

Multidimensional Poverty among Sudanese Farmers: Evidence from Gezira Scheme, 2023

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Abstract

This paper assesses the spread of poverty among rural farmers of Gezira Scheme. Empirical analysis follows Multidimensional Poverty Index to measure incidence of poverty. The research relies on primary data aided by structured questionnaires compiled by Gezira Scheme Board staff; the Head Office located in *Barakat*; data provided for year 2023 over 18 sections organized Gezira and Managil Extension Scheme, a total of 378 rural households were randomly selected and interviewed. For the purpose of the research, the Author is focusing on households headed by farmers. The result reveals that, 45.60% of the rural farmers under the study area have been found multidimensional poor with deprivation less than one third of the dimensions of education, health and standard of living. The later, has been considered as the main contributor to deprivation of poverty, its indicator of nonexistence of land ownership showing significant determining of incidence of poverty. Similarly, food shortage is found to be associated with poverty. Therefore, government policies aim to reduce poverty, should take into account rearrangement of the relation between government and farmers regarding land tenure to improve agricultural productivity.

Keywords

Multidimensional Poverty, Rural Farmers, Alkire-Foster Method, Gezira Scheme, Sudan

1. Introduction

Sudan is a lower middle-income country in Sub-Saharan Africa with GNI per capita between \$1026 and \$4035, the Human Development Index (HDI) for Sudan stood at 0.490 in 2015, which puts the country in the low human development category, positioning it at 165 out of 188 countries and territories. Money

metric poverty is high in Sudan, with 46.5% of the population living below the national poverty line in 2009 National Baseline Household Surveys (National Bureau of Statistics, 2009). As of 2014, 12.2% of the population were living on less than \$1.90 a day (World Bank, 2020) and 52.3% were multidimensional poor according to Multidimensional Poverty Index (MPI) in the same year as reported by Oxford Poverty and Human Development Initiative (2020).

Agriculture still accounts for about one-third of Sudan's gross domestic product. According to the Food and Agriculture Organization (FAO), nearly 65% of Sudan's population of 49 million is engaged in the agricultural sector. The worsening conditions for farmers suggest a looming hunger crisis could be even worse. The United Nations estimated that the number of people going hungry in Sudan would rise to 19.1 million from 16.2 million last estimated prior to the conflict, which started in April 2023. Shortages of key staples would further worsen a hunger crisis that has been steadily building in recent years. It could also cripple livelihoods and deprive Sudan of foreign currency needed to import basic commodities, as cash crops such as sesame and peanuts accounted for \$1.6 billion in export revenues in 2022, according to central bank figures (FAO, 2023).

The Gezira Irrigation Scheme was established in 1925 and enlarged to its present capacity of 2.1 million feddans of irrigable area (882,000 hectares) in the early 1960s. The scheme occupies the area between the Blue and the White Niles about one taxi hour north of Khartoum, the Sudan's capital. The scheme still contributes some 3% to the GDP of the country. It provides the opportunity of a basic livelihood to 114,000 tenant families, other job opportunities for 0.5 - 1.0 million casual workers and employs a staff of about 7000 qualified administrators, technicians, scientists, clerks and craftsmen. The irrigable area cannot be run at capacity unless the overall infrastructure and central services of the scheme are in good shape.

The scheme reached today's size with the Managil Extension through the construction of the Roseiries Dam in the early 1960s. Beyond the canalization network, the scheme's infrastructure includes machinery, equipment, staff housing, roads and vehicles. The value of the infrastructure is roughly estimated to amount to eight billion USD and is an important asset of the government, while around 12,000 farming families and thousands of state administrators usually live there (Eldaw, 2004). During the first years after independence in 1956, cotton remained the main crop for export and sorghum the second as a staple food crop for the tenants. In the mid-1970s, agriculture was intensified and diversified by adding groundnuts, vegetables and wheat. Impressive numbers materialized, such as the Gezira scheme representing less than 11% of Sudan's cultivated area, yet producing 60% of cotton, 75% of wheat, 35% of groundnuts (Verhoeven, 2015).

Nation-wide, large-scale irrigation was promoted and peaked at the end of the 1970s. The price for the expansion of the area under irrigation was a reduction in agricultural efficiency. In the Gezira scheme, the intensification and expan-

sion have produced an impressive output in the short-term, but it contributed to the deterioration of the system in the long-term. This trend was reflected in the titles of early publications about the scheme. Arthur Gaitskell's book from 1959 was called "Gezira: A Story of Development in Sudan". Not even twenty years later [Barnett \(1977\)](#) published "The Gezira Scheme: An Illusion of Development".

