences between the figures of households and household members clearly reflected family size. The high poverty incidence is consistent with the prevailing line of thought that considers both Kordofan and Kassala as poor states, but the survey identifies the northern states, which were thought to have low poverty, as harboring a considerable number of poor.

Table 16: Gomez classification

State	Households			Household Members		
	Below poverty	Above poverty	Total	Below poverty	Above poverty	Total
North Kordofan	155 (78)	45 (22)	200 (100)	1063 (81)	239 (17)	1275 (100)
Kassala	100 (49)	104 (51)	204 (100)	694 (54)	583 (46)	1277 (100)
Northern	111 (57)	85 (43)	196 (100)	868 (65)	468 (35)	1336 (100)
River Nile	87 (42)	120 (58)	207 (100)	725 (48)	785 (52)	1510 (100)

[*] *numbers in parentheses are percentages*

7.2.1 Characteristics of households and poverty status

The average family size had range 6.3–7.3 for all households in the four states. Generally, family size was larger in poor households compared to non-poor in all surveyed states (Table 16) with the largest family size reported in the River Nile (8.6 persons), followed by Northern State (7.8 persons).

In all selected states, heads of poor households were less educated than non-poor as indicated by their lower number of schooling years. It is evident that, the education level among heads of households was higher in River Nile, followed by Northern, Kassala, and lastly Kordofan States as shown by average schooling years (Table 17). Most household heads in Kordofan reported that farming (both crops and livestock) was their main occupation (91%). In comparison, the figure was slightly more than half (54%) in the River Nile, slightly less than half (48%) in Northern, and lowest (40%) in Kassala. Other occupations reported by respondents included – among others – trading, selling of their labor, and formal employment. The poverty incidence was generally high, but was highest in Kordofan (71%), followed by Kassala (66%) and Northern (59%) while it was relatively lowest in the River Nile State (40%). Overall, membership of household heads in local organizations was weak, being lowest in Kassala (28%) and highest in Kordofan (43%). As such, poor households were less likely to be members of such organizations compared to the non-poor in all regions, except for Kordofan.

7.2.2 Household incomes and poverty status

As mentioned above, households in the selected states performed various activities that formed a set of income sources in pursuit of meeting their livelihood requirements. Income sources varied in amount and contribution to total income among the four states. Total household's annual income was highest in the River Nile, followed by Northern, and Kassala State, and was extremely low in Kordofan, forming almost half of those earned in the other three states (Fig. 10) and is indicative of high poverty levels as will be addressed later.

Table 17: Characteristics of households in relation to poverty status

State/characteristic	Poor	Non-poor	All
North Kordofan:			
Average no. of household members	6.7	5.6	6.4
Average age of household head (years)	47	46	47
Average schooling years of HH	5.4	6.6	5.9
HH Membership in local organizations (%).	66	34	43
Main occupation of HH (%):			
Farmer	71	29	91
Trader	40	60	3
Others	64	36	6
Kassala:			
Average no. of household members	6.9	5.6	6.3
Average age of household head (years)	42	40	41
Average schooling years of HH	7.1	7.5	7.4
HH Membership in local organizations (%).	40	60	28
Main occupation of HH (%):			
Farmer	59	41	40
Trader	25	75	8
Others	45	55	52
Northern:			
Average no. of household members	7.8	5.5	6.8
Average age of household head (years)	50	51	51
Average schooling years of HH	7.4	9.0	8.2
HH Membership in local organizations (%)	49	51	35
Main occupation of HH (%):			
Farmer	66	34	48
Trader	-	100	2
Others	50	50	50
River Nile:			
Average no. of household members	8.6	6.7	7.3
Average age of household head (years)	49	48	48
Average schooling years of HH	8.1	8.7	8.5
HH Membership in local organizations (%)	38	62	39
Main occupation of HH (%):			
Farmer	40	60	54
Trader	38	62	4
Others	46	54	48

HH: Household Head

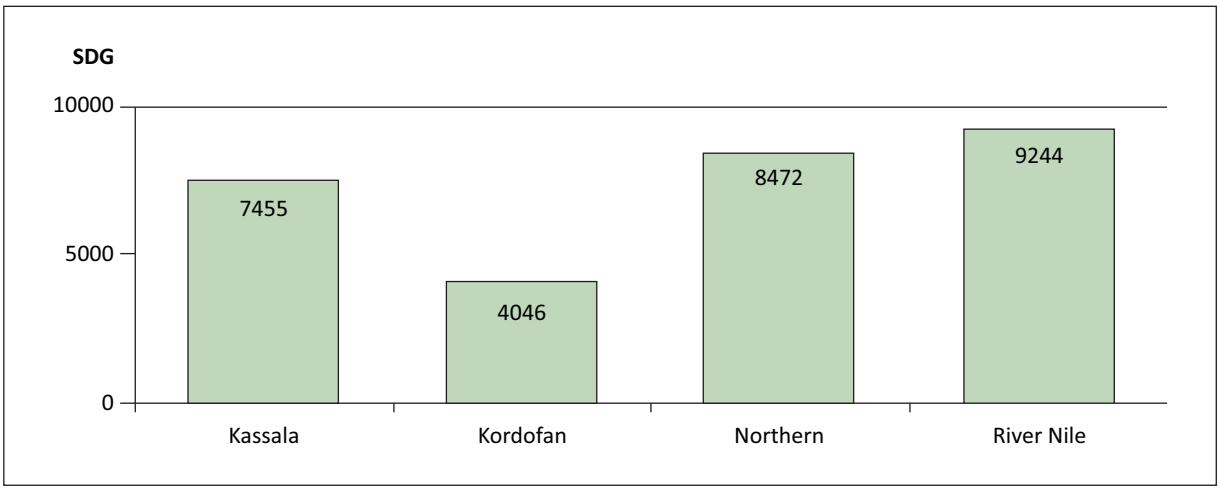


Figure 10. Total average annual income per household

The relative contributions of different income sources to total household income (Table 18), reveal that non-agricultural engagements generate substantial income that compares favorably with that of agriculture and greatly surpasses it in the case of North Kordofan. This indicates that, although agriculture remains as a major source of livelihood in rural areas, its role is not as paramount as is often conceived. This signals deterioration in agriculture and is most likely attributed to the noticeable phenomenon of disincentives to agriculture (Faki and Taha, 2007). Remittances had substantial contribution to incomes, forming more than one-fifth of the total income in North Kordofan and Kassala.

Table 18: Contribution of main income sources to total household income in selected states (%)

State/Poverty Status	Cropping	Livestock	Total Agriculture	Remittances	Non-Agriculture
North Kordofan	16	13	29	20	51
Kassala	14	25	39	23	38
Northern	13	34	47	12	41
River Nile	38	5	43	15	42

Average annual household income by poverty status (Fig. 11) revealed high disparities among households and across states. Annual income of non-poor was about seven times that of the poor households in Northern State. It also amounted to 3-, 3.8-, and 4.4-fold that of poor households in Kordofan, River Nile, and Kassala States, respectively.

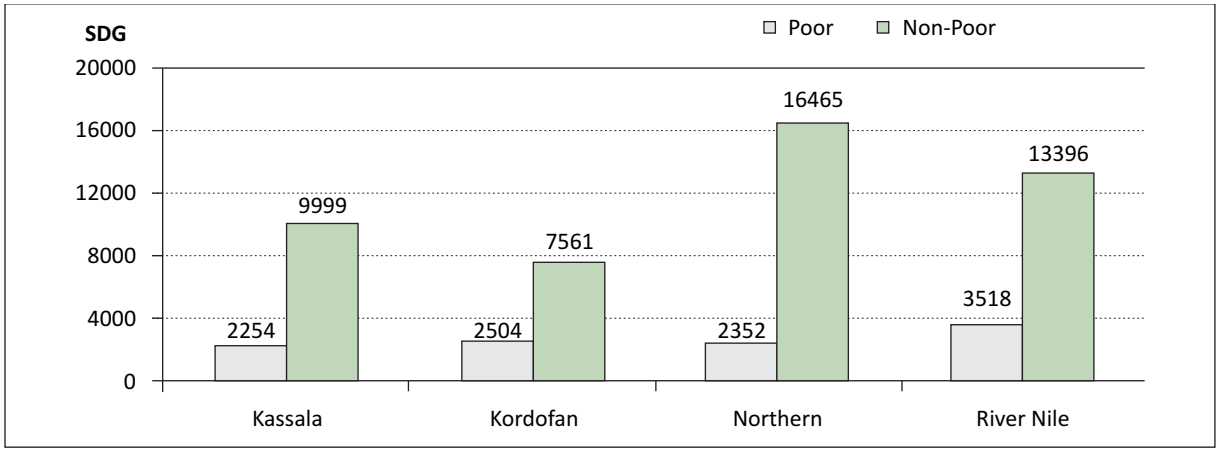
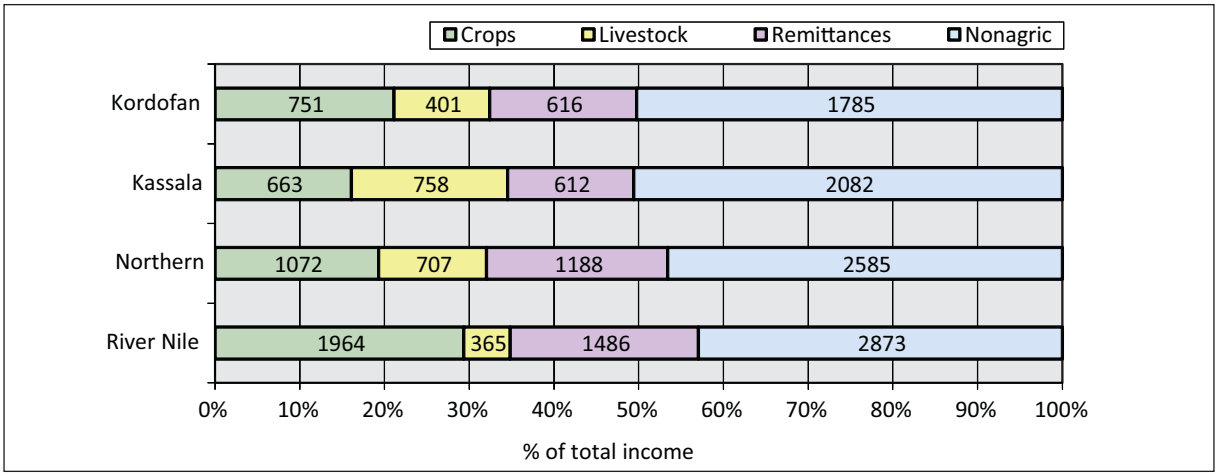


Figure 11. Total annual household income by poverty status

The contribution of different income sources for poor and non-poor sectors in the four states is illustrated in Fig. 12.

