ISDC INTERNATIONAL SECURITY AND DEVELOPMENT CENTER

BASELINE REPORT

Impact Analysis of the FAO Sudan CERF Project: 'Restoring food and nutrition security of affected farming and pastoral communities in Sudan'

isdc.org

17 May 2023

Authors
Dr Ghassan Baliki
Dr Ayşegül Kayaoğlu
Dorothee Weiffen
Mariami Marsagishvili
Prof Tilman Brück

Contact lead author
baliki@isdc.org

ISDC - International Security and Development Center gGmbH
Auguststr. 89, 10117
Berlin, Germany

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ABS	Access to Basic Services
AC	Adaptive Capacity
AST	Assets
CARI	Consolidated Approach to Reporting Indicators
CEA	Cost-Effectiveness Analysis
CERF	Central Emergency Response Fund
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station data
DID	Difference In Difference
FAO	Food and Agriculture Organisation of the United Nations
FCS	Food Consumption Score
FIES	Food Insecurity Experience Scale
FSTS	Food Security Technical Secretariat
Ha	Hectares
HH	Household
HHH	Household Head
HHS	Household Hunger Scale
IDP	Internally Displaced Persons
IPC	Integrated Food Security Phase Classification
IPM	Integrated Pest Management
ISDC	International Security and Development Center
MDE	Minimum Detectable Effect
PDS	Participatory Disease Surveillance
RCI	Resilience Capacity Index
RIMA	Resilience Index Measurement Analysis
SMD	Standardized Mean Difference
SSN	Social Safety Nets
ToT	Training of Trainers
WFP	United Nations World Food Program

Executive Summary

Background: The agricultural sector in Sudan is grappling with multiple challenges, including unpredictable rainfall patterns, outbreaks of pests and diseases, limited access to agricultural inputs, irrigation difficulties and, more recently, the onset of violence. Insufficient harvests result in food shortages and insecurity. In light of these circumstances, FAO Sudan provided emergency support to over 350,000 households across 42 localities in 14 states under CERF-funded project *"Restoring food and nutrition security of farming and pastoral communities impacted in Sudan*". The project, which was implemented from June to November 2022, aimed to address the food and nutrition needs of farming and pastoralist households by distributing seeds, providing livestock vaccination, and supplying mineral licks.

Study Objective and Design: The objective of this study is to assess the immediate impacts of the CERF program on agriculture and livestock production, as well as household welfare including income generation, food security and resilience. To conduct this assessment, we have developed a quasi-experimental impact evaluation approach comparing beneficiary households with non-beneficiary households. This involves gathering data from two groups of households: those residing in targeted villages who receive support, and those residing in non-targeted villages who have not received any intervention. Targeted villages were selected using a random proportional sampling technique based on the type of intervention received: seeds only (intervention 1), vaccination only (intervention 2), or both interventions. Control villages were selected by identifying Sudanese villages similar to the targeted villages in terms of governance and agro-climatic conditions. In total, we collected baseline data from 8,146 households across these 14 States, which took place in November 2022.

Descriptive findings: This report presents a descriptive analysis of the baseline dataset to provide a snapshot of the recent welfare and agricultural situation of farming households living in Sudan. In addition to the strong sample balance between beneficiary and non-beneficiary groups in terms of characteristics and capacities, our baseline findings show:

- ***Livelihoods and assets:*** Crop farming generates the biggest portion of income although income sources differ depending on the gender of the household head and residency status. On average, IDP households earn a considerable portion of their income from wage work, while nomadic households get the majority of their revenue from livestock. Furthermore, female-headed households earn a higher proportion of their income through wage work and transfers or remittances. In general, asset ownership (both productive and non-productive) is very low. Female-headed households are less mobile and have less time available for generating income.
- ***Crop and livestock production:*** Only 2/3 of rural households possess their own land and 37% rent land for farming. Moreover, female-headed households, IDP and nomadic households have much smaller land sizes. Sorghum, peanuts, and millet are the three major crops cultivated in 2021. Again, the choice of crops varies by state and by the gender of the household head. Livestock ownership is also low in general, however it is lower in female-headed households irrespective of households' residency status. Dependence of female-headed households on crop production for livelihoods increases their vulnerability to food insecurity and shocks. Apart from seeds, agricultural input use is scarce, and crop yields and livestock dairy productivity are very low.
- ***Access to services:*** All essential amenities are located at significant average distances. In addition, dwellings are all within a one-hour walking distance from input, land, and output markets. Except for land, accessing all other essential services, including drinking water, is more difficult for nomadic and returnee households.
- ***Food Security:*** 49% of households are classified as food insecure, according to FIES classifications. Moreover, almost half of female-headed households and more than half of the IDP and returnee households have lower than acceptable food security levels. Food security is also lower in Darfur states.
- ***Shocks and resilience:*** 96% of the households reported being exposed to at least one type of shock, highlighting high vulnerability to shocks in Sudan. Majority of

households experienced unusually high levels of food and non-food inflation, as well as unexpected income losses and unusually high levels of agricultural pests and diseases. In addition to high levels of shock exposure, the composite resilience index in our sample is 41.6 out of 100. Female-headed households are more vulnerable than male-headed households, with a lower resilience capacity index, on average. Furthermore, returnee and IDP households have weaker resilience than resident and nomadic households.

- ***Gender norms:*** Regardless of the gender of household heads or the residence status of households, we find that respondents' gender norms are, on average, not in favor of women. Importantly, women have very little influence on agricultural production decisions. Surprisingly, this is true even in dwellings headed by women. In other words, when it comes to gender norms and the ability of women to make decisions in agricultural production, the heterogeneity across all other welfare variables is no longer visible.

Analytical findings: Using baseline data to investigate the relationship between exposure to shocks and food security and household profiles, we find that:

- Female-headed households have lower food security levels even after accounting for various household and state-level characteristics. Nevertheless, improvements in food security are correlated with higher educational levels and stronger productive and non-productive asset capacity. Strengthening the productive capacity and household wealth will hence absorb any gender differences in food security and offset the negative impacts from adverse shocks.
- Higher income share from crop production is not correlated with stronger household food security while a higher income share from livestock keeping significantly improves it. Moreover, households with higher income from livestock production are less inclined to use harmful coping mechanisms, such as child labor or child marriage, to deal with lack of money or resources to purchase food.
- Exposure to personal and household-level economic shocks, such as job or income loss have more significant negative impact on household resilience compared to

agro-climatic shocks or violent conflict. Households facing economic shocks use multiple harmful coping strategies simultaneously to deal with food shortage or lack of money.

Lessons learned: Based on these descriptive and analytical findings from the baseline data, we derive the following three lessons.

- ➔ ***Lesson 1:*** Compared to crop farming, income from livestock keeping is crucial to improving the food security and resilience of households in Sudan. Therefore, FAO's veterinary interventions were both necessary and timely to enhance the animal welfare and subsequently the livelihoods of rural Sudanese households.
- ➔ ***Lesson 2:*** Because practically all farmers rely on rainfed irrigation and use low inputs, they are more susceptible to droughts and pests. This leads to low productivity and income from farming, which limits crop farmers to increase their household food security. In order to address food insecurity in Sudan, it is essential to include the development of irrigation systems and to sustainability improve the access to livestock and farming inputs.
- ➔ ***Lesson 3:*** Food security is significantly correlated with agricultural knowledge, although rural household heads typically have low levels of schooling. Thus, combating food insecurity in Sudan requires investment in agricultural training and capacity building of farmers.
- ➔ **Lesson 4:** Female-headed households, internally displaced households, and returnees in Sudan face multiple challenges and require more support to improve their asset and adaptive capacity, income generation opportunities through agriculture, their food security levels, and their resilience against future shocks.

Next Steps: Depending on the political and security situation in Sudan, we aim to collect endline data to estimate and test through causal inference if the CERF program improved the welfare outcomes of households. We will explore with FAO Sudan colleagues plausible and appropriate ways to move this study forward, which can also be used to inform much-needed emergency programing to address the repercussions of the ongoing crises.

1. Introduction

The agricultural sector in Sudan is currently facing many challenges, including high rainfall variability, outbreaks of pests and diseases, agricultural input unavailability and inaccessibility and irrigation difficulties (FAO, 2022)[1]. Compared to the average of the previous five years, the production of the two main staple crops, sorghum and millet, decreased in 2021 by 28% and 44%, respectively (FAO, 2022). For example, rainfall variability coupled with inter-communal violence had a major negative impact on millet production in Northern Darfur state, where production was estimated to be 75% below the average of the previous five years. Heavy rainfall, causing floods, further damaged the agricultural production and infrastructure, mostly in the country's southern states. Furthermore, insufficient harvests created a food shortage, making the country more dependent on food imports. The reliance on food imports has further exacerbated food insecurity, especially since international wheat prices are soaring due to the Russia-Ukraine war (FAO, 2022). The IPC assessment conducted for the period of April 2021 - February 2022 showed that approximately 16% of the population is categorized under the “Crisis” or “Emergency” phase of food insecurity (FAO, 2022). These figures are particularly high in conflict-affected regions of North and West Darfur, where the prevalence of the population under threat of acute hunger is 22% and 32%, respectively (IPC, 2023).[2]

Against this background, FAO Sudan is implementing the *“Restoring food and nutrition security of affected farming and pastoral communities in Sudan”* project funded under CERF. FAO Sudan implemented the program between June and November 2022 in 14 States across the country, providing farming and pastoralists households with seeds, livestock vaccination and mineral licks. The objective of this program is to restore crop and

[1] FAO. 2022. *Special report – 2021 FAO Crop and Food Supply Assessment Mission to Sudan. 21 March 2022.* Rome. https://doi.org/10.4060/cb9122en

[2] IPC. 2023. *Sudan: acute Food Insecurity Analysis October 2022 – February, 2023*. [online] Available at: https://www.ipcinfo.org/ipc-country-analysis/details-map/en/c/1155716/?iso3=SDN [Accessed 6 April 2023].

animal-sourced food availability to ensure adequate food and nutrition security for the affected population.

In this report, we present the descriptive and analytical findings from the baseline data, part of the impact evaluation conducted by ISDC to estimate the overall program impact on crop and livestock production and productivity, and food and nutritional security outcomes, with particular focus on the resilience of households against adverse shocks. First, we provide a detailed snapshot of the current status of households, comparing differences in outcomes of food security and resilience indicators, agricultural and livestock production for the overall sample at baseline. Where meaningful, we divide the findings by location, gender, and household residency status (i.e., residents, IDPs, and returnees). Second, we test baseline pre-harvest differences between the beneficiary and non-beneficiary villages in our study sample, ensuring that our study design is balanced at the village level. This is key for the impact analysis we will conduct after collecting the endline data with the same sample. Third, we provide three key empirical analyses to show if the bilateral associations that we present in the explanatory analysis still hold when we control for relevant household characteristics. We first present how various shocks, including conflict and natural disasters, are associated with food security at the state-level. Finally, we provide evidence about the role of household characteristics in the use of coping strategies, which is followed by an analysis of the role of exposure to shocks in the use of these coping strategies.

The baseline report is structured as follows: Section 2 presents an overview of the FAO program activities, Section 3 describes the design adopted to study the impact of the program, the sampling strategy, the data collection and processing, and safeguarding and ethics. Section 4 presents the baseline results, providing a descriptive snapshot of the current status among households engaged in farming and livestock keeping in Sudan. Section 5 provides analytical findings to understand the relationship between shocks, food security, and coping strategies used by households in the event of various shocks. Section 6 concludes and outlines the next steps of the impact evaluation.

2. FAO CERF Program

Based on the 2022 Humanitarian Needs Overview and FAO Rapid Need Assessment conducted in November 2021, FAO prioritized 42 localities in 14 states that are facing high vulnerability to acute food insecurity and malnutrition (IPC Phase 3 and above). The vulnerability of the farming and pastoral communities in these localities is heightened by the protracted crisis, the ongoing economic hardships at the macro and micro levels, poor harvests due to dry spells and high rainfall variability, conflict, and high food and input prices. In 2022, the food insecurity situation was expected to be further aggravated by the war in Ukraine and its impact on food prices. Sudan is dependent on food imports from the Black Sea region, with about 30% of its total wheat requirement being imported from Russia and Ukraine alone. Further interruptions in grain flow into Sudan increased prices and made it more difficult to import wheat. Currently, local prices of wheat are over US$ 550 per ton, an increase of 180 percent compared to last year.

In response to these challenges, FAO is implementing a large support program targeted at farming and pastoral communities in Sudan by providing **emergency agriculture and livestock inputs**. The overall objective of this program is to restore crop and animal-sourced food availability to ensure adequate food and nutrition security for the affected population through time-critical interventions. More specifically, the program aims to enhance **the productive capacity of 352,511 vulnerable households** (including IDPs, residents, and refugees) by providing emergency agriculture and livestock inputs and refresher training to access sufficient food and income **in 42 localities across 14 states in Sudan**. Figure 1 presents the locations of the states and localities included in the program.

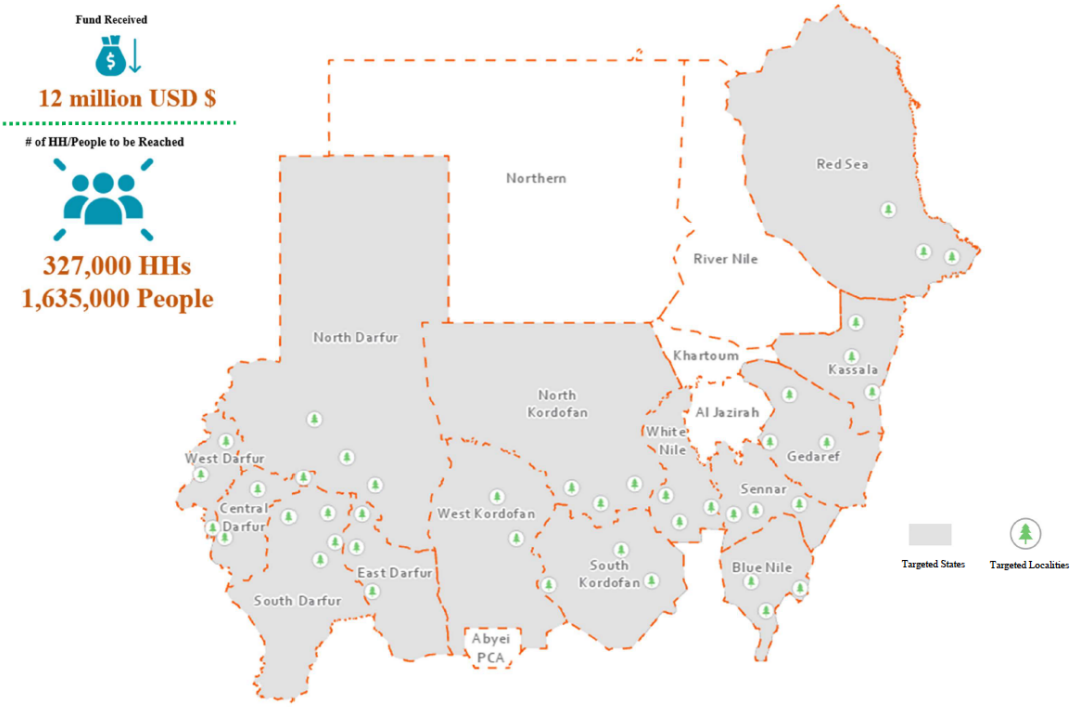
2.1. Interventions

The interventions include both agricultural and livestock assistance, which aim to immediately reduce dependence on emergency food assistance and provide a basis for medium- and long-term recovery. The interventions include:

➔ **Intervention 1:** the distribution of certified crop, legume and vegetable seeds, and the provision of refresher on-job training on good agronomic practices.

➔ **Intervention 2:** support in veterinary services, including providing livestock vaccination, mineral licks, and on-job training on improved animal husbandry practices.

Figure 1. Map of targeted states and localities in Sudan under CERF (as of July 2022)



Note: Map provided by FAO Sudan

Table 1 shows the amount of distributed seeds *in kilotons* across the 14 states in Sudan. In total, 5.3 *Megatons* (5,291 *kilotons*) of seeds were distributed under the CERF program, with the highest amount distributed in the Darfur states, as shown in the first column. The second column of Table 1 shows the number of animals that received vaccinations across these 14 states. The CERF program provided vaccinations to about 4 million animals.

Table 1. *FAO CERF 2022: the amount of seeds and the number of animals vaccinated by state*

State	*Seeds (Kilotons)*	*Vaccination (# of animals)*
Kassala	267	200,000
Central Darfur	399.33	200,000
North Darfur	477.2	200,000
Sinnar	230	200,000
Red Sea	333.56	50,000
White Nile	306.58	400,000
East Darfur	655.2	500,000
North Kordofan	279.46	300,000
Gadarif	220	50,000
Blue Nile	357.03	250,000
South Kordofan	249.03	450,000
West Kordofan	450.5	500,000
South Darfur	510	450,000
West Darfur	557	250,000
Total	**5,291.89**	**4 million**

Note: These numbers were provided to us directly by FAO Sudan.

