NUMBER 1

SUDAN WORKING PAPER

JULY 2020

Food Security and Agricultural Development in Sudan

The case of Kassala State

AUTHORS

Prof. Dr. Samia Mohamed Nour
University of Khartoum, Sudan

Dr. Eltayeb Mohamedain
University of Kassala, Sudan

CMI CHR. MICHELSEN INSTITUTE

Food Security and Agricultural Development in Sudan: the case of Kassala State
By ARUS Development Economics Group (ARUS-DEG)

Sudan Working Paper
Number 1, July 2020

ISSN 1890-5056
ISBN 978-82-8062-752-0 (print)
ISBN 978-82-8062-753-7 (PDF)

Authors
Prof. Dr. Samia Mohamed Nour, University of Khartoum, Sudan
Dr. Eltayeb Mohamedain, University of Kassala, Sudan

Cover photo
Gabriel Jimenez. CC license.

www.cmi.no

ARUS Assisting Regional Universities in Sudan

ABSTRACT

This research discusses the relationship between agricultural development and food security, determinants of supply of (production of food) and demand for (consumption of food) food and determinants of food insecurity in Kassala State. In so doing, it provides a significant contribution to the current literature. We use the measurement of household food insecurity access scale and use new primary data from a Food Security Household Survey conducted in Kassala State (2019). We find that the majority of households are food insecure (77%), out of which 32.9% of households are severely food insecure, while, few households are fully food secure (23%). We find large variation in households' food insecurity between localities, with rural Kassala having most food insecure households. This may be explained by the variation in monthly income between localities. We use OLS estimation to estimate the determinants of household level production and consumption of food. We verify our first hypothesis that the significant determinants of production of food are the size of agricultural land, livestock and irrigation systems. We find support for our second hypothesis that indicates that the family's own production of food and household income have positive effects on food consumption. Similarly, we find that the significant determinants of production of sorghum (the main staple food) are agricultural land and livestock and that the significant determinants of consumption of sorghum are the family's own production of sorghum, household income and family size. For small farmers, their own consumption of sorghum is to a larger extent determined by their own production of sorghum. Therefore, enhancing production of sorghum among smallholders would contribute to enhancing consumption of sorghum and hence food security. Using ordered probit (and logit) estimation we verify our third hypothesis that implies that the significant determinants of household food insecurity score index are family own production of food (that increases the probabilities of household being food secure), agricultural land, and other household and village characteristics. This demonstrates the importance of family production of food for supporting food security. We investigated the gender gap related to food production and food security and found that male headed households produce more food and are more food secure than female headed households. We conclude that agricultural production is impeded by the lack of agricultural land, cultivation of few crops, insufficient irrigation, shortages of agricultural services, mainly agricultural services related to technology. Therefore, the major policy implication from our results is that increased household incomes and enhancing family own production of food are important for eliminating food insecurity. We recommend policies that may increase household incomes and enhance smallholders' own production of food. Relevant policy instruments may be increased agricultural land ownership, increasing the size of cultivated land for smallholders, diversification of agricultural food crops, improvement of irrigation systems, enhancing female participation in agricultural activities and food security, improvement of agricultural services, mainly agricultural services related to technology, improving access to clean drinking water and proper sanitation systems and in general improved infrastructure which may help in access to food.

Key words:
Agricultural development
Food security
Food production
Food consumption
Kassala

Abstract (Arabic Abstract)

خلاصة الدراسة (باللغة العربية)

الأمن الغذائي والتنمية الزراعية في السودان: حالة ولاية كسلا

قدمت هذه الدراسة مساهمة مهمة وناقشت العلاقة بين التنمية الزراعية والأمن الغذائي، ومحددات العرض (انتاج الغذاء) والطلب (استهلاك الغذاء) ومحددات انعدام الأمن الغذائي في ولاية كسلا. استخدمت الدراسة مقياس انعدام الأمن الغذائي للأسر المعيشية ((HFIAS) في ولاية كسلا وإعتمدت علي استخدام البيانات الأولية من مسح الأمن الغذائي للاسر المعيشية الذى اجرى في ولاية كسلا (ابريل 2019). بينت الدراسة ارتفاع نسبة انعدام الأمن الغذائي لدي غالبية الأسر المعيشية (77٪)، ولا سيما ارتفاع نسبة انعدام الأمن الغذائي الحاد لدي معظم الأسر المعيشية (32.9٪)، وانخفاض نسبة الأمن الغذائي لدى القليل من الأسر المعيشية (23٪). اوضحت الدراسة وجود تفاوت خطير في مقياس انعدام الأمن الغذائي للأسر المعيشية وفقاً للمناطق الجغرافية (المحليات) التي من المرجح ارتباطها بالتفاوت في توزيع الدخل الشهري في المحليات. استخدمت الدراسة طريقة المربعات الصغري (OLS) لتقدير محددات عرض الغذاء باستخدام إنتاج الغذاء والطلب على الغذاء باستخدام استهلاك الغذاء. أكدت نتائج الدراسة صحة الفرضية الأولى التي تشير إلى أن المحددات المهمة لإنتاج الغذاء هي حجم ملكية الأراضي الزراعية، والثروة الحيوانية ونظم الري. كذلك أكدت نتائج الدراسة صحة الفرضية الثانية التي تشير إلى أن إنتاج الأسرة من المواد الغذائية والدخل لرب الأسرة لديهم تاثير إيجابي علي استهلاك الغذاء واستهلاك الغذاء للأفراد. أكدت نتائج الدراسة ان المحددات المهمة لإنتاج الذرة هي ملكية الأراضي الزراعية والثروة الحيوانية. كذلك أكدت نتائج الدراسة ان المحددات المهمة لاستهلاك الذرة هي إنتاج الأسرة للذرة والدخل لرب الأسرة وحجم الاسرة. كذلك اوضحت نتائج الدراسة أنه بالنسبة لصغار المزارعين فإن استهلاكهم من الذرة الرفيعة يتم تحديده إلى حد كبير من خلال إنتاجهم الخاص للذرة الرفيعة. ولذلك، فإن تعزيز إنتاج الذرة الرفيعة سيسهم في تعزيز استهلاك الذرة، وبالتالي تعزيز الأمن الغذائي لصغار المزارعين. وأكدت نتائج الدراسة صحة الفرضية الثالثة التي تشير إلى أن المحددات المهمة لمقياس انعدام الأمن الغذائي للأسر المعيشية هي إنتاج الأسرة (الذي يؤثر سلبًا على احتمال معاناة الأسرة من انعدام الأمن الغذائي)، وحجم ملكية الأراضي الزراعية. نجد أن مؤشر مقياس انعدام الأمن الغذائي للأسر يتأثر بحجم الأراضي الزراعية المملوكة، وإنتاج الأسرة للغذاء، وغيرها من خصائص الأسرة والقرية. وأكدت نتائج الدراسة أن زيادة إنتاج الاسرة للغذاء سوف يؤدي إلي التقليل من احتمال انعدام الأمن الغذائي، وهذا يدل على أهمية إنتاج الأسرة للغذاء لدعم الأمن الغذائي. قدمت نتائج الدراسة تفسير لفجوة النوع المرتبطة بإنتاج الغذاء والأمن الغذائي والتي تعني أهمية كبيرة في إنتاج الغذاء وزيادة احتمال حدوث الأمن الغذائي لدي الأسر التي يرأسها ذكور مقارنة بالأسر التي ترأسها إناث. اوضحت الدراسة معوقات الإنتاج الزراعي والتي تشمل نقص ملكية الأراضي الزراعية، وصغر حجم الأراضي المزروعة، وزراعة عدد قليل من المحاصيل، وقلة نظم الري، ونقص الخدمات الزراعية، وخاصة الخدمات الزراعية المتعلقة بالتكنولوجيا. من منظور السياسات تؤكد الدراسة على أهمية زيادة دخل الأسرة وتعزيز إنتاج الأسرة من الغذاء للقضاء على انعدام الأمن الغذائي. بناءً على نتائج الدراسة توصي الدراسة ببذل مزيد من الجهود لزيادة دخل الأسرة، وتعزيز إنتاج الأسرة للغذاء، وتعزيز ملكية الأراضي الزراعية، وزيادة حجم الأراضي المزروعة، وتنويع المحاصيل الغذائية الزراعية، وتحسين نظم الري، وتعزيز مشاركة الإناث في الأنشطة الزراعية والأمن الغذائي، وتحسين الخدمات الزراعية، ولا سيما الخدمات الزراعية المتعلقة بالتكنولوجيا، وتحسين حالة وجودة وبيئة السكن، والخدمات، والبنية التحتية الملائمة للقضاء على انعدام الأمن الغذائي ولتعزيز الأمن الغذائي في ولاية كسلا.

الكلمات المفتاحية: التنمية الزراعية، الأمن الغذائي، إنتاج الغذاء، استهلاك الغذاء، كسلا.

Acknowledgments

This research project is conducted through the 'Assisting Regional Universities in Sudan (ARUS)' Research Project Cluster 'Agriculture and Food Security'. It is part of 'ARUS – Development Economics Group (ARUS–DEG)' research project and fully supported by a research grant generously offered by ARUS. The authors would like to gratefully acknowledge and thank the ARUS for research grant, good comments and research support. The authors would like to gratefully thank the management and coordinators of the ARUS (Prof. Liv Tønnessen (CMI, Bergen, Norway), Prof. Abdel Gaffar Ahmed, Prof. Munzoul Assal and Dr. Tamer Mohamed (University of Khartoum, Sudan)) for excellent research support. We would like to gratefully thank Dr. Magnus Hatlebakk (CMI, Bergen, Norway) and Dr. Espen Villanger (CMI, Bergen, Norway) for excellent comments that significantly contributed to improvement of the questionnaire and the research report and for excellent support that significantly contributed to accomplishment of this research project. We would like to gratefully thank the part time researchers in the University of Kassala for excellent cooperation during the collection of the survey questionnaire 'Food Security Household Survey in Kassala State (2019)'. We would like to thank all the respondents to the survey in Kassala. We would like to thank the participants at the ARUS first and final workshops for good comments. All the usual disclaimers apply. The views, analysis and policy recommendations in this report are those of the authors and do not necessarily reflect the views and policies of the ARUS project and CMI, Bergen, Norway.

List of abbreviations

ARUS	Assisting Regional Universities in Sudan
ARUS - DEG	ARUS – Development Economics Group
CMI	Chr. Michelsens Institute
FAO	Food And Agriculture Organization of The United Nations
HAZ	Height-For-Age
HDR	Human Development Report
HDI	Human Development Index
HFIAS	Household Food Insecurity Access Scale
IFAD	International Fund for Agricultural Development
GDP	Gross Domestic Product
MICS	Multiple Indicator Cluster Survey
OLS	Ordinary Least Squares
SDGs	Sustainable Development Goals
UNDP	United Nations Development Programme
UNICEF	The United Nations Children's Fund
USAID	United States Agency for International Development
WAZ	Weight-For-Age
WHO	World Health Organization
WHZ	Weight-For-Height
WFP	World Food Programme

Contents

	List of Figures	
	Figure 1 – Share of agriculture in value added and employment in Sudan (1990-2017)	18
	Figure 2 – The nutrition and child nutrition in Sudan compared to world regions (2010-2017)	20
	Figure 3 – The importance of cultivating food and cash crops	36
	Figure 4 - Land tenancy status, ownership, cultivating and uncultivated land, livestock and agricultural services	40
	Figure 5 – Change in Households income, total expenditure and spending on food and options to ensure financial capability	44
	Figure 6 - Household food insecurity access scale by localities in Kassala State (2019)	58
	Figure 7 – Household adaptation and survival strategy	61

Introduction

This paper discusses the relationship between agricultural development and food security in Eastern Sudan, focusing on Kassala State. The central theme in this research is the interaction between food security and agricultural development in Kassala State. There are four main objectives motivating this research. Firstly, to provide an economic analysis (supply-demand analysis) of the four key dimensions or pillars of food security (availability, stability, access and utilization of food) in Kassala. Secondly, to examine the factors that impede (and those contribute towards) food security and agricultural development in Kassala. Thirdly, to discuss the severity of food insecurity in Kassala, to investigate the gender perspectives related to food security and agricultural development in Kassala, and finally, to provide useful policy recommendations to enhance food security through agricultural development in Kassala.

The paper first explains the research problem, significance, relevance, and objectives of the research before moving on to the economic development challenges confronting Sudan and Kassala. Next, we present the conceptual framework and literature review on defining agricultural development and food security. We then explain the methodology, before discussing the main results concerning the determinants of supply and demand of food and the determinants of food security and agricultural development in Kassala. Finally, we provide the conclusions and policy recommendations for enhancing food security through agricultural development in Kassala State. Our analysis discusses the determinants of the supply and demand of food in Kassala and investigates the factors that impede and contribute to food security and agricultural development in the state. Further, we look at the gendered inequality related to food security and agricultural development in Kassala State. Finally, we discuss the severity of food insecurity in Kassala State. While primarily focused on Kassala State, our analysis could provide insights motivating future studies in the neighboring states: Gedarif and the Red Sea States in Eastern Sudan.

This study builds on the results that demonstrate the high poverty and undernourishment rates in Eastern Sudan, and the high stunting prevalence in Kassala particularly, to investigate food security and agricultural development in Kassala State as a case study of Eastern Sudan.

1. Research problem, significance, relevance, objectives and structure of the research

The potential role of agricultural development in achieving food security is widely recognized in developing countries, including Arab countries and Sudan. In the 1970s, Sudan was considered by the Arab Gulf countries as the "breadbasket" of the Arab World. More recently, the emphasis on agricultural development and food security was recognized in the UN Declaration of Sustainable Development Goals (SDGs) which were adopted by the global community in September 2015 and are to be achieved by 2030. Goal 2 – Zero Hunger – which aims to end hunger, achieve food security, improve nutrition, and promote sustainable agriculture is particularly relevant to Sudan. As in most other developing countries, achieving SDG2 in Sudan relies heavily on sustainable food production systems, resilient agricultural practices, boosting agricultural productivity and increasing investments in public and private agriculture from domestic and foreign sources.

Levels of child malnutrition are a key indicator of food security. The geographic inequity in child malnutrition reported in the Multiple Indicator Cluster Survey (MICS) in 2014 shows that children living in rural areas are most affected by child malnutrition. In Sudan, the prevalence of underweight children is 23.2% in urban areas in comparison to 37.1% in rural areas, 17.4% of children living in rural areas are affected by acute malnutrition in comparison to 13.4% for urban areas. For child stunting, the gap is also high: 43% in rural areas and 27.1% in urban areas. In Sudan, children are mostly affected by malnutrition in the states affected by conflicts and population displacement: Darfur, Kordofan, and Kassala state, with Kassala having the highest number of children facing this issue.

A comprehensive food security assessment, conducted in 2012 by the UN World Food Programme showed that Kassala's food production, meets only a small fraction of the state's total nutritional needs (World Food Programme (WFP), 2012). Through income from non-farm activities, people are able to purchase food and the remaining shortfall is met, where possible, through contributions from the Federal Government, the WFP and international NGOs (Emergency and Humanitarian Action, 2014)**.** Major factors related to food insecurity include poverty, lack of education, unsustainable livelihood activities (unskilled labor, collection of wood/grass) and to a certain extent, isolation and cultural practices (WFP, 2012; see Abdalla, et. al., 2012). While Kassala state suffers a high prevalence of stunting, it is not one of the poorer states in Sudan implying that food insecurity in the state is not only related to poverty. Other underlying explanations may be the choice of food, access to clean water and sanitation, or the prevalence of disease and access to health services.

Previous studies in the Sudanese literature have examined agriculture and food security in Kassala State. For instance, Abdalla et. al. (2016) investigated the effect of rural non-farm activities on household food security in Kassala finding that non-farm income is widely used and has a positive impact on food security in the state. In another study, Abdalla et al. (2012) used survey data to examine the factors affecting small farmer's access to formal credit and found that nearly half of the sample households used credit. In a move away from previous studies in the Sudanese literature, our study examines the interaction between food security and agricultural development in Kassala State as a case study of Eastern Sudan. We fill the gap in the Sudanese literature by providing a more recent and comprehensive economic analysis of the four pillars of food security: availability, stability, access, and utilization of food. Our study provides an analysis of food security in Sudan structured around the supply (availability and stability) – demand (access and use) relationship.

Kassala is widely considered to be an important agricultural center and source of border-trade for Sudan, and therefore provided a suitable case for this study. The potential agricultural endowments in

Kassala, such as abundant water resources, arable land and livestock, mean it is suitable for agrarian activities. The state possesses about 2.8 million feddans of arable land beside the climate zone (Abu Sin and Abbakar, 2007). Kassala is one of the most animal-rich states in Sudan, feeding an estimated four million heads of livestock and encompassing approximately seven million feddans of pastureland. Moreover, the state possesses a huge water endowment compared to its neighbors and has abundant rainfall, ample ground water and two rivers running through El Gash and Atbara (Abdalla, et al., 2016). Despite the abundance of natural resources in Kassala State, food security and agricultural development remain crucial issues. Kassala's food production meets only a small fraction of the state's total nutritional needs (WFP, 2012). The technical report of the integrated food security classification (IPC, 2013) examined the food security condition in the state and showed evidence of food insecurity in the low-income areas of Kassala State. Food consumption was extremely inadequate in low-income areas and price increases lowered access to markets, which was already hindered by poor infrastructure, bad roads and long distance to settlements.

2. General socio-economic characteristics and economic development challenges confronting Sudan

2.1. General socio-economic characteristics in Sudan

Sudan is characterized by high population growth, relatively low standards of living (as measured by Gross Domestic Product (GDP) per capita) and a low human development index (see Tables 1 and 2). Sudan's rating in the human development index has deteriorated, from 2000-2007 the country achieved medium human development status however, this decreased to the low status between 2010 and 2017. The GNI per capita income and the value of human development index has also fluctuated in Sudan, the increasing trend (2000-2007), turned into a decreasing trend (2007-2010) and then increased from 2011-2017. Between 2000 and 2017, Sudan showed increasing trends in adult literacy rate, life expectancy, expected years of schooling, the population with at least secondary education, and gross enrolment ratio in secondary and tertiary education.

In the World Bank classification of economies, Sudan is classified among the lower-middle income economies. According to the UNDP-HDR classification of economies, Sudan is below the global average in key indicators including literacy rate, average life expectancy, expected years of schooling, and the degree of urbanization. Despite the GDP per capita in Sudan being above the levels of Sub-Saharan Africa and the least developed countries, Sudan's human development outcomes remain weak. Sudan ranks 167 out of 189 countries in the latest UNDP Human Development Report (2018) and the level of poverty is high, with nearly half (46.5%) of the population living below the national poverty line (a decline from 15% in 2009). Sudan also suffers from a low quality of standard of living and is below the global average in measurements such as vulnerable employment, rural access to electricity, improved drinking-water sources and improved sanitation facilities (UNDP-HDR, 2018)[1]. Sudan is thus below both the international and regional standards, as compared to its neighboring countries of Libya, Egypt and Kenya.

[1] According to UNDP – HDR (2018) vulnerable employment is defined as the % of employed people engaged as unpaid family workers and own account workers. Rural population with access includes electricity sold commercially (both on grid and off grid) and self-generated electricity but excludes unauthorized connections. Population using improved drinking-water sources is defined as the % of the population using drinking-water sources which by nature of their construction and design are likely to protect the source from outside contamination, in particular from fecal matter, including water piped into a dwelling, plot or yard; a public tap or standpipe, a tube well or borehole, a protected dug well, a protected spring and rainwater collection. Population using improved sanitation facilities accounts for those using facilities that hygienically separate human excreta from human contact including flush or pour-flush toilets to a piped sewer system, a septic tank or pit latrine, a ventilated improved pit latrine, a pit latrine with slab and a composting toilet. Sanitation facilities that are shared with other households or open to public use are not considered improved. See UNDP – HDR (2018), pp. 85-87.

Table 1 – The trend of socio-economic and human development indicators in Sudan (2000-2017)

Items/Year	2000	2001	2005	2007	2010	2011	2012	2014	2015	2017
Human Development Index (HDI) rank	139	138	147	150	154	169	171	167	165	167
Human Development Index (HDI) value	0.499	0.503	0.526	0.531	0.379	0.408	0.414	0.479	0.490	0.502
Human Development Classification	Low	Medium	Medium	Medium	Low	Low	Low	Low	Low	Low
Gross national income (GNI) per capita (2011 PPP $)	1,797	1,970	2,083	2,086	2,051	1,894	1,848	3,809	3,846	4,119
Life expectancy at birth (years)	56.0	55.4	57.4	57.9	58.9	61.5	61.8	63.5	63.7	64.7
Expected years of schooling (years)					2.9	3.1	3.1	7.0	7.2	7.4
Mean years of schooling (years)					4.4	4.4	4.5	3.1	3.5	3.7
Adult literacy rate (% ages 15 and older)	57.8	58.8	60.9	60.9	69.3	71.1		73.4	75.9	53.5
Population with at least secondary education					11.5	15.5		15.2	16.3	17
Gross enrolment ratio: Primary (%)					74.0	74.0	73.0	70	70	74
Gross enrolment ratio: Secondary (%)					38.0	38.0	39.0	41	43	46
Gross enrolment ratio: Tertiary (%)					5.9		6.1	17	17	17
Quality of standard of living										
Vulnerable employment										40.5
Rural population with access to electricity										22.2
Population using improved drinking-water sources										58.9
Population using improved sanitation facilities										35

Sources: United Nations Development Programme - Human Development Report (UNDP-HDR): 2002, 2003, 2007/2008, 2009, 2010, 2011, 2013, 2016, and 2018

Table 2 - Socio-economic and human development indicators in Sudan compared to selected countries (2017)

	Human Development Index (HDI)		Gross national income (GNI) per capita	Life expectancy at birth	Expected years of schooling	Mean years of schooling	Adult literacy rate	Population with at least secondary education	Gross enrolment ratio		
	HDI rank	Value	(2011 PPP $)	(years)	(years)	(years)	(% ages 15 and older)	(%)	Primary (%)	Secondary (%)	Tertiary (%)
Libya	108	0.706 (High)	11,100	72.1	13.4	7.3	..	57.4	..	..	..
Egypt	115	0.696 (Medium)	10,355	71.7	13.1	7.2	75.1	64.5	104	86	34
Kenya	142	0.590 (Medium)	2,961	67.3	12	6.5	78.7	34.6	105	..	
Sudan	167	0.502 (Low)	4,119	64.7	7.4	3.7	53.5	17	74	46	17
Ethiopia	173	0.463 (Low)	1,719	66	8.5	2.7	39	15.8	102	35	8

Sources: United Nations Development Programme - Human Development Report (HDR) (2018)

The annual growth rates of Gross Domestic Product (GDP) in Sudan declined from 6.3% in 2000 to 3.5% (2010) and 4.3. % (2017). The exploitation of and heavy reliance on oil caused a shift to an oil-based economy from 2000 to 2010. However, the secession of South Sudan led to the loss of substantial oil resources, oil output, fiscal revenue and foreign exchange earnings, and the Sudanese economy still struggles to stabilize.

Between 2000 and 2010, the industrial sector was largely based on the extractive industries, specifically extracting and exporting oil as a raw material without significant manufacturing of oil and its related products, with a minor share of the manufacturing industries. The loss of oil led to considerable decline in the share of extractive industries, causing a decline in the share of the industrial sector in GDP after 2010.

The agricultural sector continues to be the most important sector for economic growth and industry in Sudan and provides a significant contribution in terms of Sudan's exports and foreign cash earnings. The GDP of the agricultural sector was higher than the industrial sector between 1990 and 2017, in 2017 agriculture represented 39.6% of the GDP, while industry accounted for 2.6% (down from 27% in 2010). Between 1995 and 2016, more than half of all Sudanese and nearly half of Sudanese women relied on agriculture, a level higher than the global average. Approximately 27.3 million of Sudan’s 40.5 million people live in rural areas where agriculture is the main economic activity. The increase in agriculture value added per worker also demonstrates the importance of agriculture.

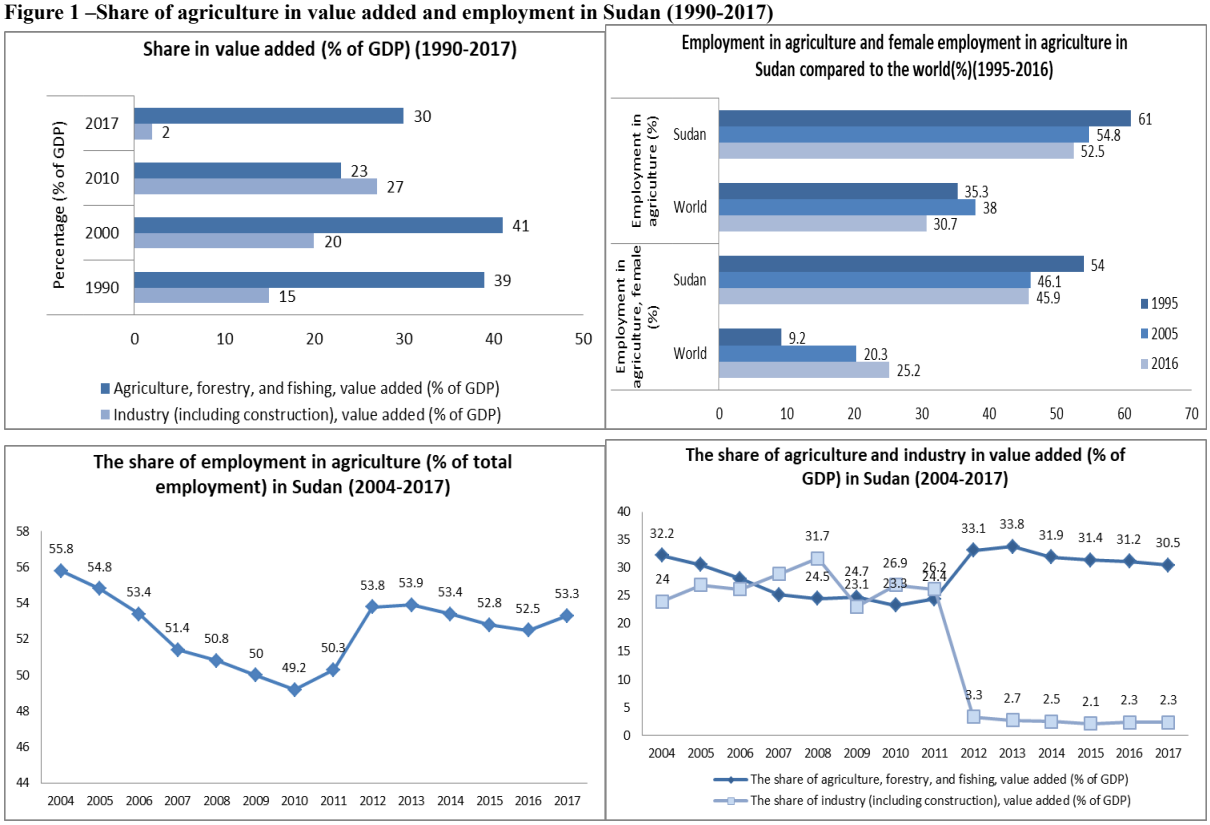
The share of agricultural employment in Sudan decreased from 55.8% in 2004 to 49.2% in 2010, but then increased to 53.3% in 2017. These figures are further detailed in Table 3 and Figure 1. Table 3 provides an overview of agriculture and industrial development across selected African countries between 2004 and 2017. Sudan shows a decreasing industrial trend, while the share of agriculture, in terms of both value added and total employment, has grown. This is against the general pattern of the rest of the region. Figure 1 illustrates the growth rate of the share of agriculture in value added and employment between 1990 and 2017.