a) Poor households



b) Non-poor households

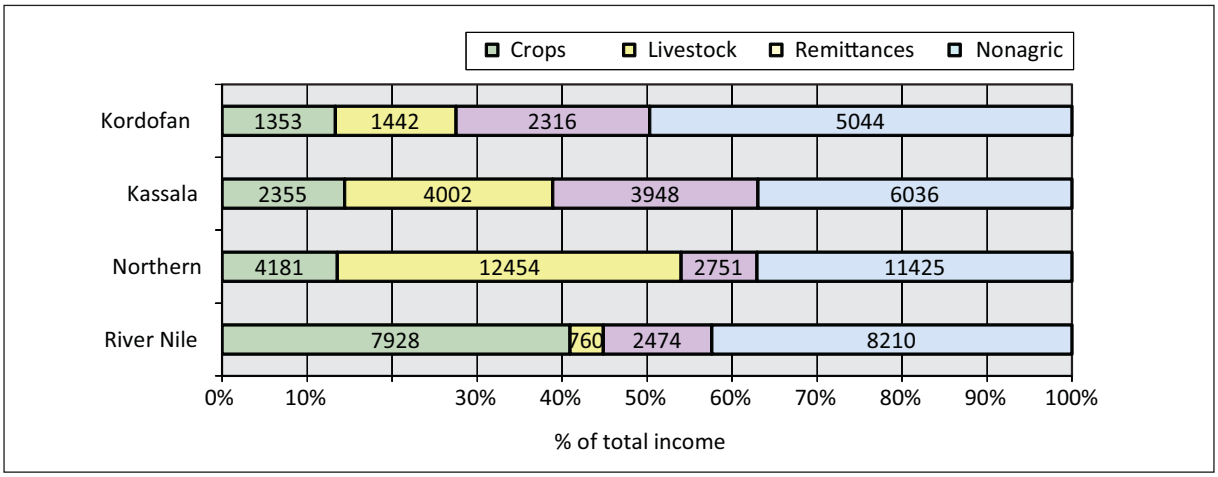


Figure 12. Income by source (SDG/household) for poor and non-poor households

Income from agriculture (including crops and livestock) represented less than half of total annual households' income for the poor and non-poor families in all four states. For poor households, non-agricultural activities represented an important source of income, accounting for about half of total annual income in each of Kassala and Kordofan, about 47% in Northern State, and 43% in the River Nile. For non-poor households, non-agricultural activities were considerable but their relative contributions in total income were lower compared to the poor except in the River Nile.

The contribution of cropping in total income was higher in River Nile State for both poor and non-poor households compared to other regions. The reason may be that farmers in this region usually grow high-value crops such as horticultural crops and spices. The share of livestock products in total income outweighed that of cropping in Kassala for both poor and non-poor and was remarkable for non-poor in Northern State. In general, the contribution of cropping to total income was higher for poor households compared to the non-poor in all states except River Nile State.

On the other hand, better-off households derive more of their incomes from livestock, with the implication that livestock is more poverty-alleviating than crops. This situation is largely attributed to low and declining productivity from crops and low crop prices to producers at harvest (Faki and van Holst Pellikaan, 2007). Remittances were particularly more tangible for poor households in the Northern and River Nile States and for non-poor in North Kordofan and Kassala.

7.2.3 Per capita income and expenditures

Total average per capita income for all households, that for households whose heads had agriculture as the main occupation and per capita agricultural income for all households are shown by (Fig. 13). The former two income levels were substantially comparable, although the former was slightly higher than the latter in all states. Average income from agriculture was, however, considerably lower compared to nonagricultural sources in all states. This indicates a relatively low level of farm income whereby agriculture as a main occupation generates incomes that are largely supplemented from other income sources.

However, average daily per capita income from agriculture (both crops and livestock) disaggregated by poverty status reflected high income-disparities (Fig. 14). Except for North Kordofan where average per capita agricultural income for the non-poor was marginally lower than the poverty line, average agricultural incomes were well above the poverty levels in the other states. This infers that while part of the farming activities produce substantial benefits that could alone alleviate poverty, others require a strong push in order to reach such levels. However, it also shows that there is considerable potential for agricultural activities to reduce income poverty through improved productivity and favorable policies.

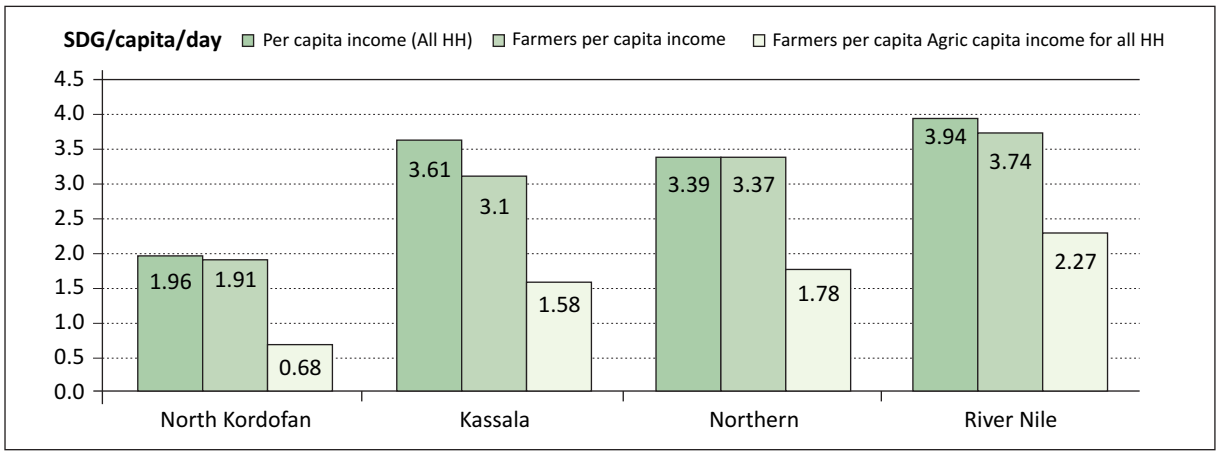


Figure 13. Average daily per capita total and farm incomes in selected states

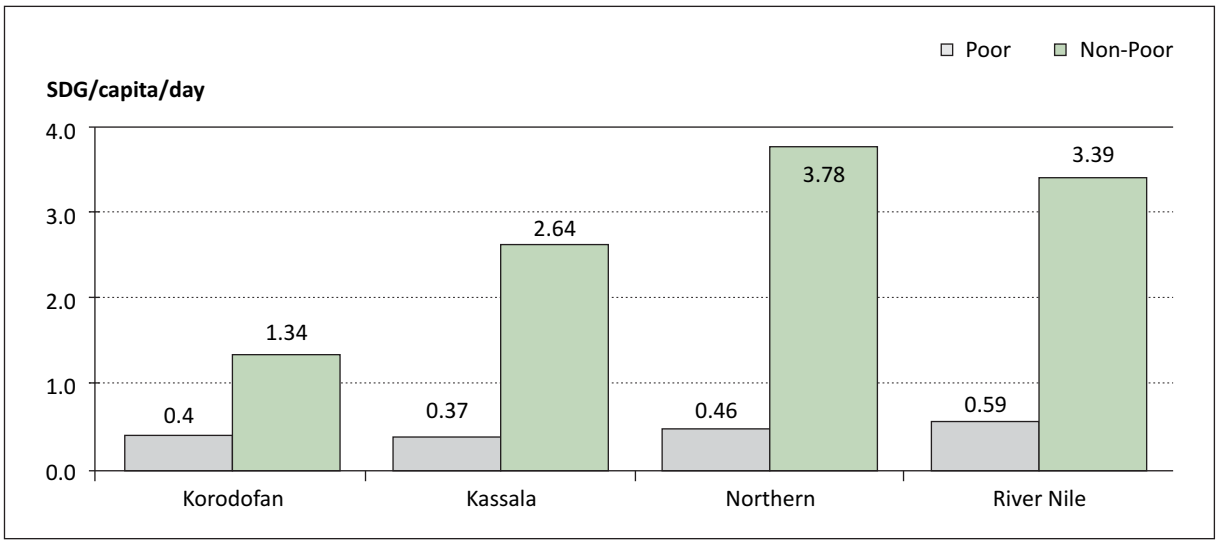


Figure 14. Per capita income per day from agriculture according to poverty status

Per capita daily expenditure and the share of food in total expenditure by poverty status (Table 19) showed that, first, expenditure of the non-poor highly outweighed that of the poor. Increases of 36, 67, 51, and 42% were calculated for North Kordofan, Kassala, Northern, and River Nile States, respectively. Second, high expenditure on food relative to incomes was incurred for both poor and non-poor, which is generally a sign of poverty. Third, there were hardly any differences in the shares of food expenditure between the two groups. This is indicative of a lower nutritional status of the poor, given their relatively low incomes.

Table 19: Per capita expenditure by poverty status

Item	North Kordofan	Kassala	Northern	River Nile
Per capita expenditure (SDG/day):				
Poor	2.11	2.84	4.03	3.32
Non-poor	2.88	4.75	6.07	4.71
All Households	2.33	3.81	4.91	4.14
Share of food in total expenditure (%):				
Poor	67	70	63	65
Non-poor	72	68	62	65
All Households	69	68	62	65

Further it can be deducted from (Fig. 14) and (Table 20) that expenditure surpassed incomes in all states. However, differences were slight in Kassala (6%) and River Nile (5%), modest in Kordofan (19%), but considerable in Northern State (45%). While the gap was possibly covered from undeclared income sources, as will be discussed later, liquidation of part of the household assets could form a source of covering such gaps. The average values of material assets per household (Table 20) indicates that poor households in Northern State had the highest asset values. Kordofan had the lowest, where it is more likely that gap coverage was from undeclared income sources.

Table 20. Average per household value of assets (SDG)

Poverty Status	North Kordofan	Kassala	Northern	River Nile
Poor	186	1426	1787	670
Non-poor	1879	4798	5095	4630
All	804	3115	3222	2887

7.2.4 Use of improved technology and poverty status

Use of modern technology as a means of increasing productivity, production and incomes, and accordingly as a powerful measure in reducing poverty was analyzed for major technology components for all respondents with agriculture as their main occupation. These were 91% of the sampled farmers in North Kordofan, 40% in Kassala, 45% in Northern State, and 53% in the River Nile State (Fig. 15).