Table 2 shows the number and distribution of beneficiary households across states and intervention types (intervention 1 or 2). Under Intervention 1, FAO provided seeds to **267,000 farming households** living in 87 localities in 14 states. In addition to the direct provision of agricultural support to households, Intervention 1 also supported 42 crop protection committees in Darfur states to reduce crop destruction and promote peaceful coexistence between farmers and herders. Moreover, another indirect agricultural support to households in Intervention 1 was provided through the provision of ToT training to 56 humanitarian actors on the use of improved agronomic practices, including post-harvest losses and Integrated Pest Management (IPM) to protect and enhance crop

production. However, indirect support is assumed to be realized in all beneficiary villages as it does not have a geographical focus.

Table 2. *Number of FAO CERF beneficiaries by Intervention group and state*

	Intervention 1: Seeds distribution		Intervention 2: Livestock vaccination and mineral lick distribution	
State	**# localities**	**# of HHs**	**# localities**	**# of HHs**
North Darfur	7	19,000	3	5,500
Sennar	7	16,000	3	3,750
Blue Nile	7	26,000	7	3,750
Red Sea	5	19,000	3	1,251
East Darfur	6	21,000	4	7,000
West Darfur	7	19,000	4	8,250
White Nile	9	21,000	3	9,900
South Kordofan	5	17,000	3	8,400
Central Darfur	5	17,000	2	2,000
West Kordofan	5	17,000	2	7,500
South Darfur	6	21,000	3	7,000
Kassala	6	19,000	5	7,750
Gadarif	7	16,000	3	1,960
North Kordofan	5	19,000	3	11,500
Total	**87**	**267,000**	**48**	**85,511**

Note: These numbers were provided to us directly by FAO Sudan.

Under Intervention 2, FAO provided **85,511 agro-pastoralist and pastoralist households** with veterinary services. The aim of Intervention 2 is to reduce livestock losses due to diseases, improve the general health of animals and, thus, increase their milk and meat yields. With this aim, 8 million bacterial and viral vaccines are distributed, targeting 3 million sheep and goats and 1 million cattle against plague, sheep pox, Hemorrhagic Septicemia (HS) and black leg. In addition to vaccinations, 100 *megatons* of mineral licks

were distributed. Similar to Intervention 1, there was also on-the-job training on improved animal husbandry practices. Finally, 28 humanitarian actors have received ToT training on Participatory Disease Surveillance (PDS) to measure the impact of the animal health package.

Sudanese livestock keeper (image provided by the enumerators)

Table 3 presents a summary of the agricultural and livestock calendar in Sudan which is provided by FAO. As can be seen, the seeds for the main crops that were provided under Intervention 1 were distributed to households during the sowing of field crops in June and July 2022 so that they could be used in the current agricultural season. The harvest season for these crops takes place from October 2022 until February 2023, depending on the crop type. We added the dates of the baseline and the (planned) endline data collection to the crop calendar (the data will be discussed in detail in Section 3). The baseline data took place in November 2022 just at the start of the harvest season of the main crops (sorghum and millet) and the endline is planned to take place in May 2023 after the end of harvesting of all other types of crops including vegetables. Vaccinations are provided during the lambing/kidding season under Intervention 2 in October and November 2022.

Table 3. Agricultural production, implementation and data collection calendar

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Weather seasons					Rainy season							
Main crop calendar (sorghum, millet, groundnut)	Harvest		Land preparation			Sowing				Harvest		
Secondary crop calendar (vegetables)	Harvest							Vegetation growth period		Land preparation and sowing		
Livestock feeding calendar	Supplementary feeding period					Natural grazing						
Livestock breeding calendar	Breeding				Calving, kidding, lambing					Lambing, kidding		
Seeds CERF Intervention '22						*Intervention 1*						
Livestock CERF Interventions '22										*Intervention 2*		
Baseline Data Collection '22											*data*	
Endline Data Collection '23 (planned)					*data*							

2.2. Theory of change

The two intervention packages of the FAO Sudan CERF program have several impact channels on the beneficiaries:

Firstly, the agricultural inputs will enable the target population to resume basic productive activities in the short-term and on time for the next agricultural season. The package involves quick maturing vegetable and legume seeds, which are planted earlier in the season as an income-generating strategy to bridge the gap until the next harvest season, and augment emergency food assistance. That said, the income-generating and yield effects of this intervention need a longer time period to be realized. Yet, we expect that it will immediately and directly impact food consumption and security after harvesting.

Secondly, veterinary support, including vaccination and mineral licks, will improve the health and wellbeing of the animals. This will increase the productivity and reproductivity of the livestock owned by households, particularly cattle. Households will have access to more livestock products, which can be consumed at home or sold in the market. Any increase in the consumption of livestock food products at home will increase the intake of the necessary daily animal protein requirements, and consequently improve food security and nutritional diversity at the household level. Moreover, protecting livestock's health and productive capacity allows target families to sell surplus animals for higher prices and generate additional profit, which can be used to purchase food and non-food items.

In addition to these primary effects, there are secondary effects of these emergency interventions. The refreshment training provided with both intervention packages will lead to higher knowledge of agricultural and husbandry practices. The inclusion of women (mainly female-headed households) will strengthen women's economic and social empowerment and reduce the need for children and female members of households to work in risky sectors to deal with income or food shortages. We hypothesize that these secondary effects are likely to take place in the longer-term, particularly since the economic and social implications of agricultural support require more time to materialize.

In summary, in the short-term, interventions are expected to reduce food insecurity and improve household income through the consumption and sale of quick-maturing vegetables and higher productivity of livestock. In the long-term, however, we expect to see additional improvements in the food consumption score of beneficiary households, an increase in their non-food consumption, a rise in household income, improvements in women's empowerment, and a reduction in the use of harmful coping strategies to deal with adverse shocks (i.e., stronger resilience).

3. Impact Evaluation Design, Data and Methods

3.1. Study objective

The aim of the study is to assess the short-term impacts of the CERF program on agriculture and livestock production and productivity and on household welfare outcomes such as income generation, food security, and resilience. More specifically, we will answer the following learning questions:

1. Does receiving seeds and agricultural inputs improve crop production and productivity?
2. Does receiving livestock vaccination reduce livestock mortality and improve livestock productivity?
3. Does receiving either livestock or crop input support strengthen household food security, income diversification and resilience in the short-term?
4. Are there any additional combined effects of the two interventions on welfare outcomes in villages where both interventions were implemented?
5. Based on the detected impacts, are the interventions cost-effective?

3.2. Impact evaluation design

In order to address these learning questions, we design a **quasi-experimental impact evaluation** where we collect data from beneficiary households residing in targeted villages (who received intervention 1 or 2 or both) and non-beneficiary households living in control villages. Targeted villages and beneficiary households should, thus, have

received at least one intervention package, while the control group villages and non-beneficiary households should not have received any support from FAO. Including control group observations at baseline and endline, and randomly selecting both beneficiary and control villages ensure that any changes we observe among beneficiaries in before-versus-after comparisons are uniquely due to the program activities. In other words, such a design rules out that these observable differences are the result of any other changes that might have taken place during the implementation period.

In any quasi-experimental design, it is key to **interview the same beneficiary and control households before and after receiving support**, in "baseline" and "endline" surveys. The validity of the design requires that these "assignments" not be changed after baseline. However, for this program, FAO had already distributed the agricultural inputs of intervention 1 before we started designing and collecting the baseline data, and vaccination support was planned to take place in November 2022 (see Table 3). In this particular case, we have jointly, in collaboration with FAO Sudan, set a target to collect baseline data from beneficiaries of intervention 1 before the harvest season of the main crops, which starts in October 2022 and lasts three months, as this would be the second best option to capture welfare outcomes before the main crops are harvested, consumed and sold. This alternative approach will allow us to keep the before and after comparison valid, especially since the endline data is collected after the harvesting season of all crops. In the baseline data, we deliberately collected data on the previous crop production season and not the current one, which will be captured instead through the endline data.

3.3. Sampling procedure

Given the large scope and coverage of the interventions implemented under CERF, we select beneficiary villages and households through a two-stage random proportional sampling based on location. In the first stage, we identified which targeted villages had received support under this program. More specifically, we divided the targeted villages into three groups: seeds only (intervention 1), vaccination only (intervention 2) and both (intervention 1 and 2). Then we randomly selected villages proportional to the size of beneficiaries in each state and each intervention package. We used the total list of

beneficiary villages that was provided by FAO Sudan to randomly select the targeted villages into the study. This randomization is important to ensure that both observed and unobserved characteristics of village-level data are accounted for and not correlated with each other. In the second stage, we then selected beneficiaries residing in these targeted villages to take part in the study. Due to the absence of a detailed list of direct beneficiaries, we were not able to identify the beneficiary households in these targeted villages before the start of the data collection. Therefore, we had to rely on the enumerators to select the beneficiaries during the field visit, which was done in coordination with FAO local officers and the village chiefs.

After identifying and selecting the targeted villages, we then selected control villages to be included in the study. To do so, we first identified all enumerated Sudanese villages (communities) with their geo-locations and matched them using unique p-codes with the full list of targeted villages provided to us by FAO. Hence, all the villages that did not match with the full list of targeted villages of the program are considered potential control villages. Based on the village geo-location (coordinates), we draw circles around the targeted villages with a radius of 15 km. For very remote villages, we increased the radius to 25 km. Then, we matched all potential control villages within this radius. Potential control villages were given unique identifiers from their matched treatment villages. We reduced the menu of potential control villages to villages that lie in a different state than their treatment match, and we then randomly selected a unique control village for each treatment village to be part of the study. This procedure for selecting the control villages, therefore, satisfies the random selection of control group villages but also ensures that treatment and control villages have similar geographic conditions that are crucial for conducting rigorous impact evaluations of agricultural interventions.

After we finalized the sampling framework for the selection of the targeted and control villages (and subsequently households) into the study, we conducted power analysis to determine the optimal sample size that is required to detect the impact of the interventions. Based on this two-stage cluster sampling design (where we first select villages and then select households within these villages), and in the absence of

information about means, standard deviations, and intracluster correlation across clusters from a pilot study or earlier research, **we have determined the sample size based on the following three pillars:**

First, the sample size should be large enough, and the beneficiary sample size should not be less than 1% of the total number of CERF beneficiaries. Second, we have a considerably large number of villages (clusters) as opposed to households (units) to ensure that intraclass correlation is reduced. Third, the sample size of the control group should be large enough to allow us to match similar households in case we do not achieve enough balance through our sampling procedure, where randomization was at the village-level. Taking these three pillars into account and based on theoretical significance levels, power, and effect size, we optimized the sample size to enable us to measure the small Minimum Detectable Effect (MDE). Once treatment and control group shares are equal to each other, we find that a total sample size of above 8,000 is able to measure an effect size of 0.08 and above with a power of 95 percent.

Based on these three pillars and our indicative power analysis, we planned to collect data from 8,016 households across 14 beneficiary states in Sudan. The proportion of the sample between the beneficiary and control groups is designed to be 0.5 and the number of households interviewed within each village is planned not to exceed 24 households. The latter was also agreed on due to practical considerations (four enumerators conducting six interviews each per village per day) to facilitate travel between villages. This was particularly important given the short number of days we had available to complete the baseline data collection. Table 4 shows the planned sample size distributed across the 14 states. **Overall, our study planned to include 8,016 households living in 334 villages from 81 localities in 14 states in Sudan.**

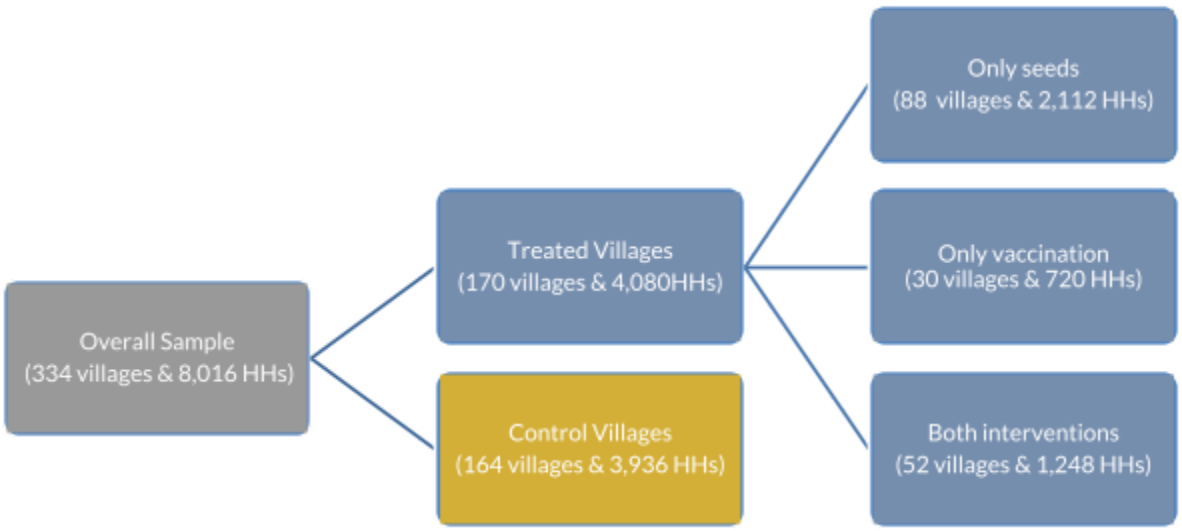
Table 4. Planned sample size and distribution of localities, villages, and households by State

State	# of localities	# of villages	# of households (24 per village)
Blue Nile	6	30	720
Central Darfur	3	18	432
East Darfur	6	26	624
Gedaref	7	16	384
Kassala	6	26	600
North Darfur	7	26	624
North Kordofan	4	28	672
Red Sea	5	18	432
Sennar	5	16	384
South Darfur	6	26	624
South Kordofan	5	24	576
West Darfur	8	26	624
West Kordofan	4	23	552
White Nile	9	32	768
Total	**81**	**334**	**8,016**

It is important to note that although a random procedure is largely followed, we replaced targeted villages (beneficiary or non-beneficiary villages) that were selected through the random procedure with similar villages if (1) the total number of beneficiaries in the villages is less than 24; (2) if there are no geo-coded locations (p-codes) available to geographically determine their locations for selecting a control village; or (3) if the FAO Sudan local team decided that it would not be feasible to visit a village either due to logistical or security reasons.

Figure 2 shows the final planned sample size and distribution of our study. Among the total 334 beneficiary villages that were planned to be visited, around 52% were categorized as receiving only seeds, 18% received only livestock vaccinations and mineral licks, and 31% received both FAO interventions.

Figure 2. *Number of villages and households by beneficiary status and intervention type*



3.4. Aftermath of design and sampling

After the sampling procedure, the proposed list of the targeted and control villages was sent to FAO's focal officers in each state to cross check if the villages were accessible before the start of the baseline data collection. Non-accessible villages were replaced. In total, 54 control villages were replaced by the FAO local teams non-randomly (a share of 16.17% of the villages) because the randomly selected control villages were not accessible either due to security reasons or environmental disasters such as floods. We informed them that the control villages should be similar to the targeted villages both in terms of the vulnerability levels of households and their geographical proximity.

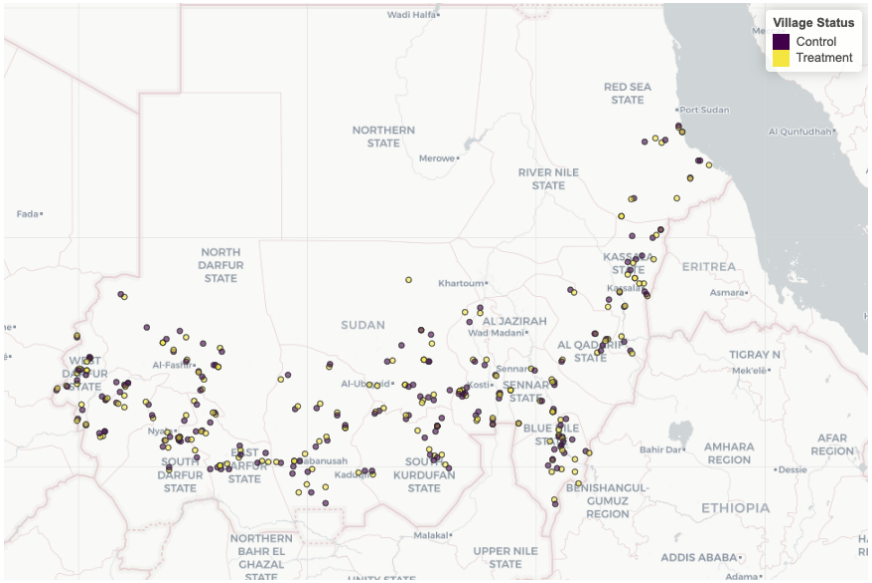
Table 5 shows how the final sample distribution in the baseline data is different from the planned sample across states and intervention types. The overall sample sizes of the beneficiary and non-beneficiary households in the sample are close to each other, and the total number of observations is 8,146, of which 3,976 are control households and 4,170 are beneficiary households. Moreover, Figure 3 compares the spatial distribution of the selected villages from our baseline sample (panel a) to the location of villages as recorded by the enumerators during the data collection (panel b). Overall, we find that, despite some changes, the coverage of the study is very similar to what has been planned, and the equal geo-climatic distribution of targeted and control villages at baseline is maintained.

