World Essays Journal / 1 (1): 13-19, 2014

ISSN 0000 ©2014 WEJ Journal

Climate Variability and Change: Implications for Household Food Security in North Kordofan State

Sayed Ali. F. Elmola Zareba[1], Salah Masri. M. [2] Maruod Elno Maruod[3],Elrashied Elimam Elkhidir[4], Tarig Elsheikh Mahmoud[5]

1. University of West Kordofan, Faculty of Administrative & Economics, Dept. of Agricultural Economics
2. University of Kordofan, Dept. of Agricultural Economics
3. Sudan University for Science and Technology, Dept. of Agric. Economics
4. University of Kordofan, Gum Arabic Research Centre
5. University of West Kordofan, Dept of Rural Development

Corresponding author email: zareba692000@yahoo.com

ABSTRACT: This study assesses the potential economic impact of climate variability and change and socio-economic characteristics that hinders the household food security, in order to provide a meaningful insight and contribute to efforts aimed at ensuring increased food availability through sustainable domestic production and increased income from agricultural production. In Sudan general and North Kordofan State in particularly many researches and studies has been carried out in the area of household food security. Most of these studies have been indicative and either descriptive or have tended to limit themselves to the national level. The data on having national food balance is not sufficient to understand the food security dynamics in the country and no clear definition of food security and categorization at the farm household level. The study was conducted on the basis of cross-district analysis and extrapolates the results to all localities in North Kordofan State, Sudan. One hundred households were randomly selected for interview using pre-constructed questionnaire during 2011-2012 season. The study identifies choice for adaptation measure that farmers are using to mitigate potential environmental impacts from expected variables in climate change conditions. The study utilized the statistical descriptive and an econometric techniques to describe the trend of impacts of climate variability and change and socio-economic characteristics on food security in North Kordofan State. The results indicated that the climate variability and change and socio-economic are the important factors that affecting the production and productivity of crops in traditional rain-fed sector and household food security in the region. The results of the household food security indicator which calculate from Gini coefficient, descriptive and econometric model showed that the production fluctuated due to many factors such as seeds, area cultivated, and type of land, costs of production, rainfall distribution, and farm and off farm income, animal ownership and educational level. In General results show that 75% of households did not have sufficient food secure their needs, whereas 73% of households reported inadequate income to buy food. It should, however, be noted that the food quantities reported by most households interviewed in the study area are considered to be inadequate and very low as indicators to characterize the household food secure and household food insecure at the household level.

INTRODUCTION

Sudan is a low-income country, with income per capita of less than US$ 400, with its vast geographic area and varied natural resources, it holds great economic potential. So far, however, it has been a land of missed opportunity (Medani etal 2006). Yet, it faces many challenges after missing the oil resource due to the separation of southern Sudan to utilize these diversified resources to attain mitigation of poverty (Abaker and Salih, 2011). Despite that and since 1970s, the country economic growth has been associated with increasing in poverty. The situation has been aggravated by liberalization policies during 1990s which has affected both growth and income distribution (World Bank, 2003).

The traditional rain-fed sub-sector is considered as one of the most important components of the agricultural sector in the Sudan. However, it experienced sever episodes of droughts in the last three decades of the 20th century. Agriculture in North Kordofan State is integral part of traditional farming, before three decades productivity was high and household used to cover all grain or cereal needs from farm production i.e. through direct access. Over the years crop production has fluctuated due to many factors such as low/erratic rainfall, pest infestation and low soil fertility. The area has experienced high environmental degradations;

resulted in declined productivity and depletion of large livestock herds along with plant species which makes most of the rural people living in highly vulnerable conditions. Accordingly, the area continuously experienced food gaps or food insecurity and getting food aids.

This study was undertaken to assess the impact of climate variability and change and socio-economic characteristics on household food security of rural farm household with emphasis on North Kordofan State. More specifically, to investigate the crucial factors regarding the decline in field crops as main sources of food security in the area as well as assess the impact of climate variability and change on livestock as second most important sources of food security in North Kordofan State.

METHODOLOGY

Study area

North Kordofan State is located in the middle west of the Sudan, lies in the arid and semi arid zones between latitudes 16°36 -16° north and 14°-12° south and longitudes 20° 21 - 32° east and 30° 56- 26° west. It encompasses an area of 244.700 km^2 with total human population estimates based on the last census 2009, of around 2,920,992 persons most of which (80%) are allocated in the rural areas and the rest (20%) in the urban areas (CBS, 2010).