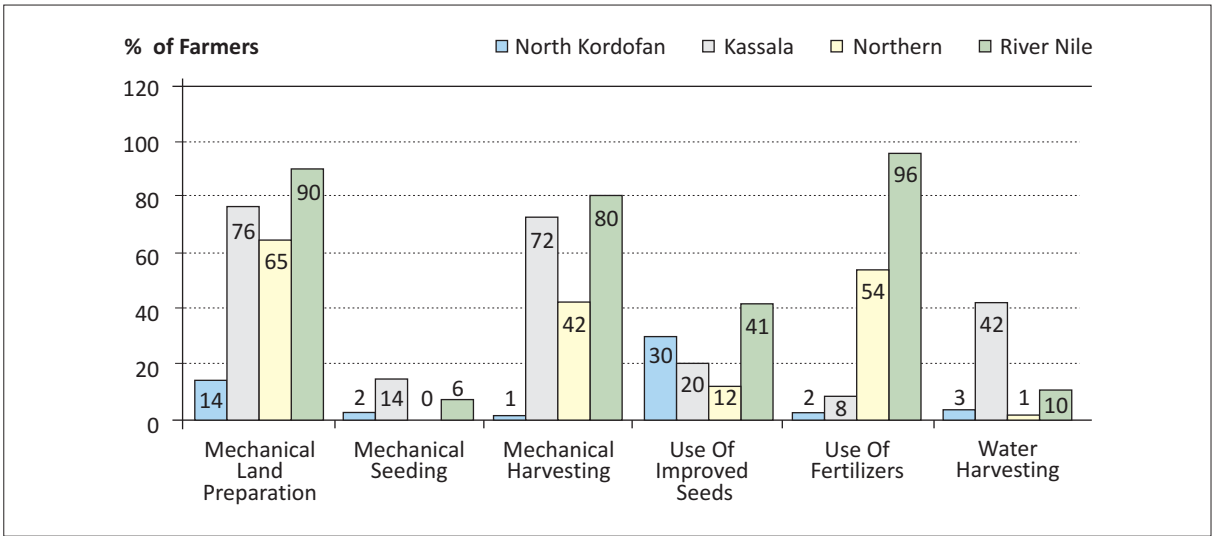


Figure 15. Percent of farmers (main occupation) using improved technology

Overall, use of modern agricultural technologies was generally high to moderate, depending on technology component, in River Nile, Northern, and Kassala States, and generally low in Kordofan (Fig. 15). Mechanical land preparation and mechanical harvesting were substantially adopted but the situation was modest in Northern State. In North Kordofan, both technologies had low adoption although the former might not be suitable for the sandy soils and rainfed conditions there; however, it or its substitute – animal draft tillage – could improve the water harvesting situation. Water harvesting was only moderate in Kassala and its very limited use, especially in North Kordofan where it is greatly needed, requires due consideration. Mechanical seeding, which is highly conducive to foster a good crop stand, is very weak in all states. Use of improved seed, which is a key factor in crop productivity and quality, was low in all studied states but was better in the River Nile, being used by 40% of the farmers.

While, generally the use of improved technology was not at the level to provide a good boost to production management, there were substantial differences between the identified poor and non-poor groups in the analysis. (Fig. 16) illustrates the proportion of farmers who use the same set of technologies presented above (Fig. 15).

Application of various forms of improved technology was considerably limited among poor farmers compared to the non-poor, bar few exceptions such as mechanical sowing and use of fertilizer in Northern State and use of improved seeds in North Kordofan. This is most probably due to the presence of organizations such as the International Fund for Agricultural Development (IFAD) that implement programs targeted at small farmers. Mechanical seeding, use of improved seeds, and water harvesting all had rather minor application. Even with technologies that found some application, farmer coverage was limited. The situation is suggestive for targeting small farmers to promote their adoption of improved technology.

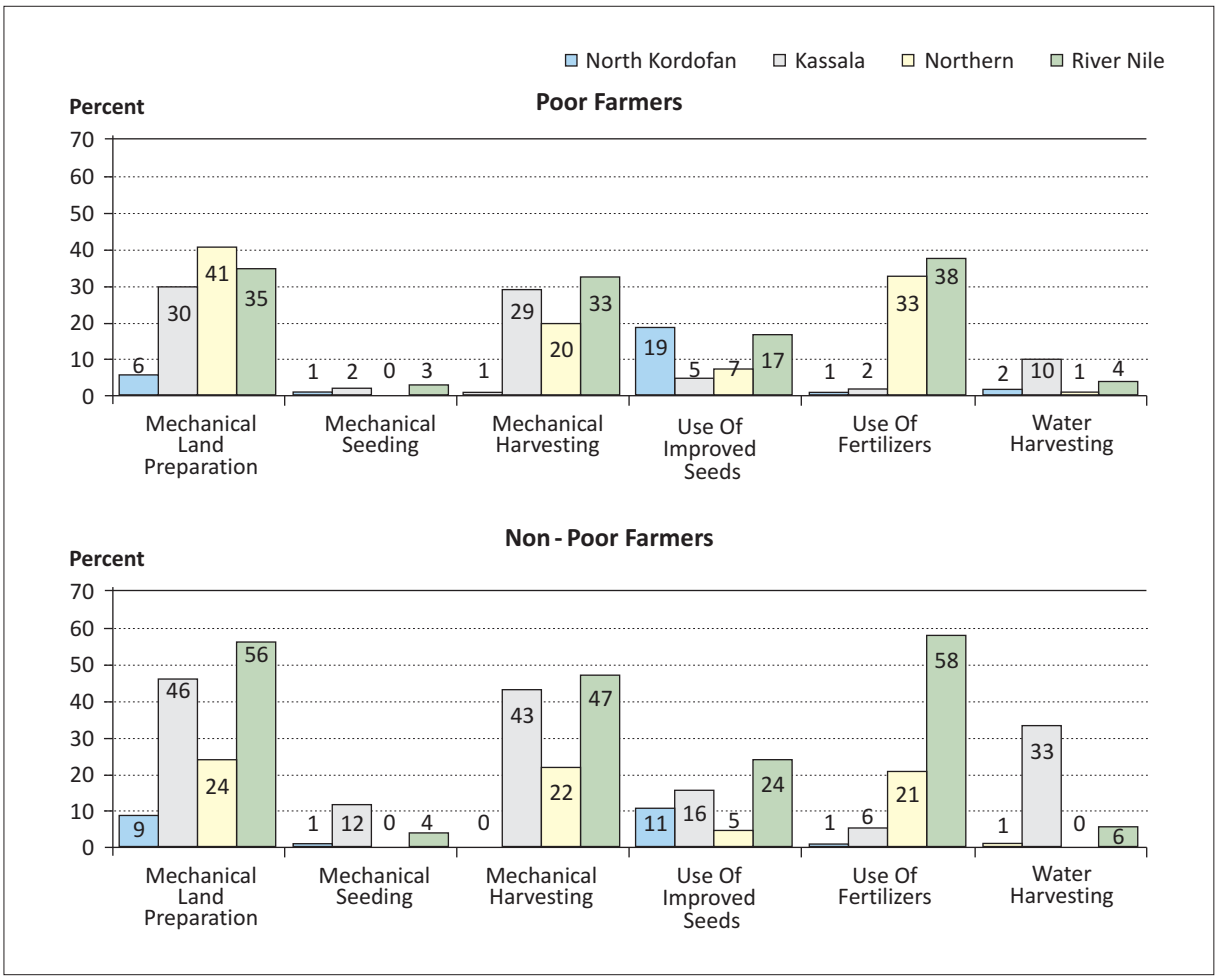


Figure 16. Extent of technology use by poverty status in selected states

7.2.5 Access to agricultural credit

Overall, the use of credit was generally low, as shown by the percentage of farmers with access to credit (Fig. 17). River Nile State had most access, where 50% of respondents whose main occupation was farming could obtain credit, followed by Kassala (46%) and Northern (36%), while only about 19% of sampled households reported use of credit in Kordofan. Access by the poor was generally comparable to that of the non-poor in all states except for River Nile where the difference was notable. Similar to the application of improved technology and probably closely connected to it, access to credit is instrumental in improving crop management and accordingly productivity and incomes.

7.2.6 Income decomposition for poor households

Applying the earlier described methodology, poverty indicators were computed for the four selected states and decomposed according to the cumulative income sources. At the start, aggregate poverty indicators were measured for income from crops, then consecutively and cumulatively poverty indicators were derived with additions of incomes from livestock, off-farm incomes, and lastly remittances. The last step gives the overall food/income poverty. The results are discussed in the following sections for individual states.

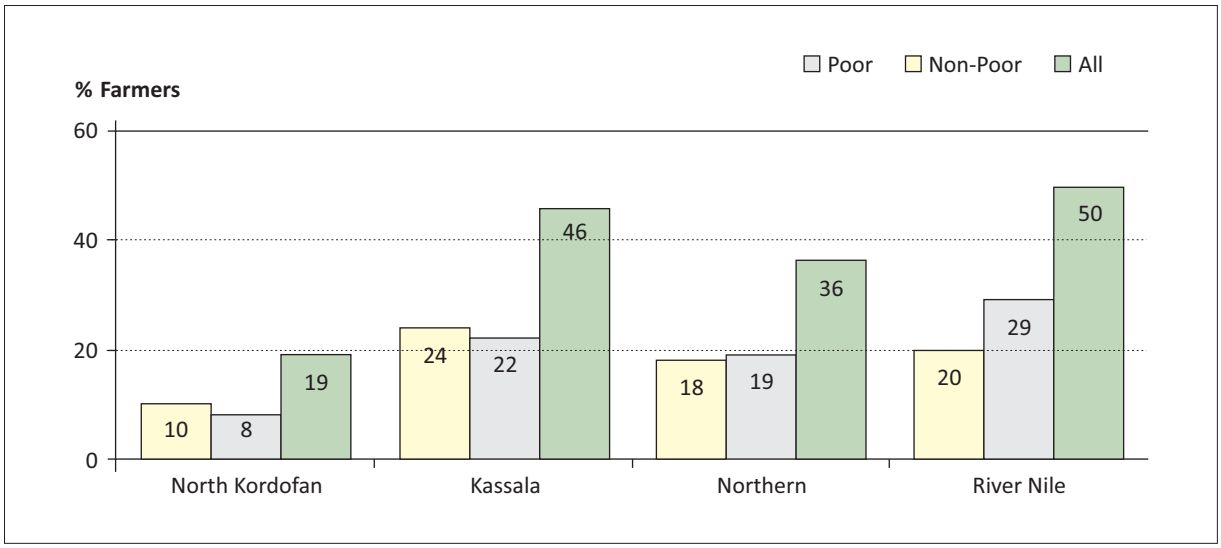


Figure 17. Farmers' access to agricultural credit by poverty status in selected states

a) North Kordofan

The results for North Kordofan are reported in (Table 21).

Table 21: Food poverty in North Kordofan State decomposed by source of income

Aggregate Poverty Indicators	Y_1	Y_2	Ch_2	Y_3	Ch_3	Y_4	Ch_4
Incidence of poverty (P0) %	99.5	98.1	–1.4	81.5	–16.6	81.3	–0.2
Income gap ratio (I) %	0.843	0.802	–0.041	0.633	–0.169	0.558	–0.075
Depth of poverty (P1) %	83.9	78.7	–5.2	51.6	–27.1	45.4	–6.2
Income inequality among poor	0.486	0.46	–0.026	0.35	–0.11	0.335	–0.015
Severity of poverty (P2) %	84.0	78.8	–5.2	51.7	–27.1	45.5	–6.2
Poverty line (SDG per year)	949	949	949	949	949	949	949

Note: Y_1 = income from crops; Y_2 = Y_1 plus income from livestock; Y_3 = Y_2 plus income off-farm activities; Y_4 = Y_3 plus remittances (all sources); Ch_1 = change in poverty due to additional income from livestock; Ch_2 = change in poverty due to additional income from off-farm activities; Ch_3 = change in poverty due to additional income from remittances.