Table 5. *Comparing planned versus actual sample distribution by village and intervention type*

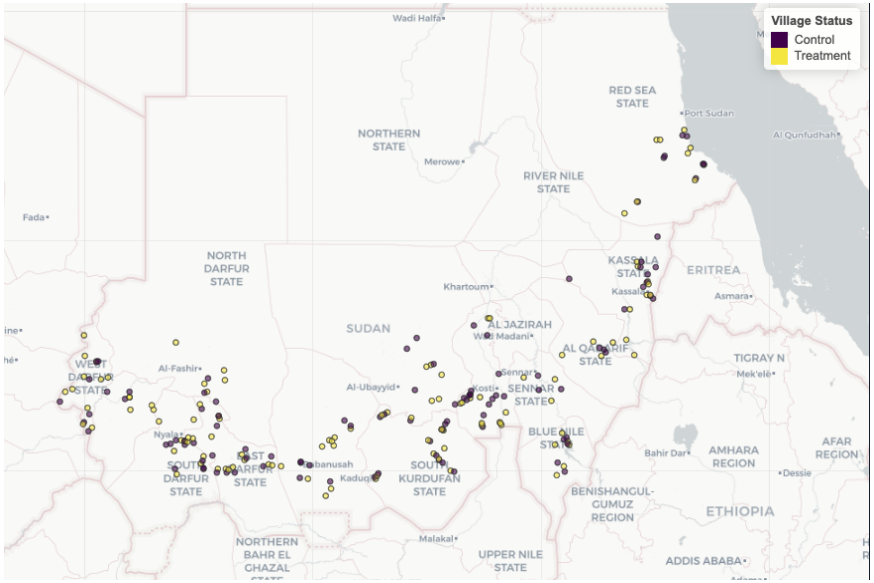
			Beneficiaries										Control		
State	**# of localities**		**# of villages**		**# of obs**	**only seeds**		**only vaccination**		**both interventions**		**NI***	**# villages**		**# of obs**
	plan	actual	plan	actual	actual	plan	actual	plan	actual	plan	actual	actual	plan	actual	actual
Blue Nile	6	5	15	10	294	9	7	5	2	1	1		15	11	291
Central Darfur	3	3	9	10	203	6	5	1	1	2	2	2	9	9	196
East Darfur	6	6	13	13	342	5	5	0	0	8	8		13	14	326
Gedaref	7	7	8	8	206	5	5	0	0	3	3		8	8	199
Kassala	7	6	13	13	298	6	5	5	2	2	1	5	12	13	328
North Darfur	7	7	13	13	285	5	5	3	3	5	5		13	13	285
North Kordofan	4	4	14	14	332	8	8	3	3	3	3		14	13	288
Red Sea	4	5	10	10	329	5	4	0	0	5	5	1	8	8	275
Sennar	5	5	9	9	288	3	3	4	4	2	2		7	7	205
South Darfur	6	6	13	14	355	7	6	0	0	6	7	1	13	12	304
South Kordofan	5	5	12	12	299	6	6	0	0	6	5	1	12	12	294
West Darfur	8	8	13	13	329	8	8	2	2	3	3		13	13	328
West Kordofan	6	4	12	12	289	6	4	2	1	4	2	5	11	11	288
White Nile	7	9	16	15	321	9	6	5	5	2	1	3	16	20	369
Total	**81**	80	**170**	**166**	**4170**	**88**	**77**	**30**	**23**	**52**	**48**	**18**	**164**	**164**	**3976**

*NI are the 18 targeted villages (10.8% of total villages) where the type of treatment they received is still currently not identified. Here we used the village types as reported to us by FAO Sudan.

Figure 3. *Planned versus actual geographical distribution of targeted and control villages*



Panel a) *Planned villages based on geo-locations*



Panel b) *Actual villages based on coordinates from baseline data*

3.5. Baseline questionnaire

There are in total 13 modules in the questionnaire that cover various issues relevant to the impact evaluation of FAO's CERF Program, which we summarize below:

- **Module 1. General Information** (for the interviewer)**:** including the location of the household, data, and time
- **Module 2. Household demographics/circumstances** (from respondents aged above 18): including, for example, the gender, age, and educational level of the respondent as well as the size, status, and income sources of the household
- **Module 3. Household head profile:** In case the respondent is not the household head, we collected additional information on the household head's profile, including gender, age, and education
- **Module 4. Assets and access to basic services:** including information about productive and household assets that are owned by the households, and the time that it takes the household members to reach basic service facilities such as water points, hospitals, and markets
- **Module 5. Crop production:** covered information on the main two crops that were cultivated by households in the previous season, including land size, harvest amount, input use, challenges, and the use of the harvest (sold or consumed)
- **Module 6. Livestock production:** including information on livestock ownership, including cattle, sheep, goats, and camels, as well as the production and productivity of the animals and the use of the livestock products
- **Module 7. Food insecurity experience profile:** based on FAO's eight yes and no questions on experiencing food security
- **Module 8. Food sources and consumption:** including information on the food consumed in households in the past 7 days
- **Module 9. Shocks:** includes information on households' exposure to multiple climatic, political, and personal shocks, such as conflict / violence, drought, flood, price increases, and sudden job losses
- **Module 10. Coping strategies:** including information on if households had to use in the past 30 days any negative coping strategies to deal with food shortages or money

- **Module 11. Assistance:** including information about any type of assistance households have received, and the sources of these supports
- **Module 12. Participation and engagement of women:** including information on women's empowerment and perceptions about women's role and agency in households, as well as questions on how decisions are made between men and women at home
- **Module 13. Knowledge and agricultural practices:** included questions that asked basic knowledge on agricultural and livestock practices

Moreover, the questionnaire is developed such that it complies with the three pillars of FAO's **RIMA II.** For the coping strategies section, we have also benefited from the World Food Program (WFP)'s Consolidated Approach to Reporting Indicators (CARI) of food security. After the finalization of the questionnaire in English, it was translated into Arabic. Both versions were double-checked and sent to FAO Sudan for feedback. The questionnaire was coded into Kobo Toolbox in both languages and was ready for testing. Kobo is a digital form of collecting data using tablets or smartphones, and it reduces data entry errors given that all answers are validated and questions only appear on the device if they are relevant. Moreover, the skip logic of the Kobo questionnaire is used to ensure that the dataset is of high quality.

ISDC and FAO conducted a two-day joint **Training of Trainers (ToT)** in Khartoum in September 2022 with FSTS. During these intensive two days, ISDC, FAO, and FSTS discussed the draft baseline questionnaire, conducted revisions to make sure that the questions were relevant and context-sensitive, and revised and updated it again in Kobo in preparation for the testing on Day 2. After testing the questionnaire among themselves, the team at FSTS provided additional feedback that was integrated back into the questionnaire. Moreover, research ethics and compliance with the "**do no harm principle**" as well as a detailed description of the quasi-experimental approach in our impact evaluation and the sampling strategy were extensively discussed with the trainers. Given the delays in starting the data collection, FAO conducted **refresher training** with the trainers using the final version of the questionnaire, which took place at the end of October 2022 in Khartoum.

Training of Trainers with FAO and ISDC members in Khartoum (image provided by FAO Sudan)

3.6. Ethics and safeguarding

ISDC has its own ethical guidelines for best practices in conducting fieldwork and empirical research. We strictly followed these practices and guidelines. We ensured that respondents provided their verbal consent to participate in the study, which clearly explained the purpose of the study and the use of the data. Moreover, we were committed to the use of the ***"do no harm"*** **approach,** ensuring that the security, safety, integrity, and well-being of participants and staff are respected and protected at all times. All respondents had the right to withdraw from the study at any point without fear of penalty. In particular, we ensured that no benefits to respondents were withheld for the purpose of the study and that non-beneficiaries were not misled into participating. The selection of

beneficiary households for the study was based directly on the selection of the beneficiaries by FAO. ISDC did not influence or control who received which type of support or what criteria the beneficiaries were selected based on. Personal information associated with respondents, including names and phone numbers, that was collected as part of this study will only be used to follow up with households at the endline data collection and will not be made public in any shape or form. We also created a unique anonymized ID number for each household, which will be mainly used to match baseline and endline datasets.

3.7. Baseline data collection, processing, and analysis

Data collection. The baseline data collection started on **November 7** and involved a large coordination effort between FSTS, FAO Sudan, and ISDC. In total, **121 enumerators and 34 vehicles worked every day in the field across all 14 states of Sudan** simultaneously. Originally, the data collection was planned to start in October 2022. However, due to some unforeseen practical challenges, we had an additional three to four weeks of delay. The number of enumerators in the field was increased in order to make sure that data collection can be **completed in at most two weeks** and finalized in November 2022. FAO Sudan has responded quickly to ensure the speeding up of the process and to collect the data before the end of the harvest season, which could have caused negative implications on our study design.

In order to minimize measurement error problems, data entries in Kobo were checked by the ISDC team on a daily basis, and regular feedback was provided to the FAO Sudan team. This required that the coordinating team from FSTS upload the data on a daily basis and whenever the opportunity arises. More specifically, the ISDC team checked for issues with data and variable structure, intra-enumerator bias, and ensured that the balance between the targeted and control villages was maintained.

Data cleaning. After the baseline data collection was completed, the data was downloaded and cleaned thoroughly by ISDC staff. Any issues arising in the assignment of the villages or discrepancies between the data and the sampling documentation were addressed with FAO to ensure all the information was correct. Moreover, we generated new variables and

indicators, including the Food Consumption Score (FCS), the Household Hunger Score (HHS), and the Resilience Capacity Index (RCI), which was calculated separately through FAO's shiny RIMA II app. We will describe how each of these indicators was developed in the results section. We then anonymized the dataset (removing any personal identifiers) before starting the analysis.

Data analysis. The cleaned data was used for analysis in this report. All figures and tables provided in Section 4 below were produced using only the baseline data. We also used additional data sources, like the Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) data, to obtain information about precipitation rates in Sudan. Baseline data comparisons between the beneficiary and non-beneficiary groups were conducted using t-test where appropriate, and we used the Standardized Mean Difference (SMD) to check if there are statistically strong differences between the two groups.

In this report, we conduct a descriptive analysis of the baseline dataset to obtain a snapshot of the current welfare and agricultural situation of farming households living in Sudan. This phase of the empirical analysis will use baseline data to understand the relationship between exposure to shocks on the one hand, and food security, well-being, and resilience on the other. After collecting the endline data, we will conduct a causal inference analysis to estimate the impact of the program on the set of outcome indicators. More specifically, we will estimate the average impact using the difference-in-difference (DID) technique. The DID depicts the average change in outcomes between beneficiaries and non-beneficiaries before and after the harvest. As we have a very rich data set that includes detailed demographic and spatial characteristics of households, we will be able to conduct a heterogeneity analysis. This will enable us to understand if the interventions were successful in particular localities or household types. Finally, based on the impact analysis findings, we will conduct a cost-effectiveness analysis (CEA) to measure the direct effects of the intervention compared with the associated costs of implementing the project. Operating and management costs of the program will be obtained from FAO financial reporting, and effects and benefits will be measured from the survey and impact analysis.

4. Descriptives and Baseline Sample Balance

In this section, we present the baseline descriptive findings for the overall sample on the profile of household and household head, livelihood and income sources, asset ownership, crop and livestock production, access to services, household food security, resilience, exposure to shocks, gender norms and equality, and agricultural knowledge. The aim of the descriptive analysis is to provide an overview of the current well-being and agricultural status of farmers and pastoralists in Sudan at large. In some instances, and to highlight the heterogeneity in these indicators, we provide a breakdown of the analysis by gender of the household head, by residency status of households (e.g., residents, IDPs), or by the state (displayed using maps). Finally, where necessary, we show the balance tables between the beneficiary and non-beneficiary households to examine if our baseline sample selection and design are valid for conducting a rigorous impact evaluation. The statistics are presented in group averages. The balance tables include the standard mean deviations (SMD) which emphasize the group variability respective to the overall variability. SMD values of over 0.1 indicate a significant difference between groups.

A methodological note: Self-reported information that can take large numerical values is prone to measurement errors, which produce outliers that skew means and bias the findings. This issue is mainly prevalent when reporting information on land size, harvest produce, livestock count, and livestock produce, which also subsequently affect the measurement of crop and harvest yields. For these variables, we detect and remove outliers that deviate from the normal distribution via the Tukey's approach[3], which removes observations if they fall above 1.5 times the value of the 75th percentile. We report the shares of outliers for each variable.

[3] Tukey, J. W. (1977). Exploratory Data Analysis. Reading, Massachusetts: Addison-Wesley.

4.1. Profile of households and household heads

Table 6 summarizes the characteristics of the heads of the surveyed households. Overall, the table emphasizes that, as intended by design, the **average characteristics of household heads do not differ significantly between beneficiary and non-beneficiary households.** More specifically, we find that 83% of the households are male-headed, where the share is slightly lower within the beneficiary group (81.8%), yet the differences are not statistically significant (SMD < 0.1).

Table 6. *Household head profile by beneficiary status (balance tables)*

Variable	*Overall*	*Non-beneficiary*	*Beneficiary*	*SMD*
n	8,146	3,976	4,170	
Male HHH (%)	82.8	83.8	81.8	0.053
Age of HHH in years	45.24 (13.70)	44.96 (13.77)	45.51 (13.62)	0.040
Education of HHH (%)				**0.113**
None	50.9	53.5	48.4	
Primary	32.9	32.0	33.8	
Secondary	12.2	11.1	13.3	
Tertiary	3.9	3.4	4.4	
Literacy of HHH (%)	59.0	56.6	61.2	0.094
Marital Status of HHH (%)				0.068
Divorced	2.7	2.2	3.1	
Married	85.1	85.9	84.3	
Single	6.9	6.5	7.3	
Widowed	5.3	5.4	5.2	

Notes. Standard deviations for continuous variables in parentheses. Standard Mean Difference (SMD) expresses the group variability relative to the overall variability. Variables are balanced across the two groups when the absolute value of SMD is < 0.1.

Moreover, the average household head is 45 years old in beneficiary and non-beneficiary households. 51% of household heads in the full sample do not have any formal education. Still, 59% report being able to read and write. Furthermore, 33% of the household heads in the overall sample have a primary school diploma, while only about 16% have a secondary or tertiary education. We find that households in the beneficiary group have, on average, slightly higher educational levels than the control groups. Finally, 85% of the household heads are married, and 5% are widowed.

Table 7. *Household head profile by gender of the household head*

Variable	*Overall*	*Female*	*Male*	*SMD*
n	8,146	1,402 (17.2%)	6,744 (82.8%)	
Age of HHH in years	45.24 (13.70)	43.61 (13.59)	45.58 (13.70)	0.144
Education HHH (%)				0.432
None	50.9	68.0	47.3	
Primary	32.9	22.7	35.1	
Secondary	12.2	7.2	13.3	
Tertiary	3.9	2.1	4.3	
Literacy of HHH (%)	59.0	34.8	64.0	0.610
Marital Status of HHH (%)				1.064
Divorced	2.7	13.3	0.5	
Married	85.1	55.1	91.2	
Single	6.9	5.5	7.2	
Widowed	5.3	26.0	1.0	

Notes. Standard deviations for continuous variables in parentheses. Standard Mean Difference (SMD) expresses the group variability relative to the overall variability. Variables are balanced across the two groups when the absolute value of SMD is < 0.1.

Next, we provide the same household characteristics broken down by the gender of its head. As can be seen in Table 7, the share of female-headed households in our sample is 17.2%. On average, female household heads are two years younger than male household heads. Moreover, the **education level of female household heads is lower than that of male household heads**. In our sample, 70% of female household heads do not have any school diplomas, whereas this rate is around 20 percentage points lower in the male household heads sample. Male household heads have higher shares at all education levels than females.

Relatedly, the **literacy rate among male household heads is almost double compared to the literacy of female household heads**. This educational difference is important because it shows that women-headed households might have additional difficulties and vulnerabilities in the absence of male breadwinners. There are also important differences in the households in terms of the marital status of household heads. **Although 91.2% of male household heads are married, this share is only 55.1% for female household heads.** As expected, 26% of female household heads are widowed, whereas the share of widows among male household heads is only 1%.

Table 8 presents household characteristics by beneficiary status. The average Sudanese family in our sample has seven to eight members. The average educational level of the most educated female member over 15 years old is notably higher than that of the female-household head. This reflects the better educational capacities of the younger generation in the household. We observe that 25% of the households have a female member with either a tertiary or secondary education. Nevertheless, **40% of households do not have a female member who has completed any formal education**. These shares are higher in the non-beneficiary groups (44%) compared to the beneficiary groups (36%). Moreover, 21% of households have a member with permanent health issues, and, on average, two people in the household engage in income-generating activities. Both of these variables are similar between the two groups.