North Kordofan State was selected as a case of the study area for two reasons: First: it can be classified as one of the vulnerable and poorest State in the Sudan, as it is a frequent drought and desertification vulnerable area. Second: no many studies have been done and only few are known about the household food security in the State. This study concentrates on the impact of climate variability and change on household food security in North Kordofan State. Four essential factors determine the significance of agricultural production in North Kordofan State in relation to household food security. These include:

1) The number of household involved in crop production.
2) Types of crops grown.
3) Area cultivated by each crops.
4) Quantity produced from each crops.

The study used both primary and secondary data. The primary data were collected through direct interviews focused on the heterogeneity of the farmer's household heads using a questionnaire. A multi-stage stratified random sample method was implemented, and accordingly a number of 100 households were randomly selected during 2011-2012 cropping season. While, the secondary data were collected from published and unpublished sources, which included records, books, periodical reports and journals from relevant institutes.

Specification of Food Security Indicators

Consumption of cereals food

the household food security indicator was specified as a measure of cereals food consumption. Conceptually, the amount of food needed by an individual is dependent upon several factors including: age, sex, type of work he/she does and the prevailing climatic condition. This study, used the recommended daily amount of cereals requirements by the FAO, AOAD and WHO, which set the average food needs at about 400 grams of cereal crops per person per day or (140 -146kg/years per person), as indicators to characterize the household food secure and household food insecure at the household level for different categories of household members. Considering the specific features in developing countries the WHO (1985) and CARE (1997) were utilized general formula as follow:

$$X = f\left(P, Q, S\right) \times 360$$

Where:

X = Amount of cereals food required per household members per year.
P = Food consumed by the age
Q = Food consumed by the sex
S = Total food consumed by the household size
360 = Number of days in the year.

However, in much of African countries, Asia and Latin America, the average intake is 400 gram of cereals or 2100 kilo calories per person per day (Fyson, 1972).

Gini coefficient

is a measure of income inequality. Gini coefficient is a number between 0 and 1, where 0 corresponds with perfect equality (where everyone has the same income) and 1 corresponds with perfect inequality (where one person has all the income, and everyone else has zero income).
The Gini Index is calculated as follow:

$G = 1+1/n-2/n^2M\ \Sigma\Phi_i\ Y_i$
Where:
G = Gini Coefficient.
n = number of sample households
Φ_i = i^{th} rank of the household when arranged in a descending order with respect to income
Y_i = income of the household in the corresponding i^{th} rank
M = sample mean income.

The Econometric model

Constructing an econometric method to identify the relationship a set of variables and the farm household expenditure will use OLS estimation. The technique based on the principle of minimizing the sum of squared residuals has the desirable properly of mathematical objectively .The criterion of OLS provides estimates that possess many useful and desirable properties (Chandan et al, 1998).

Regression model

$Y= ß_0+ ß_1x_1+ ß_2x_2+... + ß_mx_m +e_i$
Where:
Y = output (dependent variable)
$ß_0$, $ß_1$, $ß_2$… $ß_m$ are the parameters.
e_i = random variabile = (error).

x_1, x_2, **....** x_m = are Independent variables.

Regression Equation

$E (y) = ß_0+ ß_1x_1+ ß_2x_2+……+ ß_mx_m$
$\hat{Y} = b_0+b_1x_1+b_2x_2…+b_m\ x_m$
Where:
$\hat{Y}$ = Estimated value of dependent variable
b_1, b_2…. b_m = are the estimates of ß0, $ß_1$, $ß_2$... ßp.
x_1, x_2, x_3…x_m= independent variables.

RESULTS AND DISCUSSION

Cereal crops such as millet and sorghum are the main staple food crops widely grown in North Kordofan State. For example, 88% of households in North Kordofan cultivate millet. Furthermore, 74% of households in North Kordofan also grow sorghum. In recent times sorghum is usually cultivated to serve the household consumption needs since millet has declined in productivity especially in North Kordofan.

Cash crops such as groundnut and sesame are important to the household economy. For example more than 48% of households grow groundnut in surveyed sample whiles 58% grow sesame, in addition to other minor crops grown at home gardens like rosella, cucumber, okra, cowpea and other vegetables. For these crops, women and children do all farm operations and women afterwards mostly control benefits, though they are done in the interest of the whole household. The extent of food and cash crop production varies from season to season.

This section captures some of the factors that interact to characterize the food secure and insecure at the household's level based on some economic concepts. Farm household resources and assets represent the availability of productions means and the infrastructures needed in the region to enhance productivity.

The household income and sources of household basic supply; the cash income gives the purchasing power for securing household goods, which also contributes to household supply of which food is the most critical. Some gift and remittances received by farm the households could either be in cash or kind, both of which contribute to household supply.