The results show that even in North Kordofan, a predominantly agricultural state, the mean income of the poor from agriculture was only SDG 149; being smaller than in the River Nile by SDG 20. Thus, as a result of a small growth from agriculture, food poverty in North Kordofan was the highest of the selected four states. Using income from crops alone (Y_1), the incidence, depth, and severity of food poverty were 99.5, 83.9, and 84.0%, respectively. The addition of income from livestock increased the mean income of the poor from crops from SDG 149 to only SDG 188, and decreased the measure of income inequality among the poor (Gini coefficient, G) from 0.486 to only 0.460 points. Therefore, income from livestock there was not expected to reduce food poverty significantly, because it neither increased the mean income of the poor nor improved income distribution among them significantly. The addition of income from livestock to income from crops (Y_2) reduced the incidence of food poverty from 99.5 to only 98.1%, the depth of food poverty from 83.9 to only 78.7%, and the severity of food poverty from 84.0 to only 78,8%. The development paradox is that in Kordofan, which is one of the crop and livestock resource-rich states in the country, food poverty remained high under the sum of income from these two huge resources. One possible explanation for this irony is that the poor in Kordofan are sitting on economically dead land and livestock assets.

The poverty-reducing effect of the off-farm income source, which in the other three states is considered the mother of the poor, is modest and increased the mean income of the poor by only SDG 196 over the income from crops and livestock (Y_3), while in River Nile State the corresponding increase in mean income

of the poor was SDG 250. The improvement in G among the poor in Kordofan was only 0.11 points, compared with 0.32 points in River Nile State. As such, the addition of income from off-farm sources in North Kordofan reduced the incidence, depth, and severity of food poverty by only 16.6, 27.1, and 27.1 percentage points respectively, compared with respective reductions of 30.7, 40.1, and 43.7 percentage points in River Nile State.

Similar to the situation in other states the antipoverty effect of remittances in North Kordofan was also small. The addition of remittances to the sum of incomes from crops, livestock, and off-farm sources of income (Y_4) increased the mean income of the poor by only SDG 35, while the increase from the same source in Kassala was SDG 191. The improved G among the poor in North Kordofan by only 0.015 points was similarly low to that of River Nile of 0.024 points. Therefore, remittances as a source of family income in North Kordofan had small growth and antipoverty distributional effects. As a result, the addition of remittances reduced the incidence, depth, and severity of food poverty by only 0.2, 6.2, and 6.2 percentage points, respectively.

b) Kassala State

(Table 22) depicts the income decomposed food poverty results for Kassala State. Using income from crops only (Y_1) showed that all poverty indicators in Kassala were greater than in River Nile State. This is because the cost of food and crop income inequality among the poor in Kassala were higher than in River Nile, while crop mean income of the poor was smaller. For example, using income from crops only, the incidence, depth, and severity of poverty were respectively 96.2, 84.1, and 92.2% in Kassala State compared to the corresponding poverty indicators in River Nile of 83.2, 65.1, and 76.8%. Later discussion will show that the poverty situation between the two states was reversed when income from other sources was added to income from crops. This reversal of the poverty situation would imply that the antipoverty effects of incomes from sources other than agriculture in Kassala were greater than in River Nile State.

Table 22: Food poverty in Kassala State decomposed by sources of income

Aggregate Poverty Indicators	Y_1	Y_2	Ch_2	Y_3	Ch_3	Y_4	Ch_4
Incidence of poverty (P0) %	96.2	86.1	–10.0	56.4	–29.8	54.3	–2.0
Income gap ratio (I) %	87.5	80.4	–7.1	49.9	–30.6	25.8	–24.1
Depth of poverty (P1) %	84.1	69.3	–14.9	28.1	–41.2	14.0	–14.1
Income inequality among poor	0.672	0.62	–0.05	0.30	–0.33	0.28	–0.02
Severity of poverty (P2) %	92.2	75.6	–16.6	36.5	–39.1	25.3	–11.2
Poverty line (SDG per year)	792	792	–	792	–	792	–

Source: own computation based on 2009 survey data.
Note: Y_1 = income from crops; Y_2 = Y_1 plus income from livestock; Y_3 = Y_2 plus income off-farm activities; Y_4 = Y_3 plus remittances (all sources); Ch_1 = change in poverty due to additional income from livestock; Ch_2 = change in poverty due to additional income from off-farm activities; Ch_3 = change in poverty due to additional income from remittances.

When income from livestock was added to income from agriculture (Y_2), the mean income of the poor increased from SDG 99 to SDG 155 and the measure of income inequality among the poor (G) was decreased from 0.672 to 0.624 (i.e. an improvement in income distribution among the poor). Thus, compared with River Nile, the antipoverty growth and distribution effects of income from livestock in Kassala were greater than in River Nile. The addition of income from livestock to income from crops in Kassala reduced the incidence of poverty from 96.2 to 86.1% and the depth of poverty from 84.1 to 69.3%. Moreover, because it reduced income inequality among the poor, income from livestock in Kassala reduced the severity of poverty from 92.2 to 75.6%. These results would imply that livestock in Kassala is the wealth of the poor and that its contribution to family income was higher than that from crops. The difference in the antipoverty effect of livestock between Kassala and River Nile States were shown by changes in poverty (Ch_1; Tables 23 and 25).

However, the antipoverty effects of income from off-farm sources in Kassala were smaller than in River Nile (Table 23) indicating that off-farm opportunities in the River Nile were more in number and more rewarding than in Kassala. The difference in antipoverty effects due to income from off-farm sources between the two states was shown by the levels of Ch_2 (Tables 22 and 23). The addition of income from off-farm sources to incomes from crops and livestock (Y_3) increased the mean income of the poor in Kassala from SDG 155 to SDG 397 and decreased G from 0.624 to 0.297, implying enormous growth and distribution outcomes of the off-farm sources of income. As a result, income from off-farm sources decreased the incidence of poverty from 86.1 to 56.4%, the depth of poverty from 69.3 to 28.1%, and the severity of poverty from 75.6 to 36.5%. As for other states, and in contrast to what is usually conceived, the antipoverty effects of income from off-farm sources in Kassala were greater than the antipoverty effects of incomes from both crops and livestock.

The results showed that the antipoverty effects of remittances in Kassala were greater than in River Nile except for incidence of poverty (see Ch_4 in Tables 23 and 25). This implies that the growth contribution of remittances in Kassala was high and more pro-poor than in River Nile State. This is why the addition of remittances to incomes from agriculture, livestock, and off-farm sources (Y_4) in Kassala, while decreasing the incidence of poverty by only two percentage points, decreased the depth and the severity of poverty by 14.1 and 11.2 percentage points, respectively. Therefore, relative to crops and livestock, remittances and off-farm activities remain the major sources of livelihood for the poor in Kassala.

c) Northern State

Results for Northern State are reported in (Table 23).

Table 23: Food poverty in Northern State decomposed by source of income

Aggregate Poverty Indicators	Y_1	Y_2	Ch_2	Y_3	Ch_3	Y_4	Ch_4
Incidence of poverty (P0) %	94.2	90.3	–3.9	66.7	–23.6	65.0	–1.7
Income gap ratio (I) %	0.874	0.859	–0.015	0.604	–0.255	0.590	–0.014
Depth of poverty (P1) %	82.3	77.6	–4.8	40.3	–37.3	38.3	–2
Income inequality among poor	0.686	0.68	–0.006	0.4	–0.28	0.379	–0.021
Severity of poverty (P2) %	90.4	86.2	–4.2	50.8	–35.4	48.4	–2.4
Poverty line (SDG) per year	788	788	788	788	788	788	788

Source: own computation based on 2009 survey data.
Note: Y_1 = income from crops; Y_2 = Y_1 plus income from livestock; Y_3 = Y_2 plus income off-farm activities; Y_4 = Y_3 plus remittances (all sources); Ch_1 = change in poverty due to additional income from livestock; Ch_2 = change in poverty due to additional income from off-farm activities; Ch_3 = change in poverty due to additional income from remittances

Starting with household income from crops only (Y_1), the incidence, depth, and severity of poverty in Northern State were 90.4, 82.3, and 90.4%, respectively. The mean income of the poor was only SDG 99 and G = 0.686. Thus, if cropping was the only source of income, poverty in Northern State was widespread, deep, severe, and the poor were highly unequal in being poor.

When household income from livestock was added to that from crops (Y_2), a slight poverty reduction occurred. For example, the mean income of the poor only increased from SDG 99 to SDG 111 and even this slight increase in income goes to the less poor as indicated by the slight reduction in the incidence of poverty from 94.2 to 90.3% (i.e. –3.9 percentage points). Moreover, the slight reduction in G from 0.69 to 0.68 (i.e. 0.01 reduction) is indicative of the fact that income from crops ranked positively with income from livestock. This is why the additional income from livestock resulted in a small reduction in the severity of poverty from 90.4 to 86.2% only (i.e. a reduction of 4.2 percentage points only). Moreover, because its contribution to the mean income of the poor is only SDG 12, income from livestock reduced the depth of poverty from 82.3 to 77.6% (i.e. by only 4.8 percentage points). Therefore, both growth and distributional antipoverty effects of income from livestock are negligible. Thus, the contributions of both crops and livestock to rural livelihood was quite limited; a situation that requires action for improvement.

The dramatic growth and distribution of poverty reduction effects was due to income from off-farm economic activities. From the growth side, income from off-farm economic activities increased the mean income of the poor from SDG 111 to SDG 312 (i.e. by more than twofold). As a result of this dramatic increase in mean income of the poor, income from off-farm economic activities reduced the depth of food poverty from 77.6 to 40.3% (i.e. a reduction of 37.3 percentage points) and reduced the income gap ratio from 0.859 to 0.604 (i.e. a reduction of 0.255 points). From the distribution side, income from off-farm activities reduced G from 0.68 to 0.40 (i.e. a reduction of 0.28 points). As a result of this significant distribution effect, income from off-farm activities reduced the severity of food poverty from 86.2 to 50.8% (i.e. a reduction of 35.4 percentage points). These significant distribution effects on food poverty reduction imply that income from off-farm sources ranked negatively with the sum of incomes from farming and livestock. Furthermore, due to its significant contribution to growth, income from off-farm sources reduced the incidence of food poverty from 90.3 to 66.7% (i.e. a significant reduction of 23.6 percentage points).

The contribution of remittances to food poverty reduction was even smaller than that of income from livestock. They increased the mean income of the food poor from SDG 312 to SDG 323 (i.e. an increase of only SDG 11). Consequently, this reduced the depth of food poverty from 40.3% to 38.3% and reduced the incidence of food poverty from 66.7 to 65.0%. From the distribution side, remittances reduced G from 0.4 to 0.379 (i.e. a small reduction of 0.021). Consequently, remittances reduced the severity of poverty from 50.8 to 48.4% (i.e. a small reduction of 2.4) and reduced the income gap ratio from 0.604 to 0.590 (i.e. a reduction of only 0.014). So far, and at least in Northern State, the off-farm sources of income are the mothers of the poor despite the huge existing agricultural potential there.

d) River Nile State

The income decomposed food poverty results for the River Nile State are reported in (Table 24).