Table 3 – The share of agriculture in employment and the share of agriculture and industry in value added (% of GDP) in Sudan compared to selected African countries (2004-2017)

A. The share of agriculture, forestry, and fishing, value added (% of GDP)														
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Sudan	32.2	30.6	28.1	25.2	24.5	24.7	23.3	24.4	33.1	33.8	31.9	31.4	31.2	30.5
Tanzania	30.9	28.6	29	26.8	28.8	30.2	29.9	29.4	31.1	31.2	28.8	29	29.2	30.1
Zambia	15.6	14.6	13.2	12.1	11.5	11.6	9.4	9.6	9.3	8.2	6.8	5	6.2	6.7
Nigeria	27.2	26.1	24.7	24.7	25.3	26.7	23.9	22.2	21.9	20.8	20	20.6	21	20.8
Malawi	34.7	32.9	30.9	27.5	30	30.4	29.6	28.8	28.3	28.7	28.7	27.5	25.9	26.1
Kenya	24.9	24.2	20.5	20.6	22.2	23.4	24.8	26.3	26.2	26.4	27.5	30.2	32.1	34.6
Ghana	38	37.5	28.9	27.3	29.4	31	28	23.7	22.1	20.5	20	20.2	21	19.7
Ethiopia	38.7	41.2	42.5	42.3	45.2	45.9	41.4	41.2	44.3	41.2	38.5	36.1	34.8	34
B. The share of employment in agriculture (% of total employment) (modeled ILO estimate)														
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Sudan	55.8	54.8	53.4	51.4	50.8	50	49.2	50.3	53.8	53.9	53.4	52.8	52.5	53.3
Tanzania	75.7	74.7	74.6	73.5	73.4	72.9	72.2	71.3	70.6	69.7	68.1	67.7	67.2	66.7
Zambia	73.1	72.8	72.8	72.1	71.4	67.8	63.4	60.7	56	55.6	54.7	53.7	53.3	53.3
Nigeria	51.9	51.2	49.6	48.6	44	40.4	30.6	33.1	35.9	38.3	36.8	36.4	36.3	36.5
Malawi	84.9	85	84.3	83.5	84.3	84.7	84.7	85	85.1	85	85	84.8	84.7	84.7
Kenya	42.8	41.4	39.2	38.5	39.5	39.5	39.1	38.9	38.5	37.8	37.6	37.8	38.1	38
Ghana	49.7	49	45.1	44.3	43.8	43.5	42	41.4	42.9	45.4	44.7	42.5	41.2	40.6
Ethiopia	81.7	80.2	80	79.5	79.2	78.7	77.2	75.5	74.9	72.7	71.4	69.9	69	68.2
C. The share of industry (including construction), value added (% of GDP)														
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Sudan	24	26.9	26.2	28.9	31.7	23.1	26.9	26.2	3.3	2.7	2.5	2.1	2.3	2.3
Tanzania	20.8	19.7	20.7	20.2	20.4	18.6	20.3	22.8	21.8	22.7	23.2	24.3	24.9	26.4
Zambia	25.7	26.8	30.4	31.9	31	30.2	32.2	34.4	32	32.6	32.9	33.7	34.9	35.6
Nigeria	28.4	28.2	25.8	24.3	24.7	21.2	25.3	28.3	27.1	25.7	24.6	20.2	18.2	22.3
Malawi	15.6	14.9	16.3	18.1	16.1	15.3	15.2	15.4	15	14.8	14.6	14.8	14.6	14.4
Kenya	16.2	17	19.4	19.3	18.6	18.7	18.5	18.9	18.6	18	17.4	17.3	17.5	16.5
Ghana	24.7	25.1	19.8	19.5	19.4	18.5	18	23.9	27.1	34.9	34.6	31.7	28.2	30.8
Ethiopia	12.7	11.8	11.6	11.6	10.2	9.7	9.4	9.7	9.5	10.9	13.5	16.3	22.1	22.9
Botswana	38.8	42.9	43.6	41.8	36.5	28.2	31.9	35	29.7	31.5	33.1	30	32.1	30.3
Uganda	20.9	23.5	22.8	25.1	25.8	20.2	18.1	20.2	21.3	20.6	20.4	20	20.6	20.3

Source: The World Bank – The World Development Indicators Database (WDI) (2019)

Figure 1 –Share of agriculture in value added and employment in Sudan (1990-2017)



Source: Adapted from (1) United Nations Development Programme (UNDP) - Human Development Indices and Indicators (2018) Statistical Update, pp. 52-53, (2) FAO (Food and Agriculture Organization of the United Nations) (2019) Statistic, accessed 29 January, 2019, (3) The World Bank: the World Development Indicators Data: Sudan Country Profile (2019), accessed, 29 January 2019.

2.1.2. Food security in Sudan

Sudan suffers from serious food insecurity and a failure to achieve food and nutrition security. This is despite a vast and diverse agricultural resource base that provides various means of sustaining livelihood and support for the economy. According to USAID (2019), chronic food insecurity in Sudan threatens lives, livelihoods and stability. Due to prolonged conflict, environmental deterioration and other disasters such as drought and floods, many of Sudan's people are at risk of food insecurity.[2] Approximately 5.5 million people were food insecure in early 2018 – up from 3.8 million in 2017 (WFP, 2019) and it is estimated that more than 80% of the population may already be unable to afford adequate food. The chronic malnutrition rate is 38%, with 11 out of 18 states recording the stunting prevalence among children at above 40%.[3] The depth of food deficit in Sudan is high, at 184 it is more than twice the global average (77); and is above the average in developing countries (92) and even above the least developed countries (169) in 2014/2016.[4]

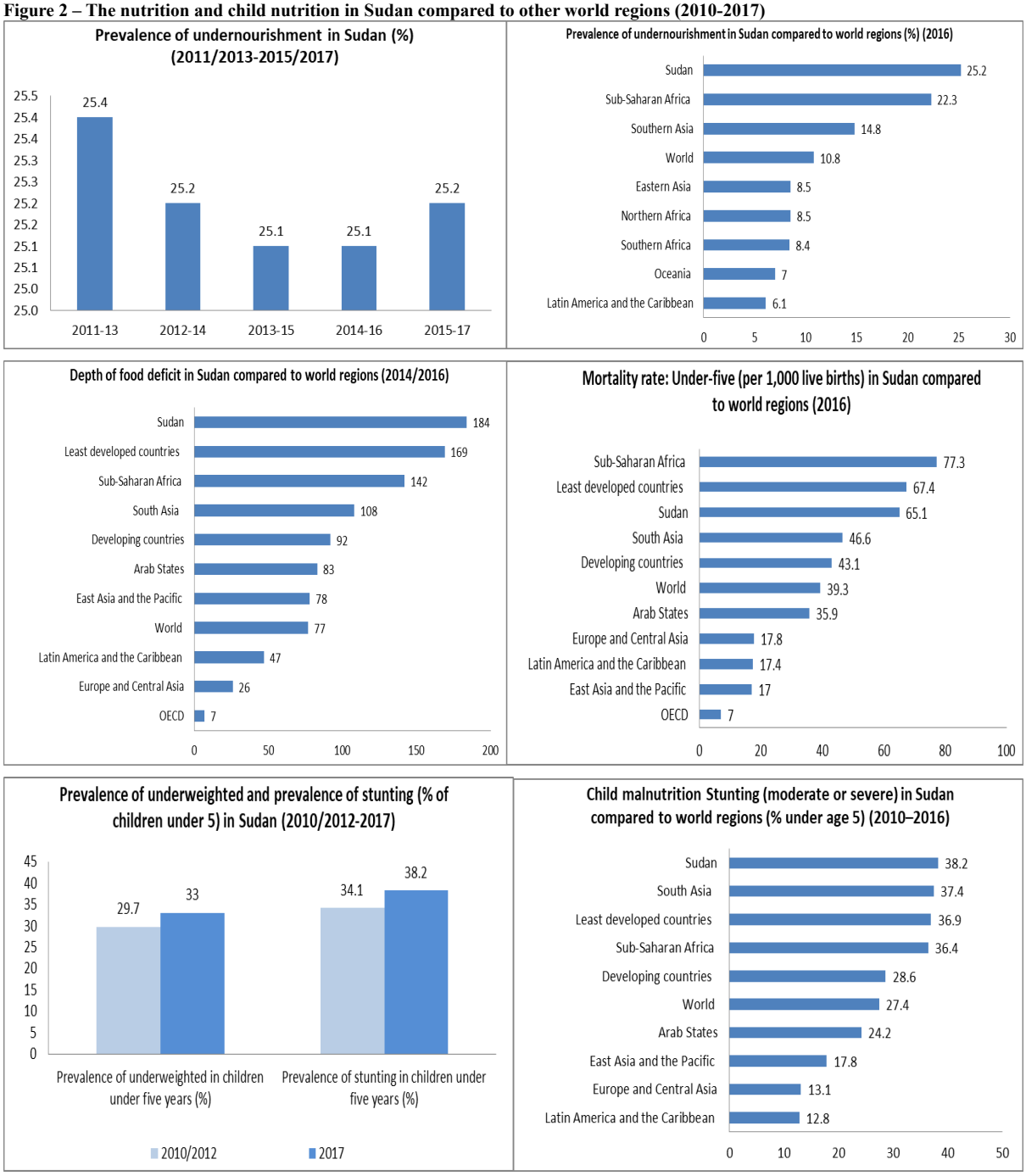
Sudan is also higher than the global average in other key indicators: the level of malnourishment, child malnutrition and stunting, child mortality rates and underweight children. The child nutrition status in Sudan is not only low (as measured by high prevalence of underweighted and stunting), but also shows an increase in the number of underweight children and the growing prevalence of stunting (von Grebmer, et al., (2018) and FAO (2018)). These findings show that nearly a quarter of the Sudanese population is undernourished and more than one third of Sudan's children under five suffer from moderate or severe child malnutrition stunting (See Figure 2).

[2] USAID: https://www.usaid.gov/sudan/agriculture-and-food-security, accessed 29 January 2019.

[3] World Food Programme (2019): https://www1.wfp.org/countries/sudan, accessed 29 January 2019.

[4] According to UNDP – HDR (2018) the depth of the food deficit is a measure used to reflect the number of kilocalories needed to lift the undernourished from their status, holding all other factors constant, See UNDP – HDR (2018), pp. 68-69. One limitation of the depth of the food measure is related to the difficulty to measure over time for all countries. Currently, FAO uses an alternative measure related to self reportedfood insufficiency for SDG 2.1 See:http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/#.XHUUFkTtwuR.

Figure 2 – The nutrition and child nutrition in Sudan compared to other world regions (2010-2017)



Sources: Adapted from (1) von Grebmer, et al., (2018) '2018 Global Hunger Index,' pp. 11, 49-50, (2) https://www.globalhungerindex.org/sudan.html, accessed 29 January 2019. (2) United Nations Development Programme (UNDP) - Human Development Indices and Indicators (2018) Statistical Update, pp. 52-53, 68-69. (3) The World Bank Data World Development Indicators database (2018) accessed 14 November 2018. (4) FAO (2018) Food Security Indicators, 11 September 2018, accessed 3 March 2019.

2.2. General socio-economic characteristics and economic development challenges confronting Kassala State

Kassala State is located in Eastern Sudan and, as of mid-2015, has an estimated population of around 2.283 million. The population is growing at a rate of 3.5% per annum and population density at a rate of 54 persons per km^2, with an average of 6 people per household (see FAO (FSPSCBP), 2016).[5] The Kassala population is divided between urban (26%), rural (63%) and nomadic (11%) peoples.

Kassala State is an important agricultural center and source of border-trade for Sudan. Around four million feddans, 40.5% of the state's total land, is cultivable (Abdalla et al. 2016). Of this land, between 1.1 million and 1.58 million feddans is actually cultivated, around half of which is irrigated. Rain-fed cultivation techniques are used by around 60% of farmers in Kassala State. However, the yield of this rain-fed land is only 16% of that achieved in equivalent areas with systems of full pump-based irrigation (Emergency & Humanitarian Action, 2014)**.**

Like other eastern states in Sudan, Kassala has been exposed to chronic poverty and lack of adequate access to basic services such as healthcare and education (WFP, 2012). Food insecurity, malnutrition and unemployment are widespread problems in the state. A World Food Program (WFP) report showed that about 2% of the households in Kassala state suffer from acute food insecurity and 4.5% are vulnerable to acute food insecurity, 22% of households were found to be suffering from chronic food insecurity, while 26% are chronically moderately food insecure (WFP, 2012). The report indicated that the North Delta locality has the highest percentage of acute food insecure households, followed by Hamashkoreeb.

Food security in Kassala State has been regularly monitored through the Integrated Food security Phase Classification (IPC). In 2013, the IPC (showed that all localities are at the borderline of adequate food security (IPC, 2013). Kassala Town and New Halfa were found as the most food secure areas, while Telkouk and Hamashkoreib were singled out as crisis areas.

Kassala has one of the lowest nutrition rates in Sudan. Due to a lack of data on food security, we used the recent comprehensive food security assessment conducted by the WFP between December 2011 and January 2012 for our data. The report collected information on child health, feeding information and mid-upper arm circumference (MUAC) for approximately 1,400 children aged between 6 and 59 months from 55 cities/villages in 11 localities across six different livelihood zones (WFP, 2012). The report indicated a serious problem of malnutrition in Kassala and found that 12.3% of children were malnourished, and that malnourished children were likely to have consumed water from an unsafe source. Children aged between 6 and 23 months were found to be more likely to be malnourished than those two years of age and over. When analysing Severe Acute Malnutrition (SAM) and Global Acute Malnutrition (GAM) by age and locality, the findings showed that some of the localities were much worse off compared to the state average. For instance, in Atbara River, 28% of children between 6 and 23 months are measured with SAM, and 56 % with GAM. In addition, the stunting prevalence was higher than 40% in Kassala state.

A baseline survey conducted by Federal Ministry of Health (FMoH) in Kassala State in 2015 showed critical levels of stunting at a rate of 67% among children aged 6-59 months. The highest levels of severe acute malnutrition were found in the Western Kassala locality. While the percentage of children with MUAC <12.5cm is highest in the Atabara River, Rural Kassla and North Delta localities. Lack of

[5] Food and Agricultural Organization (FAO) (2016) 'The Food Security Policy and Strategy Capacity Building Project (FSPSCBP),' Food and Agricultural Organization (FAO)

supplementary food items during the breastfeeding period, poor hygiene and cultural practices are among the reasons behind the high child malnutrition rates (Sudan Nutrition Sector Bulletin, 2015).

The increasing food prices, due to global economic recession and financial crises in the last decade, and the volatility of the commodity markets hinders the goal of achieving food and nutrition security, not only in Kassala but in Sudan and the region in general. Arable land and water supplies are also threatened by climate change and land degradation, which are likely to increase the probability of short-run crop failures and harm livelihood in the State in the future. Further, the macroeconomic variables undermine the efforts of FSN; these can be manifested in high inflation, exchange rate volatility and budget deficit, particularly after the secession of the South Sudan in 2011.

In Kassala, government institutions and non-governmental institutions have been variably involved in promoting food and nutrition security over the past two decades. The ministry of agriculture, livestock and fisheries conducted a number of agricultural projects to increase production, enhance productivity and meet the increasing demand for food. Likewise, the ministry of education has provided meals for school students. NGOs are also engaging in numerous efforts to support food and nutrition security through providing awareness and supporting education and healthcare services. The focal activities of UN agencies like WFP, UNICEF, WHO, and FAO also support food and nutrition security.

3. Conceptual Framework and Literature review: agricultural development and food security

3.1. Conceptual framework: definition of the concepts: agricultural development and food security

The term 'food security' first originated in the mid-1970s and is now widely used in the international literature (cf. Clay, 2002; Heidhues, et al., 2004). The 1974 World Food Conference defined food security in terms of food supply, availability and price: *"Availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices".* In 1983, Food and Agriculture Organization (FAO) analysis focused on food access, leading to a definition based on the balance between the demand and supply food: *"Ensuring that all people at all times have both physical and economic access to the basic food that they need"* (FAO, 1983). Reinforcing the different dimensions of food security, the widely accepted definition of the World Food Summit (1996) states, *"Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life*" (World Food Summit, 1996). It emphasizes the importance of food availability, food access, the use of food through adequate diet and other services in reaching a state of nutritional wellbeing and food security or stability.[6]

FAO's 'twin-track approach' for food security for fighting hunger combines sustainable agricultural and rural development with targeted programs for enhancing direct access to food for the most in need. Both tracks are intended to be mutually reinforcing, and the positive interaction between them should reinforce food security through sustainable agricultural and rural development (see Table 4).[7] Agricultural development can be defined as creating the conditions for the fulfillment of agricultural potential to serve the needs of local communities and the state. These conditions include the accumulation of knowledge, availability of technology and allocation of inputs and outputs (de Laiglesia, 2006: 10).

[6] 'Stability' refers to both the availability of and access to food, and emphasizes that families should not be at risk of losing access to food through sudden shocks (e.g. economic or climate crisis) or cyclical events (e.g. seasonal food security).

[7] See FAO Agriculture and Development Economics Division (2006) "Food Security," FAO Policy Brief, Issue No. 2, June (2006). See also Chapter 2 Food security: concepts and measurement: http://www.fao.org/docrep/005/y4671e/y4671e06.htm, accessed July 10, 2018.

Table 4 - FAO policy priorities for food security

Twin-Track Approach	Availability	Access and Use	Stability
Rural Development/ productivity enhancement	Enhancing food supply to the most vulnerable	Re-establishing rural institutions	Diversifying agriculture and employment
	Improving rural food production especially by small-scale farmers	Enhancing access to assets	Monitoring food security and vulnerability
	Investing in rural Infrastructure	Ensuring access to land	Dealing with the structural causes of food insecurity
	Investing in rural markets	Reviving rural financial systems	Reintegrating refugees and displaced people
	Revitalization of livestock sector	Strengthening the labor market	Developing risk analysis and management
	Resource rehabilitation and conservation	Mechanisms to ensure safe food	Reviving access to credit system and savings mechanisms
	Enhancing income and other entitlements to food	Social rehabilitation programs	
Direct and Immediate Access to Food	Food Aid	Transfers: Food/Cash based	Re-establishing social safety nets
	Seed/input relief	Asset redistribution	Monitoring immediate vulnerability and intervention impact
	Restocking livestock capital	Social rehabilitation programs	Peace-building efforts
	Enabling Market Revival	Nutrition intervention programs	

Source: Pingali, Alinovi and Sutton (2005).

Global food security presents problems on both the demand- and supply-side, and not all countries can address the problems simultaneously (Herrmann, 2009). On the demand side, rising food prices mean that fewer low-income houses are able to afford sufficient food. However, these rising prices can also provide a motivation for farmers to increase agricultural production. Agricultural development could improve both the availability of food and access to food, especially if agricultural laborers are able to benefit from higher incomes.

The literature on promotion of food security distinguishes both between short-term and medium-term measures, and between countries with and without agricultural potential (Herrmann, 2009). The duration of food insecurity varies from transitory food insecurity and chronic food insecurity (Devereux, 2006). Transitory food insecurity is a short-term and temporary food insecurity that can emerge suddenly, whereas, chronic food insecurity is a life-long condition of food insecurity often caused by several factors including for instance, extended periods of poverty, lack of assets and inadequate access to productive or

financial resources. Intermediate food insecurity is seasonal food insecurity related to seasonal fluctuations in the climate, cropping patterns, work opportunities (labor demand) and/or prevalence of diseases. [8]
Acute food insecurity is often used to describe severe and life-threatening situations, the most extreme of which are usually associated with substantial loss of life. The measure of hunger and food insecurity outlined by the FAO defines undernourishment as consumption falling beneath a pre-determined threshold, for example 2100kcal. Another example of measurement is the Integrated Food Security and Humanitarian Phase Classification Framework (IPC) which provides a classification system for food security and humanitarian crises based on a range of livelihood needs, including crude mortality rate, malnutrition prevalence, food access/availability, dietary diversity, water access/availability etc.[9]

3.2 Conceptual Framework: Measurement of Food Security

There are a number of different measures of food security in the scholarly and policy literature, each using different indicators and measures. Barrett (2010) discusses the indicators that measure food insecurity and argues that current research largely focuses on improving food insecurity measurement. Measurement matters for at least three major reasons. First, each measure captures different phenomena related to food security, thereby subtly influencing prioritization among food security interventions. Historically, reliance on national food availability estimates has focused attention on food aid shipments and agricultural production strategies to increase food supplies. Second, observational data necessarily reports on the past, but policy makers are most interested in the likely future effects of prospective interventions. An ideal food security indicator would therefore reflect the forward-looking time series of probabilities of satisfying the access criteria.[10] Yet, to date there has been little effort to test the forecasting accuracy of currently available indicators.[11] Third, national-level measures only lend themselves to addressing national-scale food availability shortfalls, not intranational access and utilization concerns. Insofar as food insecurity measures diagnostically inform actions, they must be readily associated with targetable characteristics of vulnerable households and individuals and remediable causal factors that lead to food insecurity. The research frontier therefore revolves around the development of cross nationally comparable, longitudinal monitoring and analysis at the household and individual level.[12]

Tiwari et al. (2013) indicate that the nebulousness of the concept of food security demonstrates the inability of any one indicator to describe and encompass all or most aspects of food security, their main conclusion implies, however, that some simple measurements are satisfactory. They indicate that the choice of which indicator to use is often guided by the context and purpose of the analysis and tradeoffs between comprehensiveness and the ease and cost of data collection. For example, Policy makers may need to address issues of transitory food insecurity, in which case their main concern may be adequate calorie availability. Alternatively, they may need to address chronic hunger and malnutrition, which may require more detailed data collection at the household or individual level.

---

[8] See FAO Food Security Concept and Framework: www.fao.org/elearning/course/FC/en/ppt/trainerresources/presentation0411.ppt, accessed July 10, 2018.

[9] See FAO Food Security Concept and Framework: www.fao.org/elearning/course/FC/en/ppt/trainerresources/presentation0411.ppt, accessed July 10, 2018.

[10] See C. B. Barrett, in Handbook of Agricultural Economics, B. L. Gardner, G. C. Rausser, (Eds.) (Elsevier Science, Amsterdam, 2002), Vol. 2B.

[11] Limited exception is Mude, et al. (2009). See A. G. Mude, C. B. Barrett, J. G. McPeak, R. Kaitho, P. Kristjanson, Food Policy 34, 329 (2009).

[12] See Barrett (2010), pp. 825-826.

The FAO uses national level food balance sheets to develop global undernourishment or hunger figures. In much of its work on poverty, the World Bank regards those below the food poverty line as food insecure, thus showing that availability of food is not sufficient without income to purchase the food. Some indicators of food security work well for populations that are relatively food secure, but less well for those living in chronic poverty (Haddad, 1992). Similarly, there may be variations based on culture, climate, agriculture, and food traditions and preferences that the food security measure will need to take into account (Ruel, 2002). Different indicators provide contrasting and sometimes contradictory accounts of the state of food security, therefore the decision about which indicators to use may impact policy decisions about food security interventions (Barrett, 2010).[13]

Bertelli and Macours (2014) discuss the different approaches to measuring food security outcomes (including uni-dimensional proxy variables and more multidimensional aggregate indicators) arguing that in order to establish the impacts of a particular intervention on food security, a good measure of food security is obviously needed. They show that different indicators and definitions are used in different studies and highlight the challenge of the lack of a common measurement of food security.[14] Very often, measures of nutritional status (such as energy intake or anthropometric measures) are used for this purpose. However, food security is a wider concept than nutritional status and is characterized by multiple dimensions, defined either at the national, local, household or individual level. Nutritional status however only concerns individuals and while it is affected by food (in)security, it is also determined by the quality of care and health services (The World Bank, 2007). The FAO defines food security based on food availability, accessibility and utilization (FAO, 1996).[15] Interventions, such as improving agricultural and post- harvesting technologies, expanding the quantity and quality of available farmland and increasing access to agricultural inputs, may primarily target food availability and are considered necessary for addressing *chronic food insecurity*. Interventions aiming at solving *transitory food insecurity* may deal with all three dimensions of availability, accessibility, and utilization, implying that all three dimensions should be considered when measuring the impact of interventions (Staatz, et al. 2009). If one were to follow the FAO definition in applied empirical work, ideally one would hence like to use a measurement that captures all three dimensions. This clearly poses a challenge, and because of the lack of an obvious measure that encompasses all these aspects, the literature has used more than 450 indicators (Hoddinott, 1999). Measures capturing at most one of the three dimensions, such as food production, food share consumption and expenditures, are often used when measuring the impacts of particular interventions on food security. Arguably, however, such measures capture the consequences of being food insecure, but not necessarily food security status per se. An alternative is to use either an aggregate index or "hunger scales" to obtain a combined measure of the three dimensions.[16] Bertelli and Macours (2014) discuss multi-dimensional measures of food security including Hunger Scales, indicating that under the impetus of the USAID's Food and Nutrition Technical Assistance (FANTA) project, a growing literature uses measures of

[13] See Tiwari, et al (2013), p. 3.

[14] See Bertell, and Macours (2014), pp.1, 7.

[15] The relation between the three dimensions is unidirectional: utilization requires accessibility, which requires availability, but it is not true the other way round. Food security results not only from producing enough food, but also from physical and economic access to food and from good health conditions that allow the body to absorb energy intakes (Sen, 1981; Staatz, et al., 2009).

[16] See Bertelli and Macours (2014), pp. 2-3.

food security based on people's experience of food security and hunger.[17] However, these indexes may be data-heavy and can require the measurement of all food items.

Following the FAO's universally accepted and applied definition of food security, Tiwari et al. (2013) select some of the most commonly used measures of food security which fall into at least one of the pillars of food security: availability, access, utilization, or stability. Food security measures considered in their work are per capita expenditure, share of food in total expenditure, per capita caloric availability, food consumption score, household dietary diversity score, mother's dietary diversity score, child dietary diversity score, household food insecurity access scale, starchy staple ratio, and share of food expenditure on starchy staples.[18] They find that measures such as food consumption score or dietary diversity score may carry as much information as other measures, such as per capita expenditure or the starchy staple ratio, which require longer and costlier surveys with detailed food consumption modules. They show that food consumption score performs extremely well in comparison with all other measures from the perspective of nutritional targeting as well as for monitoring nutritional outcomes.[19] Despite being relatively analytically simple, it still requires extensive data collection in terms of a seven-day recall for many food items.

According to Tiwari et al. (2013), per capita expenditure is a widely used measure of a household's wealth status and overall wellbeing as it indicates the availability of household resources. It is thus used as a measure to indicate access to food. Food share of total expenditure is an indicator of the household's economic vulnerability and can be a proxy measure of household's ability to access food. Households that spend a larger proportion of their total expenditure on food do not have sufficient safety net of non-food expenditure to rely on and thus are more susceptible to food deprivation. In an event of negative income shock or increase in food prices, households with higher share of food expenditure will have to adjust either by reducing food quantity or by lowering the quality of food they eat. Per capita caloric availability measures whether a household has acquired sufficient calories to meet the daily energy requirements of its members and is one of the most widely used quantitative indicators of food security and is an indicator of diet quantity and access to food. If a household's estimated per capita daily energy availability is lower than its per capita daily requirement, the household is considered energy deficient and can be classified as food insecure. Dietary diversity measures diet quality and reflects the variation in food typically consumed by households. In general, it is defined as a sum of the number of food items or food groups consumed over a given reference period. Although there is no general consensus in constructing a measure of dietary diversity, studies have shown that various measures of dietary diversity are positively correlated with other measures of household food security, such as per capita consumption, calorie availability, calorie intake, and intake of essential nutrients. Tiwari et al. (2013) use the universally accepted and applied definition of food security and use some of the most common indicators of food security to investigate the relationship between measures of household food security and nutritional outcomes. They conduct a systematic assessment of the correlation between various measures of household food security and nutritional outcomes of children and find that the various measures of

[17] See Bertelli and Macours (2014), p.5.

[18] See Tiwari, et al. (2013), p. 9.

[19] See Tiwari, et al. (2013), p. 2.

household food security appear to carry significant signals about the nutritional status of children that reside within the household.[20]

Tiwari et al. (2013) consider three different measures of dietary diversity: household dietary diversity score, individual dietary diversity score, and food consumption score. Household dietary diversity score and individual dietary diversity score, developed by USAID Food and Nutritional Technical Assistance (FANTA), are two of the most common indicators of dietary diversity. Food consumption score is a measure of the access component of food security developed by the WFP. The WFP uses food consumption score to monitor, assess, and track changes in the food security situation and needs of countries and regions in which it has programs. It is a composite score that incorporates dietary diversity, food frequency, and relative nutritional importance of different food groups consumed by a household.[21] Other studies, for instance, Banerjee, et al. (2015) use the food security index (five components), per capita food consumption and per capita non-food consumption.

Some studies in the international literature use Household Food Security Survey Measure (HFSSM) to measure food insecurity. Radimer et al. (1990) use HFSSM as a conceptual framework based on interviews with 32 women in the urban and rural areas of New York State and identify a household and individual dimension, interpreting hunger as a managed process where women adopt coping strategies that differ across households. They propose three scales (household hunger, women hunger, children hunger) which contain four dimensions: food quantity and quality, a psychological (uncertainty/worry of not having enough food) and a social component (acceptability of the way in which food is acquired).[22]

The Household Food Insecurity Access Scale (HFIAS) is another widely used measurement of food insecurity in the international literature (see Appendix 6 for the HFIAS questionnaire module). The Household Food Insecurity Access Scale (HFIAS) was developed in 2006 by the USAID Food and Nutrition Technical Assistance (FANTA) project following the validation studies of the HFSSM in different developing countries (Bertelli and Macours 2014). It aims to capture the changes in food consumption patterns and reflects the severity of food insecurity faced by households due to lack of or limited resources to access food. While keeping the underlying approach to measuring food insecurity, the HFIAS is a more universal method than the HFSSM. The main difference between the two approaches is the reduction of dimensions and items and the elimination of the social component dimension from HFIAS due to the difficulties in successfully determining an appropriate and cross-cultural question to address the sensitive and highly culturally specific issue of what is socially acceptable (Coates et al. 2007). In addition, questions about households' coping strategies to augment the resource base (such as taking a loan) have been eliminated. To better capture only the present household situation, the recall period in collecting information about food insecurity is reduced from 12 months in HFSSM to only 4 weeks in the HFIAS (Deitchler et al., 2010). The number of questions has thus reduced from 30 to 9, each one having a "frequency-of-occurrence" question that assesses how often a certain condition occurs. It asks questions relating to three different domains of the access component food insecurity: anxiety and uncertainty about household food access, insufficient quality, and insufficient food intake (Swindale, et al., 2006). Responses to the questionnaire are summarized to construct a food insecurity score, with a maximum score of 27 indicating most food insecure households and households are categorized on four levels: food secure, mild,

[20] See Tiwari, et al. (2013), p. 2.