Household income consists of farm income as mean 146156.0SDG and Std. 173343.7SDG, and off farm income and remittances. Off farm income (95541.1Sd as average and Std. 102893.5) includes income from all economic activities outside the farm work. Various uses of household income could be in form of cash or kind. The cash uses include living expenses of household including health expenses, education expenses, social obligations and others, expenses back into the farming in subsequent seasons. The uses in kind could either be direct home consumption from subsistence production and/or payment of wages in kind. There are different pathways to measuring food security at the household level. Some measures are used directly to assess food security while others are used as proxy variable. This study investigates whether an average rural farm family has both physical and economic access to enough food for all household members, and the consequential impact of their availability, accessibility, affordability of food, on food security.

Access to Food and Food Consumption in most rural areas there are three ways of obtaining food: production, purchase and transfer.

Consumption of both farm and non-farm products has changed over the years as an adjustment to the growing risk of food insecurity. Households in the study area depend mainly on their own production in order to satisfy their basic food needs. Nearly all households produce at least millet and sorghum, as staple food for home consumption in north Kordofan state mainly millet. With exception of low-income area located mainly in traditional rain-fed sub-sector, most households reported that they did not were produce enough from staple food. It should, however, be noted that the food quantities reported by most households interviewed in the study area are considered to be inadequate and very low as indicators to characterize the household food secure and household food insecure at the household level.

Table 1. Households cereals Consumption in Grams and Equivalent Units Approved by: WHO, CARE, OADA and FAO.

Consumption (Cereals) in grams	North Kordofan % Of HH
< 400	29
400 – 600	36
601 – 800	24
801- 1000	8
> 1000	3
Total	100

Source: Field Survey, 2011**.**

If these criteria are applied, only 70%of the interviewed households reported self-sufficient in north Kordofan at least in producing the main staple food crops (millet and sorghum) for home consumption. This may be explained as follow: Firstly, households generally refuse to discuss food problems with others as they feel ashamed and deny that they run out of food at certain periods of the year. Secondly, although some household may store only little millet, they may be in fact self-sufficient as they can depend on reserve crops such as, sorghum when millet stocks are depleted. In addition, they may consume other foods, which were not mentioned during the interview, e.g. wild food. About 45.5% of the interviewed household in the study area admitted to being unable to cover their food needs via home production, because food stocks do not last for more than three or four months. This differs, however, from household to household and from village to village in North Kordofan State.

Although the clear shift in the production structure from millet to sorghum as the staple food may have had an adverse effect on food security. The production of millet in North Kordofan State for home consumption may still contribute substantially to household food security; millet can be used as reserve crop it can be readily to store for a number of years.

In this study, Gini coefficient is calculated in order to measure income inequality among the rural households in North Kordofan State. In Gini coefficient, households are ranked from the lowest to highest according to their annual income. Gini coefficient of households in North Kordofan State based on total households farm income and off farm income were as fallow: Gini coefficient based on total farm income for all household in North Kordofan is 0.28725 based on annual farm income, indicating that farm income of households in North Kordofan is less equally distributed. While, the Gini coefficient based on off farm income for all households in North Kordofan is 0.19082, indicating that income earned from off farm jobs also is less equally distributed. This result explores the sources of income distributions among households in North Kordofan State in general. The general results revealed that annual household's farm income is distributed much more unequally among households than is annual households off farm income in North Kordofan State. Among different types of households in the study area, one household in each part of the localities of the State have the greatest inequality in the distribution of income and expenditure, whereas income and expenditure are most equally distributed among one household in the State.

Factors Affecting Total Household Expenditures Determination

The study aims to investigate the critical factors influencing household food security in North Kordofan State by using econometric model mainly matrix correlation and multiple regressions as a method of analysis. The relationship between dependent variable and independent variables was shown by the linear consumption function chosen as follows:

In this equation bellow, the dependent variable (Y) is total household expenditures in north Kordofan in SDG per year and continuous (predictors) variables are the "age of household, household size, total farm income, total off-farm income, and number of meals, and annual household consumption. In addition to these there are many dummy variables were used: household head, education level of household head, educate female, educate male, land ownership.