Table 24: Food poverty in River Nile State decomposed by sources of income

Aggregate Poverty Indicators	Y_1	Y_2	Ch_2	Y_3	Ch_3	Y_4	Ch_4
Incidence of poverty (P0)%	83.2	83.2	0.0	52.5	–30.7	48.0	–4.5
Income gap ratio (I)%	0.782	0.759	–0.023	0.439	–0.320	0.438	–0.001
Depth of poverty (P1)%	65.1	63.2	–1.9	23.1	–40.1	21.0	–2.0
Income inequality among poor (G)	0.645	0.62	–0.025	0.3	–0.32	0.276	–0.024
Severity of poverty (P2)%	76.8	75.6	–1.2	31.9	–43.7	28.5	–3.4
Poverty line (SDG) per year	781	781	–	781	–	781	–

Source: own computation based on 2009 survey data.
Note: Y_1 = income from crops; Y_2 = Y_1 plus income from livestock; Y_3 = Y_2 plus income off-farm activities; Y_4 = Y_3 plus remittances (all sources); Ch_1 = change in poverty due to additional income from livestock; Ch_2 = change in poverty due to additional income from off-farm activities; Ch_3 = change in poverty due to additional income from remittances

Using income from agriculture only, poverty in the River Nile (Table 25) was clearly less spread, less deep, and less severe than in Northern State. This is because the mean income of the food poor from agriculture in River Nile of SDG 71 was greater than that in Northern State and the food poverty line was SDG 7 less. As a result of these basic differences between the two states, and based on income from agriculture only, the incidence and the depth of food poverty in the River Nile were 83.2 and 65.1%, respectively. G = 0.645 and consequently, the severity of food poverty was 76.8%. These results so far imply that the growth and distributional antipoverty effects of agriculture in the River Nile, though low in absolute terms, were relatively higher than in Northern State.

The growth and distributional antipoverty effects of income from livestock in the River Nile were smaller than in Northern State. From the growth side, when income from livestock was added to income from crops (Y_2), the mean income of the poor increased by SDG 18 and consequently, the depth of poverty was reduced from 65.1 to 63.2% (i.e. a reduction of 1.9 percentage points), while the income gap ratio was

reduced from 0.782 to 0.759 (i.e. a reduction of 0.023). Because its growth effect is weak, income from livestock did not reduce the incidence of poverty in the River Nile. From the distribution side, adding income from livestock to income from crops reduced G from 0.645 to 0.62 (i.e. a slight improvement in income distribution among the poor) and as a result of this slight improvement, income from livestock slightly reduced the severity of poverty from 76.8 to 75.6% (a small reduction of 1.2 percentage points). Again off-farm sources of income were the major contributors to poverty reduction. For example, from the growth side when income from off-farm sources was added to the sum of incomes from crops and livestock (Y_3), the mean income of the poor dramatically increased from SDG 188 to SDG 438 (i.e. an increase of SDG 250). As a result of this huge growth effect, the incidence of food poverty reduced from 83.2 to 52.5% (i.e. a significant reduction of 30.7 percentage points) and the depth of poverty reduced from 63.2 to 23.1% (i.e. an enormous reduction of 40.1 percentage points). From the distribution side, income from off-farm sources enormously improved income distribution among the poor. The results in (Table 25) show that income from off-farm sources when added to the sum of incomes from crops and livestock (Y_3) decreased G from 0.62 to 0.30 (i.e. a significant reduction of 0.32 points) and as a result, the severity of poverty decreased from 75.6 to 31.9% (i.e. a huge reduction of 43.7 percentage points). These results imply that income from off-farm sources ranked negatively with the sum of incomes from crops and livestock. In comparison with (Table 24), the results indicate that the antipoverty growth and distribution effects of off-farm sources of income in River Nile were greater than in Northern State. One possible explanation of this regional difference is that the market for off-farm economic activities in River Nile is bigger than in Northern State.

The antipoverty effect of remittances continued to be low in River Nile. For example, the addition of remittances to total income from other sources (Y_4) increased the mean income of the poor by only SDG 1. Consequent to this low growth contribution, the depth of poverty decreased from 23.1 to 21.0% (i.e. a small poverty reduction of 2.1 percentage points) and the income gap ratio decreased from 0.439 to 0.438 (i.e. a negligible reduction of 0.001 points). From the distribution side, with the addition of remittances to total income from other sources, G was reduced from 0.3 to 0.276 (i.e. a marginal improvement in income distribution among the poor). As a result of this marginal improvement, the severity of poverty was reduced from 31.9 to 28.5% (i.e. a small poverty alleviation of 3.4 percentage points). Finally, while income from remittances increased the mean income of the poor by only SDG 1, it reduced the incidence of poverty from 52.5 to 48.0% (i.e. a reduction of 4.5 percentage points). One possible explanation of this irony is that income from remittances in the River Nile went to the least poor families.

7.2.6 Antipoverty effect of invisible sources of household income

It is known from the microeconomic theory that a rational consumer as a price-taker either maximizes a utility function U(X) defined over a set of goods and services (X) from a given level of income or minimizes expenditure to attain a given level of utility $U^0(X)$. In case of the former, the optimum value function is the indirect utility function V(P,M) defined over consumer income (M) and prices (P). In case of the latter, the optimum value function is the expenditure function $E(P,U^0)$ defined over the set level of utility U^0 and prices P. Under such rational consumer behavior, the duality condition requires the following equality:

$$U(X) = V(P,M) \text{ if } E(P,U0) = M \qquad (15)$$

This is a balanced household budget which says that direct utility from a bundle of goods and services is equal to the indirect utility if and only if household expenditure on that bundle is equal to household income. This duality condition holds either in an individualistic society where there is no social solidarity between the rich and poor, or in cases where respondents report balanced household budgets. However, in household budget surveys, poor people invariably underreport family incomes. In such cases the duality condition becomes an inequality of the following form:

$$U(X) > V(P,M) \text{ as } E(P,U0) > M \qquad (16)$$

The inequality in (2) says that the direct utility U(X) from a bundle of goods and services (X) is greater than its optimum value function V(P,M) because the reported household expenditure E(P,U0) is greater than the

reported household income (M). Thus, the excess of direct over indirect utility {U(X) – V(P,M)} is due to the excess in reported household expenditure over the underreported household income {E(P,U^0) – M}. The fundamental question is why do poor people underreport family income and not family expenditure? The commonly cited answer is that family income is underreported because of a recall problem. It can be argued that this is not the true cause, simply because in household budget surveys the two hands of the household budget (income and expenditure) are reported by the same respondent (the head of household) and there is no good reason for that same respondent to recall household expenditure and fail to recall household income.

The truth is that poor people deliberately hide part of family income due to social reasons. That hidden income part is eventually transformed into expenditure and reported as part of household expenditure. The socially undisclosed sources of the hidden part of family income include social solidarity, begging, theft, corruption, and the like. These are what are called here the 'invisible' sources of family income. Because reported household expenditure is greater than reported household income as explained by the inequality in equation (15) above, direct utility is greater than indirect utility.

Family income from invisible sources, like any family income from visible sources, has growth and distribution antipoverty effects. The method used here for netting-out these antipoverty effects includes separate computation of poverty using the distribution of the values of the indirect utility function as a welfare distribution and the distribution of the values of the expenditure function as a welfare distribution. Obviously, the poverty results of the first distribution are greater than those of the second because the deliberately unreported income, which is excluded from the first distribution is eventually included in the second distribution in the form of expenditure. The results of the two separate poverty computations and the netted antipoverty effects of the invisible sources of income are reported in (Table 25).

Table 25: The antipoverty effect of the invisible sources of income in the selected states

Aggregate poverty indicators	**Northern**			**River Nile**			**Kassala**			**N. Kordofan**		
Welfare indicator	V(P,M)	E(P,U)	Change	V(P,M)	E(P,U)	Change	V(P,M)	E(P,U)	Change	V(P,M)	E(P,U)	Change
Incidence of poverty (P0) %	65.0	13.53	–51.47	48.0	16.57	–31.43	54.3	31.51	–22.79	81.3	76.31	–4.99
Income gap ratio (I)	0.590	0.16	–0.43	0.438	0.19	–0.24	25.8	0.28	–25.52	0.558	0.33	–0.23
Depth of poverty (P1) %	38.3	2.21	–36.09	21.0	3.20	–17.80	14.0	8.95	–5.05	45.4	25.01	–20.39
Inequality among the poor (G)	0.379	0.087	–0.29	0.276	0.104	–0.17	0.28	0.144	–0.14	0.335	0.153	–0.18
Severity of poverty (P2) %	48.4	3.20	–45.20	28.5	4.59	–23.91	25.3	12.20	–13.10	45.5	32.86	–12.64
Poverty line (SDG/ person/ year	788	788	0.00	781	781	0.00	792	792	0.00	949	949	0.00

Source: our own computation based on the 2008 survey data
Note: (a) V(M,P) = the indirect utility function; (b) E(U,P) = the expenditure function

Throughout the four selected States, the antipoverty effect of the invisible source of income was higher than any of the visible sources individually (Table 26), including the off-farm sources. The antipoverty effect of the invisible sources of income was inversely related to the level of poverty, in that where poverty was high the antipoverty effect of the invisible source of income was small. This is logical as when poverty is high, income from invisible sources is small as little can be shared among the poor. For example, River Nile and North Kordofan States can be cited as contrasts. In River Nile where poverty was low the invisible source of income reduced the incidence, the depth, and the severity of food poverty, respectively, by 51.5, 36.1, and 45.2 percentage points; while in North Kordofan where poverty was high, the corresponding reductions were only 5.0, 20.4, and 12.6 percentage points. This implies that if poverty continued unchecked the invisible source of family income will gradually be depleted.

In River Nile State the invisible source of income increased the mean income of the food poor by SDG 191 and improved welfare distribution among the poor by decreasing G from 0.276 to 0.104. They consequently reduced the incidence, depth, and severity of food poverty by 31.4, 17.8, and 23.9 percentage points, respectively. The invisible sources of family income in Northern State increased the mean income of the poor by SDG 336 and improved welfare distribution among the poor by decreasing G from 0.379 to 0.087. As a result of their growth and improvement in income distribution, the invisible sources of family income reduced the incidence, depth, and severity of food poverty in Northern State by 51.5, 36.1, and 45.2 percentage points, respectively. The results also show that, in Kassala State, the invisible sources of income increased the mean income of the poor by SDG 21 and improved the welfare distribution by decreasing G from 0.280 to 0.144. They consequently reduced the incidence, depth, and severity of food poverty by 22.8, 5.1, and 13.1 percentage points, respectively.

Overall, regarding the income-decomposed food poverty in Sudan it can be stated that, despite the immense natural endowments, there was a growing number of food-poor people who had low incentives to fully utilize their agricultural and livestock assets and increasingly resorted to earning their living from irregular off-farm activities, sporadic remittances, and undisclosed sources of income like social solidarity, begging, theft, corruption, and the like. Unless agriculture, with its huge potential is given a strong push, especially realizing its yield potential, food-poor people would be expected to stay as economically dormant as their natural endowments.