Table 8. *Household characteristics by beneficiary status (balance tables)*

Variable	*Overall*	*Non-beneficiary*	*Beneficiary*	*SMD*
n	8,146	3,976	4,170	
Household size	7.67 (3.91)	7.56 (3.83)	7.79 (3.99)	0.059
Highest education level of females (%)				**0.229**
None	39.7	**44.0**	**35.7**	
Primary	35.4	35.8	35.0	
Secondary	18.0	15.1	20.7	
Tertiary	6.8	5.1	8.5	
Share of HHs with members having permanent health issues (%)	21.0	20.7	21.2	0.013
HH members working	1.99 (1.57)	1.96 (1.59)	2.03 (1.55)	0.044
Full Dependency	2.71 (2.47)	2.74 (2.47)	2.68 (2.47)	0.023
Partial Dependency	1.68 (1.54)	1.70 (1.53)	1.65 (1.54)	0.035
Residency status HH (%)				**0.188**
Residents	85.7	87.5	84.0	
IDPs	5.3	**3.2**	**7.3**	
Nomadic households	3.3	3.3	3.3	
Returnees	5.7	6.0	5.4	

Notes. Standard deviations for continuous variables are in parentheses. The standard mean difference (SMD) expresses the group variability relative to the overall variability. Variables are balanced across the two groups when the absolute value of SMD is < 0.1.

We also check if the dependency ratio is statistically significant between the beneficiary and non-beneficiary households to uncover any additional burden the households have to support their dependent members. We calculated the dependency ratio in two different ways. We first use the usual dependency ratio formula for comparative purposes to other countries or the previous situation in Sudan, where the number of dependents, including

children (below 15 years) and the elderly (above 64 years), is divided by the number of adults of working age (between 15 and 64 years). We denote this as the "**partial dependency**" ratio. However, this way of calculating the dependency ratio is not sufficient because it ignores the fact that not all adults have or can work (e.g., due to disabilities or gender norms). Therefore, in order to understand the dependency in a household for a given working adult (between 15 and 64 years old), we divided the total number of dependents by the total number of actively working adults in the household. This is denoted as the "**full dependency**" ratio. According to these calculations, we find that one working adult provides for 2.7 dependents, whereas one adult, independent of her/his generation of income, cares for 1.7 children and the elderly in the household.

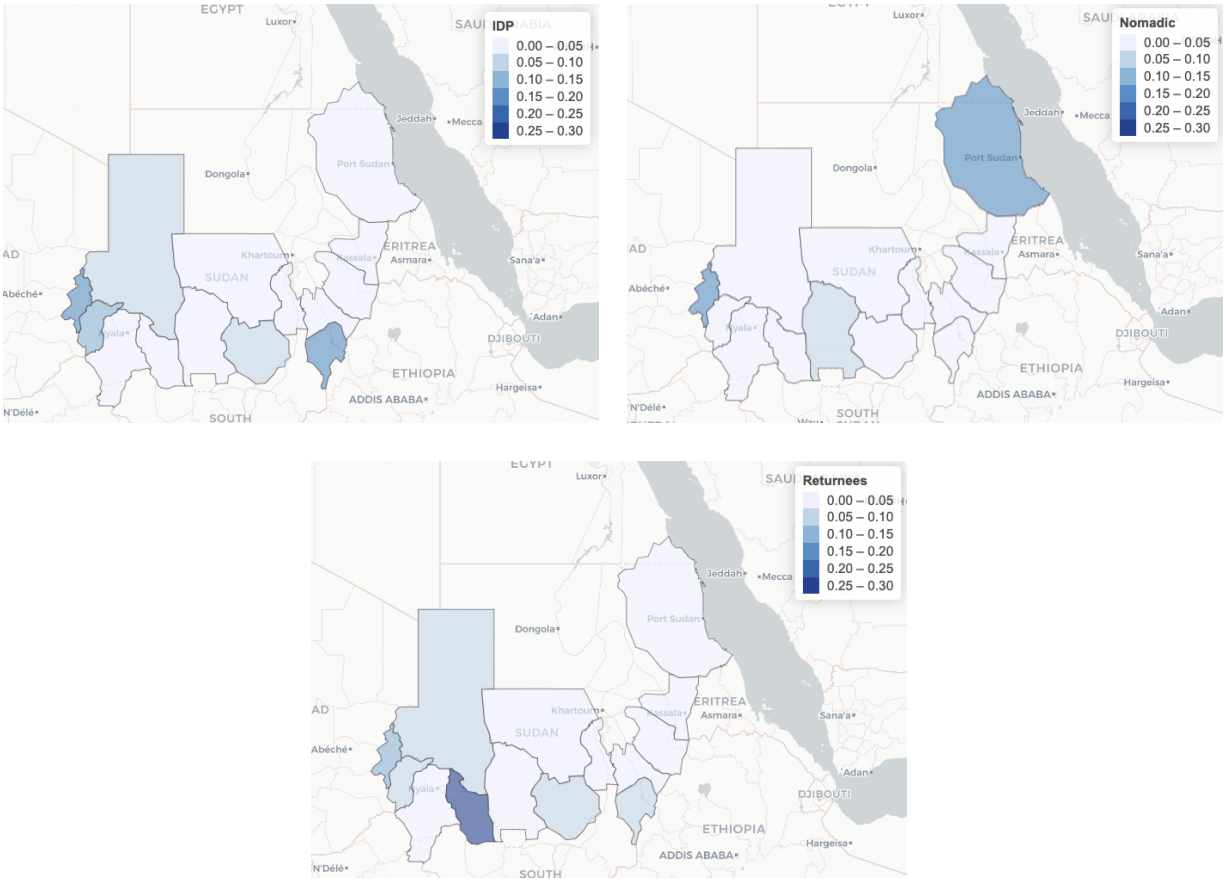
Finally, Table 8 shows that the majority of the sample (86%) belongs to a hosting or residence community, **while 5% are Internally Displaced Persons (IDPs), 6% are returnees, and only 3% are Nomadic households.** The share of IDPs is significantly larger in the beneficiary sample, in line with the targeting of the CERF FAO Program.

IDP shelter in Sudan (image provided by the enumerators)

Figure 4 displays the spatial distribution of the share of households' residency status across the 14 states. Returnees are concentrated in the Darfur region and slightly in South

Kordofan and the Blue Nile. The majority of IDPs are located in Blue Nile and West Darfur, followed by North and Central Darfur, the Kordofan states, and White Nile. Nomadic households are mainly from the Red Sea and West Darfur.

Figure 4. Residency status of households by state



In the last analysis for this subsection, we show the differences in household characteristics by gender of the household head in Table 9. The share of IDPs and returnee households is larger among female-headed households (16%) compared to male-headed households (10%). Household size is, on average, 1.5 members smaller in female-headed households. More importantly, we find that the number of household members **actively working is similar between female- and male-headed households, which implies that**

one of the household members between the ages of 15 and 64 starts working in the absence of a male breadwinner.

Table 9. Household characteristics by gender of the household head

Variable	Overall	Female	Male	SMD
n	8,146	1,402	6,744	
HH size	7.67 (3.91)	6.38 (3.44)	7.94 (3.95)	0.420
Highest education level of females (%)				0.094
None	39.7	37.9	40.1	
Primary	35.4	34.3	35.6	
Secondary	18.0	19.2	17.8	
Tertiary	6.8	8.6	6.5	
Share of HHs with members having permanent health issues (%)	21.0	24.5	20.2	0.102
HH members working	1.99 (1.57)	1.97 (1.39)	2.00 (1.60)	0.018
Full Dependency	2.71 (2.47)	2.07 (2.03)	2.84 (2.53)	0.335
Partial Dependency	1.68 (1.54)	1.63 (1.68)	1.69 (1.51)	0.037
Residency status HH (%)				0.185
Residents	85.7	81.1	86.6	
IDP	5.3	7.4	4.9	
Nomadic households	3.3	2.9	3.4	
Returnees	5.7	8.6	5.1	

Notes. Standard deviations for continuous variables are in parentheses. The standard mean difference (SMD) expresses the group variability relative to the overall variability. Variables are balanced across the two groups when the absolute value of SMD is < 0.1.

We find that the full dependency ratio is higher among male-headed households, and this is mainly because their dependent household member size is larger. As can be seen in Table 9, the partial dependency rate is almost the same across female- and male-headed

households. Moreover, we find that the **education level of a female member with the highest education level is slightly higher in female-headed households than in male-headed households**, although statistically insignificant.

4.2. Livelihoods and income diversification

In this section, we summarize the income sources and their diversification that households rely on. Table 10 shows the average share of different income sources in households by beneficiary status.

Table 10. *Crop farming is the main income source (balance tables)*

Variable	*Overall*	*Non-beneficiary*	*Beneficiary*	*SMD*
Average share from total income				
Crop Farming (%)	38.26	37.71	38.79	0.030
Livestock Keeping (%)	9.13	9.66	8.63	0.049
Off-farm Business (%)	18.15	17.64	18.64	0.034
Wage work (%)	25.39	26.57	24.26	0.065
Regular Employment (%)	5.21	4.76	5.64	0.047
Transfers/Remittances (%)	3.63	3.47	3.79	0.021

Notes. Standard mean difference (SMD) expresses the group variability relative to the overall variability. Variables are balanced across the two groups when the absolute value of SMD is < 0.1.

The **largest share of income is generated through crop farming** (38% in the overall sample). The households generate on average 25% of their income from wage work, which is evenly distributed between agricultural and non-agricultural wage work. In third place, 18% of the average household income is generated through off-farm businesses. While the beneficiary households generate slightly more income through crop farming and off-farm businesses, the control group earns slightly more income from wage work. However, none of these differences are statistically significant. Households generate on average 9% of their income through livestock produce sales, and this share is slightly

higher in non-beneficiary households. Income from regular employment and remittances or transfers contribute 5% and 4%, respectively, to the total household income.

Different levels of vulnerability are potentially associated with household income distribution. Particularly, the gender of the household head and the residency status of a household might drive income sources since male-headed residency households have better access to land and are more settled in the area compared to female-headed, IDP, nomadic or returnee households.

Figure 5. *Female-headed and IDP households generate a lower income share through agriculture*

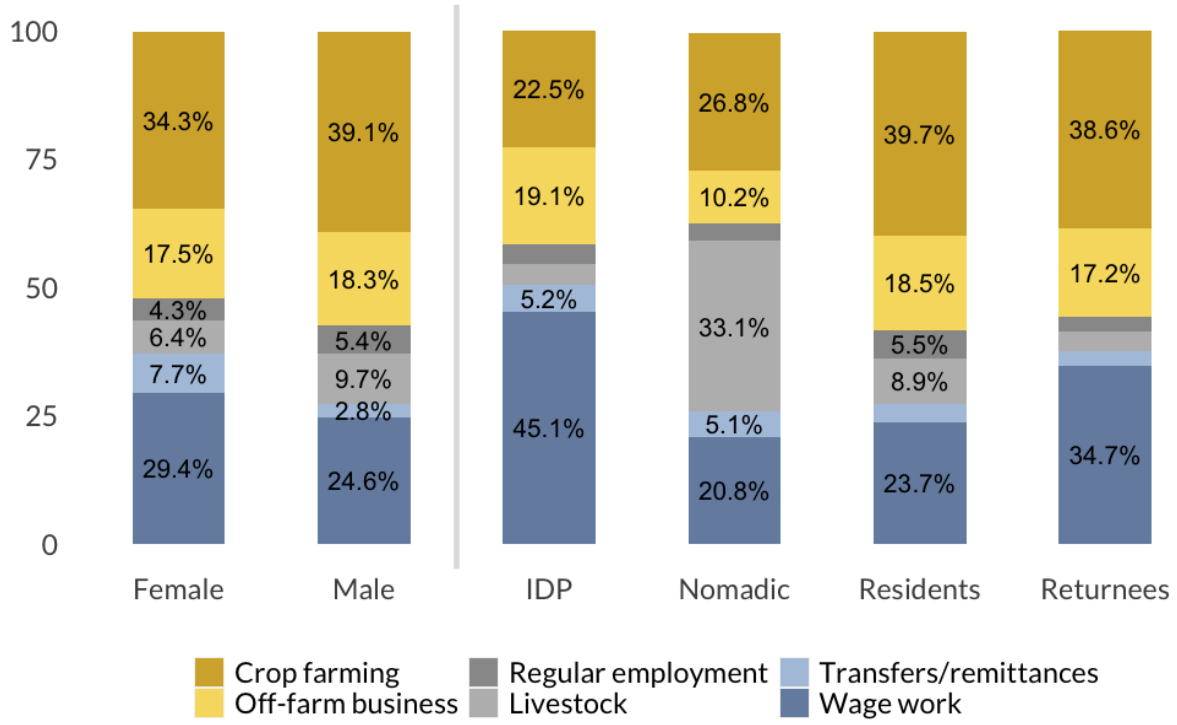


Figure 5 breaks down the share of income sources by household head gender and the residency status of the households. The shares of income generation differ between male and female-headed households, driven by **household vulnerability and property rights**. Female-headed households generate larger shares of income through wage work and

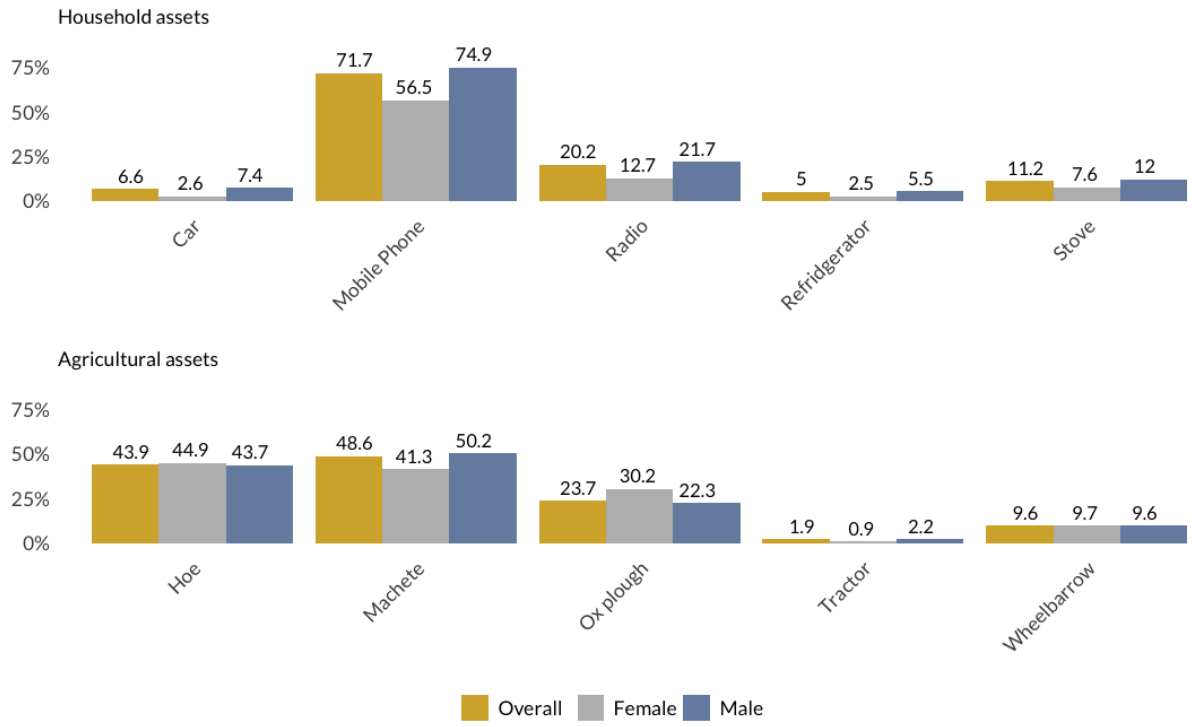
transfers or remittances (29% and 8% compared to 25% and 3% for male-headed households) and smaller shares through crop farming and livestock (34% and 6% compared to 39% and 10% for male-headed households). This can be related to the lower share of land ownership by female-headed households, as shown in the next sub-section. Interestingly, host communities and returnees have similar income shares from crop farming and off-farm businesses. The largest income shares for both groups are generated through crop farming (40% for resident communities and 39% for returnees). However, expected differences are observable in income from livestock, which is more prevalent among resident communities, and wage work, which is more dominant among returning households. Even more pronounced, **IDP households generate large shares of their income on average from wage work (45%)**. This can be attributed to less access to **agricultural property** among IDP and returnee households. However, nomadic households, similarly with restricted access to agricultural land ownership, generate the smallest share through wage work (21%), compared to the other groups. As expected, **nomadic households generate the largest share of their income from livestock (33%).**

4.3. Asset ownership and social capital

Household and agricultural asset ownership shape household productive capacity and is key from straightening resilience during times of hardship. Figure 6 summarizes the ownership of the main household assets for the overall sample, as well as broken down by the gender of the household head. **72% of households own at least one mobile phone.** Hence, phones are a common household asset, while only 7% own a car, 20% a radio, 5% a refrigerator, and 11% a stove. For all these household goods, we see that **male-headed households on average have better assets than female-headed households**, which emphasizes a stronger economic capacity. Moreover, higher ownership of household assets within male-headed households implies that female household heads have an additional burden of house chores, which might affect their agricultural productivity. Importantly, the share of cars in female-headed households is only 3%, while it is 7% for

male-headed households. **Overall, we can argue that female household heads have lower mobility and less available time.**

Figure 6. Household and agricultural asset ownership



For agricultural goods, the differences are not as clear. Male-headed households are more likely to own a machete (50% versus 41%). On the other hand, **female-headed households own on average more ox plough (30%) than male-headed households (22%)**, potentially to substitute a lower availability of labor forces within the household. Finally, the share of households with a tractor is very low in both households (1% versus 2% for female- and male-headed households, respectively), which signals their low agricultural capacities.