[21] See Tiwari, et al. (2013), pp. 9-10.

[22] See Bertelli and Macours (2014), p.5.

moderately, and severely food insecure. While the food secure household does not worry about not having enough food, the mild one experiences uncertainty. The moderately insecure household cuts down on quality of food, and sometimes reduces the quantity of food. A severely food insecure household cuts on quantity and/or quality or experiences any of the three most severe conditions such as running out of food, going to bed hungry and going a whole day and night without eating. Such an indicator can be useful for evaluating program impacts, even if they do not shed light on the causes of food insecurity. However, respondent bias can be a potential drawback.[23]

According to Bertelli and Macours (2014), the least common indicators of food security are those that assess coping strategies implemented by households when facing food insufficiency. While this methodology tries to capture the food insecurity experience more directly, it still looks at its consequences in terms of behaviors adopted by households and individuals (Coates, et al., 2006a). Maxwell (1995) proposes six different indicators of short-term food-based coping strategies.[24] The use of coping strategies in assessing food security is also adopted by Bonanno and Li (2011) who define "low food secure households" as those having "enough food to avoid substantial disruption in their eating patterns or reduced food intake by using a variety of coping strategies" while "very low food insecure households" face disruption of normal eating patterns of one or more members.[25]

3.3 Literature review on the relationship between agricultural development and food security

Several studies in the international literature discuss issues related to agricultural development and food security. The studies can be grouped according to the following themes: the role of agricultural development in enhancing food security (cf. Ganpat and Isaac, 2016); the constraints on agricultural development and food security; and the policy interventions for improving agricultural production and food security.

Agricultural development is critically important to improving food security and nutrition. Its roles include increasing the quantity and diversity of food; driving economic transformation; and providing the primary source of income for many of the world's poorest people. Numerous empirical studies across many countries (cf. Hatlebakk 2018) over many years show that both agricultural development and economy-wide growth are needed to improve food security and nutrition, and that the former can reinforce the latter (The High Level Panel of Experts on Food Security and Nutrition (HLPE), 2016). Barrett, Carter and Timmer (2010) discuss the literature of a century-long perspective on agricultural development. The discussion is organized around three "grand themes" that reveal the richness of agricultural development as an intellectual endeavor: the role of agriculture in the broader development process from a macroeconomic and political economy perspective; the role of technological and institutional change in successful agricultural development; and a microeconomic perspective on household decision-making. de Janvry and Sadoulet (2010) discuss the role of agriculture for development in sub-Saharan Africa and argue that agriculture fulfills multiple functions in the development of sub-Saharan Africa countries and should be a source of growth and an instrument for poverty reduction and contribute to the provision of environmental services. Yet, it is still used far below its potential, with gains in land and labor productivity lagging behind

---

[23] See Bertelli and Macours (2014), p.6.

[24] Eating foods that are less preferred, limiting portion size, borrowing food or money to buy food, buffering in favor of another member, skipping meals, and skipping eating for whole days. The author then develops a relative frequency scale, such that the higher the number the less frequently the strategy is used.

[25] See Bertelli and Macours (2014), p.4.

those of other regions. Successful use of agriculture for development requires greater attention from governments and donors, supported by scholarship and learning. Economists have an important role to play in helping to re-conceptualize the role of agriculture for development in a new paradigm, and in designing and evaluating new approaches, contributing to capacity building, advising on policy and to mobilizing political support.

The second group of studies explains the constraints on agricultural development [and hence, food security]. According to FAO (2006), political unrest and armed conflicts that have prevented farmers from producing, displaced populations, destroyed infrastructure and littered the countryside with land-mines are the primary constraints on agricultural development and improved food security. Poor governance and weak institutional capacity have also contributed to policies that have proven incapable of addressing the challenges of agriculture and rural development. The brain drain phenomenon and macroeconomic conditions have been unfavorable to agriculture and have undermined its competitiveness. The expansion of cultivated land in many Sub-Saharan African countries has been constrained by physical access, insecure land ownership, limited access to animal and mechanical power and reduced availability of labor. Productivity has remained low because of underutilization of water resources, limited fertilizer use, limited use of improved soil-fertility management practices and weak support services (research, extension and finance). Recurrent droughts, plagues and related increased risks have discouraged the investment that is indispensable for raising productivity. Malfunctioning and inefficient markets (largely due to a frail private sector in most countries), insufficient investment in infrastructure, high transportation costs, weak information systems and a poor regulatory framework have hampered proper remuneration of producers and deterred – indeed, incapacitated – them from investing and specializing in new and high value products. Prices remain low (which is good for those who buy food) and are highly volatile – and there are no mechanisms that can help minimize or share the risk borne by producers (FAO, 2006).

Hatlebakk (2018) discusses the impact on agricultural growth of different constraints.. The report discusses three sets of factors that particularly limit agricultural productivity and growth: infrastructure; institutional factors, such as land tenure systems and insurance mechanisms; and diffusion of new technology. The report concludes that agricultural policies should be integrated with general policies for development in remote areas. Government and donor-supported safety nets may help in reducing the risks facing poor farmers, and could also target other sectors, with the health sector being potentially the most important one. Beyond insurance and basic income support, Hatlebakk identified a need to invest in roads, infrastructure, basic education, and training in improved agricultural techniques, including localized soil management systems.[26]

In their discussion of the adoption of agricultural technology and the lessons learned from field experiments, de Janvry, et al. (2016) explain that the Green Revolution, consisting of using High Yielding Variety (HYV) seeds together with high fertilizer doses, has been widely adopted under irrigated conditions, but generally not in rainfed areas that are prone to stresses like drought and flooding. This puzzling lag in the adoption of technology holds back the role of agriculture for development in extensive regions of the world, such as Sub-Saharan Africa and Eastern India, with high aggregate costs in terms of economic growth and human welfare. According to de Janvry, et al. (2016) field experiments have been particularly useful in addressing this adoption puzzle. Significant lessons have been learned on the roles of farmer behavior and of mediating factors such as credit, insurance, markets, and policies in constraining

[26] See Hatlebakk (2018), pp. vi-vii, 13.

adoption. The findings suggest that there is a lack of improved technology fit for rainfed agriculture, and the authors recommend increased investments in research and extension services.

Barrett, Christiansen, Sheahan and Shimeles (2017) argue that from 2000 to 2014, per capita GDP in sub-Saharan Africa increased by almost 35% in real terms, doubling in some countries. Such progress occurred while agricultural productivity growth remained low in the aggregate and poverty reduction has been steady but discouragingly slow. This paper argues that ending extreme poverty will require structural change in agriculture and in rural African economies more broadly. Drawing on a range of recent research, they outline broad priority areas for policy actions to accelerate productivity and initiate structural change in the agriculture sector and the rural non-farm economy.

Sheahan and Barrett (2017) argue that much of the sustained agricultural growth necessary for economic transformation comes from expanded input use, especially of modern inputs, like improved seeds, fertilizers and other agro-chemicals, machinery and irrigation, that embody improved technologies. They discuss ten striking facts about agricultural input use in Sub-Saharan Africa (SSA), indicating that irrigation use and mechanization levels remain low in SSA agriculture. They further argue that women farmers use far fewer inputs than men and that the use of credit to purchase agricultural inputs is nearly non-existent. They find that a strong inverse relationship exists between farms, or even plot-size and input use intensity.

Finally, the third group of studies addresses policy measures and interventions for improving agricultural production and food security. The literature includes many studies focusing on a particular dimension of food security (e.g. nutritional status which can be measured at the individual level) and establishing an observational (though in most cases not causal) relationship between these outcomes and prior interventions.[27] Bertelli and Macours (2014) examine food security and agriculture in developing countries, focusing on measurement and impact evaluations, and argue that establishing credible causal links between particular interventions and aggregate food security is challenging for a number of reasons. First, there is a lack of common measurement of food security. Secondly, there is a need for credible exogenous variation to establish a causal relationship between an intervention and resulting food security outcomes.

Bertelli and Macours (2014) discuss policy measures that could help increase food security and argue that agriculture interventions targeting constraints to agricultural productivity, including constraints on new agricultural technologies, often seem obvious candidates for interventions. One suggested intervention is based on the argument that the increase in cash crops or agricultural production for commercialization would lead to higher income and also increase food security by consuming more and/or better quality food.[28] Another intervention suggests increasing food security through fertilizers subsidies and is based on the argument that the provision of subsidies and making good quality fertilizers and seed varieties more accessible lead to enhancing agricultural production and food security. Home gardening has also been suggested as a possible intervention as this promotes household horticultural activities that are managed by the family who grow food mainly for their own consumption. Nutritional education, behavioral change and women's empowerment could also improve food security as it is often assumed that interventions should focus on women, given the greater hypothesized impact of women's income on child nutrition and

[27] See Bertelli and Macours (2014), p.1.

[28] As they discuss, there may, however, be negative effects as well, for example if increased cash crop production leads to a decline in staple food production.

household food security (World Bank, 2007). Some other studies also discuss the role of women in agriculture, for instance Doss, et al. (2017) indicate that women are the primary food producers in the world. Others have claimed that women produce 60–80% of food, however, Doss et al. question this and claim that these figures are very hard to verify. It is agreed, however, that women have an important role in agriculture and that there is a need to direct policies towards women farmers. Finally, another intervention suggests that food security can increase through non-agricultural income. This is based on the argument that interventions targeting entrepreneurship and increasing non-agricultural income (e.g. micro-finance) might be equally or more important for household-level food security than agricultural interventions, as they may increase households' incomes.[29]

[29] See Bertelli and Macours (2014), pp.8-13.

4. Methodology (method of data collection and data analysis) and main results

This research uses secondary and primary data, qualitative and quantitative data, and descriptive and comparative methods to measure food security and provide an empirical investigation of the relationship between agricultural development and food security in Kassala State. The secondary data was obtained from relevant national and international sources while the primary data was obtained through a survey questionnaire distributed to 500 households representing rural and urban in Kassala State between 10-20 April 2019.[30] While the survey did not include the whole state, the sample was representative of the population and included randomly selected villages. The households were randomly selected from a list of households obtained from the head of administration of each village and was arranged by the supervisor of the survey in Kassala State.

The survey covers five of the 11 localities in Kassala State: New Halfa (NH) locality, Rural Aroma (RA), Kassala locality (KL), Rural Kassala (RK) locality, and Waldel Helew (WL) or Khasm Algirba locality. These localities were selected because they reflect the diversity of agricultural activities defined by type of irrigation (including gravity irrigated area, flood irrigated land, Basin irrigated areas and rain fed areas). They also contribute to food production and employment in Kassala State.[31]

We follow the FAO definition and conceptual framework that often used in the international literature and defines the multidimensional nature of food security and includes food access, availability, food use and stability. Regarding the supply-demand dichotomy, we use the definition that suggests that food availability and food stability address the "supply side" of food security and are determined by many factors including for instance, prices, level of food production, etc., while food access and food utilization address the "demand side" of food security and are determined by many factors including for instance, prices, the levels of income and expenditure to achieve food security, health status, etc.

Through statistical analysis, mainly OLS estimation, we estimate the determinants of production and consumption of food, the relationship between household food insecurity score index, and size of agricultural land, household income and size of household family. We test three main hypotheses: (1) the production of food is determined by the sales price, size of agricultural land, capital, labor, new agricultural techniques, and village characteristics; (2) the consumption of food is determined by the consumer price value, own family production of food, household income and size of household family, and other household characteristics; and (3) the household food insecurity score index is affected by the size of agricultural land, own family production of food, household income and size of household family, and other household and village characteristics. Through qualitative observations and assessment, we provide an in-depth explanations of the severity of food insecurity and the factors that impede or contribute towards food security and agricultural development in Kassala State. The qualitative assessment is also useful for investigating the gender perspectives and the role of women in enhancing availability, access, utilization and sustainability of access to food for the family.

---

[30] For the implementation of the survey, a team of part-time researchers from Kassala University will be hired to distribute and collect data from households. The translated Arabic version of the English version of the survey questionnaire will be distributed to facilitate, accelerate and increase the response rate. The design of the questionnaire in the survey includes three types of questions: nominal (Yes/No), scalar or categories and open questions.

[31] According to contribution in food production and employment of population in Kassala State, the main agricultural subsectors include (1) Gravity irrigated area in New Halfa Agricultural Scheme which covers New Halfa and Atbara River localities in addition to some villages in Khasm Algirba locality. (2) Flood irrigated land in AlGash Scheme comprises Rural Aroma and AlGash delta localities in addition to some areas in Kassala and Talkook localities. (3) Basin irrigated areas on the banks of Gash River and Atbara River cover parts of Rural Kassala and Kassala localities beside others. (4) Rain fed areas especially in Wadel Helew and Khasm Algirba localities.

We use descriptive analysis to explain the size, structure and composition of the families in the survey and to assess whether these measures are appropriate for supporting the food security for household families in Kassala. Through descriptive analysis, we will explore adaptation and survival strategies to deal with food insecurity and discuss measurement of food security (Household Food Insecurity Access Scale (HFIAS)), both ordered logit and probit regression will be used to examine the determinants of HFIAS.

We measure food insecurity using Household Food Insecurity Access Scale (HFIAS) that has been widely used as a universal method for measuring food insecurity in several studies (see for instance, Bertelli and Macours, 2014; Tiwari et. al., 2013). HFIAS is useful for our analysis because it classifies households according to a hunger scale with four levels and permits calculating the four categories and their prevalence in the sample. Additionally, the questionnaire used in our analysis includes questions on agricultural production, food consumption, other incomes and other expenditures.

5. Main results

5. 1. General characterstics and background information about households in the survey:

As discussed previously, we conducted a survey of the general characteristics and background information of local households. Appendix three shows the full results, but we will first outline some of the main findings. Our results show the majority of households belong to Hadandawa tribe (27.5%) and West African tribe (25.9%). We found that most households reported that they were of medium family size (39%), with most reporting few children under five (53.9%). Household sizes were determined by the total number of family members: small size refers to families with 1-5 members, medium size to families with 6-8 members and large size to families with 8 or more members. Similarly, we define the number of household children under age five in four categories: families without children, families with few (1-3) children, families with many (4-5) children and families with more than 5 children.

More than half of the household heads reported that they belonged to the middle age group of 21-45, followed by old age group of 46-60 years, very old age group (more than 60 years old), and few reported within the young age group (20 years old or younger). Unsurprisingly, more than three quarters of households reported having a male head, demonstrating the long-standing gender gap and limited participation of women in farming activities in Sudan. The skill level of household heads defined by education attainment of household heads implies low skill level and low education attainment, in particular, more than one third of household heads are illiterate (35.2%). Nearly half of all household heads work in the agricultural sector and have a low or very low income, implying a low standard of living.[32] We recognize serious discrepancies in the distribution of monthly income across localities since the majority of household heads have low income level in RK (52%), RA (65%) and NH (77.6%), while the majority of households have middle to high income level in KL (66%) and WL (75%) (See Appendix 3).When using data including all household members, we observe some differences concerning household family structure defined by age and gender. For instance, nearly half of the household members are within the young age group of twenty years or less. We find near gender parity among the composition of household members.

5. 2. Housing status, quality and environment, infrastructure and services

The survey also asked questions on housing status, quality and environment (for full results, see Appendix 4). The type of ownership shows the majority of houses are owned by the household family. For the majority of households, ownership of the house is acquired through building a new house at the family's own expense.

Poor housing quality and environment appears from several indicators: access to safe sources of drinking water; the size of the houses (one floor, two floors, etc.); number of rooms in the houses; access to sanitation; village infrastructure and market access; and access to services (banking, internet etc.). The findings are detailed in appendix four, but we notice a serious dissatisfaction concerning adequacy and sustainability of provision of services and facilities in the villages.

Our analysis illustrates that the prevailing housing status, quality, and environment, services and infrastructure available for families are not appropriate for supporting the food security for families in Kassala State.

---

[32] We define the households' family income by the level of monthly income in three groups: very low income level ((less than1500), low income level (1500-3000), and middle to high income level (more than 3000) respectively.

5. 3. Agricultural production, household income, consumption and expenditure

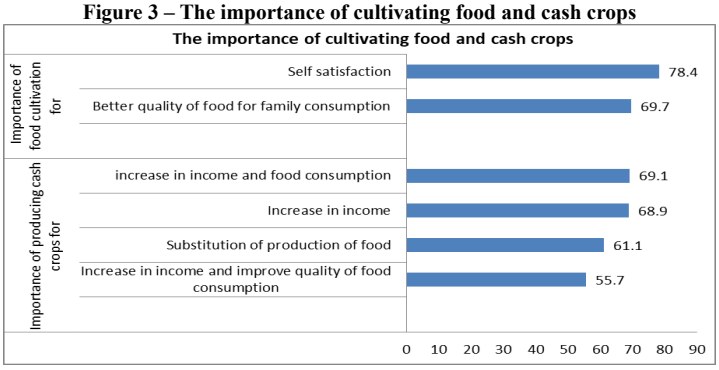
Agricultural production, particularly related to cultivating of food and cash crops, has an important role in Sudan. Table 5 and figure 3 show the reported importance of food and cash crops for family households. The survey asked why the families grow crops and food that the main reasons were for achieving self-satisfaction, for providing a better quality of food for the family, and to increase income.

Table 5 - The importance of cultivating food and cash crops

	Extremely	Moderately	Slightly	Not relevant
1. Importance of food cultivation:				
1. Self-satisfaction	50.1	28.3	20.2	1.4
2. Better quality of food for family consumption	24.6	45.1	22.0	8.3
2. Importance of producing cash crops:				
1. Increase in income	42.2	26.7	21.5	9.6
2. increase in income and food consumption	31.8	37.3	23.6	7.3
3. Increase in income and improve quality of food consumption	28.3	27.4	31.6	12.7
4. Substitution of production of food	35.8	25.3	14.7	24.2

Source: Authors' calculations based on Food Security Household Survey in Kassala State (2019)

Figure 3 – The importance of cultivating food and cash crops



Source: Authors' calculations based on Food Security Household Survey in Kassala State (2019)

Despite the wide recognition of the important role of agricultural production, agricultural production is still impeded by several serious problems that support our hypothesis, explained in section one. A major impediment is the lack of agricultural land ownership. The land tenancy status indicates that for some households, the land is owned and cultivated by households (75.2%), while for some households the land is rented in and cultivated by households (18.53%). However, more than a quarter of households hesitated or refused to respond to the question regarding land tenancy status (26.5%), and more than three quarters hesitated or refused to respond to the question regarding the purposes of uncultivated land. These results imply that the households are somewhat reluctant to discuss the land tenancy issue, which may not be surprising in view of the critical complications related to land tenancy issue and land grabbing policies in Sudan that has been well documented in the Sudanese literature (see Elhadary et.al., 2010; 2011; 2012; 2016).

Our results show both a low ownership of agricultural land and a low ownership of livestock. The tropical livestock unit, for instance, shows that more than third of households (37.3%) do not own livestock (see Figure 4 for details of ownership).[33]

Agricultural production is also hindered by the small size of cultivated land – more than half of households indicate small size of cultivated land of 1-5 feddans (53%). The size of the farm in relation to the cultivated crops is detailed in Table 6. Overall, only a few crops are cultivated in these farms including sorghum, millet, wheat, legumes, vegetables, fruit, sesame, peanuts and a few other diversified crops. The majority of households only cultivated sorghum.

The results show that the cultivation of few crops result in poor crop variety and lower food production capacity that only meets some of the households consumption needs and most probably impedes households dietary diversity. We find not only poor agricultural crop variety, but also some discrepancies in the distribution of land area cultivated by agricultural crops in different localities. The distribution of land allocated for the cultivation of crops shows that the highest median of land allocated for cultivation of crops is reported for Sesame (10), while the lowest median is reported for vegetables (2). Table 6 reports land allocated to different crops, first for the full sample, then for an example without outliers, and finally excluding the zeros. When excluding only outliers, we find that the median of land allocated for cultivation of sorghum is 2 feddans, while it is zero for the other crops. When excluding both outliers and zero, we find that the highest median of land allocated for cultivation of crops is reported for sesame (10), followed by sorghum, millet, wheat, groundnuts, diversified crops, legumes, fruit and vegetables (respectively) (see Table 6).

A further hindrance to agricultural production is the lack of choice of irrigation. Most households (20.5%) use rain fed irrigation. Small size and lower medium size farms use more diversified type of irrigation to cultivate land, but upper medium size, large size and very large size farms use less diversified types of irrigation to cultivate land.[34] A shortage of agricultural services also causes constraints. While some households receive agricultural services (21.5%), the majority (78.5%) do not.

[33] We define the number of households' ownership of livestock in five groups: households without ownership of livestock (zero), households with small ownership of livestock (1-5), households with medium ownership of livestock (6-15), households with large ownership of livestock (16-30), and households with very large ownership of livestock (more than 30) respectively.

[34] We define the households farm size by the cultivated land area measured by feddan: small size cultivated land area (1-5 feddan), medium size cultivated land area (5.5-15 feddan) (including lower medium size farm (5.5-10 feddan) and upper medium size farm (11-15)), large size cultivated land area (16-50 feddan) and very large size cultivated land area (more than 50 feddan) respectively. For the distribution of land area cultivated by agricultural crops, the term zero refers to those who don't use land to cultivate crops either because they are landless or couldn't hire it or perhaps it means people who don't engage in agricultural activity. For the landless household this will have important policy implication. mainly, because both the heavy reliance on rented land together with the limited land ownership hinder cultivation of agricultural crops in large and very large farm size and hence affect food security in Kassala

Table 6 - Distribution of land area cultivated by different crops and by type of irrigation and localities

1. Distribution of land area cultivated by different crops										
Localities	RK	RA	KL	WL	NH	All				
Land in feddan										
Sorghum only	63.0	60.0	11.7	32.0	26.2	41.5				
Millet only	2.0	0.8	0.0	0.0	0.0	0.6				
Wheat only	0.0	0.0	0.0	0.0	16.8	3.7				
Legume only	0.0	0.0	1.7	0.0	0.0	0.2				
Vegetable only	2.0	0.0	20.0	0.0	0.0	2.9				
Fruits only	0.0	0.0	13.3	0.0	0.0	1.6				
Other crops	0.0	0.0	8.3	15.0	0.9	4.3				
Combined	3.0	0.0	21.7	51.0	30.9	20.6				
No response	30.0	39.2	23.3	2.0	25.2	24.6				
Total	100	100	100	100	100	100				
2.1. Land allocated for cultivation of crops in feddan (total sample)										
Cultivated crops	N	Minimum	Maximum	Mean	Std. Deviation					
Sorghum	487	.00	1000	11.76	65.75					
Millet	487	.00	100	0.46	4.75					
Wheat	487	.00	50	0.63	2.94					
Sesame	486	.00	500	3.27	24.25					
Peanuts	487	.00	5.0	0.02	0.32					
Fruit	486	.00	36.0	0.35	2.29					
Legumes	486	.00	15.0	0.25	1.18					
Vegetables	486	.00	11.0	0.24	0.99					
Diversified crops	486	.00	20.0	0.42	1.83					
2.2. Land allocated for cultivation of crops in feddan (selected sample)										
Cultivated crops	N	Minimum	Maximum	Mean	Median	Std. Deviation				
Sorghum	264	1.00	100.00	9.19	5.00	15.2				
Millet	23	0.5	20	5.39	5.00	4.35				
Wheat	45	3.0	50	6.8	5.00	7.19				
Sesame	61	5.0	100	17.95	10.00	18.8				
Peanuts	1	5.0	5.0	5	5.00	-				
Fruit	10	0.5	10	3.25	3.00	2.72				
Legumes	13	0.5	7.0	3.07	3.00	2.12				
Vegetables	40	0.5	11.0	2.88	2.00	2.11				
Diversified crops	14	1.0	20.0	6.71	5.00	5.67				
2.3. Land allocated for cultivation of crops in feddan (adjusted sample)										
					Eliminating only outliers			Eliminating both outliers and zero values		
Cultivated crop	N	Zero percentage	Min	Max	Mean	Median	Std dev	Mean	Median	Std dev

Sorghum	485	44.5	0	500	8.3	2	36.5	15	5	48
Millet	485	95.3	0	20	0.26	0	1.47	5.4	5	4.4
Wheat	485	90.7	0	50	0.64	0	2.94	6.8	5	7.19
Sesame	485	87.4	0	500	3.08	0	23.89	24.5	10	63.8
Groundnuts	485	99.6	0	5	0.021	0	0.32	5	5	0
Fruit	485	93.8	0	36	0.35	0	2.29	5.7	3	7.5
Legumes	485	93	0	15	0.26	0	1.17	3.6	4	2.8
Vegetables	485	91.8	0	11	0.24	0	0.99	2.9	2	2.12
Diversified	485	91.8	0	20	0.42	0	1.829	5.1	5	4.1

3. Distribution of land area cultivated by agricultural crops

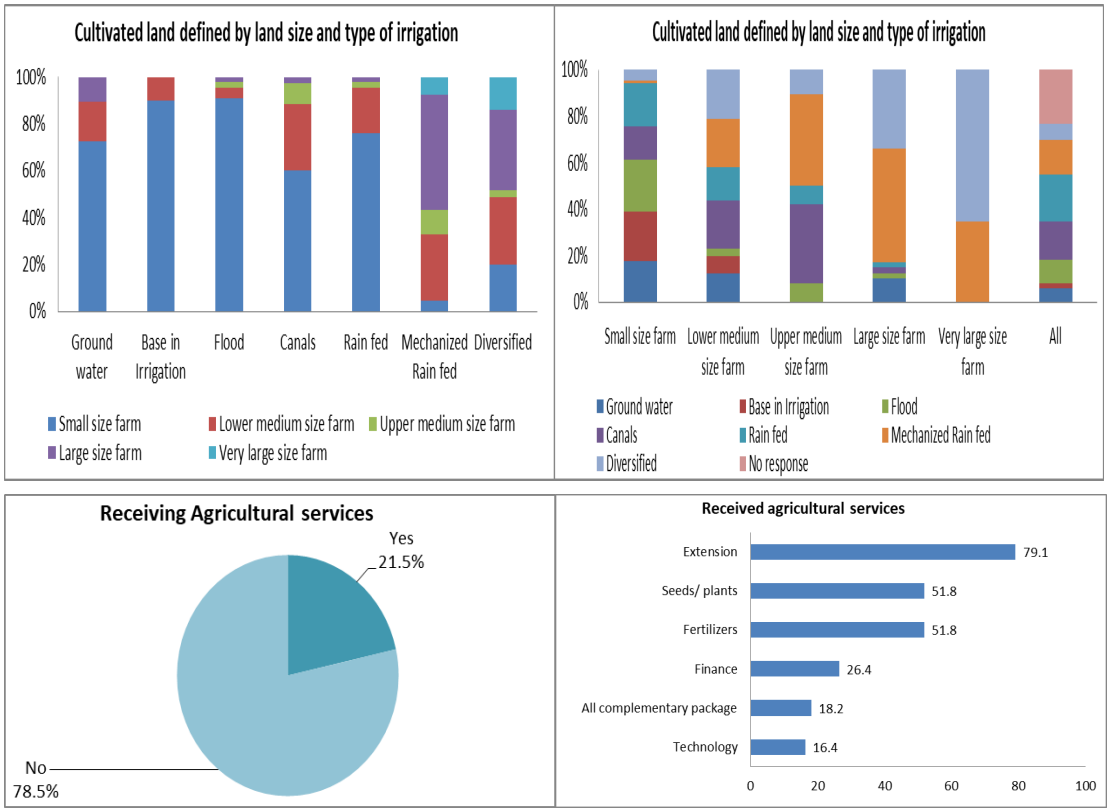
Land in Fed	Landless (without land) or very small (zero or less than 0.5)	Small size (0.5-5)	Lower medium size (5.5-10)	Upper medium size (11-15)	Large size (16-50)	Very large size (more than 50)	Total
Crop							
Sorghum	44.4	36.1	10.7	1.6	4.3	2.9	100
Millet	95.1	3.7	0.8	0.0	0.2	0.2	100
Wheat	90.8	8.0	0.6	0.2	0.4	0.0	100
legume	93.0	6.6	0.2	0.2	0.0	0.0	100
vegetable	91.8	7.6	0.4	0.2	0.0	0.0	100
Fruits	93.8	5.0	0.6	0.0	0.6	0.0	100
Sesame	87.3	1.7	5.7	1.4	3.3	0.6	100
Peanuts	99.6	0.4	0.0	0.0	0.0	0.0	100
Diversified	91.8	6.4	1.4	0.2	0.2	0.0	100

4. Cultivated land by type of irrigation

Type of irrigation	Small size (1-5)	Lower medium size (5.5-10)	Upper medium size (11-15)	Large size (16-50)	Very large size (more than 50)	All
Ground water	72.4	17.2	0.0	10.4	0.0	6.0
Base in Irrigation	90.0	10.0	0.0	0.0	0.0	2.3
Flood	91.1	4.4	2.2	2.3	0.0	9.7
Canals	60.3	28.2	9.0	2.5	0.0	16.6
Rain fed	76.2	19.4	2.2	2.2	0.0	20.5
Mechanized Rain fed	4.5	28.4	10.4	49.2	7.5	14.4
Diversified	20.0	28.6	2.9	34.3	14.2	7.1
No response						23.4
Total	100	100	100	100	100	100

Source: Authors' calculations based on Food Security Household Survey in Kassala State (2019)

Figure 4 - Land tenancy status, ownership, cultivating and uncultivated land, livestock and agricultural services



Source: Authors' calculations based on Food Security Household Survey in Kassala State (2019)

The weaknesses of agricultural production motivated households to join nonfarm activities to generate more income (see Table 7 for details of all reasons). Daily labor is a significant source of nonfarm income (measured by households reporting this type of income). The distribution of total nonfarm income shows that the majority of households are low or middle income households (66.3%), where very high income refers to more than SDG 20000 and low income is SDG 1500.