Although opening of opportunities that lead to diversified income sources should be advocated as plausible policy, the unused agricultural potential calls for exerting earnest efforts to increase agricultural productivity in both its crops and livestock components.

7.2.7 Nutritional status of children

The total number of children at or below the age of five years was about 811 in the surveyed households in all regions. However, 11 children were excluded from the analysis due to incomplete data. Of the remaining children, males represented about 53% and females about 47%. (Table 26) showed the distribution of children in the selected states. About 37% of the total number of children were from Kassala, 25% from Kordofan, 24% from River Nile, and only 14% from Northern State.

Table 26: Distribution of children (equal to or below five years) by sex

Region	Total number of children	Males	Females	No. of Households
Kassala	295	156	139	206
Kordofan	201	114	87	200
Northern	111	55	56	200
River Nile	193	101	92	213
Total	800	426	374	819

Nutritional status of children within the sampled households was recorded for two categories of children: children up to 23 months of age and those within 23–60 months (Tables 27 and 29, respectively). For the former group of children across all states mild, moderate and severe malnutrition amounted to about 29, 17, and 3%, respectively. Obesity was also considered as a form of malnutrition, and thus in total about 56% of the children in this age group were classified as malnourished (Table 27).

Table 27: Prevalence of malnutrition in children aged 0–23 months

State	Nutritional status					
	Normal	Obese	Mild	Moderate	Severe	Total
North Kordofan	29	2	12	4	1	48
Kassala	23	7	30	20	4	84
Northern	19	1	7	6	-	33
River Nile	32	7	19	10	3	70
Total	103	17	68	40	8	236

Nutritional assessment of children aged 24–60 months revealed that about 24% were underweight (not receiving adequate nourishment to meet their needs), 11% were overweight, and 6% were at risk of being overweight, indicating that a total of about 42% of children at this range of age were malnourished (Table 28). Malnutrition during childhood can cause lasting damage for which later adequate nutrition may not be compensatory.

Table 28: Assessment of nutritional status of children aged 24–60 months using BMI

State	Underweight	Overweight	At risk of being overweight	Normal weight	Total
North Kordofan	63	1	1	89	154
Kassala	58	9	10	132	209
Northern	6	8	9	56	79
River Nile	11	44	15	53	123
Total	138 (24%)	62 (11%)	35 (6%)	330 (58%)	565

The nutritional status according to poverty status among households in the selected regions (Table 29) showed that in Kordofan malnourishment of total children below five years of age was high both among all poor households (84%) and poor farmers (83%). It was also high in Northern State among all poor households (69%) and worse among farmers (82%).

Table 29: Percent of malnourished children by poverty status in selected states

Item/Region	Description*	Poor	Non-poor	Total
North Kordofan	% among all HH	84	16	43
	% among farmers	83	17	42
Kassala	% among all HH	35	65	46
	% among farmers	45	55	50
Northern:	% among all HH	69	31	33
	% among farmers	82	18	40
River Nile	% among all HH	56	44	44
	% among farmers	52	48	57

** % among farmers was computed only for households (HH) with farming as the main occupation*

Prevalence of child malnutrition in River Nile State was such that over half of children within poor households were malnourished, exceeding those of the non-poor households. In general, and except for the unexplainable higher malnutrition among non-poor compared to poor farmers in Kassala, malnutrition was more widely spread among children of poor households in all states. This is a clear reflection of income poverty on child nourishment and calls for food/income poverty reduction in the medium term and supply of child food as an emergency measure in the short term.

7.2.8 Temporal comparisons

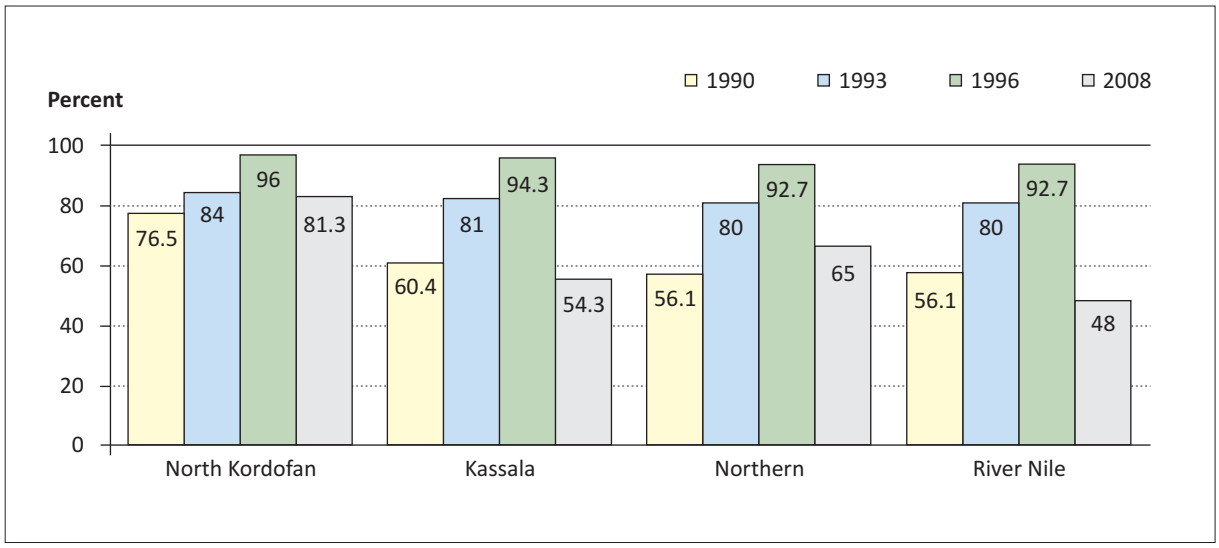
It is interesting to trace the link between the results obtained in the literature review with data in or before 2007 and those of the 2008 survey in selected states, to enable some temporal insight into the poverty issue. One aspect is per capita agricultural incomes estimated from state-level data and those computed from the survey data. Comparing per capita income in the two situations, where per capita income derived from the survey was income from agriculture only for those farmers whose main occupation is farming, showed some differences but similar patterns of poverty status (Table 30).

Table 30: Comparison of per capita agricultural incomes in 2008 and in earlier years with incomes from the 2008 survey in selected states

State	Before 2008	2008	Food basket 2008
North Kordofan	1.46	0.70	1.38
Kassala	1.38	1.69	1.56
North	4.43	1.80	1.53
River Nile	3.27	2.27	1.49

Except for Kassala State, per capita incomes declined in 2008 compared to recent earlier years. This is due to many factors, one of which is the general deterioration in agriculture; however, other factors might have influenced the gap. One of these is that the computation in earlier years included all the array of crops in the state, some of which might not be considered by the limited sample of 2008. Another factor is possible productivity differences on account of the known high year-to-year variation. A third factor is the expected difference in the set of prices of different agricultural products between the two periods, and a fourth is the expected difference in the food basket (poverty level). Yet, relating the incomes in the two periods to the food basket of 2008, the implications that can be drawn are that North Kordofan remained on average under the poverty line as far as agricultural incomes were concerned, while there was limited improvement in Kassala, graduating only marginally out of poverty. Both the North and River Nile States stayed outside the poverty line in the two periods despite the decrease in per capita agricultural income in the second period.

Another dimension is tracing poverty status with regard to income from all sources. Considering comparisons using the poverty-incidence indicator for rural areas, discrete results of the four years for the four selected states including the 2008 survey results, the temporal poverty development is shown in (Fig. 18). A drawback to the data in the figure (i.e. conclusions should be considered with care) is that the earlier analysis was based on regions rather than states because state divisions were not implemented at the time, while the later focused at the state level. Thus North Kordofan was compared with Kordofan, Kassala with the Eastern regions, but Northern and River Nile States remained compatible with the older Northern Region (Fig. 18).



Note: For the years 1990, 1993, and 1996 North Kordofan denotes the former Greater Kordofan, and Kassala denotes the former Eastern Region. The figures for 2008 are for individual states.

Figure 18: Comparison of poverty levels during 1990–2008 in selected states

The poverty incidence increased during 1990–1996. This coincides with the early period of structural adjustment and economic reforms, which had been stringent on people with removal of agricultural subsidies and levying of high agricultural taxation. Although the reforms continued with time, the 2008 figures indicated a decreasing poverty trend, thanks to people resorting to non-agricultural activities as well as undisclosed income sources and also probably sale of part of the household assets, as revealed by the 2008 survey.

As mentioned earlier, promotion of agricultural activities through intensive and prudent utilization of the huge available resources forms an inevitable option to further reduce poverty and at the same time contribute to the country's economic growth and foreign trade, see also (World Bank, 2008). Yet, off-farm opportunities will need to be further promoted since agriculture promotion will also open other job opportunities outside agriculture.

8. CONCLUSIONS AND RECOMMENDATIONS

The discussion in this study addresses the spatiotemporal distribution of poverty in Northern Sudan for two interrelated types of analyses. The first focuses on displaying various rural and urban food poverty indicators in the six former regions of the north in 1993 and over the period 1990–1996, and human poverty indicators in the current 15 states of the north (and states in the south) for the year 2000. The second deals with agriculture where the natural resource use, spatial distribution of agricultural incomes, and land productivity are subjected to spatial analysis over the current 15 states of the north and temporal assessment between the early 1970s and recent years of the current decade. The interface between the two sets of analyses helps in delineating spatial changes in the poverty situation over a wider time horizon in Northern Sudan, with adjustments made between the structure of administrative divisions, which comprised six regions that were divided into 16 states in 1994 and then 15 states in 2007.

It is evident from the analysis that poverty is widespread in Northern Sudan, but rural poverty is a more serious concern. The rural poor in the early 1990s outnumbered the urban poor and poverty was deeper, but its severity was lower due to the then similar income-earning capabilities of the poor that resulted in low, yet almost equally distributed income. However at that time, rural–urban migration was not as high as it is today, when rural people were still adhering to their relatively abundant natural resources for their livelihood. Deeper rural poverty is attributed to the encountered high income gap caused by low agricultural productivity and high cost of living, which is mainly engendered by the economic liberalization policies adopted in the early 1990s.

Increases in rural food poverty were dramatic over the period 1990–1996 when poverty was spread in almost all the regions, supporting the contention that the negative impact of adjustment and liberalization policies had reached the rural areas and hit them hard. The spread was not only geographical but also multi-dimensional. Poverty hit both male- and female-headed households, but the poverty incidence among the latter increased over-proportionally compared to the former due to the lower rewards from coping activities of female-headed households. Further, regardless of the economic sector in which the head of household was working or their education level, rural poverty increased at a higher rate than urban poverty.

Spatially judged, poverty indicators in 1993 indicating the highest poverty levels in Darfur, followed by Kordofan, and the Central region, while the Eastern, Northern, and Khartoum regions were consecutively better off. In 1996, high poverty incidence was reported in most regions and provinces therein. Yet, Kordofan and Darfur States maintained their rear position as the poorest states, with the little difference in exchanging of their ranks compared with 1993. However, poverty in the Eastern region was similarly high and was substantial in the Northern region and in half of the provinces of the Central region. Khartoum was relatively the least-poor region with the lowest incidence of poverty, with the highest degrees of income inequality.