Moreover, access to agricultural land is an important indicator of household wealth and agricultural capacity. Table 11 shows the share of households that own, rent or cultivate land, and their respective average land sizes in hectares. **74% of the households own**

agricultural land, while 37% rent land. 80% of the sampled households cultivated land in the agricultural season of 2021. On average, a household owns 3.7 ha of land, while they rent 2.6 ha. However, the standard deviation from the land size average indicates a large heterogeneity across the sample. The households cultivated on average 2.7 ha of land in the production season of 2021. **63% of both rented and owned land was cultivated on average.** There are no significant differences in land size between the beneficiary and the non-beneficiary group.

Table 11. Ownership, rental and cultivation of agricultural land (balance tables)

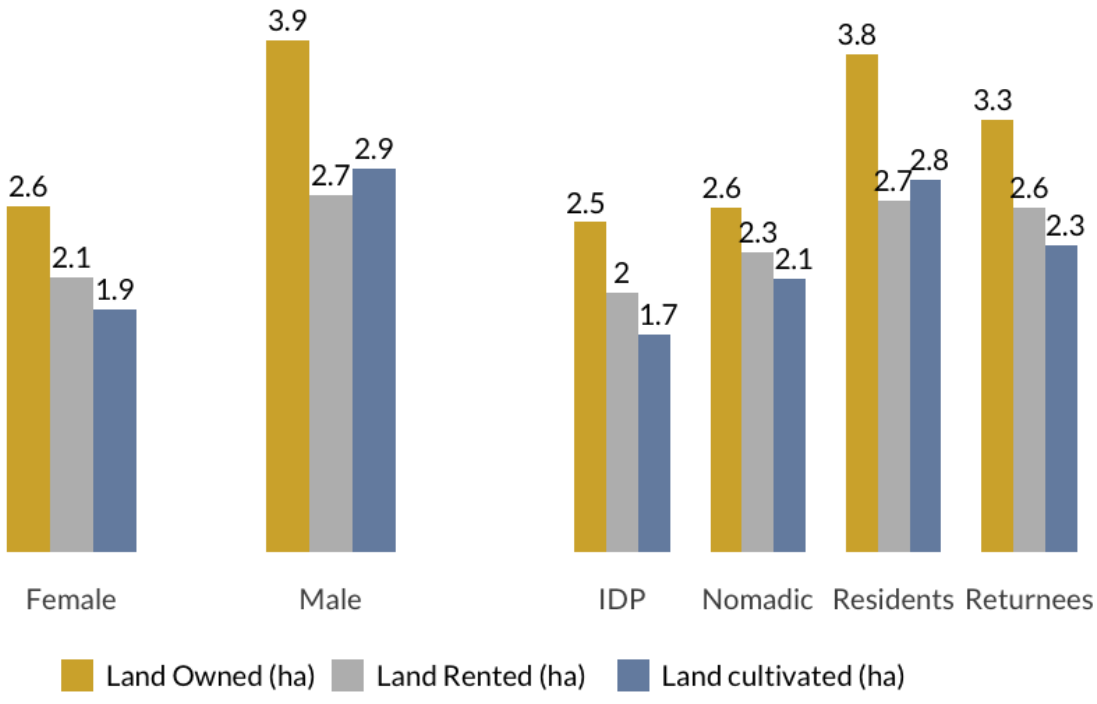
Variable	*Overall*	*Non-beneficiary*	*Beneficiary*	*SMD*
Households owning land (%)	73.85	73.69	74.00	0.007
Households renting land (%)	36.61	35.04	38.11	0.064
Households cultivating land (%)	80.38	79.43	81.29	0.047
Owned land size (ha)	3.69 (2.97)	3.69 (2.94)	3.69 (3.00)	0.001
Rented land size (ha)	2.60 (1.99)	2.62 (1.97)	2.58 (2.01)	0.021
Cultivated land size (ha)	2.73 (2.04)	2.78 (2.03)	2.69 (2.06)	0.042
Available land cultivated (%)	63.27	63 .16	63.38	0.005

Notes. Standard deviations for continuous variables in parentheses. Standard Mean Difference (SMD) expresses the group variability relative to the overall variability. Variables are balanced across the two groups when the absolute value of SMD is < 0.1. Zeros in land sizes are not considered in averages. Outliers removed. Shares of dropouts through cleaning: owned land size=7.2%, rented land size: 4%, cultivated land: 8.9%.

In Figure 7, we break down the sizes of the owned, rented and cultivated land by the gender of the household head and by their residency status**.** The average land sizes differ considerably across the groups, potentially driving different allocations of income that we summarized in the sub-section above. The wealth and productive capacity of male-headed households is clearly stronger than female-headed households. We find that **male-headed households own on average 3.9 ha of land, while female-headed households own on**

average only 2.6 ha. Likewise, resident and returnee households own, on average, 3.8 ha and 3.3 ha of agricultural land, respectively, emphasizing a larger agricultural potential compared to IDP and nomadic households, who only own on average 2.5 ha and 2.6 ha of land size, respectively. Examining the size of the cultivated land, we find that male-headed households cultivate on average 2.9 ha of land compared to 1.9 ha for female-headed households. The size of cultivated land is largest for resident households, followed by returnee and nomadic households, while IDP households cultivate on average smaller land plots. Lastly, we observe that male-headed households, resident and nomadic households cultivate larger shares of the available land while more vulnerable groups possess more fallow land. Hence, there are not only differences in availability of land but also potentially in land quality or cultivation capacity.

Figure 7. *Agricultural land size by household gender and residency status*



Notes. Land sizes include zeros. Outliers removed.

4.4. Crop production and input use

Sorghum is the main food crop in Sudan (image provided by the enumerators)

Next, we focus on crop farming. Here, we only concentrate on the main crops that the households grew and cultivated in the production season of 2021. Households that do not practice crop farming are not included in this section. We only show results from the five major crops cultivated. These include sorghum, millet, corn, peanut and sesame. While peanuts and sesame are important cash crops in Sudan, corn, millet, and sorghum are mainly subsistence crops.

Figure 8 shows the shares of crop farming households cultivating the five major crops, which are also stratified by the gender of the household head. **The main cultivated crops are sorghum and peanuts**, which were cultivated respectively by 58% and 57% of the crop farming households in 2021. These are followed by millet, which is cultivated by 52% of the crop farming households and then sesame and corn which are respectively cultivated by 28% and 26% of the farming households. Only 2% of the households do not cultivate any of these five crops. In other words, 98% of the crop farming households grow at least one of these five crops.

We observe clear differences in crop choices between male-headed and female-headed households. Male-headed households cultivate more sorghum and sesame than female-headed households (61% versus 43% and 31% versus 19%, respectively) while peanuts and millet are more prevalent among female-headed households (66% versus 55% and 58% versus 50%), respectively.

Figure 8. *Female-headed households mainly cultivate peanuts and millet*

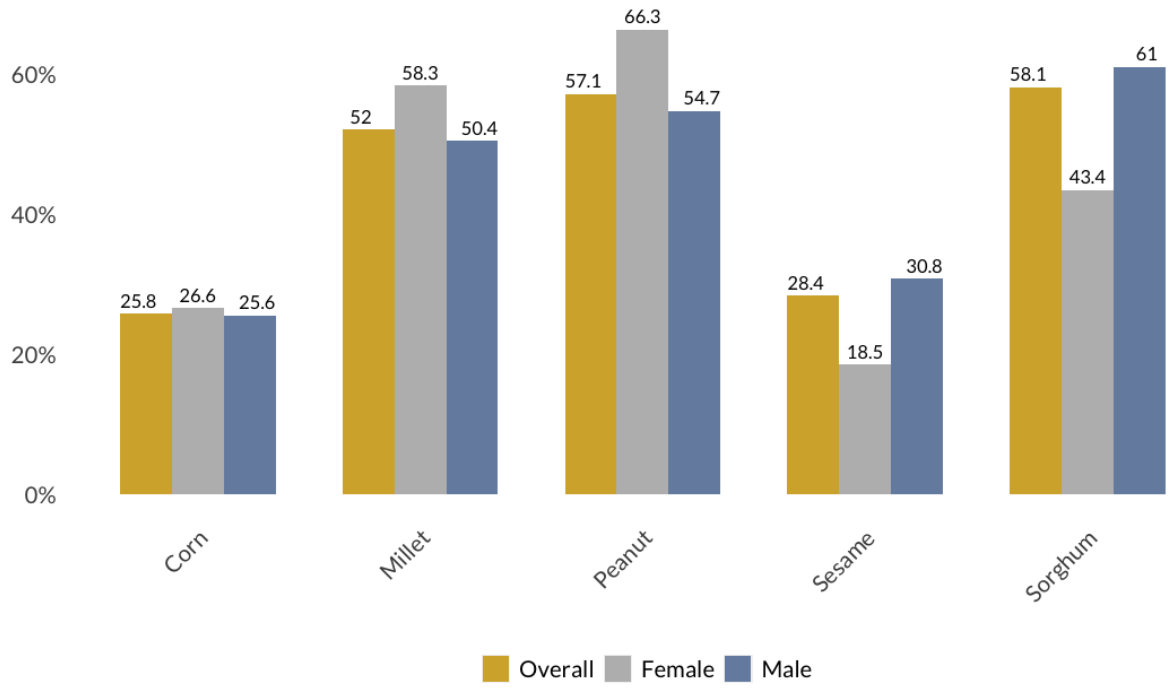
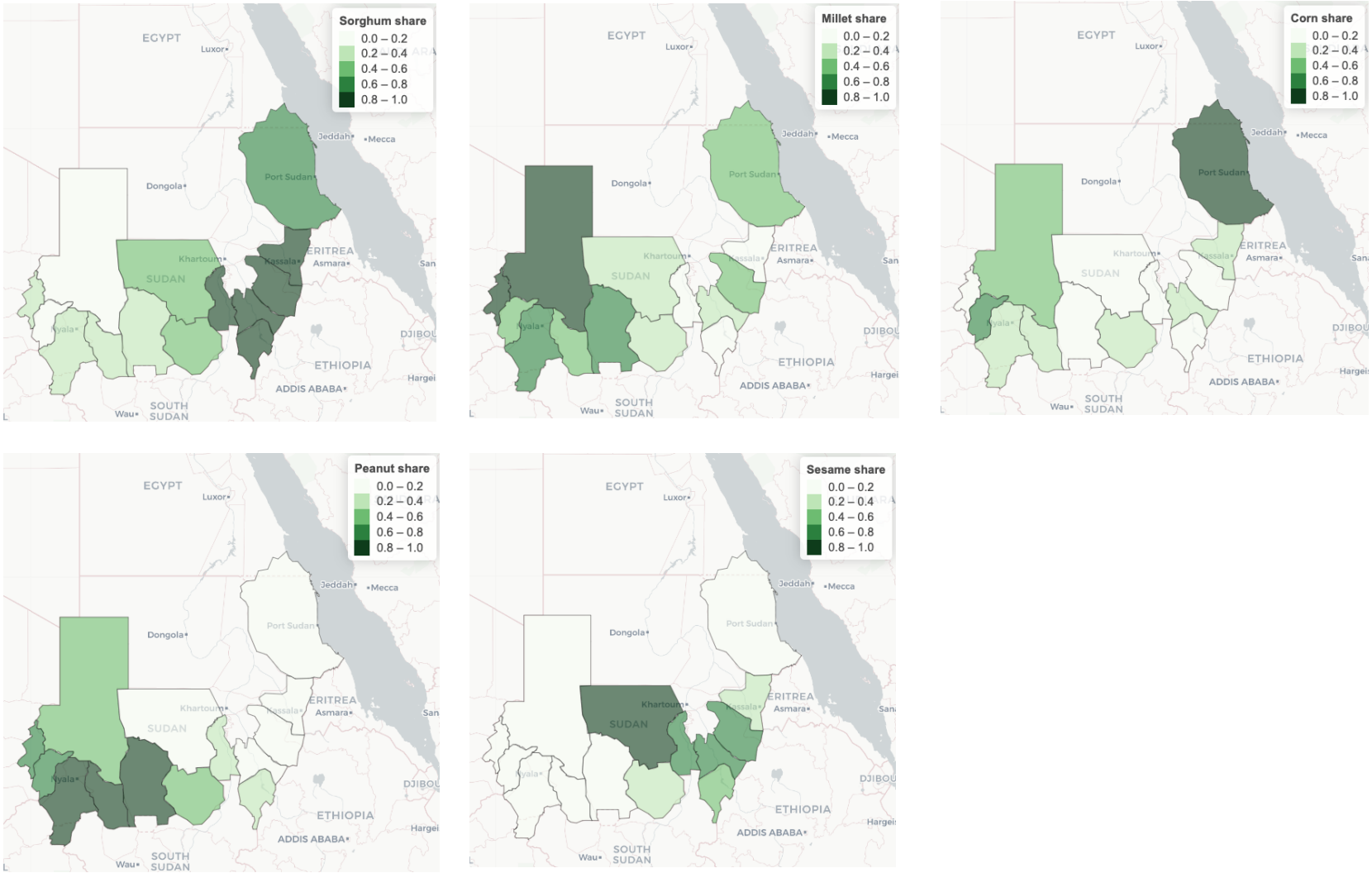


Figure 9 displays the main crops by state. We find a clear geographical difference in the type of crops cultivated, possibly driven by the agro-climatic conditions at the state level. First, we find that sorghum **is the dominant crop cultivated in 2021 in Blue Nile, Gedaref, Kassala, Sennar and White Nile.** Sorghum is cultivated by more than 91%, and up to 99%, of the crop-farming households living in these states. This is followed by sesame, which is cultivated by 50% of farmers. On the other hand, we find a very low share of farmers who cultivate millet, corn or peanuts in these South-Eastern states. Second, moving westwards, we find a significant shift in the type of crops cultivated by households, where the share of households cultivating millet increases, while those cultivating sorghum decreases. We also observe a similar shift from sesame to peanuts. **Millet cultivation is significantly widespread in the Darfur states, where 84% of crop farming households grew millet in 2021**. The Darfur region experiences high incidences of drought, making millet an appealing choice due to its drought-resistant nature, in addition to it holding a prominent position in the region as a traditional food staple. Uniquely, with its rapid growth periods, corn emerges as the predominant crop in the Red Sea region, where over 80% of farmers cultivate it. However, corn does not enjoy the same level of prevalence in other states. The cultivation of peanuts is more prevalent among farming households in the southern and western states of Darfur, as well as in West Kordofan, where over 80% of households in these states cultivated peanuts in 2021.

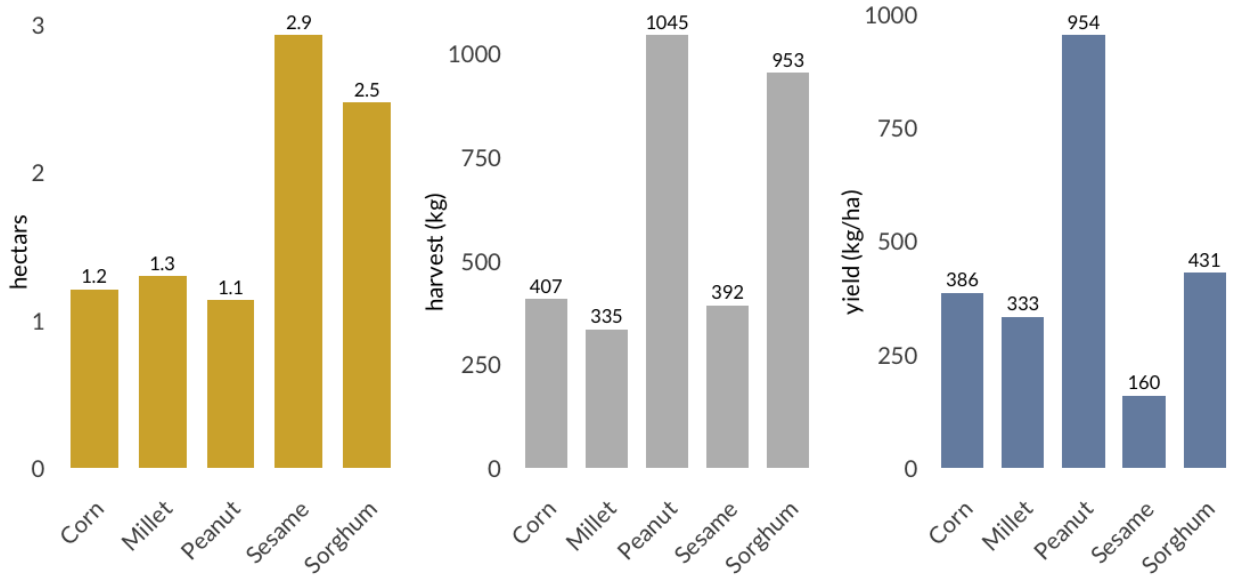
All in all, we observe large differences between the states regarding the types of cultivated crops. These disparities might be driven by climatic, economic, cultural or other local conditions and potentially shape the economic and nutritional wellbeing of households.