$Y = \beta_0 + \beta_1 HHhead + \beta_2 HHage + \beta_3 HHsiz + \beta_4 HHeduc + \beta_5 Educm + \beta_6 Educf + \beta_7 Nomeals + \beta_8 HHcons + \beta_9$ Animal own $+ \beta_{10} Fincome + \beta_{11} OFFFinc + E_i$

Where:
Y = Total household expenditure (dependent variable).
$\beta_{0 =}$ the intercept.
HH Head = Vector of dummy variables indicating gender of household.
HH Age = Variables of household age
HH Size = Variables household size.
HH Educ. = Variables of education level of the household head.
Educ M = Variables of education level of male.
Educ F = Variables of education level of female head.
No Meals = Variables of number of meals.
HH Consumption= Variables of households annual consumption indicating quantities cereal crops of households consumption.
Animal Own = Dummy variables indicating household own animal. Farm Income = Variables of net farm income.
Off Farm Income = Dummy variables of off-farm income.
E = Standard Error.
$\beta_{1,}\beta_{2...}\beta_{14}$ = are the coefficients (are parameters of explanatory variables).

Factors Affecting Total Household Expenditures Determination in North Kordofan

Table (2) shows the result of the estimated model in North Kordofan, Adjusted R-Squared 52.5%, which indicates could be explained by these variables 52.5% of the variance in the household expenditure in North Kordofan. F- Statistic was significant at 1% of significance.

Table 2. Total Household expenditure regression equation in north Kordofan

Variables	Coefficients	Standard errors	T-values
DUMMY-Household Head	0.026	19380	0.716
Age of household	-0.347*	666.3	-1.386
Household Size	0.187 ***	3200.4	3.264
Education level of HH	-0.240 *	14887.7	-1.451
DUMMY Educated male	-0.385	4051.2	-0.862
DUMMY Educated female	-0.370 **	4432.7	-1.945
Number of meals	0.307	14360.8	1.267
Household consumption of cereals	0.411	25088.4	1.110
NUMMBER OF owned Animal	-0.050***	17537.0	-3.717
Net farm income (SD)	-0.141 ***	0.018	-4.942
Off-farm income	-0.451 ***	14083.8	-6.896
Constant	53723.3 ***	5822.2	2.642

Source: Field Survey, 2011. F-value=16.325 (.000) R^2 = 0.625. Adjusted R^2 = 0.525 Standard error = 44521.87583
*, ** And *** denotes significance at 10%, 5% and 1% levels respectively.

North Kordofan localities are similar in traditional method of production and culture is thus characterized by seasonal or transitory food insecurity and rarely chronic food insecurity of household in all areas. Moreover, households in North Kordofan State hardly to cover their needs via home production and food stocks do not last for more than three or four months. In season 2011-2012, 29% of household in North Kordofan were food insecure according to the standard criteria applied by FAO, CARE, WHO and AOAD, while, this percentage is high level of food insecurity would even be worse in marginal parts of the State with less favour in resources endowment, mainly in the northern and western parts of the North Kordofan. Most of households in North Kordofan, produced (90 %) are sold. These include cash crops such as groundnut, sesame and rosella and others. Millet and sorghum are also utilized in home consumption. Generally, however, households in rural area fail to use their production resources for diversifying their production to ensuring a balanced diet from their own farming operations.

Four equations of Millet, Sorghum, Groundnut and Sesame were estimated. The regression equation coefficients and statistics for the four crops are presented in table 3.

Table3. Regression Coefficients and Statistics for the Production Functions of the Major Field Crops in North Kordofan State.

Variable	Millet	Sorghum	Groundnut	Sesame
Household size	-0.098	0.087	-0.008	-0.306
	(-0.793)	(0.874)	(-0.049)	(-2.516)
Quantity of seeds	-1.359***	-1.085*	-0.420*	000
	(-3.385)	(-1.827)	(-1.603)	(000)
Areas planted	1.455**	1.101*	0.797**	0.593
	(3.765)	(1.917)	(2.934)	(0.585)
Type of land	0.694***	0.778***	-0.585**	0.270**
	(6.268)	(7.210)	(-3.275)	(1.508)
Cost of production (SD)	-0.381	0.034	0.118	000
	(-2.737)	(0.292)	(0.731)	(000)
Net farm income (SD)	0.221*	0.231	-0.252	-0.090*
	(1.901)	(2.405)	(-1.631)	(-0.550)
Off-farm income	-0.007	-0.100*	-0.349*	0.492
	(-0.056)	(-1.039)	(-2.280)	(4.319)
Animal ownership	0.481**	0.136	000	0.197*
	(3.671)	(1.457)	(000)	(1.338)
Rate of rainfall	0.254**	-0.285*	0.537**	-0.745**
	(1.954)	(-2.661)	(3.156)	(-6.552)
Constant	-.534**	-.199**	3.078**	0.836*
	(-1.939)	(-3.619)	(3.961)	(2.497)
R –squared	0.736	0.680	0.722	0.673
F –value	6.596	8.712	4.223	5.575

Source: Calculated from field survey, season 2011/2012.
*, ** and *** denotes significance at 10%, 5% and 1% levels respectively.