The Gezira scheme has a unique land tenure arrangement. After the establishment of the scheme, the government either bought land or forced private owners to lease the land to the government for 40 years. The basically dispossessed landowners became tenants. Land allotments were limited to the size of 15 - 30 feddan (feddan equals around 0.4 hectare). After the expiration of the 1927 Land Ordinance, no new system was arranged, which still causes problems today. Ever since, the management of the Gezira Scheme has been highly centralized in the hands of the Sudan Gezira Board. The Board determined the crop rotation plan, including fallow period and was responsible for land and water management from minor to field canal. The upper system was managed by the Ministry of Water and Irrigation.

According to [World Bank \(2000\)](#) report, the Gezira scheme had become the "least efficient schemes in world" and needed to be institutionally reorganized ([Salman, 2010](#)). The performance of the Gezira Scheme has been extensively studied during the past 30 years. Several scholars from various domestic academic institutions have conducted many of these studies, while a large body of literature has accrued from studies initiated by the government in collaboration with international institutions, including the World Bank, FAO and others. In addition, the Gezira Research Station and other institutions of the Agricultural Research Corporation have conducted a bulk of research focusing on almost all aspects of crop technology development. While most of this research has located the roots of the inefficiency of the scheme's performance, almost all authors have acknowledged the potential of the scheme for sustainable development under the condition that proposed remedies be implemented.

The problems the Gezira faces include excessive government involvement in setting prices and allocating crop area. The performance of irrigated agriculture is further aggravated by the deterioration of the scheme's infrastructure and absence of technical progress. Lack of funds and the Gezira Scheme's mounting debts, in addition to inefficient recovery of overhead costs at the tenant level, have made it impossible to replace the aging irrigation infrastructure and exacerbated maintenance problems of the silted canalisation system. As a result, inefficient and wasteful water distribution became the rule and expansion in acreage and productivity of crops was limited. Accordingly, the total cultivated area of the Scheme declined during the late 1990s to levels far below the developed capacity of the irrigated area. In addition, the financial shortages of the Gezira Scheme led, further, to inadequate maintenance of equipment, machinery and transport infrastructure and difficulties in replacing them, the outcome be-

ing inefficient processing of output (ginning of cotton) and transfer of inputs and outputs.

Based on the above, a typical Gezira farm has become unable to provide an income above the poverty line for an average farmer family in the Gezira. As a result, the Gezira Scheme has become uneconomic from the national as well as from the farmer's viewpoint. While food demand will increase by 50% globally by 2050 (and 100% in developing countries), today's agricultural demand for water resources is largely unsustainable due to the depletion of aquifers, reduction of river flows, degradation of ecosystems and the salinization of irrigated soil (*The United Nations World Water Development Report, 2015*). In order to secure a world free from hunger and malnutrition, agriculture needs to become more sustainable and resources use more efficient.

The Concept of Multidimensional Poverty has been widely applied in measuring spread of poverty. Poverty has many manifestations such as unemployment, indebtedness, lack of freedom, and inability to afford basic needs (*Olarinde et al., 2020*). Many of the World's poor are small farm holders who depend on agriculture for their food, income, and employment (*De Janvry & Sadoulet, 2009*). The justification to examine poverty from a multidimensional view is because poverty shows different shapes of deprivation in major principles of life, and it refers to pronounced deprivation in one or more facets of the well-being of a person. Furthermore, multidimensional methods offer another guide to explain poverty and how it can be viewed and understood (*Alkire & Foster, 2011*). In addition, some countries have shaped national MPIs as official eternal poverty data, familiarising the technique to their own situation and national concerns. Uncertainty of rainfall, pest attacks, fire outbreaks, changes in soil condition, and social conflicts affect the farmers' agricultural productivity and are considered to be the key factors accountable for making farmers poor (*Olarinde et al., 2020*).

To further assess all mention above, this research was designed to investigate the status of farm household, tries to answer the questions: what are the factors associated with deprivations of rural farmers of Gezira Scheme? To accomplish the main objective of this paper is to calculate MPI for farmers of Gezira Scheme and assesses the contribution of factors to MPI. The researcher is set to test the validity of the following hypotheses: 1) farmers under the study area experience multiple deprivations; 2) inexistence of land ownership will be the main contributor to MPI. Hence, the present study introduces the Alkire-Foster measure that built on the FGT index, to explain multidimensional poverty in Gezira Scheme, it focuses mainly on households headed by farmers, it worth noting that, all farmers residing in rural area around farms and nearby villages.