Figure 9. Geographic variation in the types of crops cultivated



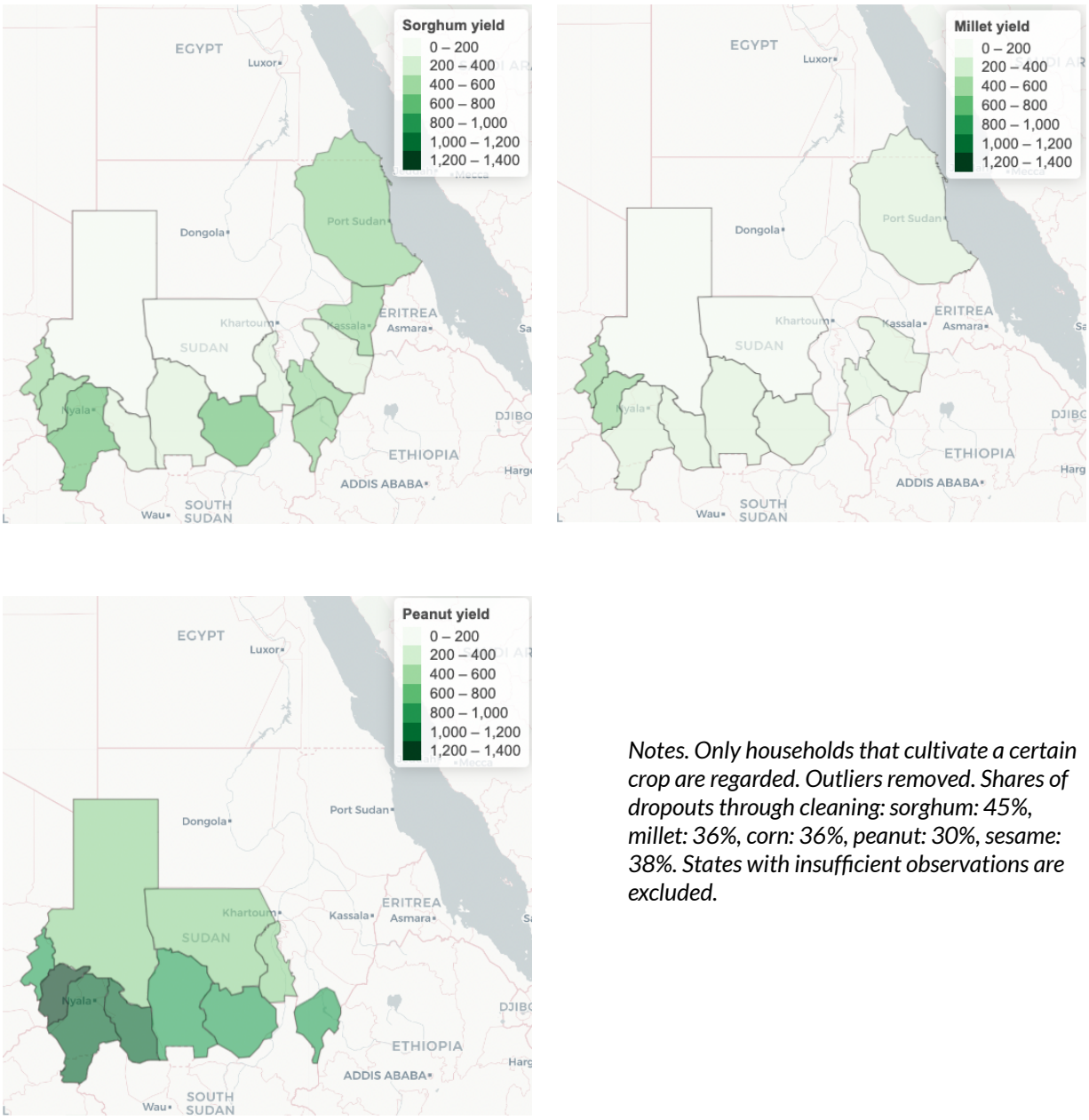
For each of these five main crops, Figure 10 shows, in the harvesting season 2021, the average land size used (in hectares), the amount of harvest (in kilogram), and the crop yield (in tonnes per hectare) for the harvesting season 2021. First, we find that farmers allocate more land for the cultivation of sesame (2.9 ha) and sorghum (2.5 ha) than to millet (1.3 ha), corn (1.2 ha) or peanut (1.1 ha). Second, the highest harvest was on average achieved with peanuts through 1.05 tonnes followed by sorghum with 0.95 tonnes on average. This difference is driven by the lower weight of sesame compared to the other crops. The yields for the main crops are remarkably below the common yield potential for these crops, but not unexpected for Sudan where most of the crops are rainfed. Sesame yields are as low as 0.16 t/ ha and sorghum had yields of 0.43 t / ha in 2021. We also find similar low yields for corn and millet. Peanuts have, on average, a yield of 0.95 t / ha.

Figure 10. *Land size, harvest and yields of the five main crops cultivated in 2021*



Notes. Only households that cultivate a certain crop are regarded. Outliers removed. Shares of dropouts through cleaning: sorghum: 45%, millet: 36%, corn: 36%, peanut: 30%, sesame: 38%.

Figure 11. Sorghum, millet and peanut yields by state (kg/ha)



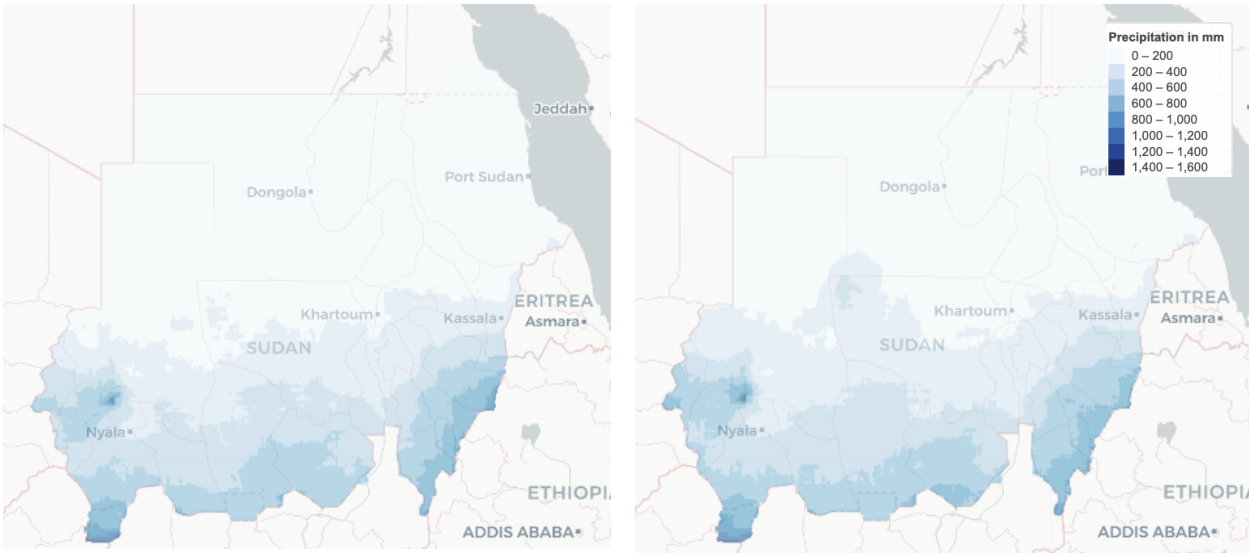
Notes. Only households that cultivate a certain crop are regarded. Outliers removed. Shares of dropouts through cleaning: sorghum: 45%, millet: 36%, corn: 36%, peanut: 30%, sesame: 38%. States with insufficient observations are excluded.

Figure 11 further explores the yields across states. Sorghum yields are lowest in arid states, such as North Darfur and North Kordofan. The average yield in later states is below 0.2 t/ha. Also, the states of Gedaref, White Nile, West Kordofan and East Darfur have lower than average sorghum yields, below 0.4 t/ha. We observe that the yields for sorghum are highest in the Southern states, where sorghum productivity in South Darfur

and South Kordofan is highest with 0.61 t/ha and 0.64 t/ha. Millet is most productive in the Western States of West and Central Darfur with 0.5 t/ha, respectively. Again in North Darfur and North Kordofan, millet is particularly unproductive, where yields are well below 0.2 t /ha. For peanut cultivation, we observe the highest productivity in the Darfur States, where some yields are reported up to 1.34 t/ha in Central Darfur. Based on these geographical variations, it is clear that rainfall is a strong determinant of crop productivity in Sudan, where almost none of the households use irrigation. Figure 12 displays the total 2021 and 2022 precipitation levels (in mm) for the months of May to November, which constitute the rainy season in Sudan. North Darfur and North Kordofan, where we find the lowest crop productivity for Sorghum and millet, are highly arid and dry areas, where precipitation levels during the rainy season was lower than 400 mm per annum. On the other hand, the Southern States receive more rainfall on average which explains the crop choice and the higher yield number.

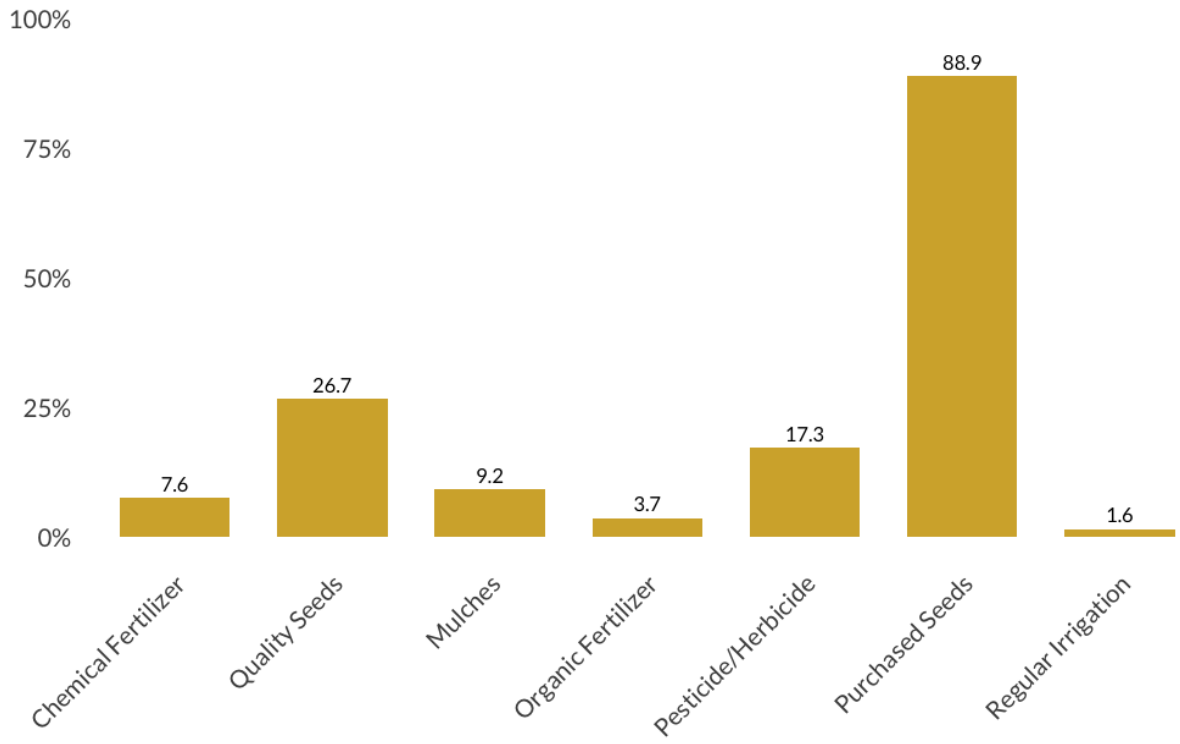
Figure 12. *Precipitation levels during the rainy seasons (May-November) of 2021 and 2022*

(a) 2021 *(b) 2022*



To better understand why the agricultural productivity is low, Figure 13 shows the use of agricultural inputs for crop production. The only frequently used input is purchased seeds which are used by 89% of the households. However, **only 27% of the households use high quality seeds. Only 1.6% of households use water irrigation for farming, which underscores the low crop productivity, particularly in the arid and dry areas.** Agriculture practices and inputs, such as the use of mulches or fertilizers, are used by less than 10% of the farming households. 17% of households rely on pesticides or herbicides in farming. Generally, the low share of input usage also explains the low degree of agricultural efficiency.

Figure 13. *Low use of agricultural inputs*

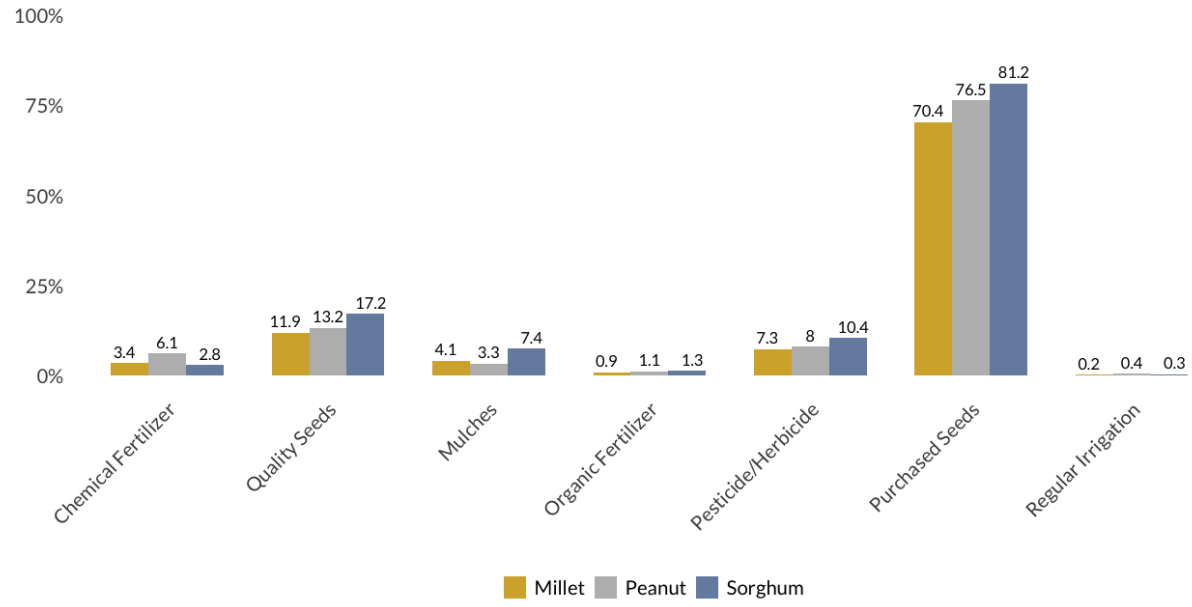


Note: Non-crop-farming households are not included in the statistics.

In Figure 14, we break down these input shares by the crop type. First, it is important to note that the share of inputs used for the individual crops are lower than the overall numbers, since farmers do not use the same inputs for each crop grown. The overall input

usage is accounted for in Figure 13 if it is used at least for one crop. Generally, we do not find strong differences in the type of inputs used by the individual crops. For sorghum, the usage of purchased seeds is slightly higher compared to other crops (81% versus 70-77%) as well as for using quality seeds (17% versus 12%) and mulches (7% versus 3-4%).