Table 7 – Household income and sources of nonfarm income

Locality	RK (%)	KL (%)	RA (%)	WL (%)	NH (%)	All (%)
1. Households income level (per month)						
Very low income level (<1500)	38.0	16.7	5.0	1.0	16.8	16.4
Low income level (1500-3000)	52	65	28.3	24.0	77.6	52.0
Middle to high income level (>3000)	10	18.3	66.7	75.0	6.6	31.6
Total	100	100	100	100	100	100

2. Sources of nonfarm income	Yes %	No %
Labor on daily basis	83.6	16.4
Salaried work in public sector	29.1	70.1
Salaried work in private sector	18.8	81.2
External remittances	13.8	86.2
Internal remittances	5.6	94.4
Gift	29.5	70.5
Rent of real estates and land	8.1	91.9
Trade surplus	27.8	72.2
Transport and travel services	13.1	86.9
Surplus from self-employment	66.1	33.9

3. Annual income from nonfarm sources				
Income	Low income (less than 1000)	Middle income (1000-6000)	high income (6001-19999)	Very high income (more than or equal 20000)
Sources				
Labor on daily basis	21.2	22.4	22.2	34.2
Salaried work in public sector	72.1	5.8	8.5	13.6
Salaried work in private sector	81.6	1.5	5.1	11.8
External remittance	87.2	9.6	1.6	1.6
Internal remittance	98.2	1.8	0	0
Gift	81.3	16.4	0.8	1.5
Rent of real estates and land	91.0	0.8	6.6	1.6
Trade surplus	74.8	18.5	3.3	3.4
Transport & travel services	89.8	4.3	2.5	3.4
Surplus from self employment	45.6	28.5	10.7	15.2
Total nonfarm income	12.5	53.8	27.9	5.8

4. Reasons for joining nonfarm activities	%
Insufficient income/return from household farm	58.5
Increasing of family size	39.8
Limited land area	27.3
Declining of soil fertility	27.7
Availability of fund opportunities	6.4
Availability of infrastructure ,road, electricity & market	3.7
Shocks arising from rain failure , epidemic, flood and others	24.2

Volatility and seasonal nature of farm activities	15.2
Crafts and manufacturing skills	9.2
Rising demand for nonfarm products	8.2
Others	4.1

Source: Authors' calculations based on Food Security Household Survey in Kassala State (2019)

The inadequate income from farm activities together with limited income from non-farm activities affected the pattern of households food and nonfood consumption. The consumption of food items does not reflect significant variation in food typically consumed by households and implies poor diet quality and poor dietary diversity as the majority of consumption come from five items: sorghum (54.37%), livestock products (12.5%), millet (12.43%), sesame (11.24%) and bread (10.24%). Minor food consumption includes legumes, fruit, wheat, purchased meal, chicken, fish, eggs and groundnut (see Table 11, Figure 11).[35] The high share of Sorghum in total food consumption is not surprising in view of the high share of Sorghum in total agricultural production (see Table 9, Figure 8). As we explained above, the lack of variation of crops and the low agricultural food production capacity meets only some of the needs of household consumption and impedes households' dietary diversity. (The household consumption of nonfood items includes many items, but is mainly concentrated on construction wood, rent, charcoal, health and medical treatment, water, clothing and shoes, education services, and wood for fuel (see appendix 5 for details of major and minor consumption).

When excluding only outliers, we find that the reported median of household consumption of food items is only 4000 Kg for sorghum, while for the other products most households report zero consumption, which gives a median of zero. However, when excluding both outliers and zero values, bread is reported as the highest median household consumption (see appendix 5). For non-food consumption, fuel is the most important, when excluding outliers. When excluding both outliers and zero values the reported highest median is for clothing and shoes (1400) (appendix 5). [36]

The composition of households' total consumption shows the high ratio of food to total consumption (0.73) that most probably reflects the economic vulnerability of households (see Table 8). This result is consistent with the arguments in the literature that indicate that food share of total expenditure is an indicator of the household's economic vulnerability and can be a proxy measure of household's ability to access food (see Tiwari et al., 2013). We find that over the past 6 months, more than half of households indicated a decrease in income (55.6%), accordingly, 52% of total households indicated a decrease in expenditure. This decrease in income and expenditure affected both a change in quality of food and a decrease in the amount of food consumed by the household. In turn, this meant that nearly half of households bought food by borrowing (44.6%). The ratio of food purchased by borrowing to total food consumed for the majority and more than half of households is either medium ratio (34.2%) or large ratio

[35] Consumed items were measured in SDG.

[36] We use frequency distribution data to specify and eliminate the outliers and make the estimation of food consumption and nonfood consumption after elimination of the outliers. Concerning food consumption, from the frequency distribution of food consumption (measured in SDG), we observe that very few households consumed seventy two thousand and more (measured in SDG), they constitute less than five %. Therefore, when considering eliminating outliers, we eliminate all data included food consumption more than sixty seven thousand (measured in SDG). Regarding nonfood consumption, from the frequency distribution of nonfood consumption (measured in SDG), we observe that very few households consumed seventy four thousand and more (measured in SDG), they constitute less than two %. Therefore, when considering eliminating outliers, we eliminate all data included more than 61390 (measured in SDG).

(30.1%), while some households reported small ratio (29.5%) and few reported very large ratio (6.2%) (see Figure 5).[37]

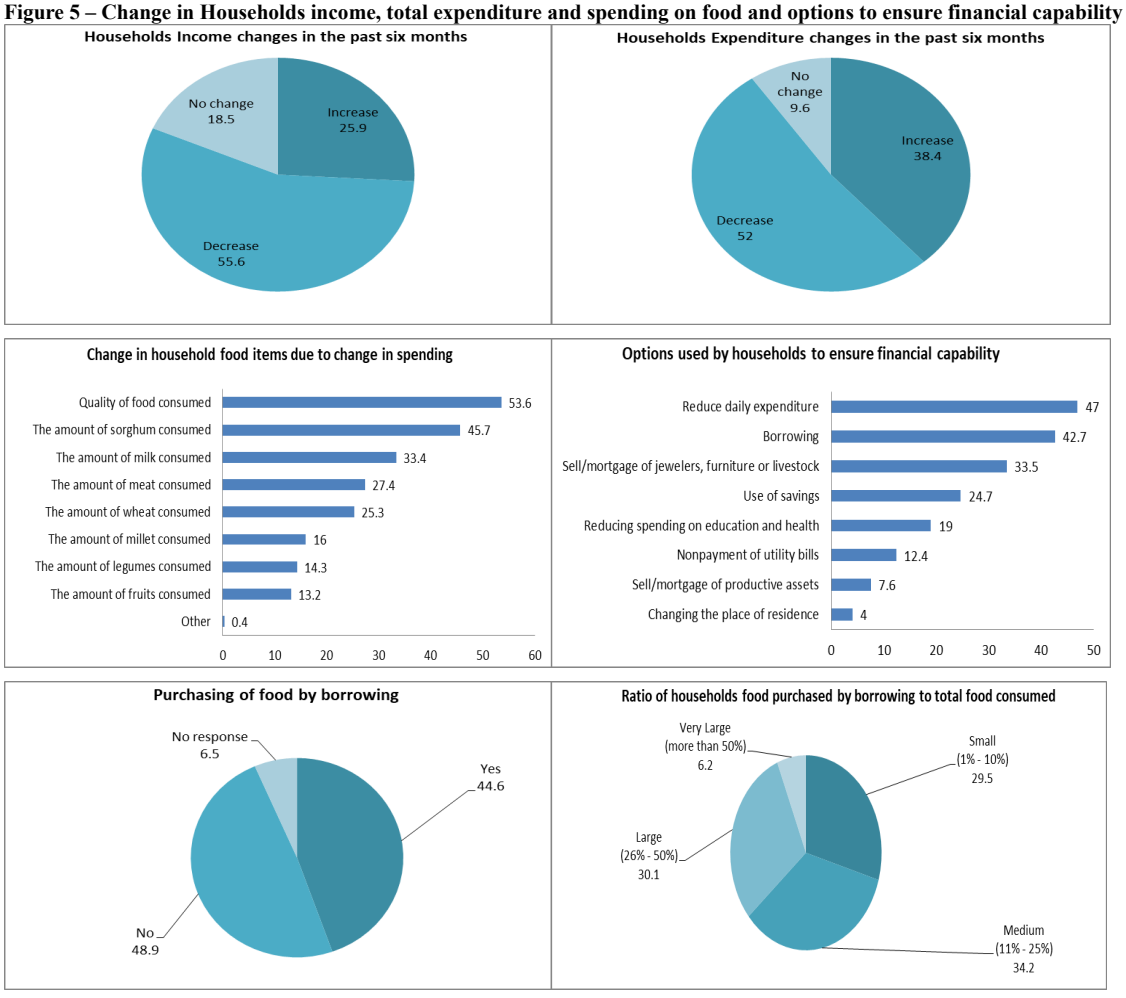
Households increasingly turned to other measures to ensure financial capacity including reducing the daily household expenditure; borrowing, selling or pawning jewelry, furniture or livestock; using savings, and so on.

Table 8 - Total consumption and ratio of food consumption to total consumption:

Consumption	N	Minimum	Maximum	Mean	Std. Deviation
Total consumption	485	2000	872210	35558.8	78456.4
Ratio of food to total consumption	485	0.3	1	0.73	0.23

Source: Authors' calculations based on Food Security Household Survey in Kassala State (2019)

Figure 5 – Change in Households income, total expenditure and spending on food and options to ensure financial capability



Source: Authors' calculations based on Food Security Household Survey in Kassala State (2019)

[37] We define the ratio of food purchased by borrowing to the total food consumed in four groups: small ratio (1% - 10%), medium ratio (11% - 25%), large ratio (26% - 50%) and very large ratio (more than 50%) respectively.

5.4. Aggregated and single supply-demand analysis: the determinants of production of food and consumption of food and sorghum

5.4.1. Aggregated supply-demand analysis: determinants of production of food and consumption of food

Food availability and food stability address the "supply side" of food security and are determined by many factors including, for instance, prices, level of food production, etc. Food access and food utilization address the "demand side" of food security and are determined by factors including prices, the levels of income and expenditure to achieve food security, health status, etc.

Our investigation of the determinants of production of food (after excluding price), assuming that the core dependent variable include production of food as measured by the value of main agricultural food products, implies that the significant determinants of production of food are size of agricultural land, sex of household head, family labor, livestock, agricultural services, marketing services, banking services, road characteristics, and irrigation systems (see Table 9). As expected, we find that the size of agricultural land, livestock and irrigation system are significant and positively influence the production of food. Regarding water supply and irrigations systems, we find a positive effect from the use of gravity (canals) irrigation, ground water, and cultivating by diversifying systems (using more than one irrigation system), flood and the mechanized rain fed (see Table 9).

Table 9 - Linear Regression Model Results of the determinants of food production (with log) (measured in SDG)

	(1)	(2)
Explanatory variables	Coefficient (t-Statistic)	Coefficient (t-Statistic)
Constant	4.164*** (12.08)	3.746*** (6.12)
Agricultural land	1.342*** (8.66)	1.319*** (8.45)
Sex of HH		-0.261 (0.58)
Family labor		0.452 (1.48)
Livestock	0.311*** (4.28)	0.312*** (4.26)
Agricultural services		0.365 (0.89)
Marketing services	-0.374** (2.44)	0.412 (2.65)
Road characteristics	-0.326*** (2.40)	-0.319** (2.31)
Banking services		0.198 (0.55)
Irrigation systems: (Ref: Traditional rain fed) -Ground water	2.030*** (2.81)	1.989*** (2.72)
Irrigation systems: (Ref: Traditional rain fed) -Basin		1.008 (0.99)
Irrigation systems: (Ref: Traditional rain fed) -Flood	1.954*** (3.41)	2.042*** (3.52)
Irrigation systems: (Ref: Traditional rain fed) -Canals (Gravity)	3.88*** (6.33)	3.184*** (6.17)
Irrigation systems: (Ref: Traditional rain fed) -Mechanized rain fed	2.983*** (5.22)	3.094*** (4.95)
Irrigation systems: (Ref: Traditional rain fed) -Combined(using more than one system)	1.856*** (2.80)	2.259*** (2.77)
R-squared	0.439	0.445
Adjusted R-squared	0.428	0.428
F statistics	39.72	25.82
DW statistics	1.74	1.75
N	466	467

*Note: ***, ** and *, indicate significant at the 1, 5 and 10 % level respectively*
Note: (1) Reduced model (only significant variables), (2) complete model (all variables).

Our investigation of the determinants of food consumption (after excluding price) uses the OLS estimation to estimate the determinants of food consumption assuming that the core dependent variable includes food consumption as measured by quantity of household food consumption (purchased).[38] The core explanatory variables (and after excluding price as independent variable) include own family production of food, household income, size of household family, livestock, and other household characteristics (sex of household head), and other variables (education services/ facilities, health services, health insurance, marketing services, road characteristics, banking services, housing and drinking water sources) (Table 10.a). We find that the household income, livestock, sex of household head, education services/ facilities, health insurance, characteristics of road between village and near market and drinking water sources (getting water through piped into dwelling) show significant positive effects on consumption of food. On the other hand, we find that somewhat surprising that the family own production of food, marketing services, banking services, housing (family owned house), and drinking water sources (getting water from wells) show insignificant positive effects on consumption of food. This result contradicts the stylized facts on economic theories and contradicts the prior expectations, this might be explained in relation to recent uncertainty of economic and political conditions that most probably affected family own production of food Health services and drinking water sources somewhat surprisingly show significant negative effects on consumption of food, and family size and a brick-built house rather than one constructed with interim materials (as an indicator of wealth) show insignificant negative effects on consumption of food. (See Table 10.a)

Further investigation of the determinants of food consumption, as measured by quantity of household food consumption (purchased)[39], assuming that the core explanatory variables include price (as measured by consumption (through purchased) value),[40] own family production of food and other characteristics (sex of household head, health services, marketing services, road characteristics and drinking water sources). Our findings from the regression analysis corroborate part of our second hypothesis that indicates that the significant determinants of food consumption are family own production of food, consumer price, sex of household head, health and marketing services, characteristics of the road between the village and near market (as an indicator for infrastructure development), and drinking water sources, and that these factors have a significant positive effect on household food consumption. However, we find that somewhat surprising the consumer price shows significant positive effects on consumption of food. This result contradicts the stylized facts on economic theories and also contradicts the prior expectations and might be explained in relation to recent uncertainty of economic and political conditions that most probably affected consumer expectations to increase consumption (through purchasing) of necessary goods in spite of prices rising. Drinking water sources, somewhat surprisingly, show significant negative effects on consumption of food, particularly getting water from wells which is probably due to distances and time consumed to get water (see Table 10.a).

We conducted further analysis of the determinants of food consumption defined by the per capita food consumption (Table 15.b). We find that household income and own family production of food show positive signs and turns statistically significant (Table 10.b), this shows that own family production of food and household income show significant and positive effects on per capita food consumption, this result is

[38] The dependent variable is measured in value in SDG.

[39] The dependent variable is measured in value in SDG.

[40] The consumer price is measured by dividing the value of purchases by the quantity purchased. It is an average weighted price.

consistent with the stylized facts in the theoretical and empirical literature. Our results show that the own family production of food, household income, road quality between the village and near market (as an indicator for infrastructure development), education services/ facilities, livestock, health insurance, and drinking water sources (through pipes into dwelling) show significant positive effects on per capita food consumption of household. Access to health services shows significant negative effects on per capita food consumption, while drinking water sources shows insignificant negative effects on per capita food consumption (Table 10.b).

Table 10-a: Linear Regression Model Results of the determinants of food consumption (measured in SDG)

	(1)	(2).	(3).	(4).
Explanatory variables	Coefficient (t-Statistic)	Coefficient (t-Statistic)	Coefficient (t-Statistic)	Coefficient (t-Statistic)
Constant	7.14*** (18.66)	7.23*** (16.46)	1.217*** (5.25)	379.65 (0.11)
Consumer price			0.932*** (33.61)	
Sex of HH	0292*** (2.73)	0.300*** (2.78)	0.159*** (2.59)	2907.41 (1.52)
Family production		0.010 (1.13)	0.019*** (3.76)	0.001 (0.90)
Family size		-0.117 (1.31)		342.23 (1.43)
Livestock	0.018*** (3.10)	0.052*** (2.87)		575.57* (1.66)
Household Income	0.179*** (3.47)	0.167*** (3.20)		0.377*** (2.77)
Education services/ facilities	0.215*** (3.73)	0.199*** (3.38)		2951.81*** (3.04)
Health services	-0.223*** (4.23)	-0.222*** (4.14)	0.090*** (3.40)	-2636.48*** (2.97)
Health insurance	0.155*** (4.49)	0.141*** (3.46)		2038.67*** (3.07)
Marketing services		0.040 (0.95)	0.054*** (2.76)	-613.91 (0.87)
Road characteristics	0.162*** (4.83)	0.169*** (4.81)	0.104*** (5.26)	1925.35*** (3.33)
Banking services		0.127 (1.46)		2087.94 (1.44)
Housing: -Family owned house		0.1546 (1.15)		2962.95 (1.32)
Housing: - Bricks built (Ref: Interim)		-0.013 (0.10)		-591.10 (0.28)
Drinking water sources: (Ref: Tanker) -Piped in to dwelling	0.322*** (3.53)	0.272*** (2.67)		6612.94*** (4.08)
Drinking water sources: (Ref: Tanker) -Piped out dwelling	-0.354** (2.20)	-0.352** (2.16)		2058.71** (0.77)
Drinking water sources: (Ref: Tanker) -Well		0.0124 (0.13)	-0.619*** (5.79)	-2275.35 (0.75)
R-squared	0.3084	30.8	75.4	0.2369
Adjusted R-squared	0.2839	28.4	75.1	0.2097
F statistics	12.54	12.54	201.25	8.73
DW statistics	1.70	1.70	1.80	1.77
N	467	467	467	467

*Note: ***, ** and *, indicate significant at the 1, 5 and 10 % level respectively*

Note: (1) Reduced model (only significant variables), (2) Complete model (with log) (all variables), (3) Reduced model (with log) (only significant variables), (4) Complete model (all variables) (without log).

Table 10.b- Linear Regression Model Results of the determinants of per capita food consumption (with log) (measured in SDG)

	(1)	(2)
Explanatory variables	Coefficient (t-Statistic)	Coefficient (t-Statistic)
Constant	5.41*** (12.81)	5.23*** (12.02)
Sex of HH		0.158 (1.33)
Family production	0.019* (1.96)	0.037*** (3.05)
Livestock	0.044** (2.19)	0.040** (2.01)
Household Income	0.169*** (2.98)	0.149*** (2.61)
Education services facilities	0.259*** (4.09)	0.252*** (3.89)
Health services	-0.221*** (3.79)	-0.209*** (3.56)
Health insurance	0.123*** (3.16)	0.108** (2.42)
Marketing services		0.020 (0.43)
Road characteristics	0.179*** (4.80)	0.177*** (4.58)
Banking services		0.140 (1.45)
Housing: -Family owned house		0.121 (0.81)
Housing: - Bricks built (Ref: Interim)		0.122 (0.86)
Drinking water sources: (Ref: Tanker) -Piped in to dwelling	0.396*** (3.80)	0.341*** (3.05)
Drinking water sources: (Ref: Tanker) -Piped out dwelling	-0.352** (1.98)	-0.357** (2.00)
Drinking water sources: (Ref: Tanker) -Well		0.201 (0.99)
R-squared	0.282	0.3021
Adjusted R-squared	0.268	0.2788
F statistics	19.96	13.01
DW statistics	1.63	1.67
N	467	467

*Note: ***, ** and *, indicate significant at the 1, 5 and 10 % level respectively*
Note: (1) Reduced model (only significant variables), (2) complete model (all variables).

5.4.2. Single supply-demand analysis: the determinants of production and consumption of sorghum

In addition to the aggregate supply and demand analysis of the determinants of food production and consumption, it would be very useful to provide single supply and demand analysis of the determinants of production and consumption of sorghum, especially given the importance of sorghum for food security.

Our analysis of the determinants of sorghum production, defined by sorghum production (as the dependent variable after excluding price), assumes that the core explanatory variables include sex of household head (HH), the agricultural land, family labor, livestock, agricultural services, marketing services, road characteristics, banking services and irrigation systems (compared to traditional rain fed system), ground water, basin, flood, canals (gravity), mechanized rain fed and combined irrigation system (using more than one system irrigation system) (see Table 11).

We find that the family production of sorghum, household income and family size show significant positive effects on sorghum consumption (Table 12), and is consistent with our findings explained above related to food consumption.

Furthermore, our in-depth analysis of the determinants of sorghum consumption model (linear, log, full model, reduced model, before and after excluding some large observations of sorghum consumption and production) shows robust findings regarding the significant positive effects of the family production of sorghum on sorghum consumption. Table 12.a explains the results of the linear regression model of the determinants of sorghum consumption (without log and for the full sample without excluding some observations), it displays that the family production of sorghum shows significant positive effects on sorghum consumption and indicates that the parameter of the effects of family production of sorghum on sorghum consumption is robustly close to 0.35 even when we add explanatory variables. In addition, Table 12.b. presents the results of the linear regression model of the determinants of sorghum consumption (with log and for the full sample without excluding some observations), it implies that the family production of sorghum shows significant positive effects on sorghum consumption and indicates that the parameter of the effects of family production of sorghum on sorghum consumption is robustly close to 0.38 even when we add explanatory variables. Table 12.c. presents the results of the linear regression model of the determinants of sorghum consumption (without log and for the sample excluding some observations, mainly, large sorghum consumption and production equivalent to 7000 KG and more), it demonstrates that the family production of sorghum shows significant positive effects on sorghum consumption and indicates that the parameter of the effects of family production of sorghum on sorghum consumption is robustly close to 0.64, even when we add explanatory variables. Furthermore, Table 12.d. shows the results of the linear regression model of the determinants of sorghum consumption (with log and for the sample excluding some observations, mainly, the large sorghum consumption and production equivalent to 7000 KG and more), demonstrating that the family production of sorghum, showing shows significant positive effects on sorghum consumption and indicating that the parameter of the effects of family production of sorghum on sorghum consumption is robustly close to 0.38 even when we add explanatory variables. We find that it is important to show the difference for the linear model (0.35 for the full sample, 0.64 for the sample omitting the largest values), as it demonstrates that for small farmers their own consumption of sorghum is to a larger extent determined by their own production of sorghum. Therefore, the major policy implication from our findings is that enhancing production of sorghum would contribute to enhancing consumption of sorghum and hence, enhancing food security for small farmers.

Table 11 - Linear Regression Model Results of the determinants of sorghum Production (with log) (measured in KG)

	(1)	(2)
Explanatory variables	Coefficient (t-Statistic)	Coefficient (t-Statistic)
Constant	2.929*** (10.58)	2.617*** (5.31)
Aricultural land	0.558*** (5.00)	0.636*** (5.05)
Livestock	0.125** (2.12)	0.123** (2.08)
Sex of HH		0.072 (0.20)
Family labour		0.259 (1.05)
Agricultural services		-0.409 (1.23)
Marketing services	-0.631*** (5.10)	-0.642*** (4.94)
Road characteristics	-0.476*** (4.36)	-0.456*** (4.10)
Banking services		0.253 (0.86)
Irrigation systems: (Ref: Traditional rain fed) -Ground water	-1.437*** (2.53)	-1.707*** (2.89)
Irrigation systems: (Ref: Traditional rain fed) -Basin		-0.292 (0.36)
Irrigation systems: (Ref: Traditional rain fed) -Flood	2.036*** (4.57)	1.924*** (4.11)
Irrigation systems: (Ref: Traditional rain fed) -Canals (Gravity)		-0.559*** (1.35)
Irrigation systems: (Ref: Traditional rain fed) -Mechanized rain fed	2.719*** (6.58)	2.714*** (5.39)
Irrigation systems: (Ref: Traditional rain fed) -Combined(using more than one system)	3.242*** (5.42)	3.217*** (4.89)
R-squared	0.358	0.3680
Adjusted R-squared	0.347	0.3481
F statistics	31.86	18.71
DW statistics	1.72	1.75
N	466	465

*Note: ***, ** and *, indicate significant at the 1, 5 and 10 % level respectively*
Note: (1) Reduced model (only significant variables), (2) complete model (all variables).