2. Literature Review

2.1. Case Study: Gezira Scheme

The Gezira Scheme received a lot of attention from researchers and international organizations. There are several studies on the development of the scheme and

possible reasons for its poor performance (Salman, 2010; World Bank, 2000). In the Gezira scheme, irrigation water reaches the field via the main canal, major canals, minor canals and eventually the field canals through gated field outlets pipes. The field canals irrigate 90 feddan through 9 small field ditches.

The 2005 Gezira Act replaced the 1984 Act; adopted after the last great rehabilitation project in 1983; and the 1927 Gezira Land Ordinance, which had forced private landowners to lease their land to the government. However, already in 2009, the Ministry of Agriculture and forestry admitted in a report that these reforms have been “a total failure” since the disposition of scheme’s assets, the crop choice freedom and the establishment of WUAs lacking needed capacities have resulted in “irrecoverable damage” to the scheme (Salman, 2010).

Administratively, the scheme was divided into 18 sections, composed of five to seven blocks (114 in total) headed by a block inspector. The blocks were divided into a unit called number/nimra (90 feddan) which consisted of up to 18 Hawashas (farm/tenant plot) (Hussein & El Daw, 2002). The scheme continued to deteriorate at an alarming rate, in order to illustrate the major performance problems of the Gezira scheme.

2.2. Land Tenure

Arrangements for endorsement of land ownership existed in the Gezira area already before the establishment of the Gezira Scheme. With the advent of the irrigation system, legislation was passed to avoid speculation and to prevent sale of land to non-inhabitants (Awad, 1987). In establishing the Gezira Scheme, the government either bought or leased land from its owners under the 1921 Gezira Land Ordinance. As a result, up to 40% resp. 60% of the existing land of the Gezira Scheme is under tenant and government ownership. The privately owned land was leased to the government on a compulsory basis for a fixed annual rate of Ls 0.10 per feddan for 40 years. Finally, land allotments of farms (tenancies) of 15 or 30 feddans, called hawashas, were made according to the size of land owned, and landowners became tenants.

Priority in allocation of tenancies was given first of all to title-holders. Landowners in possession of large landholdings (more than 80 feddans) were also fixed a 30 feddan tenancy, but, in addition, they were also given the right to nominate others to be tenants. The reason for this was that the Gezira Land Ordinance of 1921 specifies that farmers were not allowed to own more than one tenancy. Therefore, landowners with large holdings nominated family members (including sons, wives, daughters and other relatives), and where there were no nominees, the tenancies were allotted to other inhabitants. In 1934, the size of the standard tenancies was increased to 20 and 40 feddans. This upscaling was necessitated by the introduction of the then 8-course rotation, which aimed at combating the outbreak of plant diseases that occurred in 1933. The same procedure of tenancy allotment was adopted for the Managil Extension. However, the standard holding for tenants were smaller, i.e. 15 and 30 feddans, respectively.

The Gezira Land Ordinance of 1921 specifies, also, that farmers may not sell, rent or sublet their tenancies. A tenancy can be inherited, but officially it can only be broken down into half the size of a full tenancy. As a result, the present rigid land tenure system of the Gezira Scheme represents a source of inefficiency of resource allocation, both for the tenants and from a national perspective. The ban on sale of tenancies limits the options for aggregation of land to increase tenancy sizes to sizes that provide enough income under present producer price ratios and cost of living conditions.

2.3. Production Relations

The Gezira Scheme was established as a parastatal enterprise under which production is a joint responsibility of the government, the British company (Sudan Plantation Syndicate) and the tenants. The backbone of this triple relationship is the tenancy agreement, which, in essence, governs the obligations and rights of the three parties concerning the production of cotton and the sharing of its net proceeds. Within the context of the tenancy agreement, the government is responsible for input provision, supply of irrigation water and financing of cotton production. The Gezira Board, on the other hand, is responsible for administration and provision of central management as well as mechanized work (ploughing, sowing, spraying, maintenance of irrigation infrastructure), and the tenants are responsible for the whole of cotton cultivation operations, including picking. After deduction of certain cotton production costs that are regarded as joint collective charges, the net proceeds are divided among the tenants, the government and the Gezira Board according to the rules of a joint account system (Awad, 1987).