***Figure 14.** Input use by crop type*

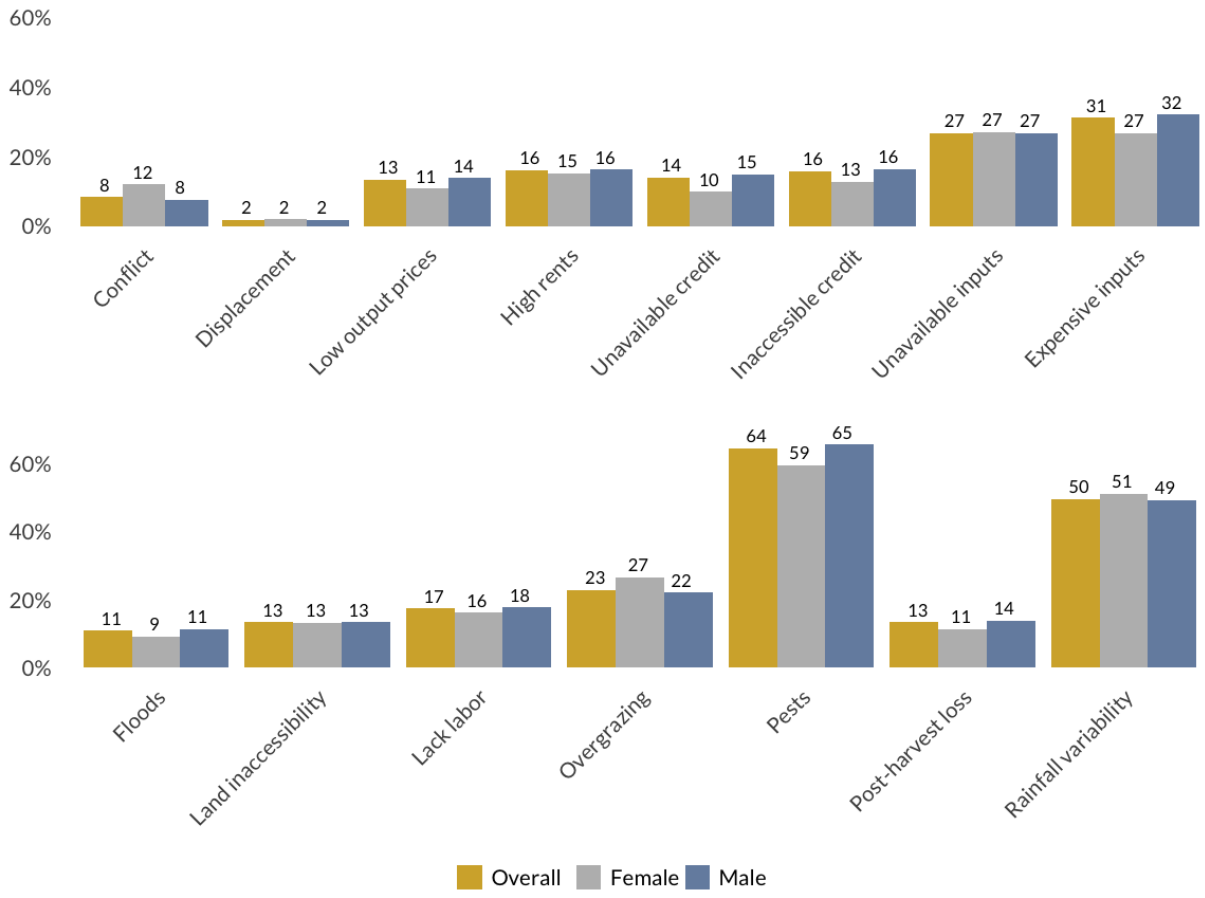


Note: Non-crop-farming households are disregarded in the statistics.

Figure 15 concentrates on the challenges crop farmers faced in the 2021 harvesting season. Only 3% of crop farmers did not report any constraints while 76% of the responding crop farmers shared more than one constraints. The most prevalent obstacles were crop pests which affected 64% of the crop farmers, followed by high variability of rain (50% of farmers), high cost of inputs (31% of farmers), unavailability of inputs in the markets (27% of farmers), overgrazing (23% of farmers). We observe slight differences between male- and female-headed households. Female-headed crop farming households were less exposed to credit unavailability and inaccessibility and expensive inputs. This might be related to the generally smaller farm size of female-headed households and correspondingly less demand for credit and inputs. On the other hand, **female-headed**

households report more frequent agricultural constraints due to conflict (12% versus 8%). Hence, women's agricultural productivity seems to be more prone to the presence of violence compared to men's.

Figure 15. *Crop farmers are vulnerable to crop pests and rainfall variability*

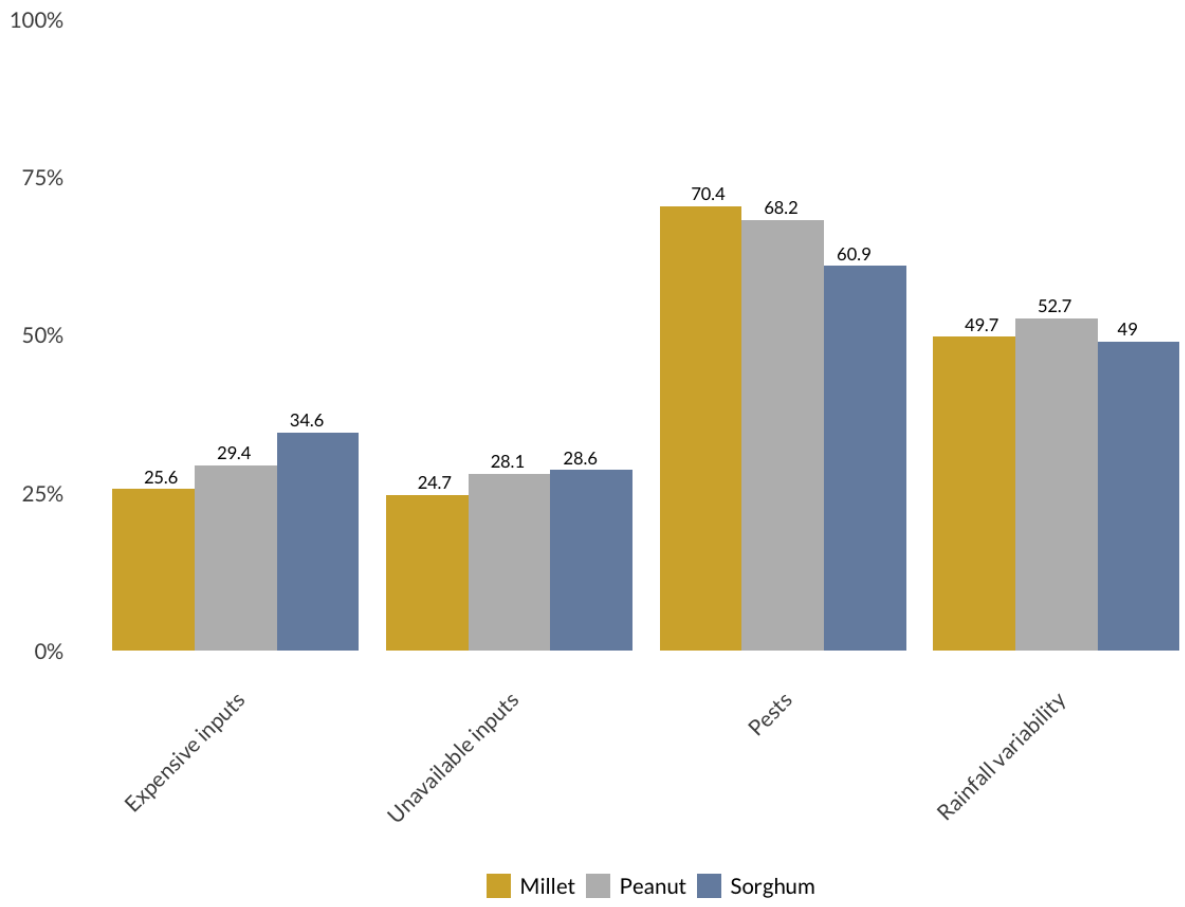


Note. Non-crop-farming households are disregarded in this figure.

Figure 16 elaborates the concentration of the four most prevalent constraints in crop farming by the three most common crops. Interestingly, an **increased incidence of crop pests is associated with the cultivation of peanuts and millet.** Although millet is famous for being resistant to pests, this association might be observed because households prefer to crop millet in regions with a high incidence of pests. Furthermore, inputs are particularly expensive for sorghum farmers and more likely to be unavailable for peanut

and sorghum farmers. The incidence of rainfall variability is similar across the farmers of different crops.

Figure 16. *Constraints faced by sorghum, millet and peanuts crop farmers*



Note. Only households that cultivate the three crops are considered in this figure.

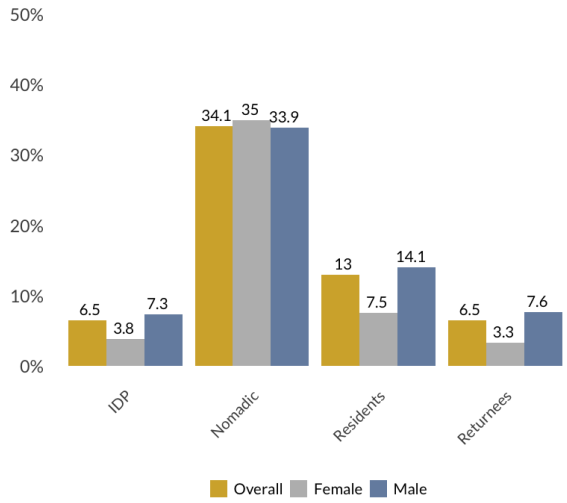
4.5. Livestock ownership and production

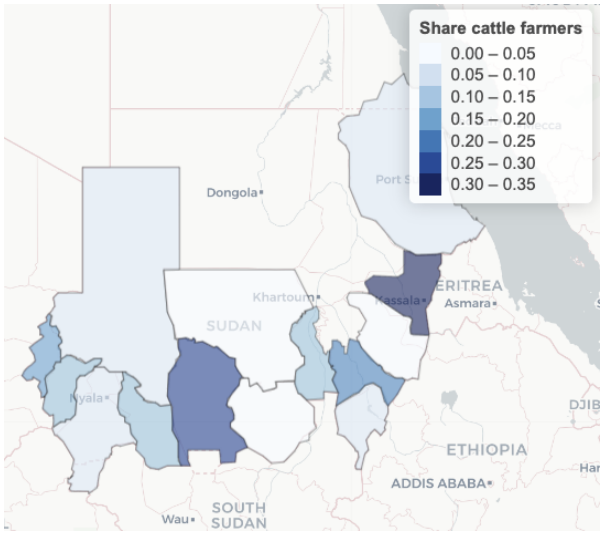
Cattle farmers in Sudan (image provided by FAO)

In this section, we summarize the livestock ownership and production of households by their residency status, gender of the household head, and state. 13% of the households own cattle (not displayed). In Sudan, cattle is regarded as a valuable asset and is, therefore, also an indicator of household wealth. Figure 17 presents the share of cattle ownership in households by their residency status and gender. As expected, a higher share of **nomadic households own cattle** (34%) compared to residents (13%), IDP or returnees (both 7%)**.** This is similar across the gender of household heads. For residents, the share of cattle ownership is 14% for male-headed households, while it is half for female-headed households. The share of cattle ownership is similar in returnee and IDP households compared to resident female-headed households among. The lowest share of cattle ownership is within female-headed households in IDP and returnee households. As livestock ownership is an important source of nutrition for families and crucial for the food security of households, one can argue that female-headed households in each residency status are disadvantaged in that regard. In other words, they are more dependent on crop production for their livelihoods, and this increases the vulnerability of

their households to food insecurity in an environment with a high risk of climate shock and conflict.

Figure 17. *Cattle ownership by household head gender, residency status and states*





Grazing goats in Sudan (image provided by the enumerators)

Moreover, the second panel of Figure 17 presents the spatial distribution of cattle ownership in our sample. The share of households with cattle ownership is lowest in North Kordofan, South Kordofan and Gedaref, which is under 5%; and is **highest in the Kassala, West Kordofan and Sennar states where 32%, 25% and 21% of the households own cattle.**

Figure 18. *Sheep and goat ownership by household head gender, residency status and states*

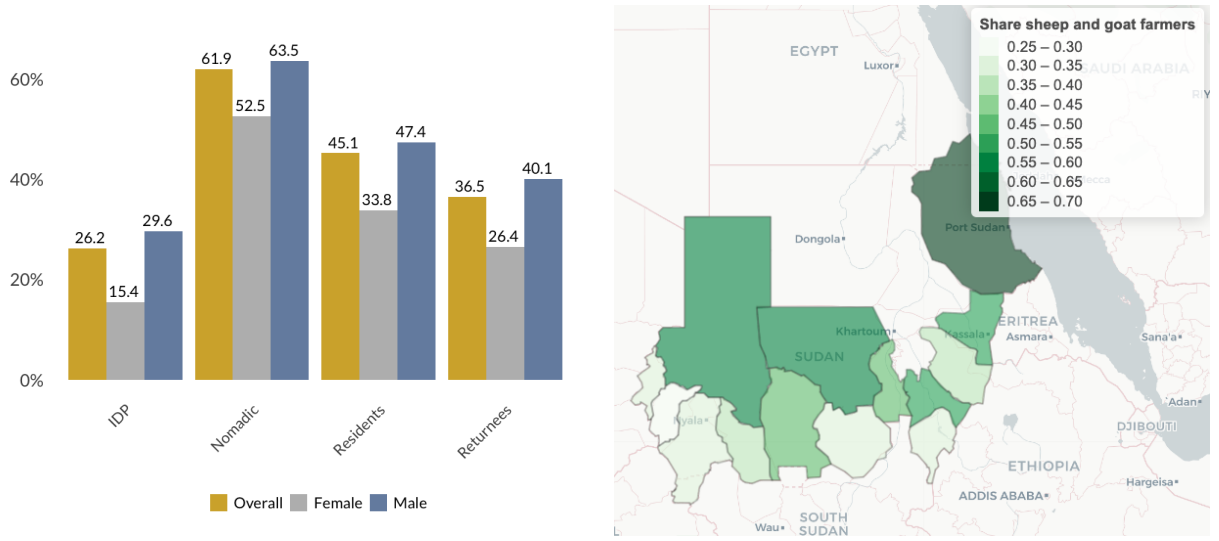
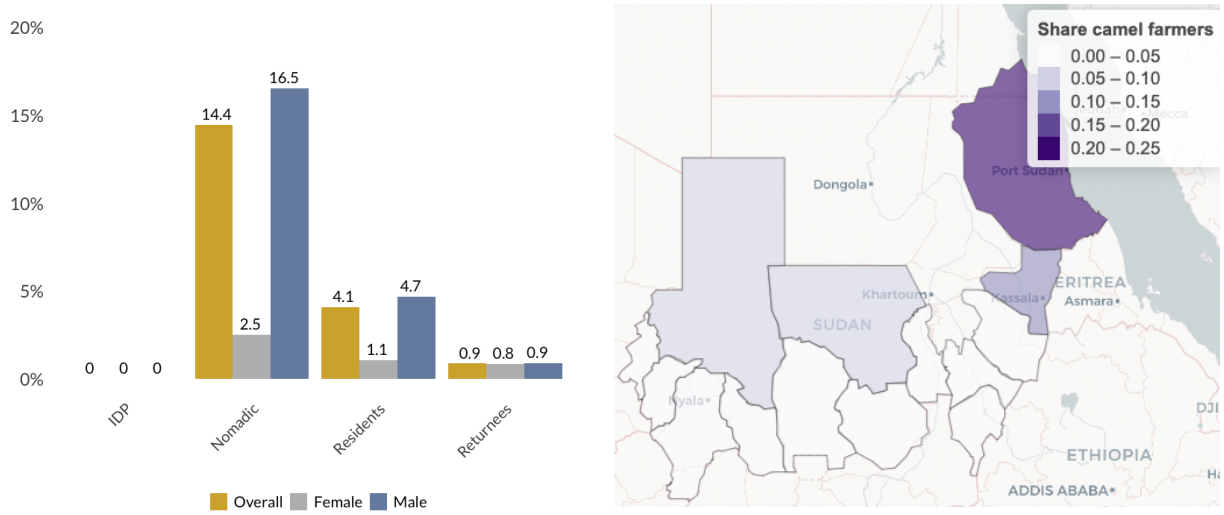


Figure 18 presents the share of sheep and goat ownership in households by their residency status. 44% of the sampled households own sheep or goats (not displayed). Again, nomadic households have a higher share of sheep/goat ownership than other households (more than 61.9%). That said, **irrespective of residency status, female-headed households have lower shares of sheep/goat ownership than male-headed households.** For example, among residents, 47% of male-headed households own goats or sheep compared to 34% of female-headed households. Moreover, IDP households have the lowest share of sheep ownership. As we see in the map of Figure 18, there is a very clear spatial heterogeneity in sheep/goat ownership in Sudan. The share of sheep/goat ownership is lower in the Southern States. It is particularly low in Central

Darfur, South Darfur, West Darfur, Blue Nile, Gedaref and South Kordofan. The highest share is in Red Sea Sate, where 68% of the households own sheep or goats.

***Figure 19**. Camel ownership by household head gender, residency status and states*



Camel herds in Sudan (image provided by the enumerators)

In reference to Figure 19, the analysis examines the distribution of camel ownership among households based on gender, residency status, and states. We find that no IDP households own any camels, whereas the **highest ownership rate is observed among male-headed nomadic households, accounting for 17%**. With respect to geographic

distribution, Red Sea exhibits the greatest ownership shares, where 24% of households own camels, followed by Kassala with 11%.

Lastly, we focus on livestock productivity. Table 12 summarizes the average livestock size and growth for cattle, sheep and goats and camels, as well as the dairy production and productivity. In these numbers, we only consider households who own the respective livestock. In terms of livestock reproductivity, we find that within a period of three months, a **cattle calf or lamb was born for every third animal owned, and a calf for every fifth camel.** This can be attributed to the longer gestation and higher life expectancy of camels than cattle, sheep or goats.