Table 12.a. - Linear Regression Model Results of the determinants of Sorghum consumption (full sample without log without excluding observations) (measured in KG)

	(1)	(2)	(3)	(4)
Explanatory variables	Coefficient (t-Statistic)	Coefficient (t-Statistic)	Coefficient (t-Statistic)	Coefficient (t-Statistic)
Constant	492.867*** (5.554)	411.891*** (4.338)	263.722 (1.136)	772.375 (1.637)
Family production of sorghum	0.354*** (13.747)	0.352*** (13.737)	0.354*** (13.739)	0.373*** (13.260)
Livestock		90.517** (2.323)	89.401** (2.291)	87.533* (1.847)
Family size			22.078 (0.700)	6.336 (0.191)
Household income				0.003 (0.169)
Sex of HH				-44.309 (0.179)
Banking services				-164.095 (0.807)
Marketing services				123.409 (1.242)
Road characteristics				1.069 (0.013)
Health services				-21.823 (0.176)
Health insurance				13.140 (0.138)
Education services				-190.689 (1.406)
Housing: - Family owned house				-16.375 (0.052)
Housing: - Bricks built (Ref: Interim)				133.545 (0.447)
Drinking water sources: (Ref: Tanker) -Piped in to dwelling				-231.336 (1.024)
Drinking water sources: (Ref: Tanker) - Piped out dwelling				-372.824 (0.998)
Drinking water sources: (Ref: Tanker) -Well				-27.073 (0.063)
R-squared	0.289	0.297	0.298	0.310
Adjusted R-squared	0.287	0.294	0.293	0.285
F statistic	188.97	98.077	65.476	12.578
DW statistic	1.44	1.499	1.508	1.535
N	467	467	467	465

*Note: ***, ** and *, indicate significant at the 1, 5 and 10 % level respectively*

Table 12.b. - Linear Regression Model Results of the determinants of Sorghum consumption (full sample with log without excluding observations) (measured in KG)

	(1)	(2)	(3)	(4)	(5)
Explanatory variables	Coefficient (t-Statistic)	Coefficient (t-Statistic)	Coefficient (t-Statistic)	Coefficient (t-Statistic)	Coefficient (t-Statistic)
constant	3.744*** (26.725)	2.317*** (5.260)	2.278*** (5.182)	2.920*** (4.789)	0.445 (0.424)
Family production of sorghum	0.391*** (13.062)	0.392*** (13.216)	0.386*** (13.004)	0.343*** (11.100)	0.334*** (10.804)
Household income					0.372*** (2.885)
Family size		0.787*** (3.414)	0.775*** (3.372)	0.468** (2.090)	0.460** (2.072)
Livestock			0.082* (1.781)	0.077* (1.761)	0.052 (1.178)
Sex of HH				0.212 (0.785)	0.095 (0.352)
Banking services				-0.329 (1.506)	-0.335 (1.542)
Marketing services				-0.204* (1.892)	-0.219** (2.040)
Road characteristics				0.182** (2.070)	0.174** (1.995)
Health services				0.133 (1.001)	0.118 (0.885)
Health insurance				-0.74 (0.702)	-0.097 (0.934)
Education services				-0.044 (0.297)	-0.105 (0.713)
Housing: - Family owned house				0.395 (1.156)	0.348 (1.024)
Housing: - Bricks built (Ref: Interim)				-0.071 (0.216)	-0.079 (0.243)
Drinking water sources: (Ref: Tanker) -Piped in to dwelling				-1.662*** (6.821)	-1.733*** (7.135)
Drinking water sources: (Ref: Tanker) -Piped out dwelling				-0.656 (1.621)	-0.615 (1.531)
Drinking water sources: (Ref: Tanker) -Well				-0.133 (0.290)	-0.113 (0.249)
R-squared	0.268	0.286	0.291	0.402	0.413
Adjusted R-squared	0.267	0.283	0.287	0.382	0.392
F statistic	170.613	93.090	83.407	20.096	19.668
DW statistic	1.210	1.259	1.263	1.483	1.517
N	467	467	467	465	465

*Note: ***, ** and *, indicate significant at the 1, 5 and 10 % level respectively*

Table 12.c. - Linear Regression Model Results of the determinants of Sorghum consumption (full sample without log with excluding some observations of sorghum consumption 7000 KG and more) (measured in KG) 69

	(1)	(2)	(3)	(4)
Explanatory variables	Coefficient (t-Statistic)	Coefficient(t-Statistic)	Coefficient(t-Statistic)	Coefficient (t-Statistic)
Constant	244.181*** (8.941)	136.54** (2.029)	109.546* (1.691)	181.553 (1.438)
Family production of sorghum	0.644*** (25.049)	0.647*** (25.167)	0.612*** (24.161)	0.652*** (23.202)
Family size		15.827* (1.749)	13.015 (1.495)	7.388 (0.832)
Livestock			67.409*** (6.223)	67.974*** (5.319)
Household income				-0.002 (0.466)
Sex of HH				7.937 (0.120)
Banking services				-28.726 (0.513)
Marketing services				11.858 (0.447)
Road characteristics				65.083*** (3.026)
Health services				-37.006 (1.128)
Health insurance				10.130 (0.397)
Education services				-21.115 (0.584)
Housing: - Family owned house				2.410 (0.028)
Housing: - Bricks built (Ref: Interim)				-60.353 (0.753)
Drinking water sources: (Ref: Tanker) -Piped in to dwelling				-255.203*** (4.122)
Drinking water sources: (Ref: Tanker) - -Piped out dwelling				-137.574 (1.399)
Drinking water sources: (Ref: Tanker) -Well				141.947 (1.274)
R-squared	0.582	0.585	0.618	0.646
Adjusted R-squared	0.581	0.583	0.616	0.633
F statistic	627.454	316.692	241.773	49.404
DW statistic	1.615	1.633	1.674	1.818
N	452	452	452	450

*Note: ***, ** and *, indicate significant at the 1, 5 and 10 % level respectively*

Table 12.d. - Linear Regression Model Results of the determinants of Sorghum consumption (full sample with log with excluding some observations of sorghum consumption 7000 KG and more) (measured in KG)

	(1)	(2)	(3)	(4)	(5)
Explanatory variables	Coefficient (t-Statistic)	Coefficient (t-Statistic)	Coefficient (t-Statistic)	Coefficient (t-Statistic)	Coefficient (t-Statistic)
Constant	3.716*** (26.459)	2.206*** (4.920)	2.164*** (4.836)	2.681*** (4.400)	0.575 (0.547)
Family production of sorghum	0.384*** (12.217)	0.382*** (12.298)	0.375*** (12.029)	0.319*** (10.050)	0.313*** (9.895)
Family size		0.834*** (3.540)	0.823*** (3.505)	0.481** (2.142)	0.466** (2.086)
Livestock			0.090** (1. 961)	0.084** (1. 976)	0.062 (1.424)
Sex of HH				0.240 (0.800)	0.143 (0.533)
Household income					0.317** (2.446)
Banking services				-0.480** (2.126)	-0.481** (2.145)
Marketing services				-0.228** (2.122)	-0.240** (2.246)
Road characteristics				0.174** (2.013)	0.165* (1.918)
Health services				0.140 (1.065)	0.132 (1.008)
Health insurance				-0.71 (0.697)	-0.093 (0.909)
Education services				0.009 (0.062)	-0.041 (0. 279)
Housing: - Family owned house				0.563 (1.643)	0.524 (1.537)
Housing: - Bricks built (Ref: Interim)				-0.084 (0.262)	-0.085 (0.266)
Drinking water sources: (Ref: Tanker) -Piped in to dwelling				-1.747*** (7.149)	-1.815*** (7.422)
Drinking water sources: (Ref: Tanker) -Piped out dwelling				-0.593 (1.497)	-0.564 (1.433)
Drinking water sources: (Ref: Tanker) -Well				-0.088 (0.196)	-0.082 (0.183)
R-squared	0.249	0.269	0.276	0.406	0.414
Adjusted R-squared	0.247	0.266	0.271	0.385	0.392
F statistic	49.265 (0.00)	82.813	56.840	19.756	19.108
DW statistic	1.159	1.199	1.197	1.483	1.520
N	452	452	452	450	450

*Note: ***, ** and *, indicate significant at the 1, 5 and 10 % level respectively*

5. 5. Measurement of food security (Household Food Insecurity Access Scale (HFIAS)) in Kassala State

Our findings discuss the measurement of Household Food Insecurity Access Scale (HFIAS) in Kassala State in 2019 and verify food insecurity as indicated by the prevalence of households that follow these indicators: do not eat a variety of food (69%), are unable to eat preferred food (68.5%), eat food really don't eat if they are food secure (66.3%), eat smaller amounts in meal (62.1%), eat fewer meals in a day (59.5%), worry about not having enough food (58.8%), have no food of any kind in household (52.2%), while some households go to sleep hungry at night (40.4%) and go a whole day and night without food (32.1%) (see Table 13).

Table 13 – The incidence of Household Food Insecurity Access Scale (HFIAS) conditions in Kassala State (2019) (%)

Indicators	No		Yes	
	N	%	N	%
Worry about not having enough food	194	41.2	282	58.8
Unable to eat preferred food	144	31.5	327	68.5
Eat just a few kind of food	143	31	332	69
Eat food really don't eat	155	33.7	312	66.3
Eat smaller amounts in meal	177	37.9	291	62.1
Eat fewer meals in a day	188	40.5	278	59.5
No food of any kind in household	229	47.8	243	52.2
Go to sleep hungry at night	284	59.6	189	40.4
Go a whole day and night without food	326	67.9	153	32.1

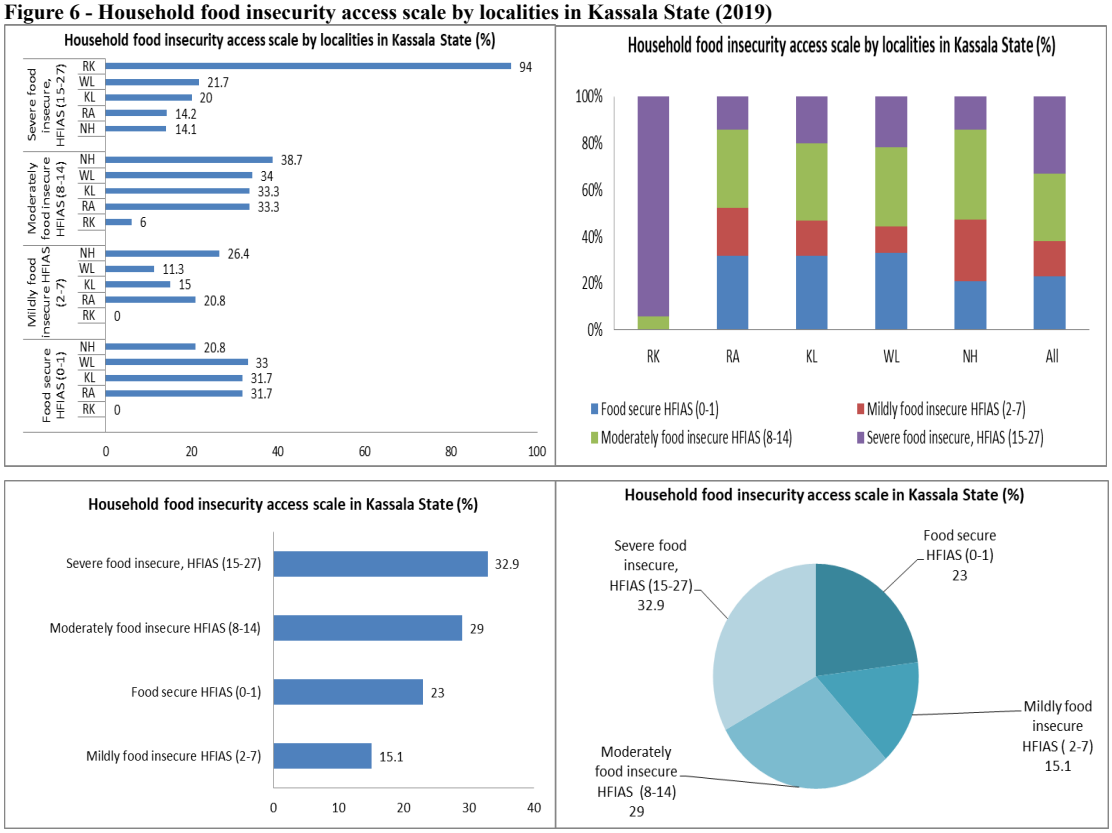
Source: Authors' calculations based on Food Security Household Survey in Kassala State (2019)

We find that more than three quarters of household are food insecure (77%), and that 32.9% of households are severely food insecure (see Table 14, Figure 6).[41] There are serious discrepancies in households' food insecurity access scale by localities in Kassala State. For instance, HFIAS implies that food insecurity is a very serious problem in RK, since all households in RK suffer from either severe or moderate food insecurity. In contrast to RK, less than half of households suffer from either severe or moderate food insecurity in RA (47.5%), and nearly half of the households suffer from either severe or moderate food insecurity in NH (52.8%), KL (53.3%) and WL (55.7%) (see Table 14, Figure 6). Our findings also indicate that the incidence of food security is higher in WL (33%), followed by RA (31.7%), KL (31.7%) and NH (20.8%). These results are not surprising and can be explained in relation to earlier results concerning the discrepancies in the distribution of monthly income in localities showing that the majority of households have low income level in RK (52%), RA (65%) and NH (77.6%). Our results concerning the disparities in monthly income, mainly the low income in RK and/ or RA localities is not surprising in view of limitations imposed on sources of income generated through trade borders in RK and/ or RA localities (see for instance, Eltayeb and Abdelatti, 2015). Our results regarding low income in the NH locality is somewhat surprising in view of the rich environment suitable for rich agricultural production. Our results can be explained in relation to demographic pressures and increasing family size that put pressure on the limited natural resources (including agricultural land and irrigation sources). In addition, as indicated for

[41] We use the measurement of household food insecurity access scale defined in four groups: food secure HFIAS (0-1), mildly food insecure HFIAS (2-7), moderately food insecure HFIAS (8-14) and severe food insecure, HFIAS (15-27) respectively.

more than 90% of the respondents in NH locality, the reported monthly income is three thousand pounds or less. This may be because approximately 30% of the population are low income employees and technicians and more than 30% are working as farmers in irrigated sector with limited area where the proportion of family members to the land area decreases over time. Our results thus demonstrate the importance of improving households' income level to eliminate food insecurity in Kassala State.

Figure 6 - Household food insecurity access scale by localities in Kassala State (2019)



Source: Authors' calculations based on Food Security Household Survey in Kassala State (2019)

Table 14 - Household food insecurity access scale (HFIAS) by localities in Kassala State (2019)

Locality	RK%	RA%	KL%	WL%	NH%	All%
Food secure HFIAS (0-1)	0	31.7	31.7	33	20.8	23
Mildly food insecure HFIAS (2-7)	0	20.8	15	11.3	26.4	15.1
Moderately food insecure HFIAS (8-14)	6	33.3	33.3	34	38.7	29
Severe food insecure, HFIAS (15-27)	94	14.2	20	21.7	14.1	32.9
Total	100	100	100	100	100	100
Severe, and Moderately Food insecurity HFIAS (8-27)	100	47.5	53.3	55.7	52.8	61.9
Severe, Moderately and Mildly Food insecurity HFIAS (2-27)	100	68.3	68.3	67	79.2	77

Source: Authors' calculations based on Food Security Household Survey in Kassala State (2019)

5.6. The determinants of Household Food Insecurity Score Index (HFIAS)

We examine the relationship between the household food insecurity score index, the size of agricultural land, household income and the size of household family. To examine the determinants of HFIAS, we use both ordered logit and probit regression (see Tables 15 and 16).[42] We find that male headed households are likely to decrease the probability of reporting food insecurity (from severe, moderately, mildly to food secure) by 0.631 points, when holding other variables constant. We observe that family production of food is in favor of improving food security, because an increase in family production by one unit will decrease the probability of food insecurity by 0.136 points. We find that the status of food security is likely to improve with the probability of male headed household; decrease of dependency ratio; increase of family production; increase of owned agricultural land; more livestock and availability of good marketing services and road characteristics.

Therefore, we support part of our third hypothesis that the household food insecurity score index is affected by the size of agricultural land, family production of food, and other household and village characteristics. A major policy implication from our results is the importance of improvement of ownership of agricultural land and enhancing family production of food to satisfy households consumption of food, to eliminate food insecurity and therefore, to achieve food security in Kassala and in Sudan.

Table 15 – The ordered logistic regression results: The determinants of of Household Food Insecurity Access Scale (HFIAS)

Explanatory variables	**Coefficient**	**Z-Statistic**	**Prob**	**95% conf**	**Interval**
Sex of HH	-0.631**	2.01	0.044	-1.246	-0.0163
Dependency ratio	1.297***	2.90	0.004	0.419	2.176
Family production	-0.247***	3.07	0.002	-0.405	-0.0894
Agricultural land	-0.218**	2.46	0.044	-0.392	-0.044
Family labor	0.110*	1.82	0.069	0.008	0.2297
Livestock	-0.088**	2.23	0.026	-0.166	-0.010
Marketing services	-0.443***	4.29	0.000	-0.645	-0.2410
Road characteristics	-0.50***	5.16	0.000	-0.696	-0.3131
Water services: (Ref: Tanker) - Well	-1.89 ***	3.90	0.000	-2.845	0.9399
/cut1	-5.209			-6.947	-3.471
/cut2	-4.406			-6.120	-2.693
/cut3	-2.919			-4.60	-1.232
N	348				

*Note: ***, ** and *, indicate significant at the 1, 5 and 10 % level respectively*

#Ordered Logistic Model fitting criteria:

log likelihood	-405.323
LRchi2(9)	126.38
Prob>chi2	0.000
Pseudo R square:	0.134

[42] The ordered Logit and Probit model in its contemporary regression based form was proposed by Mc Elvey and Zavoina (1969,1971,1975) for the analysis of ordered , categorical, non-quantitative choices, outcomes and responses, the mode is used to describe the data generating process for a random outcome that takes one of a set of discrete, ordered outcomes (William H.Greene and D, A. Hensher, 2009).

Table 16 – The ordered probit regression results: The determinants of Household Food Insecurity Access Scale (HFIAS)

Explanatory variables	Coefficient	Z-Statistic	Prob	95% conf	Interval
Sex of HH	-0.631**	2.01	0.044	-1.246	-0.0163
Dependency ratio	0.708***	2.72	0.006	0.198	1.217
Family production	-0.136***	3.10	0.002	-0.223	-0.050
Agricultural land	-0.138***	2.65	0.008	-0.241	-0.036
Family labor	0.069*	1.93	0.054	0.0012	0.140
Livestock	-0.055***	2.60	0.009	-0.096	-0.013
Marketing services	-0.243***	4.13	0.000	-0.359	-0.128
Road characteristics	-0.287***	5.04	0.000	-0.399	-0.175
Water services: (Ref: Tanker) - Well	-1.083 ***	3.73	0.000	-1.652	0.514
/cut1	-2.956			-3.9003	-2.124
/cut2	-2.480			-3.4135	-1.5476
/cut3	-1.601			-2.5269	-0.6759
N	348				

*Note: ***, ** and *, indicate significant at the 1, 5 and 10 % level respectively*

#Ordered Probit Model fitting criteria:

log likelihood	-406.2046
LRchi2(9)	124.61
Prob>chi2	0.000
Pseudo R square:	0.133

5. 7. Adaptation and survival strategy

We find that more than half of households (57.5% and 55%) are worried about not having enough food over the past 7 days and in the past month respectively and that the adaptation and survival strategy and the numerous actions adopted by households to face expected decrease of food are quite consistent in the past seven days and in the past month. The household strategies include, for instance, reliance on less preferred and or less expensive food, limited portion size at meal, reduction of meals eaten in a day, restricted consumption by adults for small children to eat and borrow food or rely on help from friend or relatives.

Figure 7 – Household adaptation and survival strategy

Source: Authors' calculations based on Food Security Household Survey in Kassala State (2019)

Table 17 – Household adaptation and survival strategy

1. Actions adopted by households to face expected decrease of food in the past seven days								
Actions	Zero days		1-2 days		3-4 days		5-7 days	
	N	%	N	%	N	%	N	%
Rely on less preferred and or less expensive food	89	25.6	95	27.3	98	28.2	66	18.9
Limit portion size at meal times	158	46.9	109	31.8	54	16	18	5.3
Reduce meals eaten in a day	154	45.7	114	33.8	51	15.2	18	5.3
Restrict consumption by adults for small children to eat	205	65.5	60	19.1	28	8.9	20	6.5
Borrow food or rely on help from friend or relatives	184	61.5	73	24.4	30	10.1	12	4
2. Actions adopted by households to face expected decrease of food in the past month								
Actions	Zero days		1-7 days		8-15 days		More than 15 days	
	N	%	N	%	N	%	N	%
Rely on less preferred and or less expensive food	84	25.3	123	37	87	26.3	38	11.4
Limit portion size at meal times	129	39.6	116	35.6	65	19.9	16	4.9
Reduce meals eaten in a day	125	38	101	30.7	83	25.2	20	6.1
Restrict consumption by adults for small children to eat	172	54.4	86	27.3	43	13.6	15	4.7
Borrow food or rely on help from friend or relatives	143	47.1	97	32.1	56	18.5	7	2.3

Source: Authors' calculations based on Food Security Household Survey in Kassala State (2019)

6. Conclusions and policy recommendations

This paper has discussed the relationship between agricultural development and food security, the determinants of production of food and consumption of food and the determinants of food security and agricultural development in Eastern Sudan, with particular reference to Kassala State.

We find that poor housing quality and environment appears from several indicators, including the poor access to safe sources of drinking water through piped water into dwelling that is available for just a few households (33.5%), and the limited use of toilet inside the house that is available for only 18.7% of households. The poor housing quality and environment is not surprising given that the majority of households have very low or low standard of living, as defined by very low or low income levels. Inadequacies in and availability of services and infrastructure in the villages, mainly, lack of availability of banking services, Internet services, market, primary health insurance facilities, sanitation facilities, telecommunication network services, electricity, health care facilities, clean water, and education facilities and other services are also prominent factors. This implies that the prevailing housing status, quality, and environment, services and infrastructure are not appropriate for supporting the food security for houshold families in Kassala State.

We find that, despite the wide recognition of the important role of agricultural production of food and cash crops, the agricultural production is still impeded by several serious problems that support our hypothesis explained in section one. The main impeding factors are the lack of agricultural land ownership, the small size of cultivated land, few crops cultivated in agricultural land, few types of irrigation, shortages of agricultural services that available only for few households (21.5%), particularly, the shortage of agricultural services related to technology that are available only for few households (16.4%).

We find that the weaknesses of agricultural production imply inadequate income from farm activities that motivated the households to join nonfarm activities to generate more income. For instance, the most important reasons for joining nonfarm activities include insufficient income/return from household farm, increasing family size, declining soil fertility, shocks arising from rain failure, limited land area, epidemic, flood and others, volatility and seasonal nature of farm activities, crafts and manufacturing skills and rising demand for nonfarm products. This low income has affected the pattern of households' food and nonfood consumption. For instance, we observe that the consumption of food items does not reflect significant variation in food typically consumed by households and also implies poor diet quality and poor dietary diversity as the majority of consumption come from five items: Sorghum (54.37%), Products (12.50%), Millet (12.43%), Sesame (11.24%) and Bread (10.24%), while minor food consumption includes Legumes, Fruit, Wheat, Purchased meal, Chicken, Fish, Eggs and Groundnut respectively. The high share of Sorghum in total food consumption (54.37%) is not surprising as Sorghum has a high share of total agricultural production (41.5%). The poor variety of agricultural crops also implies poor agricultural food production capacity that meets just some of the households consumption and demand for various food needs that most probably impeded households dietary diversity in Kassala State.

The Measurement of Household Food Insecurity Access Scale (HFIAS) in Kassala State verifies the incidence of food insecurity that appears from the fact that the majority of households eat just a few kinds of food (69%), are unable to eat preferred food (68.5%), eat food they don't eat if they are food secure (66.3%), eat smaller amounts for a meal (62.1%), eat fewer meals in a day (59.5%), worry about not having enough food (58.8%), no food of any kind in household (52.2%), while some households go to sleep hungry at night (40.4%) and go a whole day and night without food (32.1%).

Our results discuss the measurement of household food insecurity access scale and indicate that few, less than a quarter of households, are food secure (23%) in Kassala State. We find that more than three quarters of household are food insecure (77%), in particular, the majority of households are severely food insecure (32.9%). We observe serious discrepancies concerning households' food insecurity access scale by localities in Kassala State. Food insecurity is a very serious problem in RK since all households in RK suffer from either severe or moderately food insecurity (100%). In RA, however, less than half of households suffer from either severe or moderate food insecurity (47.5%), and nearly half of households suffer from either severe or moderate food insecurity in NH (52.8%), in KL (53.3%) and in WL (55.7%). These results are not surprising and can be explained in relation to earlier results concerning the discrepancies in the distribution of monthly income in localities showing that the majority of households have low income level in RK (52%), RA (65%) and NH (77.6%), while the majority of households have middle to high income level in KL (66%) and WL (75%). The major policy implications from our results suggest the importance of improving households' income level to eliminate food insecurity in Kassala State.

Along with the high incidence of food insecurity, the incidence of poor child nutrition in Kassala State, as indicated by the nutritional indicators of child (under five years), showed that there is a high prevalence of underweight, stunting and wasting for children in Kassala State and it is nearly twice the average of the national standard for males and females in rural Sudan. Our results are consistent with recent results in the Sudanese literature (see Nour and Ebaidalla, 2020) and with the results in the international literature that imply that the various measures of household food security appear to carry significant signals about the nutritional status of children that reside within the household (see Tiwari, et al., 2013).

We use statistical analysis, mainly OLS estimation, to estimate the determinants of supply of food defined by production of food and demand for food defined by consumption of food. Our results from the regression analysis verify part of our first hypothesis that implies that the size of agricultural land, livestock and irrigation system show significant positive effects on production of food, while, family labor, agricultural services, marketing services and banking services show insignificant positive effects on production of food.

Our findings from the regression analysis corroborate part of our second hypothesis that indicates that household income, livestock, sex of household head, education services/ facilities, health insurance, characteristics of road between village and near market and drinking water sources (getting water through pipes into dwelling) show significant positive effects on consumption of food, while, family own production of food, marketing services, banking services, housing (family owned house), and drinking water sources (getting water from wells) show insignificant positive effects on consumption of food. We find that the own family production of food and household income show significant positive effects on per capita food consumption, in addition, other variables (road characteristics between the village and the closest market (as an indicator for infrastructure development), education services/ facilities, livestock, health insurance, and drinking water sources (through pipes into dwelling) show significant positive effects on per capita food consumption.

We find that the agricultural land and livestock show positive significant effects on household sorghum production, whereas, the sex of household head, family labor and banking services show insignificant positive effect on household sorghum production. Regarding household sorghum consumption, we find that family production of sorghum, household income and family size show

significant positive effects, while livestock, sex of household head, health services and housing (family owned house) show insignificant positive effects. We find that it is important to show the difference for the linear model (0.35 for the full sample, 0.64 for the sample omitting the largest values), as it demonstrates that for small farmers their own consumption of sorghum is to a larger extent determined by their own production of sorghum. Thus, we find that the production of sorghum would contribute to enhancing consumption of sorghum and hence, enhancing food security for small farmers. This constitutes a major policy implication.

To examine the determinants of HFIAS, we use both ordered logit and probit regression. We find that using both ordered logit and probit regression shows that the male headed households are likely to decrease the probability of reporting food insecurity (from severe, moderately, mildly to food secure) by 0.631 points, when holding other variables constant. We observe that family production of food is in favor of improving food security, because an increase in family production by one unit will decrease the probability of food insecurity by 0.136 points. We find that the status of food security is likely to improve from severe food insecure to moderately to mildly to food secure with probability of male headed household; decrease of dependency ratio; increase of family production; increase of agricultural land; more livestock and availability of good marketing services and road characteristics.

Therefore, we support part of our third hypothesis that the household food insecurity score index is affected by the size of agricultural land, family production of food, and other household and village characteristics. Therefore, a major policy implication from our results is the importance of improvement of ownership of agricultural land and enhancing family production of food to satisfy households consumption of food, to eliminate food insecurity and therefore, to achieve food security in Kassala. We recommend enhancing family own production, enhancing agricultural land ownership, increasing the size of cultivated land, diversification of agricultural food crops, improvement of irrigation systems, enhancing female participation in agricultural activities and food security, improvement of agricultural services, mainly, agricultural services related to technology, creation of appropriate housing status, quality, environment, services and infrastructure to supprt food security in Kassala State.

7. Direction for Future Research:

We plan to extend the major findings from this study for future empirical research aimed at improving the understanding of the interaction between agricultural development and food security in other developing countries with similar circumstances. It is hoped that our research results can be generalized to be of relevance and value to other developing countries. We hope to generate some useful insights for international comparison across developing countries and contribute to enhance agricultural development and food security and SDGs. The results could motivate our future research to extend our analysis for the case of Kassala State to conduct a more comprehensive comparative study for enhancing agricultural development and food security in Eastern Sudan (including El-Gedarif and Red Sea states).

Appendix 1: Questionnaire: Food security in Kassala State Household Questionnaire (2019) (English Version)

Food security in Kassala State - Household Questionnaire (2019)

Code (file No.): ……... (For coding only: please do not write in this item)

1. Background information about household family:

1-7 Please provide the following background information

1. Name of household head (optional): ……..……

2. Ethnicity of household: ……..……..……

3. Locality:……..…….

4. Village: ……. ……..

5. The total number of family members: ……. ……

6. Number of adult family members (15 years+): ……..…….....

7.a. Number of children (5-14 years): ……..…….....

7.b. Number of children (0-4 years): ……..……....

2. Family size and characterstics of household members:

8.-18. Please provide listing of household members and identify their respective characterstics

		8	9	10	11	12	13	14	15	16	17	18
ID	Name	Relation with HH head	Sex	Age (years)	Marital status	Education	Length of children (6 months to 5 years)	Weight of children	Main job during last 12 months	Secondary job during last 12 months	Daily wage	Income per month
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												

Notes:
1. Relation with the head of household: (1) Head; (2) Wife/husband; (3) Son/daughter; (4) Brother/sister; (5) Father/mother; (6) Grandchildren; (7) Other relative; (8) Employee living with family; (9) Other (please specify).
2. Sex: (1) Male; (2) Female.
3. Marital status: (1) Married; (2) Single; (3) Divorced; (4) Widowed; (5) Under the age of marriage.
4. Education: (1) Illiterate); (2) Read and write; (3) Khalwa; (4) Primary; (5) Intermediate; (6) Secondary; (7) Above secondary and below university; (8) University education and above.