2.4. Tenants in Financial Difficulties

Most of the approximately 120,000 tenant farmers cannot earn an adequate income for their families from crops on a typical 20 feddans irrigated farm. Consequently, the majority of tenants, given that they do not consider higher yields and more intensive cropping systems are feasible under current circumstances, depend on off-farm income to stay above the poverty line. This is why sharecropping and livestock production (which involves considerable grazing outside the Scheme) have become popular solutions to the financial difficulties facing tenants. The proportion of tenants who enter into sharecropping arrangements with the landless is about 30 percent. About 40 percent of tenants earn additional income from livestock production while most households have some livestock in the Gezira community.

2.5. Uneconomic Production

Because of low average yields, the Gezira Scheme is uneconomic from the national and tenant point of view. Research has shown that irrigated agriculture in Sudan, measured through the impact on irrigated wheat and cotton production,

generated the smallest income multiplier for rural households.

3. Data and Methodology

The MPI classifies many lacks in the same households in the three dimensions. Ten indicators built The MPI, two indicators stand on education and two indicators stand on health, while the six indicators construct the standard of living dimension. All of the indicators should be taken from the same household survey. The next step weighs the indicators and computing the deprivation to set the scores for households individually in the same survey. A cut-off of 33.3% is used to differentiate between poor and non-poor, the household and all persons are multidimensionally poor if the deprivation score is 33.3% or greater. Likewise, households are at danger of being multidimensionally poor if the deprivations score equal or greater than 20% and lower than 33.3%.

3.1. Aggregation Stage

The three dimensions made up the MPI express by ten indicators, each indicator means a minimum level of satisfaction, generally based on international standards, such as the MDGs for example this minimum level of satisfaction is named a deprivation cut-off. In order to calculate the MPI two steps are then followed to find it.

Step 1: Everyone is measured depending on family achievements to determine if he or she is below the deprivation cut-off in each indicator. A person under the cut-off is considered deprived in that indicator.

Step 2: The deprivation for everyone is weighted by indicator's weight, everyone is considered to be multidimensionally poor if the sum of the weighted deprivations is 33% or above of probable deficiencies.

3.2. MPI Mathematical Structure

The MPI is the creation of two numbers, the poverty headcount denoted by (H) and the Average Intensity of deprivation denoted by (A), this most valuable because it reflects the ratio of dimensions in which households are deprived. Also the technique has the mathematical structure of one member of a family of multidimensional poverty measures. This member of that family is named M_0 .

Where, M_0 : an adjusted head count ratio reflects both incidence and intensity of poverty.

Selection of dimensions: M_0 measures poverty in d indicators across all people n . It is important to mention that in the multidimensional framework, distributional data are presented in the formula of a matrix of size $n \times d$. $X^{n,d}$, in which the typical component x_{ij} parallels the attainment of person i in dimension j , with $i = 1, \dots, n$ and $j = 1, \dots, d$. vector x_i contains attainment of person i in the d indicators.

That means, row i of X represents the attainment vector of person i , summarising the person's attainment in all d indicators. Moreover, column j of X

represents the vector containing the attainment of all n persons in indicator j .

The supreme common methodology for classifying the poor in the multidimensional framework is to first state a threshold level for each indicator j , below which a person is considered to be deprived. The assortment of these thresholds can be conveyed in a vector of poverty lines $z_j = (z_{1j}, \dots, z_{dj})$ or $x_{ij} < z_{ij}$, which we refer as the deprivation cut-off of indicator j . The deprivation cut-offs are shortened by the deprivation cut-off vector z . In this way, whether a person is deprived or not in each indicator can be defined. Next judgement is to be made, between those who fall short in some indicator, who is to be considered multidimensionally poor.

A usual opening point is to set all those deprived in at least one indicator, the so named union approach. Other more challenging standards can be used, even to the risk of needful deprivation in all considered indicators, the so-called intersection approach.

In the case of the MPI, as mentioned earlier, most of the deprivation cut-offs are based on the internationally agreed standards, as presented in **Table 1**. When designing a national measure, different cut-offs may be set based on present policy priorities that exist in the country and who is considered to be deprived or non-deprived agreeing to the nation.