Similar to the case of food poverty, human poverty was particularly high among rural people in 2000, with state-level human poverty indices being both high and largely similar. Human poverty in Northern Sudan was then primarily a rural phenomenon characterized by huge disparities between states and between regions (groups of states) and dominated by deprivation in decent standards of living. Disparity is reflected by the fact that population proportion in the poorest state (Lakes State) who were under the triple effect of deprivations in survival, knowledge, and economic provisioning was five times that in the better-off state (Khartoum). Other most-deprived states in the country were in Southern Sudan while the least deprived were Sennar, River Nile, Northern, Gezira, and Khartoum States. However, these least deprived states were dominated by deprivation in decent standards of living. According to the derived rural human poverty index in Northern Sudan, the states of North Kordofan, West Darfur, Blue Nile, Red Sea, and the White Nile were in sequence identified with the highest human poverty, while lower human poverty was recorded for the Northern, River Nile, Khartoum, and Gezira States. Given the current allocation of public expenditure among states, computed equitable regional share indexes that will be associated with equal opportunities in regional development, survival, knowledge and a decent standard of living necessitate redistribution of such expenditures. Generally, since the deprivation in the decent standard of living is the dominant component of the human poverty, human poverty reduction in Sudan will quickly respond to pro-poor economic growth.

Overall, policies have perpetuated in a rather combined way, the three causes of food poverty: low growth, bad income distribution, and high cost of living during that period. The compounded negative effect of these policies paved its way rather cumulatively into 1996 and resulted in rising and widely increasing poverty.

Agriculture, forming the main source of livelihood and highly influencing the level of poverty in the country, is basically founded on the exploitation of natural resources, especially land and water, with limited use of modern inputs. Shaped largely by climatic and soil variability, major farming systems comprise irrigated, semi-mechanized rainfed and traditional rainfed systems. Livestock production prevails all over the country under the three systems, but is more widespread within the traditional rainfed sector, largely in a pastoralist mode. However, many diverse sub-systems exist within these four major systems and, along with diversity in agricultural activities, influence spatial livelihood conditions, incomes, and poverty levels. An alarming concern is, however, the enormous pressures being exerted on natural resources over time. Confounded with a problematic land tenure system, mounting human and livestock populations, expanded arable cropping, and deforestation have resulted in successive degradation of the natural resource base, particularly under rainfed farming.

Derivation of current income distribution from agriculture in the 15 states of Northern Sudan reveals that overall average agricultural per capita income per day amounts to an equivalent US$1.08 with range US$0.61–2.56. While acknowledging variation among states, this indicates that the country as a whole is on the brink of poverty. Seven states, namely Red Sea, Kassala, North Kordofan, South Darfur, North Darfur, Gezira and Gedaref fall below the poverty line in regard to agricultural incomes. While the former five states are usually reported to have high poverty levels, the latter two have until now been considered to be outside the poverty zone. This is further indicative of temporal spread of poverty in Sudan's rural areas. It is also worth noting that the estimates confirm that the frequently mentioned problems in the Blue Nile, West Darfur, and South Kordofan are in fact a product of instability due to civil conflict rather than poor resource productivity, and human poverty is consequently prevalent there.
Spatial agricultural income disparities revealed that states with high income from crops are endowed with irrigation facilities, and those having high income from livestock enjoy substantial rainfall under the pastoral system of animal keeping. One striking feature is the dominance of livestock in contributing to total income from agriculture in most states. Except for North Darfur and Red Seas, the bulk of income in states with incomes below the US$1 threshold was generated from field and horticultural crops in contrast to the higher-income group of states where livestock had a higher contribution.

Assessment of spatial poverty ranking over time, which was only possible to make by region rather than by state (due to differences in administrative structures over time) showed that the three regions of Eastern, Darfur, and Kordofan had exchanged low positions while North, Khartoum, and Central states maintained a better status. Resource endowments and their management make the difference between the poor and relatively better regions. The three poorer regions were largely rainfed and showed irrational management, poor investment, deteriorating resources, and decreasing productivity. The relatively better regions were largely irrigated, with generally rising productivity but the management and policy issues also posed problems there as indicated by lower ranks of the Central region in 2007.

Land productivity, which is largely a function of the status of natural resources, is a major factor in determining income differences and changes in poverty levels among states. Yields of crops that are either fully or largely rainfed, namely sorghum, millet, sesame, and groundnuts, depict a clear decline over time; while yields of irrigated crops, mainly wheat and cotton, had a rising trend due to higher certainty of soil moisture, use of better technology, and government backing. However, while higher yields were currently realized under irrigation compared to rainfed farming for most crops, their levels were probably not sufficiently high to offset their high production costs.

However, there is enormous potential to raise crop yields by bridging at least part of the yield gaps that vary from 46% to as high as 566% between on-farm trials and prevailing commercial productivity. Irrigated crops can be improved by margins ranging from about 50% to > 140%. Even higher potential exists for crops under rainfed farming where potential margins range from twofold to over fivefold.

The field survey in four selected states (North Kordofan, Kassala, Northern, and River Nile) revealed that poverty was also substantial in states that were considered to have a low poverty level, e.g. Northern and River Nile States. This calls for a country-wide consideration of poverty reduction. It is however evident that there were signs of poverty reduction in later years despite the weaker returns from agriculture, thanks to the utilization of income opportunities outside agriculture. Livestock, generally a characteristic of better-off households, brought more income and enriched the asset dimension. Conversely, poor households depended more on cropping, indicating that cropping was related to poverty. This is explained by the low and declining crop productivity in addition to low prices to producers at the time of harvest. That more poor households resort to off-farm activities indicates either poor access to land or limited resources to increase income from agriculture where credit provision, especially to the poor proved to be weak. However, even off-farm opportunities, which are conducive to poverty reduction, seemed not to be available to all job seekers. Larger families were poorer than smaller ones, a situation most likely related to the level of employment. Agriculture, based on its quite limited contribution to incomes, forms a key area to be targeted for improvement, given the high potential it offers as clearly shown from the yield-gaps

stated above and also its facilitation of job creation outside agriculture. In this regard, technology use and credit access are generally quite limited and particularly so for poor households.

Not only is income poverty of concern to interventions, but human poverty also requires due consideration. There is generally considerable deprivation in education and health, but poor households stand in a substantial disadvantageous position. The level of education is consistently instrumental in reducing poverty, implying the need for education strengthening or other forms of farmer training. This is supported by the fact that younger household heads, who are likely to be more educated, sustained lower poverty levels. On the other hand, child malnutrition was more widely spread among children of poor households; a clear reflection of income poverty on child nourishment. Further, people's participation and particularly that of heads of poor households, in local and community organizations was weak, revealing a strong sign of powerlessness.

It is recommended that priority for poverty targeting should go to poorer states, and within those, to poorer households, i.e. those under the poverty line, even though wide poverty targeting in all parts of the country was essentially based on ubiquitous and substantial poverty. A targeting procedure that would be conducive to poverty reduction in the Sudan is proposed in (Fig 19).

In the illustration in Fugue we first classify sates into poor and on-poor and the poor are classified into those with high income poverty and those with high human poverty. In each group we identify the major factors associated with poverty which are low productivity, poor access to finance and malnutrition. We then proposed specific government interventions for each of these types. In the second level we identified specific agricultural activities that are priorities and should be targeted for each state.