3. Housing status, quality and environment,infrastructure and services

19. Please indicate the type of housing tenure. (Please tick one box)

Type of housing tenure	
1. Owned by the family	1
2. Tenant	2
3. Offered by employer	3
4. Offered by others for free	4
5. Other/ please specify …….……	5

20. If the house is owned by the family, please indicate the way through which the ownership is acquired. (Please tick one box)

Type of ownership	
1. Ownership acquired through purchasing of house	1
2. Ownership acquired through grant	2
3. Ownership acquired through building of a new house at own family expenses	3
4. Ownership acquired through inheritance	4
5. Other/ please specify …….……	5

21. Please indicate the type of building materials used in building your house and the type of house facilities available in your house. Please tick the relevant answer(s) in respective columns. (Multiple Answers Possible [MAP])

Type of building materials	
1. Concrete	1
2. Bricks	2
3. Interim materials	3
4. Clay/ mud	4
5. Clean water	5
6. Electricity	6
7. Sanitation facilities	7
8. Other/ please specify …….……	8

22. Please indicate the main source of drinking water available in your house. (Please tick one box)

Main source of drinking water	
1. Piped water in to dwelling	1
2. Piped water out of the dwelling	2
3. Well	3
4. Pond	4
5. Stream /river	5
6. Tanker truck	6
7. Other/ please specify …….……	7

23. Please indicate the number of floors and the number of rooms in your house. (Please tick one box)

23. a. The number of floors in your house			
1. One	2. Two	3. Three	4. More than three
1	2	3	4
23.b. The number of rooms in your house			
1. One	2. Two	3. Three	4. More than three
1	2	3	4

24. Please indicate the type of Toilet used in your house. (Please tick one box)

Type of Toilet	
1. Toilet inside the house	1
2. Pit latrine with slab	2
3. Pit latrine without slab	3
4. Other/ please specify …….……	4

25. Please indicate the characteristics of the road linking your village with the nearest market. (Please tick one box)

Characteristics of the road	
1. Asphalt	1
2. Roadbed gravel	2
3. Dirt road	3
4. Wretched dirt road	4

26. Please indicate the availability of the following facilities/services in your village? Please tick the relevant answer(s) in respective columns. (Multiple Answers Possible [MAP])

	Yes	No
	1	2
1. Primary health clinic		
2. Primary health insurance facilities		
3. Primary school		
4. Internet services		
5. Telecommunication network/services		
6. Banking services		
7. Market		
8. Other/ please specify ……..…		

27. If the above facilities/ services are available, how do you rate your satisfaction regarding adequacy of regular and sustainable access to the following facilities/ services in your village? Please tick the relevant answer(s) in respective columns. (Multiple Answers Possible [MAP])

	Adequate and sustainable	Adequate but not sustainable	Inadequate and not sustainable	Not available
	1	2	3	4
1. Health care facilities/ services				
2. Health insurance facilities/ services				
3. Education facilities/ services				
4. Clean water				
5. Electricity				
6. Internet services				
7. Telecommunication network/ services				
8. Banking services				
9. Sanitation facilities				
10. Market				
11. Other/ please specify……				

4. Agricultural production, household income and expenditure

28. Please explain if the household cultivate land. (Please tick one box)

Yes	No
1	2 (Skip to Q30)

29. If yes, please explain the tenancy status.

	Land in feddan
1. Owned and cultivated by household	
2. Rented in and cultivated by household	
3. Owned by others, cultivated for free	
4. Communal or public land	

30. Please explain if the household has land that he/she do not cultivate. (Please tick one box)

Yes	No
1	2 (Skip to Q32)

31. If yes, please explain the quantity for each of the following items.

	Land in feddan
1. Owned, not for cultivation (e.g. houseplot)	
2. Rented in not for cultivation	
3. Owned, rented out for cultivation by others	
4. Owned, rented out for other purposes	

32. Please explain the quantity of land area cultivated by the follwing agricultural products

land area used for cultivation different products:	Land in feddan
1. Land area cultivated by sorghum	
2. Land area cultivated by millet	
3. Land area cultivated by wheat	
4. Land area cultivated by legumes	
5. Land area cultivated by vegetables	
6. Land area cultivated by fruit	
7. Land area cultivated by other crops	

33. Please explain the cultivated land in feddan by type of irrigation

Type of irrigation	Land in feddan
1. Ground water	
2. Basin irrigation	
3. Flood	
4. Canals	
5. Rain fed	

6. Mechanized rain-fed	
7. Other/ please specify ……...	

34. If the household produce or cultivate both food and cash crops how important are the following conditions related to the production or cultivation of both food and cash crops? Please tick the relevant answer(s) in respective columns. (Multiple Answers Possible [MAP])

	Importance			Not relevant
	Extremely	Moderately	Slightly	
	3	2	1	0
The production or cultivation of food lead to:				
1. Self-satisfaction: production of enough food for family consumption				
2. Better quality of food for family consumption				
The production or cultivation of cash crops lead to:				
1. Increase in income				
2. Increase in income and increase in food consumption				
3. Increase in income and improve quality of food consumption				
4. Substitution of production of food				
5. Others/ please specify …….				

35. How many adult animals of the following categories do you or other members of your family currently own? Please indicate the number?

Quantity (number)	1. Cattle	2. Sheep and goats	3. Camels	4. Other (write e.g. poultry)

36. Did you or other members of your family receive agricultural services from the government and other institutions during the last two years? (Please tick one box)

Yes	No
1	2 (Skip to Q38)

37 If yes, what are the agricultural services you or other members of your family received from the government and other institutions during the last two years? Please tick the relevant answer(s) in respective columns. (Multiple Answers Possible [MAP])

Agricultural services	
1. Extension	1
2. Finance	2
3. Technology	3
4. All complementary package	4
5. Fertilizers	5
6. Seeds/plants	6
7. Other services/ please specify……	7

38. – 42. Please explain the household farm production, sales, and purchases, (consumption and expenditure on purchased food) during the last year

Product	Production		Sales		Purchases	
38. Crops:	Quantity	value	Quantity	value	Quantity	value
	(kg)	(SDG)	(kg)	(SDG)	(kg)	(SDG)
1. Sorghum						
2. Millet						
3. Wheat						
4. Sesame						
5. Peanuts						
6. Cotton						
7. Fruit						
8. Legumes						
39. Livestock						
1. Livestock						
2. Livestock products						
40. Poultry & fish:						
1. Fish						
2. Chicken						
3. Eggs						
41. Forestry products:						
1. Fuel wood						
2. Building wood						
3. Charcoal						
42. Other food purchases						
1. Bread						
2. Purchased meals						

43. - 52. Please explain the household non-farm income (during the last year, month)

	Source	Yes	No	Income (SDG)	
				Last month	Last year
43.	Laborer on a daily basis				
44.	Salaried work in public sector				
45.	Salaried work in private sector				
46.	External Remittance				
47.	Internal remittance				
48.	Gift				
49.	Rent of real estates &land				
50.	Trade-surplus				
51.	Transport and travel services				
52.	Surplus from self-employment: Handcrafts, Carpentry, Building& Construction, Gold mining				
	Total				

53. Please explain the reason(s) for joining non-farm activities. Please tick the relevant answer(s) in respective columns. (Multiple Answers Possible [MAP])

Main reason(s) for joining non-farm activities	
1. Insufficient income/ return from household farm	1
2. Increasing of family size	2
3. Limited land area	3
4. Declining of soil fertility and productivity	4
5. Availability of fund opportunities	5
6. Availability of infrastructure, roads , electricity and market	6
7. Shocks arising from rain failure, epidemics, flood and others	7
8. Volatility and seasonal nature of farm activities	8
9. Craft and manufacturing skills	9
10. Rising demand for non –farm products	10
11. Other/ please specify ……..……	11

54 – 61. Please explain the non food expenditure during the last month

No	Items	Quantity	Unit price	Expenditure in SDG
54.	Non durable household goods:			
	1. Soap and cleaning			
	2. Other non durable goods			
55.	The housing:			
	1. Electricity			
	2. Water			
	3. Rent			
	4. Real estate tax & services			
56.	The fuel: (Wood, charcoal & gas)			
57.	Transport & traveling:			
58.	Clothing & shoes:			
59.	Education service			
60.	Health and medical treatment			
61.	Others			

5. Adaptation and survival strategy:

62. Please explain if the household income changed in the past 6 months. (Please tick one box)

Increase	Decrease	No change
1	2	3

63. Please explain if the household spending changed in the past 6 months. (Please tick one box)

Increase	Decrease	No change
1	2	3 (Skip to Q 65)

64. If the household spending has changed, which of the following item(s) has changed due to change in household spending? Please tick the relevant answer(s) in respective columns. (Multiple Answers Possible [MAP])

Items	
1. Food	1
2. Clothing	2
3. Education	3
4. Miscellaneous housing needs	4
5. Health	5
6. Travel and leisure	6
7. Transport	7
8. Utility bills	8
9. Other/ please specify …….……	9

65. If the household spending on food has decreased, which of the following item(s) has changed due to change in household spending on food?. Please tick the relevant answer(s) in respective columns. (Multiple Answers Possible [MAP])

1. Quality of food consumed	1
2. The amount of sorghum consumed	2
3. The amount of millet consumed	3
4. The amount of wheat consumed	4
5. The amount of legumes consumed	5
6. The amount of meat consumed	6
7. The amount of fruit consumed	7
8. The amount of milk consumed	8
9. Other/ please specify …….……	9

66. Please explain if the household purchased food by borrowing. (Please tick one box)

Yes	No
1	2 (Skip to Q68)

67. If yes, please specify the ratio of food purchased by borrowing to the total food consumed? …….. ……..

68. Please explain if the household used any of the following options to ensure financial capability? Please tick the relevant answer(s) in respective columns. (Multiple Answers Possible [MAP])

1. Non – payment of utility bills	1
2. Sell / mortgage of jewellery, furniture, or livestock	2
3. Sell / mortgage of productive assets	3
4. Use of savings	4
5. Borrowing	5
6. Reduce daily expenditures	6
7. Reducing spending on education and health	7
8. Changing the place of residence	8

69. In the past 7 days, did you worry that your household would not have enough food? (Please tick one box)

Yes	No
1	2

70. In the past 7 days, how many days have you or someone in your household had to (……) (IF NO DAYS, RECORD ZERO):

	Days
1. Rely on less preferred and/or less expensive foods	
2. Limit portion size at mealtimes?	
3. Reduce number of meals eaten in a day?	
4. Restrict consumption by adults in order for small children to eat?	
5. Borrow food, or rely on help from a friend or relative?	

71. In the past [4 weeks/ 30 days], did you worry that your household would not have enough food? (Please tick one box)

Yes	No
1	2

72. In the past [4 weeks/ 30 days], how many days have you or someone in your household had to (……) (IF NO DAYS, RECORD ZERO):

	Days
1. Rely on less preferred and/or less expensive foods	
2. Limit portion size at mealtimes?	
3. Reduce number of meals eaten in a day?	
4. Restrict consumption by adults in order for small children to eat?	
5. Borrow food, or rely on help from a friend or relative?	

6. Measurement of food security (Household Food Insecurity Access Scale (HFIAS)) in Kassala State

73.a. In the past [4 weeks/30 days] did you worry that your household would not have enough food? (Please tick one box)

No	Yes
0 (Skip to Q74)	1

73.b. How often did this happen in the past [4 weeks/30 days]? (Please tick one box)

Never	Rarely (1-2 times)	Sometimes (3-10 times)	Often (more than 10 times)
0	1	2	3

74.a. In the past [4 weeks/30 days] were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources? (Please tick one box)

No	Yes
0 (Skip to Q75)	1

74.b. How often did this happen in the past [4 weeks/30 days]? (Please tick one box)

Never	Rarely (1-2 times)	Sometimes (3-10 times)	Often (more than 10 times)
0	1	2	3

75.a. In the past [4 weeks/30 days] did you or any household member have to eat a limited variety of foods due to a lack of resources? (Please tick one box)

No	Yes
0 (Skip to Q76)	1

75.b. How often did this happen in the past [4 weeks/30 days]? (Please tick one box)

Never	Rarely (1-2 times)	Sometimes (3-10 times)	Often (more than 10 times)
0	1	2	3

76. a. In the past [4 weeks/30 days] did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food? (Please tick one box)

No	Yes
0 (Skip to 77)	1

76.b. How often did this happen in the past [4 weeks/30 days]? (Please tick one box)

Never	Rarely (1-2 times)	Sometimes (3-10 times)	Often (more than 10 times)
0	1	2	3

77.a. In the past [4 weeks/30 days] did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food? (Please tick one box)

No	Yes
0 (Skip to Q78)	1

77.b. How often did this happen in the past [4 weeks/30 days]? (Please tick one box)

Never	Rarely (1-2 times)	Sometimes (3-10 times)	Often (more than 10 times)
0	1	2	3

78.a. In the past [4 weeks/30 days] did you or any other household member have to eat fewer meals in a day because there was not enough food? (Please tick one box)

No	Yes
0 (Skip to Q79)	1

78.b. How often did this happen in the past [4 weeks/30 days]? (Please tick one box)

Never	Rarely (1-2 times)	Sometimes (3-10 times)	Often (more than 10 times)
0	1	2	3

79.a. In the past [4 weeks/30 days] was there ever no food to eat of any kind in your household because of lack of resources to get food? (Please tick one box)

No	Yes
0 (Skip to Q80)	1

79.b. How often did this happen in the past [4 weeks/30 days]? (Please tick one box)

Never	Rarely (1-2 times)	Sometimes (3-10 times)	Often (more than 10 times)
0	1	2	3

80. a. In the past [4 weeks/ 30 days] did you or any household member go to sleep at night hungry because there was not enough food? (Please tick one box)

No	Yes
0 (Skip to Q81)	1

80.b. How often did this happen in the past [4 weeks/30 days]? (Please tick one box)

Never	Rarely (1-2 times)	Sometimes (3-10 times)	Often (more than 10 times)
0	1	2	3

81.a. In the past [4 weeks/30days] did you or any household member go a whole day and night without eating anything because there was not enough food? (Please tick one box)

No	Yes
0 (Skip to Q82)	1

81.b. How often did this happen in the past [4 weeks/30 days]? (Please tick one box)

Never	Rarely (1-2 times)	Sometimes (3-10 times)	Often (more than 10 times)
0	1	2	3

82. How important is the role of female for enhancing availability, access, utilization and sustainability of access to food for household family? Please tick the relevant answer(s) in respective columns. (Multiple Answers Possible [MAP])

	Importance			Not relevant
	Extremely	Moderately	Slightly	
	3	2	1	0
Increasing availability of food				
Increasing accessibility to food				
Increasing utilization of food				
Increasing sustainable access to food				

7. Conclusions and recommendations

83. Do you want to add any other general comments or suggestions for enhancing agricultural development and food security in Kassala State?

……
……
……
……
……

We would like to extend to you sincere thanks for your kind cooperation and for finding the time to completing this questionnaire
Name of the person:
Position:
Telephone number:
E-mail:
Date:

Appendix 2: Questionnaire: Food security in Kassala State Household Questionnaire (2019) (Translated Arabic Version)

الأمن الغذائي في ولاية كسلا
استبيان الأسرة (2019)

الرمز (رقم الملف): ..... (للترميز فقط: يرجى عدم الكتابة في هذا البند)

1. معلومات أساسية عن الأسرة المنزلية:

1.-7. الرجاء تقديم المعلومات الأساسية التالية

1. اسم رب الأسرة (اختياري): .....
1. الاصول العرقية للأسرة..... :
2. الموقع..... :
3. القرية : ....
4. إجمالي عدد أفراد الأسرة: ....
5. عدد أفراد الأسرة البالغين (15 سنة فأكثر): .....

7.a. عدد الأطفال (5-14 سنة): .....

7.b . عدد الأطفال (عمر أربعة سنوات أو اقل): .....

2. حجم الأسرة وخصائص أفرادها:

.18-.8 الرجاء تقديم قائمة بأفراد الأسرة وتحديد خصائص كل منهم

		8	9	10	11	12	13	14	15	16	17	18
	الاسم	العلاقة مع رب الاسرة	النوع	السن (بالسنوات)	الحالة الاجتماعية	التعليم	طول الأطفال (من 6 شهور إلى 5 سنوات)	وزن الأطفال (من 6 شهور إلى 5 سنوات)	الوظيفة الرئيسية خلال آخر 12 شهرًا	الوظيفة الثانوية خلال آخر 12 شهرًا	الأجر اليومي	الدخل الشهريً
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												

ملاحظات:

1. العلاقة مع رب الأسرة: (1) رب الاسرة؛ (2) الزوجة / الزوج ؛ (3) الابن / الابنة؛ (4) الأخ / الأخت؛ (5) الأب / الأم؛ (6) الأحفاد؛ (7) قريب آخر؛ (8) الموظف الذي يعيش مع الأسرة؛ (9) غير ذلك (الرجاء التحديد).

2. الجنس: (1) ذكر؛ (2) أنثى.

3. الحالة الاجتماعية: (1) متزوج. (2) غير متزوج ؛ (3) مطلق/مطلقة ؛ (4) ارمل/أرملة. (5) تحت سن الزواج.

4. التعليم: (1) أمي. (2) يعرف القراءة والكتابة؛ (3) الخلوة؛ (4) الابتدائية؛ (5) المتوسطة؛ (6) الثانوية؛ (7) فوق الثانوية وتحت الجامعة؛ (8) التعليم الجامعي وما فوق.

2. حالة السكن والجودة والبيئة والبنية التحتية والخدمات

19. الرجاء توضيح نوع حيازة السكن. (الرجاء إختيار إجابة واحدة)

نوع الحيازة السكنية	
1. مملوكة من قبل الأسرة	1
2. مستأجرة	2
3. مقدمة من صاحب العمل	3
4. مقدمة من قبل الآخرين مجانا	4
5. أخرى (الرجاء ذكرها).....	5

20. إذا كان المنزل مملوكًا للأسرة، الرجاء توضيح طريقة الحصول على/ اكتساب الملكية. (الرجاء إختيار إجابة واحدة)

نوع الملكية	
1. الملكية المكتسبة من خلال شراء المنزل	1
2. الملكية المكتسبة من خلال المنحة	2
3. الملكية المكتسبة من خلال بناء منزل جديد على نفقة الأسرة الخاصة	3
4. الملكية المكتسبة من خلال الميراث	4
5. أخرى (الرجاء ذكرها)	5

21. الرجاء توضيح نوع مواد البناء المستخدمة في بناء منزلك ونوع التسهيلات المنزلية المتاحة في منزلك. (يرجى التأشير على جميع الإجابات المناسبة قرين كل منها (يمكن إختيار اكثر من إجابة واحدة)

نوع مواد البناء	
1. الخرسانة	1
2. الطوب	2
3. المواد المؤقتة	3
4. الطين	4
5. المياه النظيفة/ النقية/ الامنه	5
6. الكهرباء	6
7. مرافق الصرف الصحي	7
8. أخرى (الرجاء ذكرها)	8

22. الرجاء توضيح المصدر الرئيسي لمياه الشرب المتوفرة في منزلك. (الرجاء إختيار إجابة واحدة)

المصدر الرئيسي لمياه الشرب	
1. المياه في الأنابيب إلى داخل المسكن	1
2. مياه الأنابيب من خارج المسكن	2
3. مياه بئر	3
4. مياه بركة/ حفير	4
5. مياه تيار / نهر	5
6. مياه شاحنة نقل / صهريج/ كارو	6
7. أخرى (الرجاء ذكرها)	7

23. الرجاء توضيح عدد الطوابق وعدد الغرف في منزلك. (الرجاء إختيار إجابة واحدة)

23. a.. عدد الطوابق في منزلك			
1. واحد	**2. اثنان**	**3. . ثلاثة**	**4. أكثر من ثلاثة**
1	**2**	**3**	**4**
b.23.. عدد الغرف في منزلك			
1. واحد	**2. اثنان**	**3. . ثلاثة**	**4. أكثر من ثلاثة**
1	**2**	**3**	**4**

24. الرجاء توضيح نوع المرحاض المستخدم في منزلك. (الرجاء إختيار إجابة واحدة)

نوع المرحاض	
1. مرحاض داخل المنزل	**1**
2. حفرة مرحاض مع بلاطه	**2**
3. حفرة مرحاض دون بلاطه	**3**
4. أخرى (الرجاء ذكرها)	**4**

25. الرجاء توضيح خصائص الطريق الذى يربط قريتك بأقرب سوق. (الرجاء إختيار إجابة واحدة)

خصائص الطريق	
1. طريق من الأسفلت	**1**
2. طريق مرصوف من الحصى/ ردميه	**2**
3. طريق ترابي	**3**
4. طريق ترابي ردئ	**4**
5. أخرى (الرجاء ذكرها)	**5**

26. الرجاء توضيح مدى توفر التسهيلات / الخدمات التالية في قريتك؟ (يرجى التأشير على جميع الإجابات المناسبة قرين كل منها (يمكن إختيار اكثر من إجابة واحدة)

نوع الخدمات	**نعم**	**لا**
	1	**2**
1. خدمات الرعاية والعيادة الصحية الأولية		
2. خدمات وتسهيلات التأمين الصحي الأولية		
3. المدرسة الابتدائية		
4. خدمات الإنترنت		
5. شبكة الاتصالات / الخدمات		
6. الخدمات المصرفية		
7. السوق		
8. أخرى (الرجاء ذكرها)		

27. اذا كانت الخدمات المذكورة أعلاه متوفرة، الرجاء توضيح تقييمكم لمدى رضاكم عن مدى كفاية الوصول المنتظم والمستدام إلى الخدمات والتسهيلات التالية في قريتك؟ (يرجى التأشير على جميع الإجابات المناسبة قرين كل منها (يمكن إختيار اكثر من إجابة واحدة)

نوع الخدمات	كافية ومستدامة	كافية ولكنها غير مستدامة	غير كافية وغير مستدامة	غير موجودة
	1	2	3	4
1. تسهيلات / خدمات الرعاية الصحية				
2. تسهيلات / خدمات التأمين الصحي				
3. تسهيلات / خدمات التعليم				
4. المياه النظيفة/ النقية				
5. الكهرباء				
6. خدمات الإنترنت				
7. شبكة الاتصالات / الخدمات				
8. الخدمات المصرفية				
9. تسهيلات / خدمات الصرف الصحي				
10. السوق				
11. أخرى (الرجاء ذكرها)				

4. الإنتاج الزراعي ، دخل الأسرة والإنفاق

28. الرجاء توضيح ما إذا كانت الأسرة تزرع الأرض. (الرجاء إختيار إجابة واحدة)

نعم	لا
1	(إقفز إلى السؤال (30))2

29. إذا كانت الإجابة بنعم ، فيرجى توضيح حالة الحيازة / الإيجارة.

نوع الحيازة	الأرض بالفدان
1. مملوكة ومزروعة من قبل الأسرة	
2. مستأجرة ومزروعة من قبل الأسرة	
3. مملوكة من قبل الآخرين، ومزروعة مجانا	
4. أراضي العامة	

30. الرجاء توضيح ما إذا كانت الأسرة لديها أرض لا تزرعها. (الرجاء إختيار إجابة واحدة)

نعم	لا
1	(إقفز إلى السؤال (32))2

31. إذا كانت الإجابة بنعم ، الرجاء توضيح الكمية لكل بند من البنود التالية.

	الأرض بالفدان
1. مملوكة ، وليست للزراعة (مثل قطعة أرض)	
2. مستأجرة وليست للزراعة	
3. مملوكة ، مستأجرة للزراعة من قبل الآخرين	
4. مملوكة ، مستأجرة لأغراض أخرى	

32. الرجاء توضيح كمية مساحة الأرض التي تم زرعها بالمنتجات الزراعية التالية

مساحة الأرض المستخدمة لزراعة المنتجات المختلفة:	الأرض بالفدان
1. مساحة الأرض المزروعة بالذرة الرفيعة	
2. مساحة الأرض المزروعة بالدخن	
3. مساحة الأرض المزروعة بالقمح	
5. مساحة الأرض المزروعة بالبقوليات	
6. مساحة الأرض المزروعة بالخضروات	
7. مساحة الأرض المزروعة بالفاكهة	
8. مساحة الأرض المزروعة بمحاصيل أخرى	

33. الرجاء نوع الري توضيح الأرض المزروعة بالفدان حسب نوع الري

نوع الري	الأرض بالفدان
1. المياه الجوفية	
2. الري الحوضي	
3. الفيضانات	
4. القنوات	
5. المطرية	
6. الآلية المطرية	
7. أخرى (الرجاء ذكرها)	

34. إذا كانت الأسرة تنتج أو تزرع محاصيل غذائية ونقدية ، ما أهمية الحالات التالية المتعلقة بإنتاج أو زراعة كل من المحاصيل الغذائية والنقدية؟ (يرجى التأشير على جميع الإجابات المناسبة قرين كل منها (يمكن إختيار اكثر من إجابة واحدة)

	درجة الاهمية			
	قصوي	متوسطه	ضعيفة	غير مهمة
إنتاج أو زراعة المحاصيل الغذائية أدي إلى				
1. الاكتفاء الذاتي: إنتاج ما يكفي من الغذاء للاستهلاك للأسرة				
2. تحسين نوعية لانتاج أفضل الغذاء للاستهلاك للأسرة				
إنتاج أو زراعة المحاصيل النقدية أدي إلى:				
1. زيادة في الدخل				
2. زيادة في الدخل وزيادة في استهلاك الأغذية				
3. زيادة الدخل وتحسين جودة استهلاك الغذاء				
4. استبدال إنتاج المحاصيل الغذائية بانتاج المحاصيل النقدية				
5. أخرى (الرجاء ذكرها)				

35: الرجاء توضيح عدد الحيوانات البالغة من الفئات التالية التي تمتلكها أنت أو أفراد أسرتك حالياً؟ يرجى الإشارة إلى الرقم؟

الكمية (العدد)	1. الأبقار	2. الأغنام والماعز	3. الإبل	4. أخرى (الكتابة على سبيل المثال الدواجن(

28. هل تلقيت أنت أو أفراد أسرتك الآخرين خدمات زراعية من الحكومة والمؤسسات الأخرى خلال العامين الماضيين؟ . (الرجاء إختيار إجابة واحدة)

نعم	لا
1	(إقفز إلى السؤال (38))2

37. إذا كانت الإجابة بنعم ، فما هي الخدمات الزراعية التي تلقيتها أنت أو أفراد أسرتك الأخرين من الحكومة والمؤسسات الأخرى خلال العامين الماضيين؟ (يرجى التأشير على جميع الإجابات المناسبة قرين كل منها (يمكن إختيار اكثر من إجابة واحدة)

الخدمات الزراعية	
1. خدمات تمديد/ ارشاد زراعي	1
2. الخدمات المالية	2
3. الخدمات التكنولوجية	3
4. حزمة متكاملة من جميع خدمات	4
5. الأسمدة	5
6. البذور / النباتات	6
7. خدمات أخرى (الرجاء ذكرها)	7

42. - 38. الرجاء توضيح إنتاج مزرعة الأسرة ومبيعاتها ومشترياتها (الاستهلاك والإنفاق على الأغذية المشتراة) خلال العام الماضي

المنتج	الإنتاج		المبيعات		المشتريات	
	الكمية	القيمة	الكمية	القيمة	الكمية	القيمة
38 :. المحاصيل	)كغم(	(SDG)	)كلغ(	(SDG)	)كغم(	(SDG)
1. الذرة الرفيعة						
2. الدخن						
3. القمح						
4. السمسم						
5. الفول السوداني						
6. القطن						
7. الفاكهة						
8. البقوليات						
39. الثروة الحيوانية:						
1. الثروة الحيوانية						
2. منتجات الثروة الحيوانية						
40. الدواجن والأسماك:						
1. السمك						
2. الدجاج						
3. البيض						
41. منتجات الغابات						
1. خشب الوقود						
2. الخشب البناء						
3. الفحم						

42. مشتريات الأغذية الأخرى						
1. الخبز						
2. وجبات الطعام المشتراة						

52 – .43.. الرجاء توضيح دخل الأسرة من القطاع غير الزراعي (خلال السنة الماضية)

المصدر			الدخل)SDG(	
	نعم	لا	الشهر الماضي	السنة الماضية
43. عامل يومية				
.44 العمل بأجر في القطاع العام				
45. العمل بأجر في القطاع الخاص				
46. التحويلات الخارجية				
47. التحويلات الداخلية.				
48. هبة ومنحة وهدية				
49. استئجار العقارات والأراضي				
50. الفوائض التجارية				
51. خدمات النقل والسفر				
52. الفائض من العمل الحر: 1. حرف يدوية، 2. نجارة، 3. بناء& اعمال بناء 4. تعدين الذهب.				
المجموع				

53. الرجاء توضيح سبب (أسباب) العمل في الأنشطة غير الزراعية. (يرجى التأشير على جميع الإجابات المناسبة قرين كل منها (يمكن إختيار اكثر من إجابة واحدة)

السبب الرئيسي (الأسباب) للعمل في الأنشطة غير الزراعية	
1. عدم كفاية الدخل / العائد من المزرعة المنزلية	1
2. زيادة حجم الأسرة	2
3. محدودية مساحة الأرض	3
4. انخفاض خصوبة التربة والإنتاجية	4
5. توافر فرص النمويل	5
6. توفر البنية التحتية والطرق والكهرباء والسوق	6
7. الصدمات الناجمة عن فشل موسم الامطار والأوبئة والفيضانات وغيرها	7
8. التقلبات والطبيعة الموسمية للأنشطة الزراعية	8
9. مهارات التصنيع والحرفية	9
10. زيادة الطلب على المنتجات غير الزراعية	10
11. خدمات أخرى (الرجاء ذكرها)	11

61. - 54 . الرجاء توضيح النفقات غير الغذائية خلال الشهر الماضي

	العناصر	الكمية	سعر الوحدة	الإنفاق بالجنيه السوداني (SDG)
54.	السلع غير المعمرة للاسرة:			
	1. الصابون والتنظيف			
	2. السلع الأخرى غير المعمرة			
55.	السكن:			
	1. الكهرباء			
	2. المياه			
	3. الإيجار			
	4. الضرائب العقارية والخدمات			
56.	الوقود: (الخشب والفحم والغاز)			
57.	النقل والسفر:			
58.	الملابس والأحذية:			
59.	خدمات التعليم			
60.	الصحة والعلاج الطبي			
61.	أخرى			

5. استراتيجية التكيف والبقاء على قيد الحياة:

62. الرجاء توضيح ما إذا كان دخل الأسرة قد تغير في الستة شهور الماضية. (الرجاء إختيار إجابة واحدة)

زاد	انخفض	لم يتغير
1	2	3

63. الرجاء توضيح ما إذا كان إنفاق الأسرة قد تغير في الستة شهور الماضي . (الرجاء إختيار إجابة واحدة)

زاد (أقفز للسؤال 65)	انخفض	لم يتغير
1	2	3((65) (اقفز إلى السؤال

64. إذا كان إنفاق الأسرة قد تغير، أي من البنود (العناصر) التالية قد تغيرت بسبب التغيير في إنفاق الأسرة؟ (يرجى التأشير على جميع الإجابات المناسبة قرين كل منها (يمكن إختيار اكثر من إجابة واحدة)

البنود (العناصر)	
1. الغذاء	1
2. الملابس	2
3. التعليم	3
4. احتياجات السكن المتنوعة	4
5. الصحة	5
6. السفر والترفيه	6
7. النقل	7
8. فواتير الخدمات	8
9. أخرى (الرجاء ذكرها)	9

65. إذا كان إنفاق الأسرة على الغذاء قد انخفض ، أي من البنود (العناصر) التالية قد تغير بسبب التغيير في إنفاق الأسرة على الغذاء؟ (يرجى التأشير على جميع الإجابات المناسبة قرين كل منها (يمكن إختيار اكثر من إجابة واحدة)

البنود (العناصر)	
1. جودة المواد الغذائية المستهلكة	1
2. كمية الذرة الرفيعة المستهلكة	2
3. كمية الدخن المستهلكة	3
4. كمية القمح المستهلكة	4
5. كمية البقوليات المستهلكة	5
6. كمية اللحوم المستهلكة	6
7. كمية الفاكهة المستهلكة	7
8. كمية الحليب المستهلكة	8
9. أخرى (الرجاء ذكرها)	9

66. الرجاء توضيح ما إذا كانت الأسرة قد اشترت الطعام عن طريق الاقتراض. . (الرجاء إختيار إجابة واحدة)

نعم	لا
1	(إقفز إلى السؤال (68))2

67. إذا كانت الإجابة بنعم ، الرجاء تحديد نسبة الأغذية المشتراة عن طريق الاقتراض إلى إجمالي الأغذية المستهلكة؟ .. ..