As shown in table (3) from the variables included in the equations of production function the significant independent variables were: age of household, household size, quantity of seeds, area cultivated, and type of land, net farm income, off farm income, animal ownership, and rate of rainfall.

The explanatory powers of the equations were very high, as coefficient of determination (R^2) for the regression equations were 62.5%, 60.5%, 55.1% and 55.2% for millet, sorghum, groundnut and sesame in north Kordofan, respectively. Moreover, the F-test of each equation indicates its overall significance at 5%. However, these differences in the productivity in North Kordofan State between crops

Household farmers in North Kordofan State are free to select their size farm; they fallow a prescribed rainy season. In this regard, (Mukhtar and Elfadni, 2004) reported that variations in the productivity of crops in North Kordofan State coupled with poor sandy soils; high variability of rainfall between years and within a year, and land misused had upset ecological balance and socio-economic problems. Most importantly is declining crops productivity, especially on sandy soils, which occupy 60% of the State. These results may tend to support the common assumption of high shortages of food in western Sudan, some people still rely on food assistance because of the lingering effects of last decades droughts, coupled with tribal conflict in some parts of the State. This shows that the households attempt to balance between food and cash crops production. Moreover these trends of household in the cropping pattern in the traditional rain-fed sector point out the relative high production risk and as a result the household inclination to go through different ways to risk management strategies, which are required to cope with the expected relatively high probability of crop failure. Productivity of crops depends on several factors including land type, rainfall distribution (starting and ending)**,** early planting, weeding, moisture distribution and pest and farm management practice. The average household produce is very low of all cereal crops. However, low yields of different crops in surveyed area could be attributed to that household tend to fallow a mono-cropping pattern; inorganic fertilizer was not applied for various season. Also, agriculture is practiced on low rainfall agro-climatic zones that experience below 300mm of rainfall. All of these factors led to low yields.

CONCLUSION

This study tries to fill the existing research gap in the literature by examining the impact of climate variability and change and socio-economic on farming activities in dry land agriculture. The empirical results implied that the test of the efficiency of high food security and inequality among farmers is due to many economical, social and environmental factors in North Kordofan State do not behave as predicted by the production function analysis; among which the recent neglect of the government to traditional rain-fed subsector is the main factor that make agriculture performing below its potential in recent years. The unstable weather conditions led the majority of farmers depend on fluctuated rainfall for crop cultivation. In fact, agriculture can contribute to rural household food security and poverty reduction three times or more than any other sectors do. Thus combating overall farmer food security in general and poverty in particular, requires

policy interventions that consider the variation among farmers for eliminating the existing inequalities and boost farm output.

However, this result may be taken with caution given the fact that in reality many existing conditions support the factors of production behavior.

REFERENCES

Abaker AC, Ali M, Salih AAE.2011. Poverty and inequality in industrial sector of Sudan. Research Paper. Scholarly Journal of Business Administration, Vol. 1(4) pp. 83-88. Available online http:// www.scholarly-journals.com/SJBA

CBS.2010.Central Bureau of Statistical, Khartoum, Sudan.

Chandan MH, Marc W.1998. Econometric and Data Analysis for Developing Countries. London and New York.

Elamin EM.1998. Towards Understanding the Behavior of Small Producers Facing Additional Risk of Cash- Oriented Agricultural Policy. The case of Dry-land Farming in Western Sudan. Agricultural Research Journal, Wad- Madani, Sudan Vol.1

FAO.1983. Approaches to World Food Security-Selected Working Papers of the Commodities and Trade Division. FAO Economic and Social Development Paper, No. 2, Rome.

FAO/WFP.2004. FAO Global Information and Early Warning System on Food and Agriculture, World Food Program, Special Report.

Fyson N.1972. World Food B.T. Batts Ltd, London pp. 7.

Medani etal.2006. Macroeconomic Policies for Poverty Reduction: The Case of Sudan. UNDP-SUDAN. Accessed on line at: http://www.sd.undp.org/publications/Macroeconomic.pdf

Mukhtar M, Bashir AE, Elfadni O.2004. Plans of Action for the affected Kordofan States by Drought. Elobeid Agric. Research Station, North Kordofan, Sudan. P.O Box, 429.

World Bank.2003. World Development Indicators 2003. Sudan Health Status Report/ AFTH3. Washington, D.C. CD ROM.