3.3. Components of the MPI

1) Schooling: the MPI has 2 indicators that balance each other in the schooling element, one focuses on finished years of schooling of family participants, the other at if children are going to school. Years of schooling acts as a proxy for the level of knowledge and understanding of the household members. The

Table 1. The dimensions, indicators, deprivation cut-offs and weights.

Dimensions	Indicator	Poverty Cut-off	Related to...	Weight
Education (1/3)	Years of education (1/6)	No member of the household has done 6 years of education.	MDG2	16.67%
	Child staffing (1/6)	Any child school-age is out of school in years 1 - 86.		16.67%
Health (1/3)	Food (1/6)	Any child or adult for whom there is nutritional data is undernourished.	MDG4	16.67%
	Child mortality (1/6)	One child at least has died in the household in the last 5 years.	MDG1	16.67%
Standard of living (1/3)	Electrical energy (1/18)	The family has no electrical energy.	-	5.56%
	Better hygiene (1/18)	The family's hygiene ability is not better or it is public.	MDG2	5.56%
	Better-quality drinking water (1/18)	The family does not have access to better drinking water, waking up 30 minutes from home-based, roundtrip.	MDG7	5.56%
	Flooring (1/18)	The household's ground is dirty, sandy or dunging.	-	5.56%
	Cooking gas (1/18)	The family cooks with charcoal, wood or dung.	MDG7	5.56%
	Assets (1/18)	The family does not own one of: receiver, TV, phone, bicycle, motorcycle or freezer or does not own a car or tractor.	MDG7	5.56%

deprivation cut-offs for this dimension, the MPI, requires that one member at least in the household has finished 5 years of education and that all children of school-age are attending grades 1 to 6 of school.

Some important things to mention with the practice of constructing this indicator, sometime occurred that someone living with a family and there one member at least found 5 years of education is stated non-deprived, even though he/she may not be educated. Likewise, someone living in a family and there is one child at least not attending school is stated deprived in this indicator, even though he/she might have finished schooling. Again, members are living in one house where no school-aged children are stated non-deprived in school attendance. Henceforth the rate of deficiency in this indicator will reveal the demographic structure of the family and nation, as well as the educational achievements.

2) Health: the MPI has two health indicators, food of family members and adults or children who are malnourished. A child is under-weight if he/she is two or more standard deviations below the median of the reference population. Noting that, the global MPI does not state adults or children that are overweight as poor in nutrition, unless he/she is malnourished. For purpose of the present research, food security defines as when there was not enough food or money for food in the past 7 days.

The second indicator uses data on child death. Generally, child deaths are preventable, being caused by infectious disease or diarrhoea. Child malnutrition also contributes to child death. In the MPI each household member is considered to be deprived if there has been at least one observed child death (of any age) in the household. It is important to observe that this indicator differs from the standard mortality statistics.

3) Living Standard: this indicator provides some fundamental indication of the quality of housing for the household these are: access to better-quality drinking water, access to better hygiene and the use of clean cooking gas, access to electricity and flooring material.

The indicator covers the ownership of some consumer goods, each of which has a literature describing them: receiver, TV, phone, bicycle, motorcycle or freezer or does not own a car or tractor. The cut-offs for each one can be determined according to the nature of the country under study, the assets index of the MPI by default is the same for all countries, it is relative cut-off rather than an absolute cut-off for, and rarely used for comparable purposes across countries or across time. Also prices have been difficult to use to build the asset index as the surveys lack information on the price, quality or age of assets. Clearly, all the living standard indicators are means rather than ends, some of the common classification that has been identified as follows:

- Water: water for family needs do not include vendor-provided water, tankers trucks or unprotected wells and springs, if the water source is/or piped water, public tap, borehole or pump, protected well, protected spring or rainwater and it is within a distance of 30 minutes' walk (round-trip) a family is not poor in this term of drinking water. If it fails to satisfy these conditions, then

the household is considered deprived of access to water.

- Hygiene: if the household has some type of flush toilet or latrine, or ventilated improved pit or composting toilet, a person is considered to have access to improved hygiene, provided that they are not shared, otherwise, it is considered deprived of hygiene.
- Electrical energy: if a person does not have access to electricity it is considered to be deprived here.
- Overcrowding: if there is at least 4 members per room.
- Cooking gas: a household is measured deprived of cooking gas if no gas is available, it cooks with dung, charcoal or wood.
- Assets: if a household does not own at least 2 feddans to farm then each person in it is measured poorly.