68. الرجاء توضيح ما إذا كانت الأسرة قد استخدمت أيً من الخيارات التالية لضمان القدرة المالية؟ (يرجى التأشير على جميع الإجابات المناسبة قرين كل منها (يمكن إختيار اكثر من إجابة واحدة)

الخيارات	
1. عدم دفع فواتير الخدمات	1
2. بيع / رهن مجوهرات أو أثاث أو ماشية	2
3. بيع / رهن الأصول الإنتاجية	3
4. استخدام المدخرات	4
5. الاقتراض	5
6. تقليل النفقات اليومية	6
7. خفض الإنفاق على التعليم والصحة	7
8. تغيير مكان الإقامة	8

69. في الأيام السبعة الماضية ، هل كنت قلقًا من أن أسرتك لن تحصل على ما يكفي من الطعام؟ . (الرجاء إختيار إجابة واحدة)

نعم	لا
1	2

70. في الأيام السبعة الماضية ، كم عدد الأيام التي اضطررت أنت أو أحد أفراد أسرتك إلى (.....) (إذا لم يكن هناك يوم ، سجل :(ZERO)

	الايام
1. الاعتماد على الأطعمة الأقل تفضيلا و / أو أقل تكلفة	
2. الحد من جزء من حجم وجبات الطعام	
3. تقليل عدد الوجبات التي يتم تناولها في اليوم	
4. تقييد الاستهلاك من قبل البالغين من أجل الأطفال الصغار لتناول الطعام	
5. اقتراض الطعام ، أو الاعتماد على مساعدة من صديق أو قريب	

71. في الماضي [4 أسابيع / 30 يومًا]، هل كنت قلقًا من أن أسرتك لن تحصل على ما يكفي من الطعام؟ . (الرجاء إختيار إجابة واحدة)

نعم	لا
1	2

72. في الماضي [4 أسابيع / 30 يومًا]، كم عدد الأيام التي اضطررت أنت أو أحد أفراد أسرتك إلى (.....) (إذا لم يكن هناك يوم ، سجل (ZERO):

	الايام
1. الاعتماد على الأطعمة الأقل تفضيلا و / أو أقل تكلفة	
2. الحد من جزء من حجم وجبات الطعام	
3. تقليل عدد الوجبات التي يتم تناولها في اليوم	
4. تقييد الاستهلاك من قبل البالغين من أجل الأطفال الصغار لتناول الطعام	
5. اقتراض الطعام ، أو الاعتماد على مساعدة من صديق أو قريب	

6. قياس الأمن الغذائي (مقياس انعدام الأمن الغذائي للأسر المعيشية ((HFIAS) في ولاية كسلا

73.a . في الماضي [4 أسابيع / 30 يومًا] هل شعرت بالقلق من أن أسرتك لن تحصل على ما يكفي من الطعام؟ . (الرجاء إختيار إجابة واحدة)

نعم	لا
1	(إقفز إلى السؤال (74))2

73.b . كم مرة حدث هذا في الماضي [4 أسابيع / 30 يومًا]؟ . (الرجاء إختيار إجابة واحدة)

لم يحدث	نادرًا (1-2 مرات)	أحيانًا (3-10 مرات)	غالبًا (أكثر من 10 مرات)
0	1	2	3

74.a . في الماضي [4 أسابيع / 30 يومًا] هل لم تكن أنت أو أي فرد من أفراد الأسرة قادرًا على تناول أنواع الأطعمة التي تفضلها بسبب نقص الموارد؟ . (الرجاء إختيار إجابة واحدة)

نعم	لا
1	(إقفز إلى السؤال (75))2

74.b . كم مرة حدث هذا في الماضي [4 أسابيع / 30 يومًا]؟ . (الرجاء إختيار إجابة واحدة)

لم يحدث	نادرًا (1-2 مرات)	أحيانًا (3-10 مرات)	غالبًا (أكثر من 10 مرات)
0	1	2	3

75 .a.. في الماضي [4 أسابيع / 30 يومًا] هل تناولت أنت أو أي فرد من أفراد الأسرة مجموعة محدودة من الأطعمة بسبب نقص الموارد؟ . (الرجاء إختيار إجابة واحدة)

نعم	لا
1	(إقفز إلى السؤال (76))2

75.b. كم مرة حدث هذا في الماضي [4 أسابيع / 30 يومًا]؟ . (الرجاء إختيار إجابة واحدة)

لم يحدث	نادرًا (1-2 مرات)	أحيانًا (3-10 مرات)	غالبًا (أكثر من 10 مرات)
0	1	2	3

76. في الماضي [4 أسابيع / 30 يومًا] هل اضطررت أنت أو أي فرد من أفراد الأسرة إلى تناول بعض الأطعمة التي لم ترغب في تناولها حقًا بسبب نقص الموارد للحصول على أنواع أخرى من الطعام؟ . (الرجاء إختيار إجابة واحدة)

نعم	لا
1	(إقفز إلى السؤال (77))2

76.b. كم مرة حدث هذا في الماضي [4 أسابيع / 30 يومًا]؟ (الرجاء إختيار إجابة واحدة)

لم يحدث	نادرًا (1-2 مرات)	أحيانًا (3-10 مرات)	غالبًا (أكثر من 10 مرات)
0	1	2	3

77 .a.. في الماضي [4 أسابيع / 30 يومًا] هل اضطررت أنت أو أي فرد من أفراد الأسرة إلى تناول وجبة أصغر مما شعرت بالحاجة إليه لعدم وجود ما يكفي من الطعام؟ . (الرجاء إختيار إجابة واحدة)

نعم	لا
1	(إقفز إلى السؤال (78))2

77.b . كم مرة حدث هذا في الماضي [4 أسابيع / 30 يومًا]؟ . (الرجاء إختيار إجابة واحدة)

لم يحدث	نادرًا (1-2 مرات)	أحيانًا (3-10 مرات)	غالبًا (أكثر من 10 مرات)
0	1	2	3

78.a. في الماضي [4 أسابيع / 30 يومًا] هل اضطررت أنت أو أي فرد آخر من أفراد الأسرة إلى تناول وجبات أقل في اليوم بسبب عدم وجود طعام كافٍ؟ . (الرجاء إختيار إجابة واحدة)

نعم	لا
1	(إقفز إلى السؤال (79))2

78.b. كم مرة حدث هذا في الماضي [4 أسابيع / 30 يومًا]؟ . (الرجاء إختيار إجابة واحدة)

لم يحدث	نادرًا (1-2 مرات)	أحيانًا (3-10 مرات)	غالبًا (أكثر من 10 مرات)
0	1	2	3

79.a . في الماضي [4 أسابيع / 30 يومًا] هل لم يكن هناك أي نوع من طعام لتناوله في منزلك بسبب نقص الموارد اللازمة للحصول على الطعام؟ . (الرجاء إختيار إجابة واحدة)

نعم	لا
1	(إقفز إلى السؤال (80))2

79.b . كم مرة حدث هذا في الماضي [4 أسابيع / 30 يومًا]؟ . (الرجاء إختيار إجابة واحدة)

لم يحدث	نادرًا (1-2 مرات)	أحيانًا (3-10 مرات)	غالبًا (أكثر من 10 مرات)
0	1	2	3

80. في الماضي [4 أسابيع / 30 يومًا] هل ذهبت أنت أو أي فرد من أفراد الأسرة للنوم ليلا جائعًا لأنه لم يكن هناك ما يكفي من الطعام؟ . (الرجاء إختيار إجابة واحدة)

نعم	لا
1	(إقفز إلى السؤال (81))2

80.b . كم مرة حدث هذا في الماضي [4 أسابيع / 30 يومًا]؟ . (الرجاء إختيار إجابة واحدة)

لم يحدث	نادرًا (1-2 مرات)	أحيانًا (3-10 مرات)	غالبًا (أكثر من 10 مرات)
0	1	2	3

81.a. في الماضي [4 أسابيع / 30 يومًا] هل ذهبت أنت أو أي فرد من أفراد الأسرة طوال اليوم والليل دون تناول أي شيء لأنه لم يكن هناك ما يكفي من الطعام؟ . (الرجاء إختيار إجابة واحدة)

نعم	لا
1	(إقفز إلى السؤال (82))2

81.b . كم مرة حدث هذا في الماضي [4 أسابيع / 30 يومًا]؟ . (الرجاء إختيار إجابة واحدة)

لم يحدث	نادرًا (1-2 مرات)	أحيانًا (3-10 مرات)	غالبًا (أكثر من 10 مرات)
0	1	2	3

82. ما مدى أهمية دور المرأة في تعزيز توافر الغذاء والوصول إليه واستخدامه واستدامته للأسرة ؟ (يرجى التأشير على جميع الإجابات المناسبة قرين كل منها (يمكن إختيار اكثر من إجابة واحدة)

	درجة الاهمية			
	قصوي	متوسطه	ضعيفة	غير مهمة
1. زيادة توافر الغذاء				
2. زيادة الوصول إلى / الحصول على الغذاء				
3. زيادة استخدام الغذاء				
4. زيادة الحصول المستدام على الغذاء				

7. الاستنتاجات والتوصيات

83. هل ترغب في إضافة أي تعليقات أو اقتراحات عامة أخرى لتعزيز التنمية الزراعية والأمن الغذائي في ولاية كسلا؟

.....
.....
.....
.....
.....

نود أن نعرب لكم عن خالص الشكر على تعاونكم الطيب ولإيجاد الوقت الكافي لاستكمال هذا الاستبيان
اسم الشخص:
الوظيفة : .....
رقم الهاتف: .....
البريد الإلكتروني: .....
التاريخ: .....

Appendix 3 – General household characteristics

General characteristics of household heads in the survey

Locality	Rural Kassala (RK)	Kassala Locality (KL)	Rural Aroma (RA)	Wad Elhelew Locality (WL)	New Halfa (NH)	All
Composition of the survey						
Number of households in the sample	100	60	120	100	107	487
Share in the sample (%)	20.5	12.3	24.6	20.5	22	100
Households ethnicity background (Distribution by tribes)						
Hadandawa (%)	30	1.7	84.2	0.0	1.9	27.5
Bani Amir	40	1.7	0.8	18.0	0.0	12.3
West African	28	15.0	13.3	37.0	0.0	25.9
Northern	2	81.6	1.7	0.0	0.9	11.1
Halfaween	0	0.0	0.0	0.0	37.4	8.2
Shukriya	0	0.0	0.0	9.0	52.3	13.3
Darfur tribes	0	0.0	0.0	0.0	7.5	1.7
Total (%)	100	100	100	100	100	100
Households Family structure						
1. Households Family size						
Small size (1 – 5)	25	28	45	39	46	36
Medium size (6 – 8)	39	44	37	39	32	39
Large size (more than 8)	36	28	18	22	22	25
Total	100	100	100	100	100	100
2. Households Number of children (less than 5 years)						
Families without children (zero)	56.0	36.0	47.5	8.1	60.6	43.6
Families with few children (1-3)	43.0	59.0	52.5	87.1	38.3	53.9
Families with many children (4-5)	0.0	4.0	0.0	3.2	1.1	1.7
Families with a large number of children (more than 5)	1.0	1.0	0.0	1.6	0.0	0.8
Total	100	100	100	100	100	100
3. Households Age						
Young age group (less than or equal 20)	2.0	0.0	0.8	0.0	0.9	0.8
middle age group (21-45 years)	56.0	43.3	70.0	74.0	43.0	58.7
Old age group (46-60 years)	26.0	36.7	23.4	22.0	38.3	28.6
Very old age group (more than 60 years)	16.0	20.0	5.8	4.0	17.8	11.9
Total	100	100	100	100	100	100
4. Households gender						
Male	82.0	85.0	85.8	94.0	85	86.4
Female	18.0	15.0	14.2	6.0	15	13.6
Total	100	100	100	100	100	100
Households Marital status						
Married	86.0	73.3	82.5	86.8	82.2	82.9
Unmarried	1.0	11.7	5.8	6.1	2.8	5.0
Separated	4.0	3.3	1.7	2.0	1.9	2.4
Widow	9.0	11.7	9.2	5.1	12.1	9.3
Under marriage	0.0	0.0	0.8	0.0	1.0	0.4
Total	100	100	100	100	100	100
Household skill level						

1. Households Education attainment level						
Illiterate	62	23.7	51.3	17.1	15.2	35.3
Read & write	1.0	18.6	7.5	5.1	6.7	6.8
Khalwa	8.0	1.7	21.0	28.3	2.9	13.5
Primary	23.0	10.2	10.1	20.2	22.8	17.6
Intermediate	1.0	18.6	2.5	1.0	9.5	5.4
Secondary	3.0	27.2	5.0	23.2	25.7	15.6
Over secondary & under university	0.0	0.0	0.0	5.1	3.8	1.9
University and above	2.0	0.0	2.5	0.0	13.3	3.9
Total	100	100	100	100	100	100
2. Households Main Occupation						
Manual work	5.0	0.0	5.0	0.0	0.0	2.3
Skilled work	7.0	6.8	3.2	1.0	9.3	5.3
Agriculture	10.0	62.7	42.5	92.0	35.5	46.9
Animal husbandry	1.0	1.7	4.2	1.0	2.8	2.3
Trade	4.0	3.4	1.7	1.0	0.0	1.9
Marginal/informal work	73.0	18.6	35.0	1.0	19.6	30.5
Employee/teacher	0.0	6.8	4.2	3.0	21.5	7.2
Technicians	0.0	0.0	1.7	1.0	4.7	1.6
Retired	0.0	0.0	0.0	0.0	2.8	0.6
Housewife	0.0	0.0	0.0	0.0	3.8	0.6
Unemployed	0.0	4.2	0.0	0.0	0.0	1.0
Total	100	100	100	100	100	100
Households standard of living: households income level (per month)						
Very low income level (less than1500)	38.0	5.0	16.7	1.0	16.8	16.4
Low income level (1500-3000)	52	28.3	65	25.0	77.7	52.2
Middle to high income level (more than 3000)	10	66.7	18.3	74.0	6.5	31.4
Total	100	100	100	100	100	100

Source: Authors' calculations based on Food Security Household Survey in Kassala State (2019)

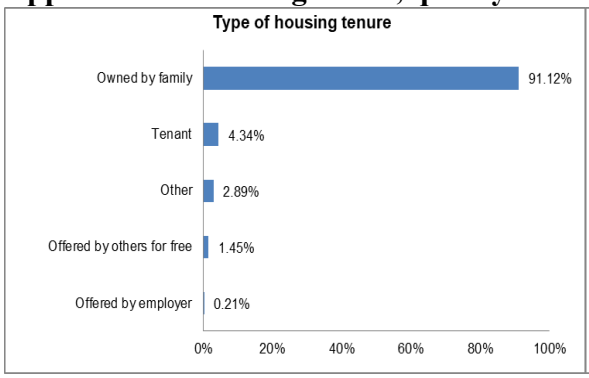
General characteristics of households in the survey (using data for all households families

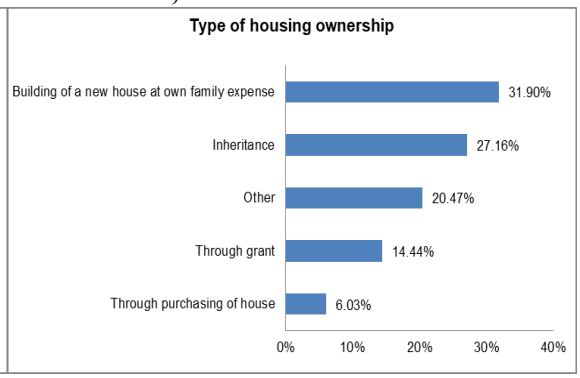
Locality	Rural Kassala (RK)	Kassala Locality (KL)	Rural Aroma (RA)	Wad Elhelew Locality (WL)	New Halfa (NH)	All
Composition of the survey						
Number of households in the sample	100	60	120	100	107	487
Share in the sample (%)	20.5	12.3	24.6	20.5	22	100
Households ethnicity background (Distribution by tribes)						
Hadandawa (%)	30	1.7	84.2	0.0	1.9	27.5
Bani Amir	40	1.7	0.8	18.0	0.0	12.3
West African	28	15.0	13.3	37.0	0.0	25.9
Northern	2	81.6	1.7	0.0	0.9	11.1
Halfaween	0	0.0	0.0	0.0	37.4	8.2
Shukriya	0	0.0	0.0	9.0	52.3	13.3
Darfur tribes	0	0.0	0.0	0.0	7.5	1.7
Total (%)	100	100	100	100	100	100
Households Family structure						
1. Households Family size						
Small size (1 – 5)	25	28	45	39	46	36
Medium size (6 – 8)	39	44	37	39	32	39
Large size (more than 8)	36	28	18	22	22	25
Total	100	100	100	100	100	100
2. Households Number of children (less than 5 years)						
Families without children (zero)	56.0	36.0	47.5	8.1	60.6	43.6
Families with few children (1-3)	43.0	59.0	52.5	87.1	38.3	53.9
Families with many children (4-5)	0.0	4.0	0.0	3.2	1.1	1.7
Families with a large number of children (more than 5)	1.0	1.0	0.0	1.6	0.0	0.8
Total	100	100	100	100	100	100
3. Households Age						
Young age group (less than or equal 20)	61.7	33.2	67.6	62.4	48.8	57.8
middle age group (21-45 years)	27.1	48.6	25.6	30.4	33.0	31.0
Old age group (46-60 years)	6.3	12.4	5.4	5.7	10.5	7.4
Very old age group (more than 60 years)	4.9	5.8	1.4	1.5	7.7	3.8
Total	100	100	100	100	100	100
4. Households gender						
Male	49.6	48.2	52.2	52.7	49.7	50.8
Female	50.4	51.8	47.8	47.3	50.3	49.2
Total	100	100	100	100	100	100
Households Marital status						
Married	29.7	44.5	30.8	35.7	37.3	34.2
Unmarried	20.8	25.3	23.8	17.5	37.0	24.3
Separated	4.2	3.0	1.9	1.9	4.6	2.9
Widow	5.5	5.7	3.2	2.0	5.5	4.1
Under marriage	39.8	21.5	40.3	42.9	15.6	34.5
Total	100	100	100	100	100	100
Household skill level						
1. Households Education attainment level						

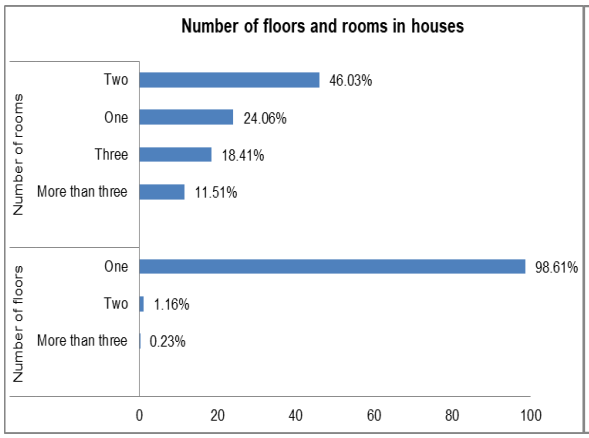
Illiterate	34.2	11.8	25.8	14.8	14.3	21.7
Read & write	1.8	8.3	6.8	2.5	6.0	4.8
Khalwa	8.9	0.9	14.6	12.7	5.8	9.4
Primary	42.3	24.2	35.7	41.7	36.7	37.4
Intermediate	5.4	8.0	7.8	6.2	8.1	7.0
Secondary	5.8	24.2	7.1	20.3	18.1	13.4
Over secondary & under university	0.3	5.1	0.8	1.4	2.1	1.6
University and above	1.3	17.5	1.4	0.4	8.9	4.7
Total	100	100	100	100	100	100
2. Households Main Occupation						
Manual work	4.0	0.2	8.0	1.6	1.6	5.2
Skilled work	8.7	7.4	2.4	2.5	6.4	4.4
Agriculture	7.4	39.0	34.8	85.7	33.6	38.4
Animal husbandry	0.7	6.8	6.3	1.6	4.0	4.3
Trade	4.6	5.1	1.8	0.8	0.0	2.5
Marginal/informal work	71.1	25.1	33.5	2.6	18.4	31.4
Employee/teacher	2.1	16.0	5.6	3.4	24.8	9.1
Technicians	0.0	0.0	1.8	1.7	4.0	1.5
Retired	1.4	0.0	0.0	0.0	2.4	0.9
Housewife	0.0	0.0	0.0	0.0	3.2	0.6
Unemployed	0.0	0.4	5.8	0.1	1.6	1.7
Total	100	100	100	100	100	100
Households standard of living: households income level (per month)						
Very low income level (less than1500)	86.4	69.2	84.3	78.7	80.7	81.2
Low income level (1500-3000)	11.7	12.8	12.3	6.2	17.6	12.0
Middle to high income level (more than 3000)	1.9	18.0	3.4	15.1	1.7	6.8
Total	100	100	100	100	100	100

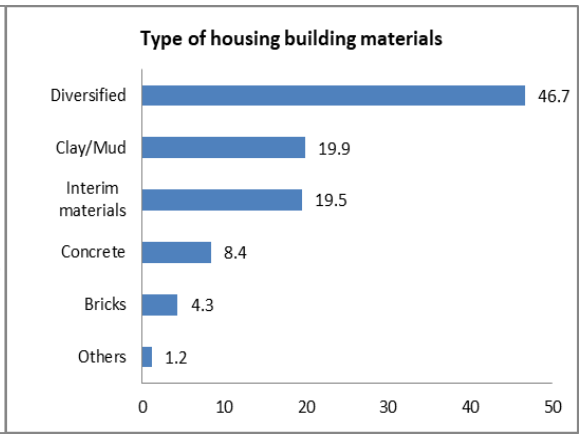
Source: Authors' calculations based on Food Security Household Survey in Kassala State (2019)

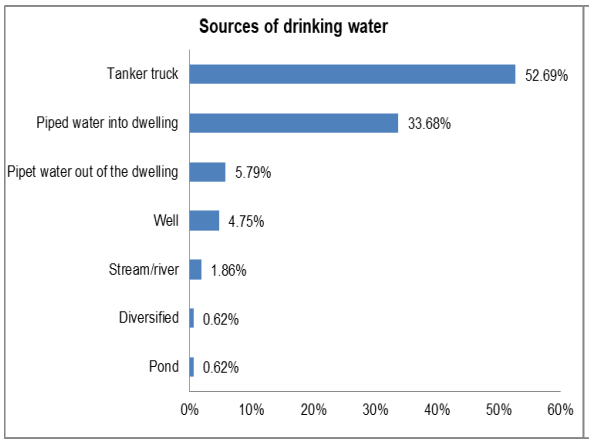
Appendix 4 – Housing status, quality and environment, infrastructure and services

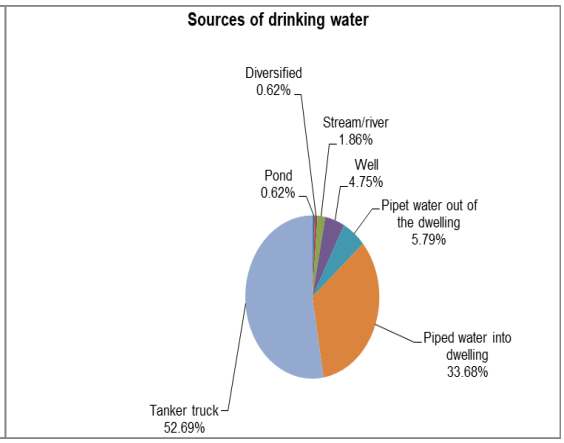


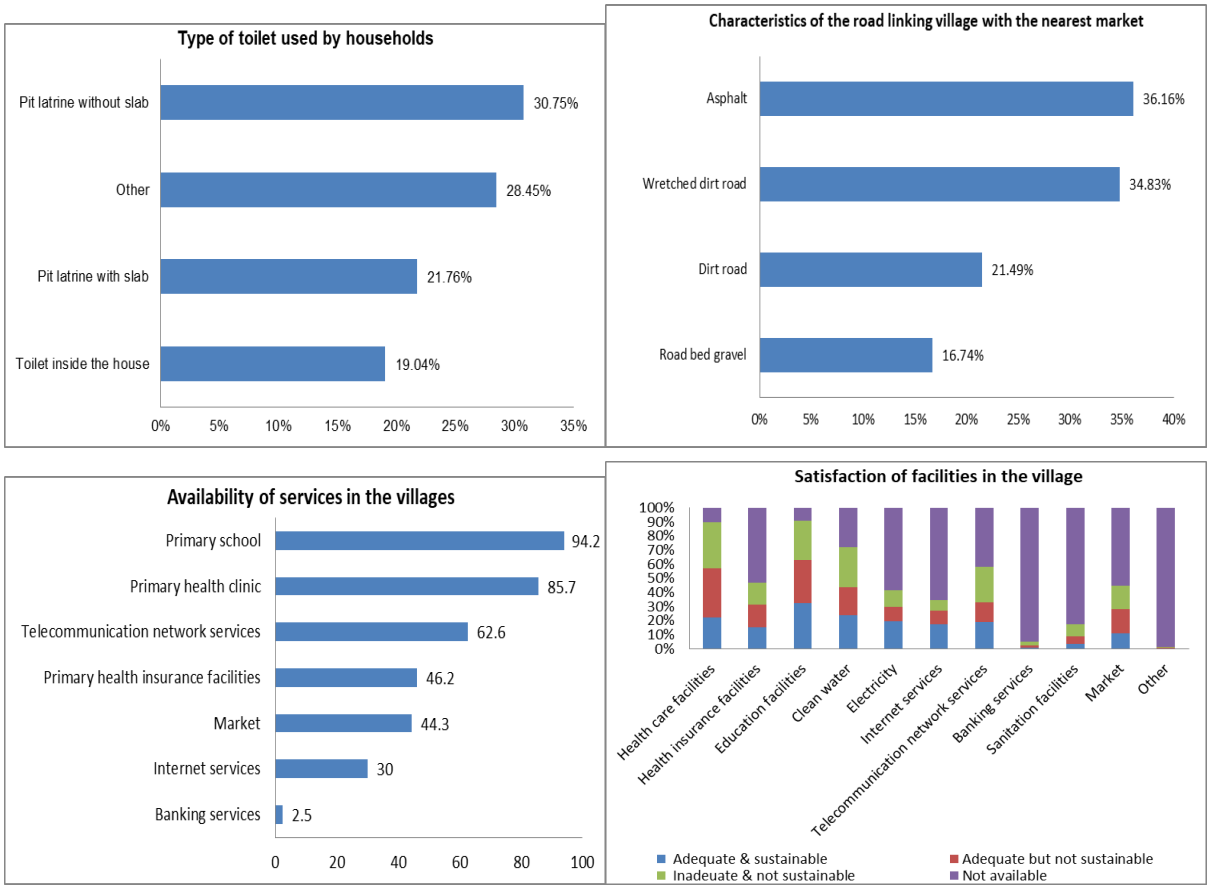












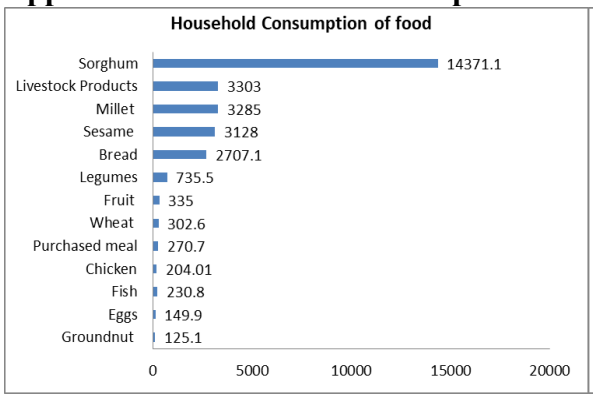
Source: Authors' calculations based on Food Security Household Survey in Kassala State (2019)