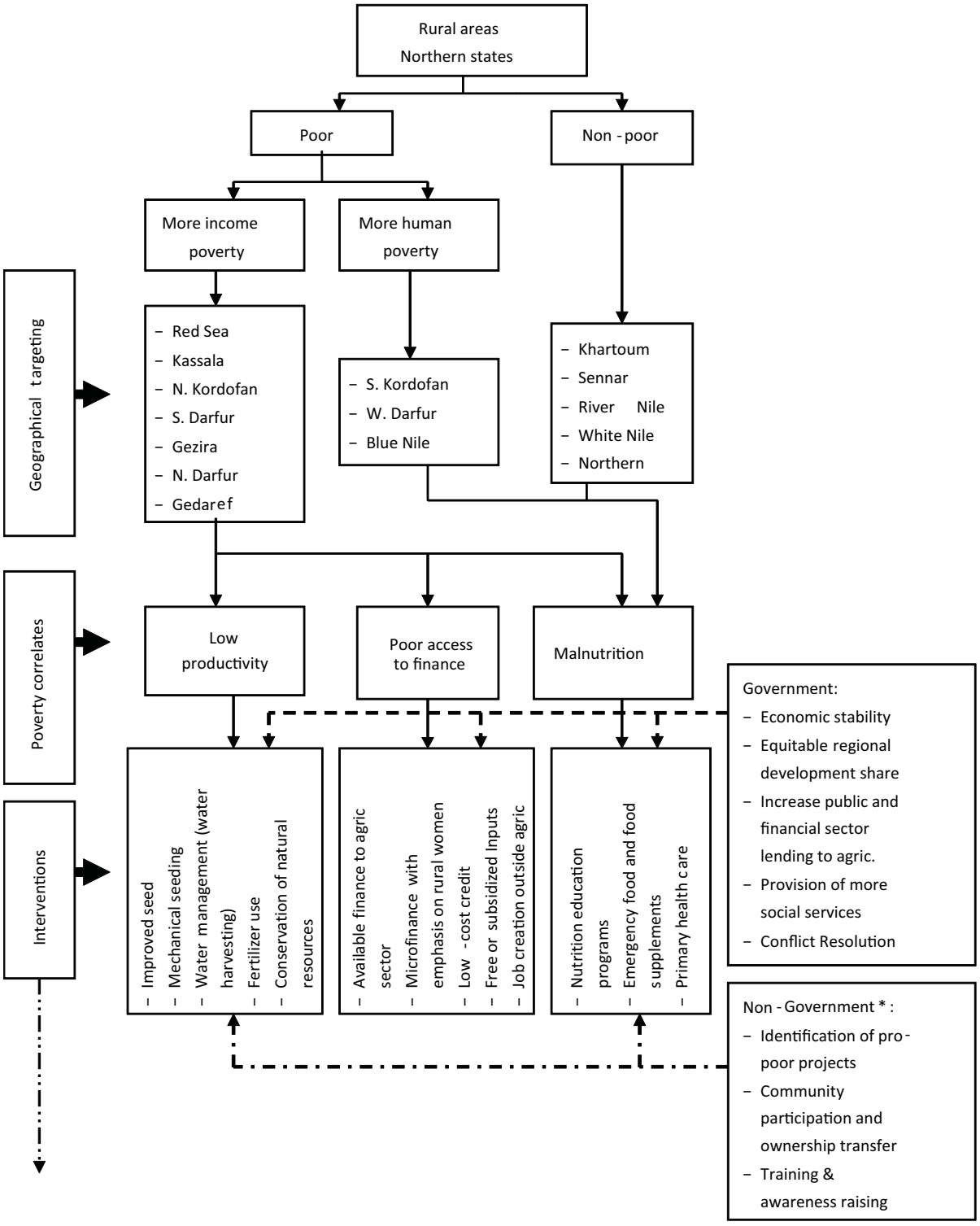
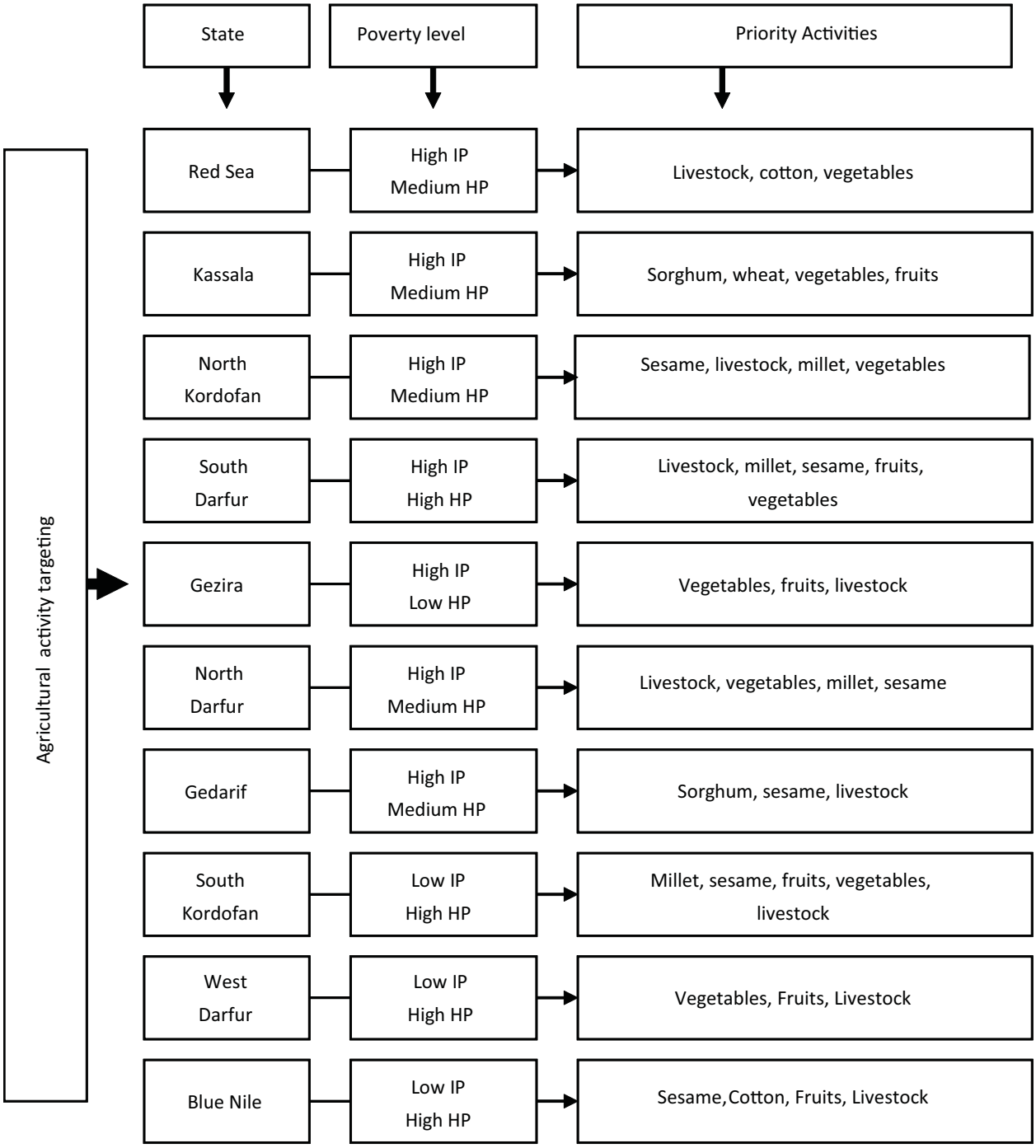


Figure 19: lllustration of recommendations to reduce poverty in the Sudan



Note: IP = Income Poverty; HP = Human Poverty

** Non-government organizations (NGOs) include international and regional organizations as well as local and foreign NGOs engaged in developmental activities.*

Figure 19: (Continued)

REFERENCES: POVERTY ASSESSMENT AND MAPPING IN NORTHERN SUDAN

Ali, M.A. 1996. The natural resource base. in Proceedings of the Agricultural Conference, Ministry of Agriculture and Forests, 2–3 March 1996, Khartoum (in Arabic), pp 9-25.

CBS. 1992. Poverty Line Survey. Central Bureau of Statistics, Sudan.

Deaton, A. 1980. The Measurement of Welfare: Theory and Practice Guidelines. World Bank Development Research Centre, World Bank.

Deaton and Muelbauer. 1980. Economics and Consumer Behaviour.' New York: Cambridge University Press.

De Wit, P.V. 2001. Legality and Legitimacy: A study of the Access to Land, Pasture and Water; Sudan (Draft). A study financed by the European Community; prepared for the IGAD Partner Forum Working Group on Planning for Peace in Sudan by the Food and Agriculture Organization of the United Nations; FAO, Rome.

DTIS. 2008. Sudan: Revitalizing Non-Oil Exports. Diagnostic Trade Integration Study (DTIS) for the Integrated Framework Program. Study prepared by the World Bank and other international agencies in collaboration with Sudan's Commission for WTO Affairs (CWTOA), Khartoum, Sudan.

Elbashier, A. and H. Faki. 2008. The Role of Agriculture in Poverty Reduction and Food Security in the Sudan. An IFAD-funded study draft report prepared for the Ministry of Finance and National Economy, Sudan.

Eltom, O. 1996. Irrigation and Water Resources. in Proceedings of the Agricultural Conference, Ministry of Agriculture and Forests, 2–3 March 1996, Khartoum (in Arabic); pp 26-43.

El Wakeel, A. 2005. Desertification: The Number One Environmental Problem in Sudan. Presentation made to The National Council, Khartoum.

Executive Program for Agricultural Revival. 2008. High Committee for Studying the Existing Situation and Future Vision for Agriculture in the Sudan, Sudan Government.

Faki Hamid and Abdelmoneim Ahmed. 2007. Distortions to agricultural incentives in Sudan. Agricultural Distortions Working Paper 44; a product of a research project on Distortions to Agricultural Incentives, under the leadership of Kym Anderson of the World Bank's Development Research Group, December 2007.

Faki, H. and van Holst Pellekaan, J. 2007. Sudan Diagnostic Trade Integration Study: Background Paper on Trade in agricultural products. Poverty Reduction and Economic Management, Africa Region, The World Bank.

Faki, H., I. El-Dukheri, M. Mekki and D. Peden. 2008. Opportunities for increasing livestock water productivity in Sudan. Proceedings of the Second International Forum on Water and Food (IFWF2, Addis Ababa, Ethiopia, 9-14 November 2008.

FAO .1970 and 1971. Energy and Protein Requirement, Report of the joint FAO/WHO Expert Group, FAO, Rome, 1970 and 1971

FAO. 1997. National Programme for the Development of Agriculture, Livestock and Irrigation Sectors. Mission Report, Part III, Policy Assistance Branch. FAO Regional Office for the Near East, Cairo.

FAO/WFP. 2008. Crop and Food Security Assessment Mission to Southern Sudan, 21 January 2008.
Farah, S.M. 1998. Republic of Sudan: Review of Some Aspects of Water Management Research in Sudan; Agricultural Research Corporation, Sudan.

Gomez, F., R.R. Galvan, J. Cravioto and S. Frank. 1955. Malnutrition in infancy and childhood with special reference to Kwashiorkor. (7: 131–136) in Advances in Pediatrics (Levine, S., ed.). Year Book Publisher, Chicago.

Nur, E.M. 1992. Poverty in Sudan With and Without Coping Practices. UNICEF, Khartoum.

Park, J.E. and K. Park. 1989. Text Book of Preventive and Social Medicine. Banarasi Ds Bhanot, Jabalpur.

Purnell, M.F. and J.H. Venema. 1976. Agricultural potential regions of the Sudan. UNDP Project for Strengthening the Soil Survey (SUD/71/553) Project Working Paper. Ministry of Agriculture, Food and Natural Resources, Democratic Republic of Sudan.

Samar Shams Elddin. 2008. The effect of technological production package on the yields of major crops in Sudan during seasons 1985/1986–2004/2005. Draft Annual Report 2007, Agricultural Economics and Policy Research Center, Agricultural Research Corporation, Sudan.

SSCCSE (Southern Sudan Centre for Census, Statistics and Evaluation) (undated). Southern Sudan Livelihood Profiles: A Guide for Humanitarian and Development Planning. Parklands, Nairobi.

Szönyi, J.A., E. De Pauw, A. Aw-Hassan, R. La Rovere and B. Nseir. 2005. Mapping agricultural income distribution in rural Syria : a case study in linking poverty to resource endowments. International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria.

Tothill J.D. (ed.) 1948. Agriculture in the Sudan: A Handbook of Agriculture as Practiced in the Anglo-Egyptian Sudan. Oxford University Press, London.

UNDP. 1990. Human Development Report 1990. Published for the United Nations development Programme (UNDP), New York Oxford, Oxford University Press 1997.

UNDP. 1997. Human Development Report. Published for the United Nations development Programme (UNDP), New York Oxford, Oxford University Press 1997.

UNEP. 2007. Sudan Post Conflict Environmental Assessment. United Nations Environment Programme, Nairobi, Kenya.

van Holst Pellekaan, J. with Abdalla el Hag Mohamed, Ahmed Hassan Hood, Yousif El Fadl Mubarak, Babo Fadlalla, Hassan Abdel Noor, Hassan Mohamed Hassan, Ibrahim Ahmed Adam, Ibrahim Dukheiri, Lucy Podszun, Lisa Overby and Sandra Pagoda. 2007. Agriculture, rural development and the environment. in Darfur: Dimensions of Challenge for Development; A Background Volume. The World Bank; pp 171-211.

World Bank. 2008. Sudan: Revitalizing Non-oil Exports - Diagnostic Trade Integration Study (DTIS) for the Integrated Framework Program.

Zarroug, M. 1996. The pastoral sector: current situation and development prospects. in Proceedings of the Agricultural Conference, Ministry of Agriculture and Forests, 2-3 March 1996, Khartoum (in Arabic); pp 293-322.

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ICARDA has a global mandate for the improvement of barley, lentil and faba bean, and serves the non-tropical dry areas for the improvement of on-farm water use efficiency, rangeland and small-ruminant production. In the Central and West Asia and North Africa region, ICARDA contributes to the improvement of bread and durum wheats, kabuli chickpea, pasture and forage legumes, and associated farming systems. It also works on improved land management, diversification of production systems, and value-added crop and livestock products. Social, economic and policy research is an integral component of ICARDA's research to better target poverty and to enhance the uptake and maximize impact of research outputs.

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