Specific definitions of cut-off points for each dimension employed by the present empirical model presented in **Table 2**.

3.4. Data Source

The Gezira Scheme constitutes the main sampling unit. Primary data had to be analyzed to test the hypotheses relating to the objectives of the study. There are 18 sections in the Gezira and Almanagil Scheme, about 2.2 Million acres farmed by 144,000 farmers (Ministry of Agriculture, 2022).

3.5. Sample Design and Sample Size

To draw the sample size of the study a two stage cluster sampling design was employed. Random selections in each administrative unit were with the probability of selection proportional to size. The sample size for the survey was determined by

Table 2. Definitions of cut-off points for each dimension employed by the empirical model.

No.	Dimension	Cut-off Points
1	School Enrolment	At least one child, age 6 and above, is not currently enrolled in school.
2	School Attendance	No household member has completed 6 years of schooling.
3	Child Mortality	Any child has died in the family in the last 5 years.
4	Food Security	There was not enough food or money for food in the past 7 days.
5	Overcrowding	Household lives with 4 members and above.
6	Electricity	Household not electrified.
7	Cooking Gas	The household cooks with dung, wood or charcoal.
8	Sanitation	If the household doesn't use a flush toilet, unimproved latrine, pit or shared.
9	Safe Drinking Water	If the water source piped outside the house.
10	Assets Ownership	The household has not owned at least 2 feddans to farms.

the accuracy and degree of precision required for the survey assessments for each administrative unit. The number of households selected within each village was determined keeping in observation the study objectives. It was accepted that for estimations at national level, it would be more effective to have proportional distribution of the sample to the national state based on its approximate population.

In order to having a random and representative sample, in addition to provide good geographic coverage, the households' sample size is determined on the base of the following equation, given by:

$$N = P(1 - P)Z^2/D^2$$

where:

N : the sample size.

P : the prevalence of the phenomena in the population under study.

$(1 - P)$: being the probability of failure.

Z : the critical standard value corresponding to the 95% confidence level.

D : the degree of precision.

For the calculation of the sample size, at 95% confidence interval (D) is assumed to be 5% level of significance of the true value, as such (Z) is equal to 1.96. Based on a previous study, the NBHS (2009), about 46.5% of the Northern Sudan' population is found below the national poverty line, at that time the poverty line was 113.8 SDG per person per month. Therefore, the estimated population proportion (P) is set at 0.46, setting (D) = 0.05, using these values into the above equation, we obtain the sample size of 378 households. Fortunately, all respondents of the selected sample had fully responded and all groups of farmers have been selected were fully covered after a household listing was carried out, due to preparation of summer planting season in May.

3.6. Questionnaire

A set of interviewer-administered questionnaire was used to obtain data for the research. The data include a range of household well-being issues collected through interviews, using structured form with the head of the family or other educated members. The questionnaire administration was sectional in nature, it investigates households' financial, social, demographic and land ownership data.

Twelve expert interviews were conducted associated with three leadership staff from the Gezira Board; Head Office located in *Barakat*. The sample design follows two-stage stratified sampling. Two questionnaire forms are to be designed, in order to get accurate data and minimise bias, the questionnaire prepared in Arabic language. The first is the household questionnaire, referred to as the core sample questionnaire structured to elucidate data and information necessary to construct the MPI for the case study, was administered in ~ 30 minutes per farmer.

Overall time management is left to the enumerator staff of Gezira Board, as many factors will determine how many farmers can be surveyed per day depending on the distances between houses and farm. All the respondents are in good health and in age between 16 - 65 years old, therefore, this study did not try

to distinguish men and women. However, local conditions, weather, road quality and other factors will determine which houses have been randomly selected.

The household-level information will be based on the definitions of the MDGs, which are often important for assessment of health deprivation. To do this, information will be collected in relation to MDGs 4, 5 and 6 or nutritional status pertaining to MDG 1 is required. Deprivation relating to housing characteristics was assessed using indicators: electricity for lightening, sanitation and overcrowding. The questionnaire is divided into two main sections. Section (1), at the top of the household questionnaire, for basic demographic information is referred to the respondent and the head of the family (overview). The questions in this section relate to variables such as the head of the household's age and gender, respondent's age and gender and married status of the household' head.