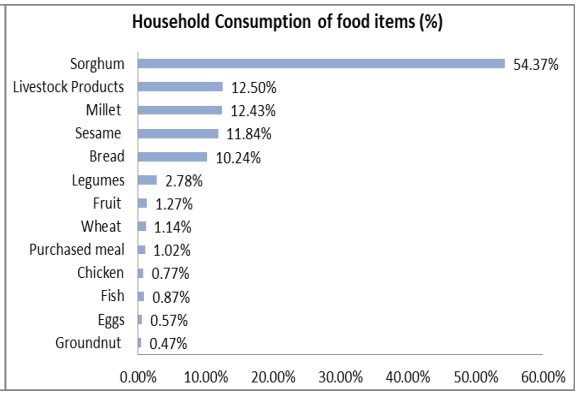
Infrastructure and services

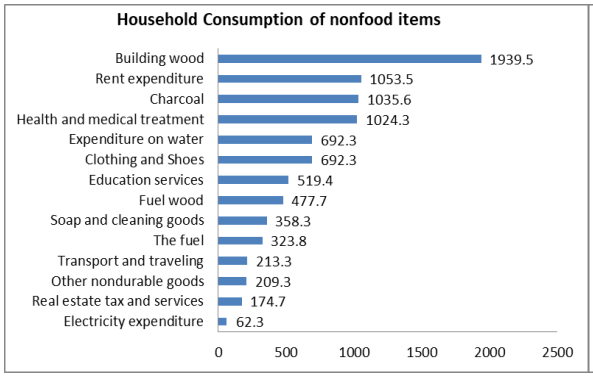
1. Availability of services			Yes %	%No
Primary health clinic			85.7	14.3
Primary health insurance facilities			46.2	53.8
Primary school			94.2	5.8
Internet services			30.0	70.0
Telecommunication network services			62.6	37.4
Banking services			2.5	97.5
Market			44.3	55.7
Total			100	100
2. Satisfaction of services	**Adequate& sustainable**	**Adequate but not sustainable**	**Inadequate& Not sustainable**	**Not available**
Health care facilities	22.2	34.9	32.9	10.1
Health insurance facilities	15.4	16.2	15.2	53.2
Education facilities	32.4	30.4	27.9	9.2
Clean water	24.0	19.7	28.4	27.9
Electricity	19.7	9.9	12.1	58.3
Internet services	16.8	9.5	7.4	63.3
Telecommunication network services	19.1	13.8	25.2	41.9
Banking services	1.0	1.4	2.7	94.9
Sanitation facilities	3.5	5.3	8.4	82.8
Market	10.9	17.0	16.8	55.2
Other	0.4	0.4	0.4	98.8

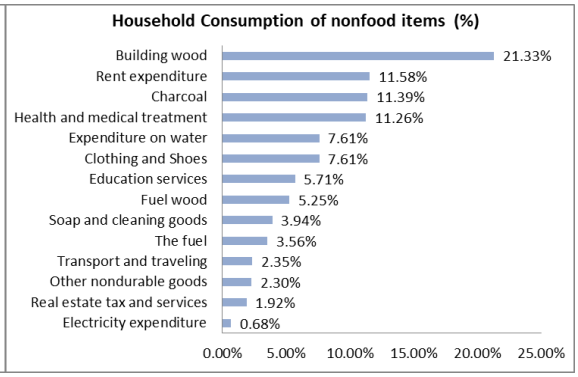
Source: Authors' calculations based on Food Security Household Survey in Kassala State (2019)

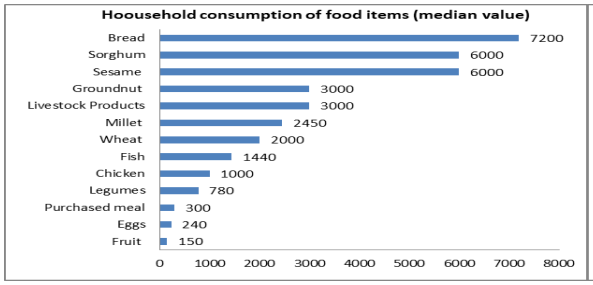
Appendix 5 – Household consumption of food and non-food items

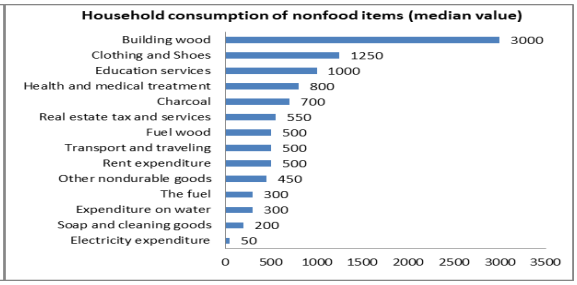












Source: Authors' calculations based on Food Security Household Survey in Kassala State (2019)

Household consumption of food

A. Total sample

Consumption of food items	N	Minimum	Maximum	Mean	Std. Deviation	Share in Mean Value (%)
Sorghum	487	0	778000	14371.1	58407.6	54.37%
Millet	487	0	300000	3285	15449.9	12.43%
Wheat	487	0	20000	302.6	1526.6	1.14%
Sesame	486	0	30000	3128	2487.5	11.84%
Groundnut	487	0	12000	125.1	305.6	0.47%
Fruit	486	0	50000	335	2734	1.27%
Legumes	486	0	26400	735.5	2768.6	2.78%
Livestock Products	486	0	80000	3303	7656.8	12.50%
Fish	486	0	7200	230.8	1032.6	0.87%
Chicken	487	0	15000	204.01	1093.2	0.77%
Eggs	487	0	5500	149.9	556.5	0.57%
Bread	487	0	42200	2707.1	6059.8	10.24%
Purchased meal	487	0	24000	270.7	1920.9	1.02%
Total food consumed	485	180	800000	26430	65823	100%

B. Selected sample of consumption of food items

Consumption of food items	N	Minimum	Maximum	Mean	Median	Std. Deviation
Sorghum	394	90	36420	7289.6	6000	6526.08
Millet	174	150	37000	5851.1	2450	7143.5
Wheat	42	15	11000	3032.9	2000	3088.06
Sesame	11	300	15000	6321.8	6000	5503.9
Groundnut	17	120	12000	3583.5	3000	3426.9
Fruit	48	30	11250	1496.1	150	2336.8
Legumes	134	100	13200	1879.5	780	2325.6
Livestock Products	170	100	18000	5265.6	3000	5136.8
Fish	42	150	7200	2670.7	1440	2437
Chicken	49	120	10000	1719.1	1000	2195.2
Eggs	87	100	4000	664.5	240	752.8
Bread	118	100	20000	8023.2	7200	5411.7
Purchased meal	56	100	20000	1533.5	300	3440.6
Total food consumed	454	1000	58800	16633.1	13230	12887.07

C. Adjusted sample of consumption of food items

Food item	N	Zero percentage	Min	Max	Eliminating only outliers			Eliminating both outliers and zero values		
					Mean	Median	Std dev	Mean	Median	Std dev
Sorghum	456	14.5	0	57600	6662.1	4000	8153.1	7789.6	6000	8303.4
Millet	456	62.3	0	48100	2223.6	0	5530.6	5895.1	2325	7721.2
Wheat	456	90.8	0	20000	301.3	0	1508.9	3271.1	2000	3913.5
Sesame	456	97.4	0	30000	234.7	0	2042.8	8920	7000	9385.7

Groundnut	456	96.7	0	12000	103.9	0	824.1	3161.3	3000	3423.2
Fruit	456	89.5	0	21000	248.9	0	1608.4	2345.3	245	4474.1
Legumes	456	69.1	0	26400	725.4	0	2586.3	2346.1	760	4232
Livestock Products	456	55.9	0	43200	3039.4	0	6775.9	6895.2	3000	8816.4
Fish	456	91	0	7200	246.7	0	1064.4	2732.2	1440	2434.1
Chicken	456	89.3	0	15000	183.5	0	1036.6	1708	900	2743.5
Eggs	456	80.9	0	5500	135.4	0	502.4	709.7	240	960.9
Bread	456	71.9	0	42200	2645.1	0	5981.3	9423.5	7250	7987.3
Purchased meat	456	87.3	0	21600	235.8	0	1640.1	1854.1	300	4291.8
Total food consumed	456	zero	180	67000	16983.1	13100	13758.5	16983.1	13100	13758.5

Source: Authors' calculations based on Food Security Household Survey in Kassala State (2019)

Table 12 - Household consumption of nonfood items

A. Total sample						
Consumption of nonfood items	N	Minimum	Maximum	Mean	Std. Deviation	Share in Mean Value (%)
Soap and cleaning goods	486	0	24000	358.3	1121.5	3.94%
Other nondurable goods	485	0	10000	209.3	806.9	2.30%
Electricity expenditure	486	0	7500	62.3	483.4	0.68%
Expenditure on water	486	0	40000	692.3	2453.6	7.61%
Rent expenditure	487	0	39600	1053.5	2682.3	11.58%
Real estate tax and services	485	0	30000	174.7	1749.9	1.92%
The fuel	476	0	9000	323.8	708.8	3.56%
Transport and traveling	486	0	12000	213.3	369.1	2.35%
Clothing and Shoes	486	0	40000	692.3	2453.6	7.61%
Education services	486	0	20000	519.4	1767.1	5.71%
Health and medical treatment	487	0	40000	1024.3	3601.7	11.26%
Fuel wood	487	0	60000	477.7	2869	5.25%
Building wood	487	0	70000	1939.5	9014.7	21.33%
Charcoal	487	0	39600	1035.6	2682.3	11.39%
All nonfood consumption	487	0	831710	9094.9	39659.2	100%
B. Selected sample of consumption of nonfood items						
Consumption of nonfood items	N	Minimum	Maximum	Mean	Median	Std. Deviation
Soap and cleaning goods	115	10	2400	352.7	200	1353.0
Other nondurable goods	117	110	10000	840	450	1478.4
Electricity expenditure	162	10	900	79.9	50	86.2
Expenditure on water	395	10	5440	517.8	300	644.5
Rent expenditure	6	35	1500	622.5	500	541.5
Real estate tax and services	8	40	900	580	550	275.5
The fuel	292	10	4500	466.2	300	465.5
Transport and traveling	79	30	5000	919.6	500	1048.8
Clothing and Shoes	139	30	10000	1847.7	1250	1969.3
Education services	115	20	7000	1429.9	1000	1377.8
Health and medical treatment	252	100	20000	1534.7	800	2904.9
Fuel wood	152	100	8000	1134.4	500	1446.7
Building wood	31	120	25000	7888.3	3000	8940.7
Charcoal	257	100	18000	1730.7	700	2243.7
All nonfood consumption	446	155	29450	4873.1	2975	5282.4
C. Adjusted sample of consumption of nonfood items						

Item	N	Zero percentage	Min	Max	Eliminating only outliers			Eliminating both outliers and zero values		
					Mean	Median	Std dev	Mean	Median	Std dev
Soap and cleaning	456	4.6	0	2400	558.7	0	2345.9	306.2	240	290.7

Other nondurable goods	456	66.1	0	10000	378.9	0	1182.1	590.5	250	1315.3
Electricity	456	60.9	0	7500	64.2	0	499.4	164.1	50	789.4
Water	456	17.6	0	7200	599.6	0	2315.7	548.8	300	740.4
Rent	456	98	0	1500	9.5	0	93.9	477.8	500	498.6
Real estate tax and services	456	96.7	0	1500	23.2	0	141.3	701	750	369.5
The fuel	456	38.2	0	4500	284.2	200	433.7	459.9	300	473
Transport and travelling	456	84.6	0	12000	158.2	0	806.3	1028.6	400	1835.5
Clothing and shoes	456	73.4	0	40000	378.9	0	1182.2	2254.8	1400	4065.1
Education services	456	77.6	0	12000	378.9	0	1182.2	1690.2	1000	2010.6
Health and medical treatment	456	47.4	0	39700	916.4	150	3172.1	1740.8	700	4208.5
Fuel wood	456	84.9	0	8000	558.7	0	2345.9	1466.1	750	1778.5
Building wood	456	98	0	8000	558	0	2345.9	1821.1	950	2446.8
Charcoal	456	69.3	0	39600	558.7	0	2345.9	1819.7	900	3962.8
All nonfood consumption	456	1.1	0	61390	6092.1	2975	9210.3	6159.6	3020	9238.8

Source: Authors' calculations based on Food Security Household Survey in Kassala State (2019)

Appendix 6: Household Food Insecurity Access Scale (HFIAS) questionnaire module

No	Questions	Response	Code
1.	In the past [4 weeks/30 days] did you worry that your household would not have enough food?	0=NO (Skip to Q2) 1=Yes	|___|
1.a	How often did this happen in the past [4 weeks/30 days]?	1 = Rarely (1-2 times) 2 = Sometimes (3-10 times) 3 = Often (more than 10 times)	|___|
2	In the past [4 weeks/30 days] were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	0=NO (Skip to Q3) 1=Yes	|___|
2.a	How often did this happen in the past [4 weeks/30 days]?	1 = Rarely (1-2 times) 2 = Sometimes (3-10 times) 3 = Often (more than 10 times)	|___|
3	In the past [4 weeks/30 days] did you or any household member have to eat a limited variety of foods due to a lack of resources?	0=NO (Skip to Q4) 1=Yes	|___|
3.a	How often did this happen in the past [4 weeks/30 days]?	1 = Rarely (1-2 times) 2 = Sometimes (3-10 times) 3 = Often (more than 10 times)	|___|
4	In the past [4 weeks/30 days] did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0=NO (Skip to Q5) 1=Yes	|___|
4.a	How often did this happen in the past [4 weeks/30 days]?	1 = Rarely (1-2 times) 2 = Sometimes (3-10 times) 3 = Often (more than 10 times)	|___|
5	In the past [4 weeks/30 days] did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0=NO (Skip to Q6) 1=Yes	|___|
5.a	How often did this happen in the past [4 weeks/30 days]?	1 = Rarely (1-2 times) 2 = Sometimes (3-10 times) 3 = Often (more than 10 times)	|___|
6	In the past [4 weeks/30 days] did you or any other household member have to eat fewer meals in a day because there was not enough food?	0=NO (Skip to Q7) 1=Yes	|___|
6.a	How often did this happen in the past [4 weeks/30 days]?	1 = Rarely (1-2 times) 2 = Sometimes (3-10 times) 3 = Often (more than 10 times)	|___|
7	In the past [4 weeks/30 days] was there ever no food to eat of any kind in your household because of lack of resources to get food?	0=NO (Skip to Q8) 1=Yes	|___|
7.a	How often did this happen in the past [4 weeks/30 days]?	1 = Rarely (1-2 times) 2 = Sometimes (3-10 times) 3 = Often (more than 10 times)	|___|
8	In the past [4 weeks/ 30 days] did you or any household member go to sleep at night hungry because there was not enough food?	0=NO (Skip to Q9) 1=Yes	|___|
8.a	How often did this happen in the past [4 weeks/30 days]?	1 = Rarely (1-2 times) 2 = Sometimes (3-10 times) 3 = Often (more than 10 times)	|___|
9	In the past [4 weeks/30days] did you or any household member go a whole day and night without eating anything because there was not enough food?	0=NO (questionnaire is finished) 1=Yes	|___|
9.a	How often did this happen in the past [4 weeks/30 days]?	1 = Rarely (1-2 times) 2 = Sometimes (3-10 times) 3 = Often (more than 10 times)	|___|

Source: Coates, et al. (2007), cited in Tiwari et al. (2013), pp. 41-42.

References

Abdalla, E., M, and Ebaidalla, M. E., and Ahmed, H. M., (2016) “Impact of Non-farm Income Activities on Food Security in Kassala,” Kassala University Journal, Vol. 8, No. 7, pp. 176-201.

Abdalla, E., M, and Ebaidalla, M. E., (2012) “Determinants of Small Farmer's Access to the Formal Credit Institutions in Kassala State, East Sudan,” Kassala University Journal, Vol. 1, June (2012), pp. 31-70

Abdalla, E. M., and Abdel Ati, H., (2015) Informal Cross –Border Trade in Eastern Sudan, A case study from Kassala and Gedarif states " Sudan Working Paper (SWP) 2016:6 CHR. MICHELSEN Institute (CMI), University of Bergen , Norway.

Abu Sin and Abbakar (2007) “Kassala: the Bridging State in Eastern Sudan”, in Ahmed and Manger (eds.): Peace in Eastern Sudan: some Important Aspect for Consideration. University of Bergen, Norway.

Bertelli, O., and Macours, K., (2014) “Food security and agriculture in developing countries: Measurement and hypotheses for impact evaluations,” Foodsecure Working Paper No. 21. LEI Wageningen.

Banerjee, A., Duflo, E., Goldberg, N., Karlan, D., Osei, R., Parienté, W., Shapiro, J., Thuysbaert, B., and Udry, C. (2015). “A multifaceted program causes lasting progress for the very poor: evidence from six countries,” Science. 348(6236): 1260799.

Barrett, C. B. (2010). "Measuring food insecurity," *Science* 327, no. 5967: 825-828.

Barrett, C. B., Carter, M.R. and Timmer, C.P. (2010). "A Century-long Perspective on Agricultural Development,” American Journal of Agricultural Economics, 92(2): 447-468.

Barrett, C. B., Christiansen, L., Sheahan, M. and Shimeles, A. (2017) “On the Structural Transformation of Rural Africa,” Journal of African Economies, 26 (AERC Supplement 1): i11-i35.

Bonanno, A., and Li, J., (2011) “Food Insecurity and Food Access,” Discussion Paper No. 1399-12, Institute for Research on Poverty (IRP), University of Wisconsin–Madison. November 2011: www.irp.wisc.edu/publications/dps/pdfs/dp139912.pdf.

Central Bureau of Statistics(CBS),Sudan,2015 "Multiple Indicator Cluster Survey(MICS), 2014: Final Report, December 2015".

Central Bureau of Statistics (CBS) and UNICEF (2014) “Multiple Indicator Cluster Survey 2014 of Sudan,” Final Report, Khartoum, Sudan, UNICEF, Central Bureau of Statistics (CBS), December 2015, pp. 39 - 40.

Chapter 2 Food security: concepts and measurement: http://www.fao.org/docrep/005/y4671e/y4671e06.htm, accessed July 10, 2018.

Clay, E. (2002) “Food Security: Concepts and Measurement,” Paper for FAO Expert Consultation on Trade and Food Security: Conceptualising the Linkages, Rome, 11-12 July 2002. Published as Chapter 2 of Trade Reforms and Food Security: conceptualising the linkages. Rome: FAO, 2003.

Coates, J., Frongillo, E., Rogers, B. L., Webb, P., Wilde, P. E., and Houser, R., (2006)“Commonalities in the experience of household food insecurity across cultures: what are measures missing?” Journal of Nutrition 136.

Coates, J., A. Swindale, and P. Bilinsky (2007). “Household Food Insecurity Access Scale (HFIAS) for Measurement of Household Food Access: Indicator Guide (v.3).” Washington, D.C.: Food and Nutrition Technical Assistance Project, Academy for Educational Development.

Devereux, S. (2006) “Distinguishing between chronic and transitory food insecurity in emergency needs assessments,” SENAC, WFP, Rome.

de Janvry, A., Emerick, K., Sadoulet, E. and Dar, M. (2016) “The agricultural technology adoption puzzle: what can we learn from field experiments?,” Fondation pour les études et recherches sur le développement international Working Paper: FERDI-WP-178.

de Janvry, A. and Sadoulet, E. (2010) “Agriculture for development in sub-Saharan Africa: An update,” African Journal of Agricultural and Resource Economics. 5(1):194-204.

de Laiglesia, J. R., (2006) “International Bottlenecks for Agricultural Development,” OECD Development Centre, Working Paper 248.

Dossa, C., Meinzen-Dicka, R., Quisumbinga, A. and Theis S. (2017) “Women in agriculture: Four myths,” Global Food Security. 16 (2018) 69–74, Elsevier B.V., Elsevier Science, Amsterdam, the Netherlands.

FAO (Food and Agriculture Organization of the United Nations) (2019) Statistic, accessed 29 January, 2019.

FAO (2018) Food Security Indicators, 11 September 2018, accessed 3 March 2019.

Food and Agricultural Organization (FAO) '(2016) 'The Food Security Policy and Strategy Capacity Building Project (FSPSCBP),' Food and Agricultural Organization (FAO).

Food and Agriculture Organization (FAO) Policy Assistance Division (TCA) (2006) "Food Security and Agricultural Development in Sub-Saharan Africa Building a case for more public support," Policy Brief No. 1, Rome.

FAO (2006) "Integrated Food Security and Humanitarian Phase Classification (IPC) Framework," ESA Policy Brief, 06-01. ftp://ftp.fao.org/es/ESA/policybriefs/pb_01.pdf.

FAO (1996) World Food Summit: Rome Declaration and Plan of Action. October 1996. www.fao.org/wfs

FAO Food Security Concept and Framework: www.fao.org/elearning/course/FC/en/ppt/trainerresources/presentation0411.ppt, accessed July 10, 2018.

Food and Agriculture Organization (FAO) (1983) "World Food Security: a Reappraisal of the Concepts and Approaches. Director Generals Report," Rome.

FAO(2012) Special Report: Quasi Crop and Food supply Assessment Mission to Sudan, http://www.fao.org/sudanfoodsecurity

FMoH (2015), Sudan Nutrition Sector Bulletin, Issue No 1, August 2015.

Food Security Household Survey in Kassala State (2019)

Ganpat, W. and Isaac, W.-A. (2016) "Agricultural Development and Food Security in Developing Nation," IGI Global , Hershey, USA, October, 2016.

Hatlebakk, M. (2018) "Norwegian aid to food security, nutrition and agriculture." CMI Report 2018-01, Bergen, Norway, 2018.

Heidhues, F., Atsain, A., Nyangito, H. Padilla, M., Ghersi, G. and Le Vallée, J. (2004) "Development Strategies and Food and Nutrition Security in Africa: An Assessment," 2020 Discussion Paper No. 38.

Herrmann, M. (2009) "Food security and agricultural development in times of high commodity prices," United Nations Conference on Trade and Development (UNCTAD), UNCTAD Discussion Paper No. 196, November 2009, UNCTAD/OSG/DP/2009/4, Geneva, Switzerland.

IPC (2013) 'Integrated Food Security Phase Classification (IPC),' February – April 2013

Kassala State (Emergency Profile), "Emergency and Humanitarian Action: Saving Life Protection Health", 1st Edition 2014.

Maxwell, D. G., (1995) "Measuring food insecurity: the frequency and severity of coping strategies," Technical report, IFPRI.

Nour, S. (2013), "Technological Change and Skill Development in Sudan," Springer, Berlin, Heidelberg, Germany, 2013, pp. 35-42.

Nour, S. and Ebaidalla M. (2020) 'The Impact of Agricultural Land ownership on Child nutritional status: Evidence from Rural Sudan,' African Journal of Agricultural and Resource Economics (AfJARE), the African Association of Agricultural Economists (AAAE) (forthcoming, 2020).

Pingali, P., Alinovi, L. and Sutton, J. (2005) "Food Security in complex emergencies: enhancing food system resilience. *Disasters,"* Volume 29, June 2005.

Sheahan, M. and Barrett, C.B. (2017) "Ten striking facts about agricultural input use in Sub-Saharan Africa," Food Policy. 67: 12-25.

Swindindale, A. and P. Bilinsky (2006). "Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide (v2)," Washington, D.C.: Food and Nutrition Technical Assistance Project, Academy for Educational Development.

The High Level Panel of Experts on Food Security and Nutrition (HLPE) (2016) "Sustainable agricultural development for food security and nutrition: what roles for livestock? A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome, 2016.

The United Nations Children's Fund (UNICEF) (2014) 'Sudan Multiple Indicator Cluster Survey,' http://mics.unicef.org/surveys, accessed on 10 June, 2019.

The United Nations Development Programme (UNDP) - Human Development Indices and Indicators UNDP – HDR (2018) (2018) Statistical Update, pp. 52-53, 68-69.

The technical report of the integrated food security classification (IPC, 2013) 'Republic of Sudan: Current Acute Food Insecurity, Overview in Sudan, Food Security Phase Classification (IPC), February – April 2013.

The World Bank (2007) 'From Agriculture to Nutrition: Pathways Synergies and Outcome,' Washington, DC.: the World Bank.

The World Bank Data World Development Indicators database (2018) accessed 14 November 2018

The World Bank – The World Development Indicators Database (WDI) (2019)- Sudan Country Profile (2019), accessed, 29 January 2019.

The World Food Summit 1996, "Rome Declaration on World Food Security."

Tiwari, S., Skoufias, E., and Sherpa, M., (2013) "Shorter, cheaper, quicker, better: linking measures of household food security to nutritional outcomes in Bangladesh, Nepal, Pakistan, Uganda, and Tanzania," World Bank. Policy Research Working Paper 6584, the World Bank, Washington, D.C..

USAID: https://www.usaid.gov/sudan/agriculture-and-food-security, accessed 29 January 2019.

von Grebmer, K., Bernstein, J., Hammond, L., Patterson, F., Sonntag, A., Klaus, L., Fahlbusch, J., Towey, O., Foley, C., Gitter, S., Ekstrom, K., and Fritschel. H., (2018) '2018 Global Hunger Index: Forced Migration and Hunger,' Bonn and Dublin: Welthungerhilfe and Concern Worldwide, pp. 1, 49-50. https://www.globalhungerindex.org/sudan.html, accessed 29 January 2019.

World Food Programme, (WFP) (2012) "Comprehensive food security assessment," United Nations World Food Programme (WFP 2012), December 2011 and January 2012.World Food Programme, (WFP) (2012) "Comprehensive Food Security Assessment in Kassala State, Sudan," WFP, Sudan.

World Food Programme (2019): https://www1.wfp.org/countries/sudan, accessed 29 January 2019

Chr. Michelsen Institute (CMI) is an independent, non-profit research institution and a major international centre in policy-oriented and applied development research. Focus is on development and human rights issues and on international conditions that affect such issues. The geographical focus is Sub-Saharan Africa, Southern and Central Asia, the Middle East and Latin America.

CMI combines applied and theoretical research. CMI research intends to assist policy formulation, improve the basis for decision-making and promote public debate on international development issues.

Engage with us

CMInorway
cmi_no
cmi.no
cmi.no

Contact us
Phone: 47 93 80 00 (from Norway)
Phone: +47 55 70 55 65 (from abroad)

cmi@cmi.no
www.cmi.no

P.O. Box 6033,
N-5892 Bergen, Norway
Jekteviksbakken 31, Bergen

ISSN 1890-5056 ISBN 978-82-8062-752-0 (print) ISBN 978-82-8062-753-7 (PDF)