Section (2) is meant to collect data on a household's income either from production of farming or others. Section (3) relates to information on a household's expenditure by item, including expenditure on food, housing, source of fuel, clothing, education, medical treatment. Section (4) is devoted for questions related to some poverty correlates, these include house characteristics such as tenure status, kind of cooking gas or none, type of electricity energy or none, source of improved drinking water. Section (5) includes questions related to ownership of valuable assets, which may provide information on land tenure that could influence households' standard of living.

Random sampling technique will be used because of the homogeneity of the household's socioeconomic characteristics within study area, done by random selection by villages from each section. The data provided for year 2023, field work began on 20 April to 10 of May 2023, data coding and processing presented in **Table 3**.

4. Results and Discussion

A total (378) of rural households was interviewed during 20 April to 10 May, they are residing over 18 sections, the study estimated MPI using 10 indicators across 3 dimensions adopting, the result observed that, 45.6% of total farmers are experience multidimensional of deprivation. The finding proved the validity of the first hypothesis, the structure of poverty among the poor farmers of Gezira Scheme, **Table 4** and **Figure 1** show the values. This result is similar to the finding of **World Bank (2020)** poverty is widespread among those engaged in agriculture production.

The researcher could reach the following findings. Of these, about 11.32% are literate and 14.56% out of school. 17.76% do not have enough food or money to buy food. Child mortality rate found to be at 9.00%. 12.23% live in crowded house with 4 members and above. 5.81% of the houses are not electrified and 9.71% of households use unimproved cooking fuel, cooks with dung, wood and charcoal. Approximately 4.51% do not have improved hygiene facilities. 1.55% do not have safe drinking water. 13.55% of household found without own land

Table 3. Binary scoring indicators/poverty cut-off.

Indicator	Definition of Indicator
School Enrolment	1 if at least one child, age 6 and above, is not currently enrolled in school; 0 otherwise.
School Attendance	1 if no household member age 6 and above has completed 6 years of schooling; 0 otherwise.
Food Security	1 if there was not enough food or money for food in the past 7 days; 0 otherwise.
Child Mortality	1 if at least one child has died within the household during last 5 years; 0 otherwise.
Overcrowding	1 if 4 members of household per room; 0 otherwise.
Electricity	1 if the house is not electrified; 0 otherwise.
Cooking Gas	1 if the household has no gas for cooking; 0 otherwise.
Sanitation	1 if the household doesn't use a flush toilet or shared; 0 otherwise.
Safe Drinking Water	1 if the water source piped outside the house; 0 otherwise.
Assets Ownership	1 if the household doesn't have at least 2 feddans to farm; 0 otherwise.

Table 4. MPI indicators of deprivation for farmers of the Gezira scheme.

Domain	Dimension	Value %
Education	School Enrolment	14.56
	School Attendance	11.32
	% of MPI	25.88
Health	Food Security	17.76
	Child Mortality	9.00
	% of MPI	26.76
Standard of Living	Overcrowding	12.23
	Electricity	5.81
	Cooking Gas	9.71
	Sanitation	4.51
	Safe Drinking Water	1.55
	Assets Ownership	13.55
	% of MPI	47.36
	Total MPI	45.6

to cultivate to produce food and earn money.

Furthermore, the analysis across dimensions, reveal that a higher deprivation level is observed in the case of standard of living contributes to 47.36% to overall

MPI value with highest value reported by land ownership. This implies that, the majority of the household are deprived in essential livelihoods needs, this is mainly explained by the higher incidence of food shortage, the latter, registered a large percentage of the deprivation, this profile of poverty showing land tenant a serious factor in the study area and this answered the question of the present research (see **Figure 2** for more details). And this finding not surprising since the majority of households headed by farmer's adults depend mainly on agriculture productivities as a source of earning and generating income, according to (FAO, 2015; World Bank, 2020) figures, the average rural household earns at least one-third of its total income from agriculture, while this is only 5 percent in

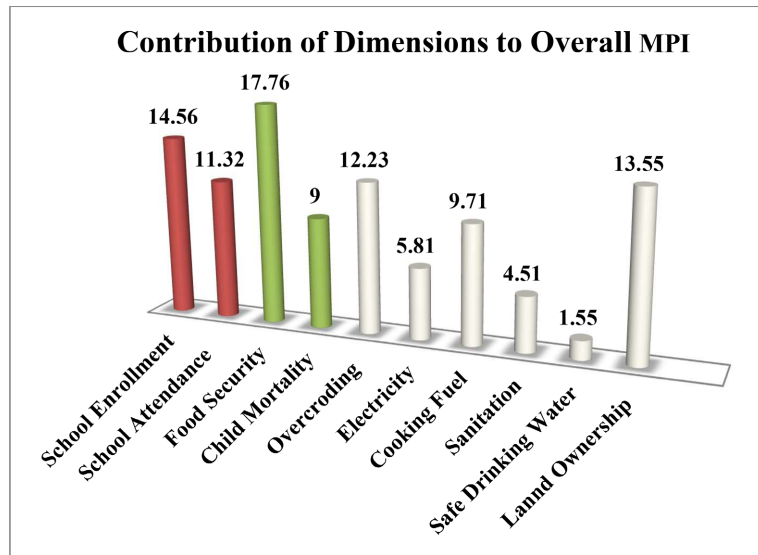


Figure 1. The contribution of indicators to overall MPI.

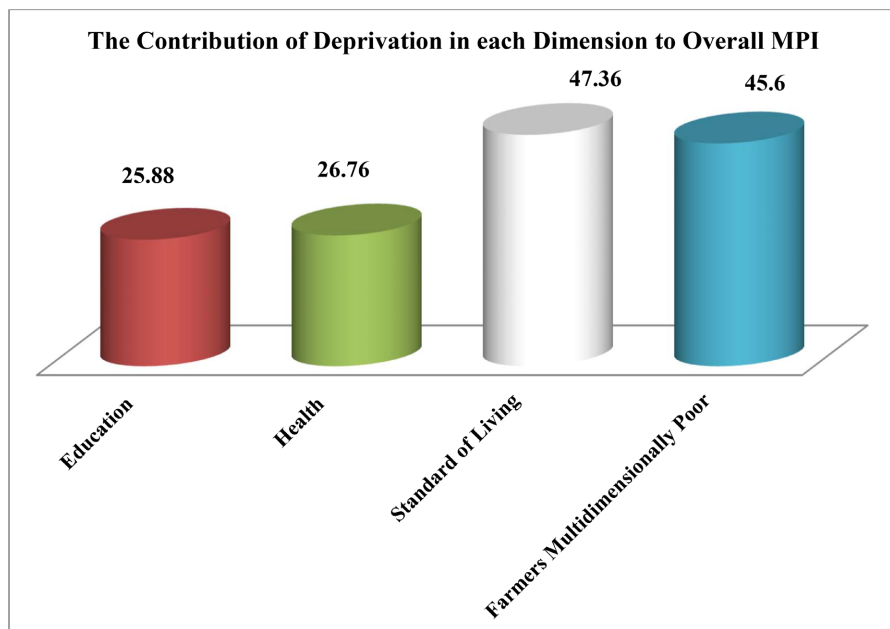


Figure 2. The contribution of deprivation in each dimension to overall MPI.

urban Sudan, in Gezira State where Gezira Scheme located wages and salaries are mostly tied to agricultural employment.

Health dimension in terms of food security and child mortality contributes relatively little to poverty. This finding proved the validity of the second hypothesis, inexistence of land ownership will be the main contributor to MPI.

Figure 1 and **Figure 2** describes the behaviour of the dimensional that the most prevalent deprivations are the low level of education and health with values 25.88% and 26.76% respectively, according to graphs major differences were observed between the three dimensions.

5. Conclusion

This paper assesses the spread of poverty among rural farmers of Gezira Scheme. Empirical analysis follows Multidimensional Poverty Index to measure incidence of poverty. The research relies on primary data aided by structured questionnaires compiled by Gezira Scheme Board staff; a total of (378) rural households were randomly selected and interviewed. The result reveals that, about forty-five point six percent of the rural farmers under the study area have been found multidimensional poor with deprivation less than one third of the dimensions of education, health and standard of living. The later, has been considered as main contributor to deprivation of poverty, indicators of nonexistence of land ownership showing significant determining of incidence of poverty and significantly affected food security. Similarly, food shortage leads poor farmers to deeply deteriorate into poverty. Therefore, the study recommends government efforts should focus on further reducing poverty, effective ways like: 1) rearrange the relation between government and farmers regarding land tenure to improve agricultural productivity; 2) empower the farmers by intensifying the cultivation of food crops and raising livestock; 3) developing banking and institutions system is needed to finance farmers. Moreover, research is needed on how farmers can access technologies that will help them improve agricultural productivity.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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