Table 12. *Livestock count, milk production and productivity, and use of livestock produce*

	Cattle	*Sheep/goats*	*Camels*
n	553	1,623	136
# Heads	6.16 (5.55)	7.02 (5.04)	6.97 (11.22)
Birth per head (past three months)	0.34 (0.35)	0.35 (0.33)	0.18 (0.28)
Total daily milk production (in liter)	4.01 (5.54)	1.47 (1.32)	2.33 (1.78)
Milk per day per capita (in liter)	1.78 (1.48)	0.52 (0.33)	1.27 (0.96)
Share of milk for home consumption (%)	81.55 (27.93)	95.54 (14.81)	77.72 (29.34)
Share of milk sold (%)	13.41 (25.99)	1.52 (9.25)	11.50 (25.23)

Note. Information is for the period of September-November 2022. Table only includes households that own cattle, sheep/goats, or camels. Outliers removed. Shares of dropouts through cleaning: cattle: 34%, sheep and goats: 31%, camels: 19%.

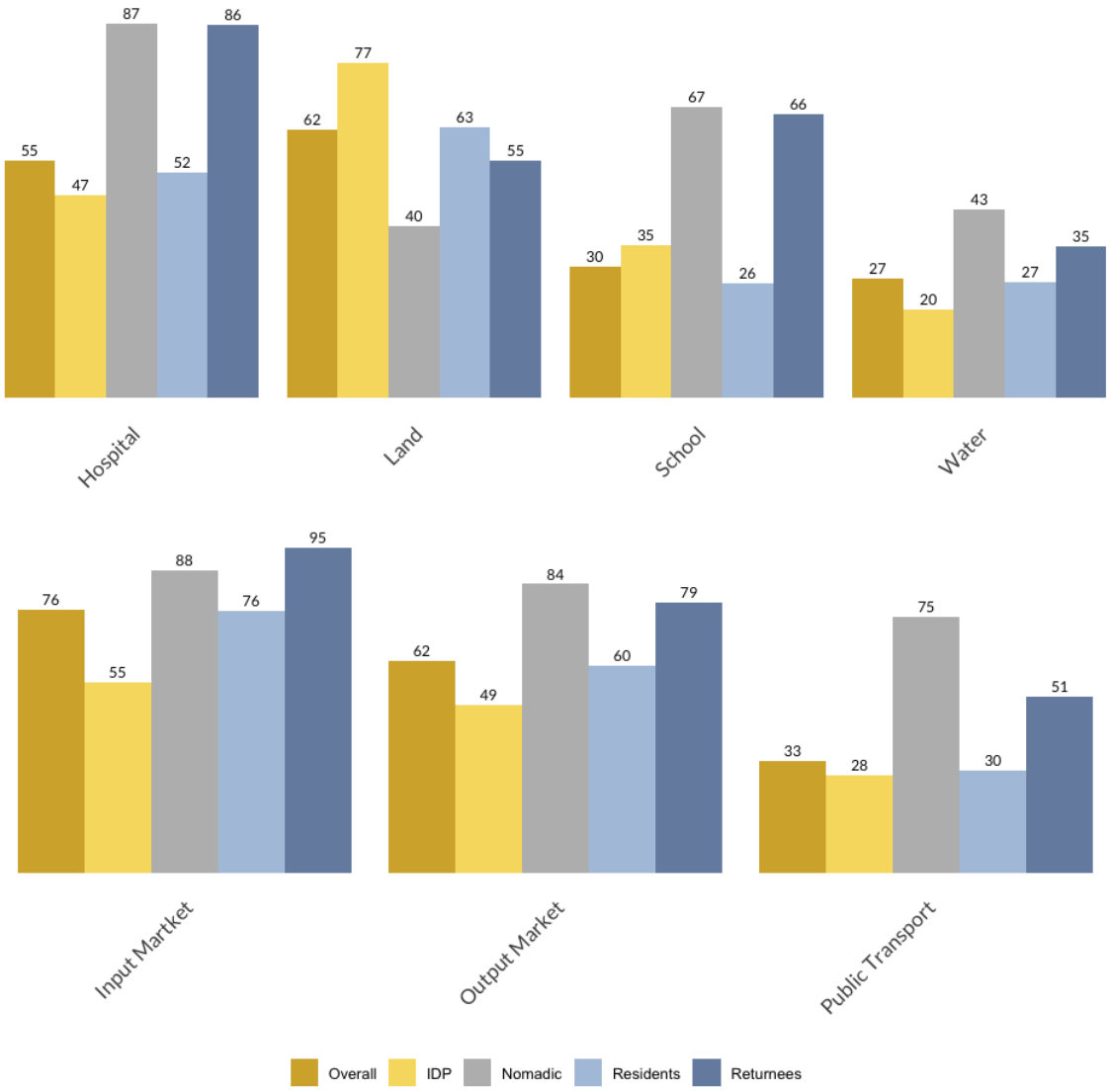
We do not have information about the share of animals that produce milk. Hence, we assume that every second livestock animal produces milk for the per capita estimation. **Dairy production and productivity are low across the sample.** On average, cattle farmers keep 6.2 animals. Cattle farming households produce on average 4 liters of milk per day.

The estimated average daily production per cow is 1.8 liters which is comparatively low. 82% of the cattle milk is consumed at home while 13% is sold. Looking at sheep and goat production, livestock farmers keep on average 7 sheep or goats and produce in total 1.5 liters of milk, which translates into a productivity of 0.5 liters per day per dairy animal. Most of the goat milk is consumed at home (96%). This is attributed to the low scale of production which impedes profitable commercialisation. Camel farmers have on average 7 animals, which produce 2.3 liters of milk per day in total and 1.27 liters per dairy camel. 12% of the camel milk is on average sold.

4.6. Access to basic services

Quick access to basic services not only saves time but also encourages people to use them more frequently. This can have a significant positive impact on the overall welfare and well-being of the households. Figure 20 displays the households' access to basic infrastructure in minutes. First of all, the large average distances to services underscore the remoteness of most of the sampled households. Knowing that only 7% of the households own cars, the one-way walking distances (in minutes) that we present here shows us how **challenging it is for households to access these basic services.** As can be seen in Figure 20, **hospitals, land, input and output markets are on average 55-76 minutes walking distance** from the households. The distance to schools and public transportation is on average half an hour. Importantly, **access to drinking water is, on average, half an hour away from households** which implies a daily loss of time. The figure shows additionally that there are significant inequalities in access to basic services by the residency status of households. As can be seen, except for access to land, **nomadic and returnee households have more difficulty accessing all basic services, including drinking water.** Host community households and IDPs are on average 20-35 minutes away from schools, public transport and drinking water although their distance to hospital, land, input/output market on average takes almost one and a half hours. These differences highlight that vulnerable households like returnees and nomadic households are prone to face additional hardships as they have a worse access to essential services through long distances.

Figure 20. Access to basic services (in minutes) disaggregated by residency status



Notes: Values over 5 hours for hospitals, land, schools, public transportation and water are removed. Values over 8 hours to input and output markets are removed. Up to 2% of the observations were removed in the cleaning process.

4.7. Food security

This section provides an overview of food security in Sudan. The aim is to gain insights into the prevalence of food insecurity and accessibility to nutritious food. This section presents key findings based on three main indicators: Food Consumption Score (FCS), Food Insecurity Experience Scale (FIES), Household Hunger Score (HHS). These indicators

are further examined based on factors such as regional disparities, household types, and gender dynamics.

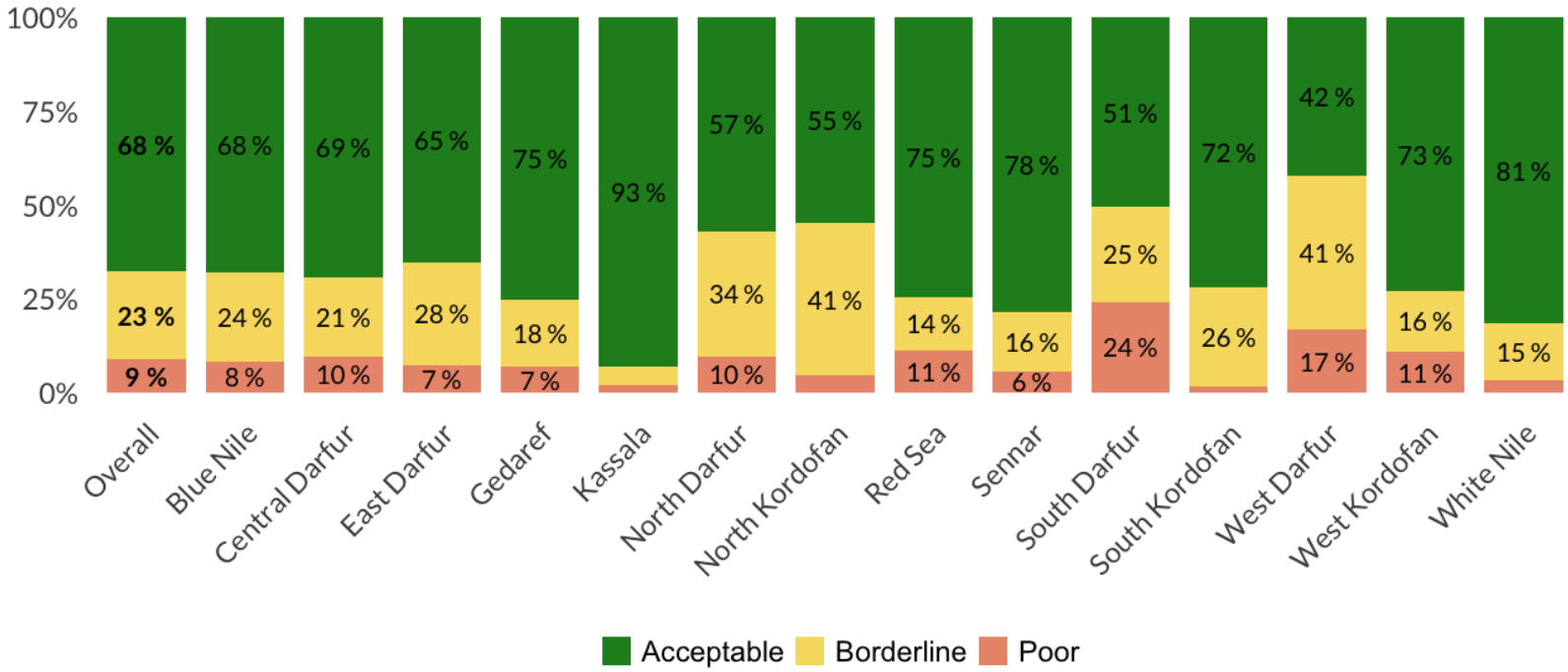
Sorghum is the main food crop in Sudan (Picture provided by enumerators).

Food Consumption Score (FCS)

First, we present the findings on food security using the Food Consumption Score (FCS). The FCS indicates the frequency of the consumption of various food categories at the household level. Households are asked how many days they ate food from a certain food category in the last seven days. The following categories with the corresponding weights in parentheses are included: starches (2), pulses (3), vegetables (1), fruit (1), meat/fish/eggs (4), milk/dairy (4), fats (0.5), sugar (0.5), and condiments (0). The FCS is derived from the sum of the weighted category values. The score takes a value between 0 and 112 and is classified into "poor" (0 - 28), "borderline" (28.5 - 42) and "acceptable" (> 42) food consumption.[4]

[4] https://resources.vam.wfp.org/data-analysis/quantitative/food-security/food-consumption-score

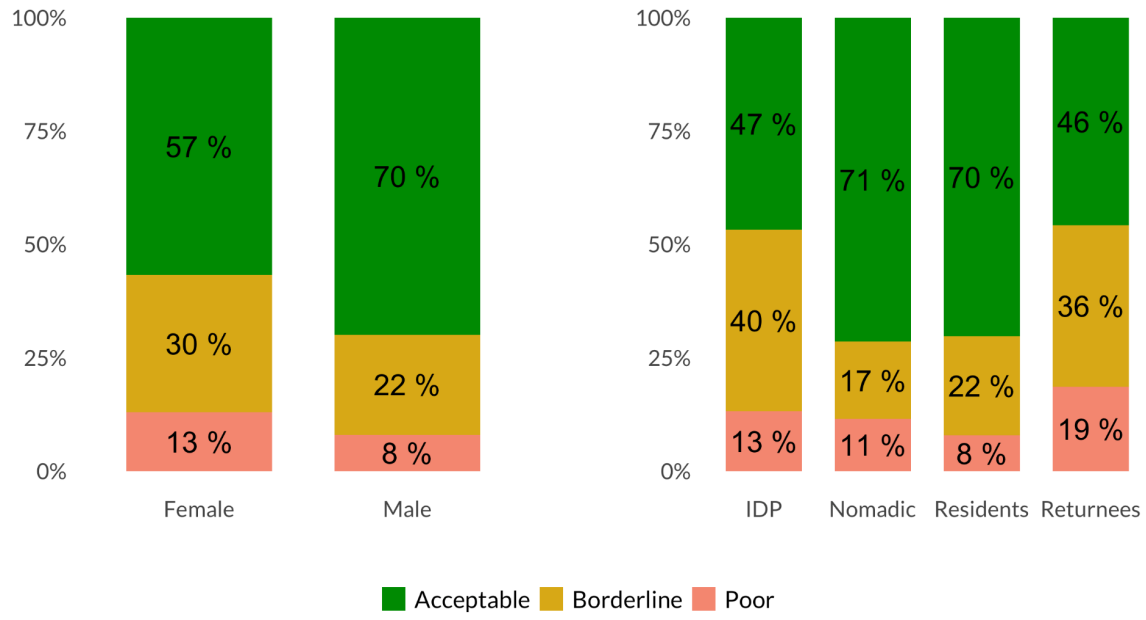
Figure 21. *Food Consumption Score (FCS) disaggregated by state*



The first bar in Figure 21 shows that **68% of the sample has acceptable levels of food security, 23% have borderline levels, and 9% of households are poor food secure**. Moreover, the largest share of households with poor food security levels are in South Darfur (24%) and West Darfur (17%). Kassala has the highest FCS, with 93% of its households having acceptable levels of food security.

In addition to the variation of FCS across states, we also observe large differences by the gender of the household head and the household residency status. As can be seen in Figure 22, **43% of female-headed households have either borderline or poor FCS, compared to 30% of male-headed households**. Moreover, resident households and, unexpectedly, **nomadic households have higher shares of acceptable food security levels,** while more than half of the IDP and returnee households have borderline or poor food security. These figures clearly emphasize that female-headed, IDPs and returnee households are more food insecure.

Figure 22. *FCS disaggregated by household head gender and residency status*



Food Insecurity Experience Scale (FIES)

Second, we examine FAO's Food Insecurity Experience Scale (FIES). It measures the prevalence and severity of food insecurity based on responses to questions about constraints in the ability of households to obtain and consume adequate food. This approach represents a significant change compared to traditional measures - which assess determinants such as food availability, or consequences like poor quality diets, and other signs of malnutrition.

The FIES indicator consists of a set of eight short yes or no questions referring each to a different experience and severity level. The questions focus on self-reported, food-related behaviors and experiences associated with increasing difficulties in accessing food due to resource constraints.[5] The eight questions are:

During the past 30 days, was there a time when, because of lack of money or other resources you or any member of your household… (Acronyms in parenthesis):

1. *… were worried you would not have enough food to eat?* (WORRIED)
2. *… were unable to eat healthy and nutritious food?* (HEALTHY)
3. *… ate only a few kinds of foods?* (FEWFOOD)
4. *… had to skip a meal?* (SKIPPED)
5. *… ate less than you thought you should?* (ATELESS)
6. *… ran out of food?* (RUNOUT)
7. *… were hungry but did not eat?* (HUNGRY)
8. *… went without eating for a whole day?* (WHLDAY)

We use the Rasch Model from the Item Response Theory that includes the measurement of unobservable traits to analyze all responses at once and classify the households as moderately or as severely food insecure. The remaining households are classified as mildly food insecure or not food insecure at all.

[5] https://www.fao.org/in-action/voices-of-the-hungry/fies/en/

Overall, **74% of the households surveyed expressed to have experienced at least one of the eight FIES items** in the past 30 days before the survey was conducted (not displayed). Figure 23 displays the overall share of households categorized as moderately and severely food insecure by FIES, broken down by household head gender and residency status. **Overall, around 49% of the sampled households are classified as food insecure, where 40% are moderately food insecure and 9% are severely food insecure.** We find the lowest shares of food insecurity among male-headed and resident households each with 39% classified as moderately food insecure and 9% as severely food insecure. Within the nomadic households, 46% experience moderate food insecurity and only 5% experience severe food insecurity which is the lowest share between all groups. Particularly for IDP and returnee households, but also for female-headed households, the shares are alarmingly high with up to 64% of the households are classified as food insecure.

Figure 23. *FIES classification by gender of household head and residency status*

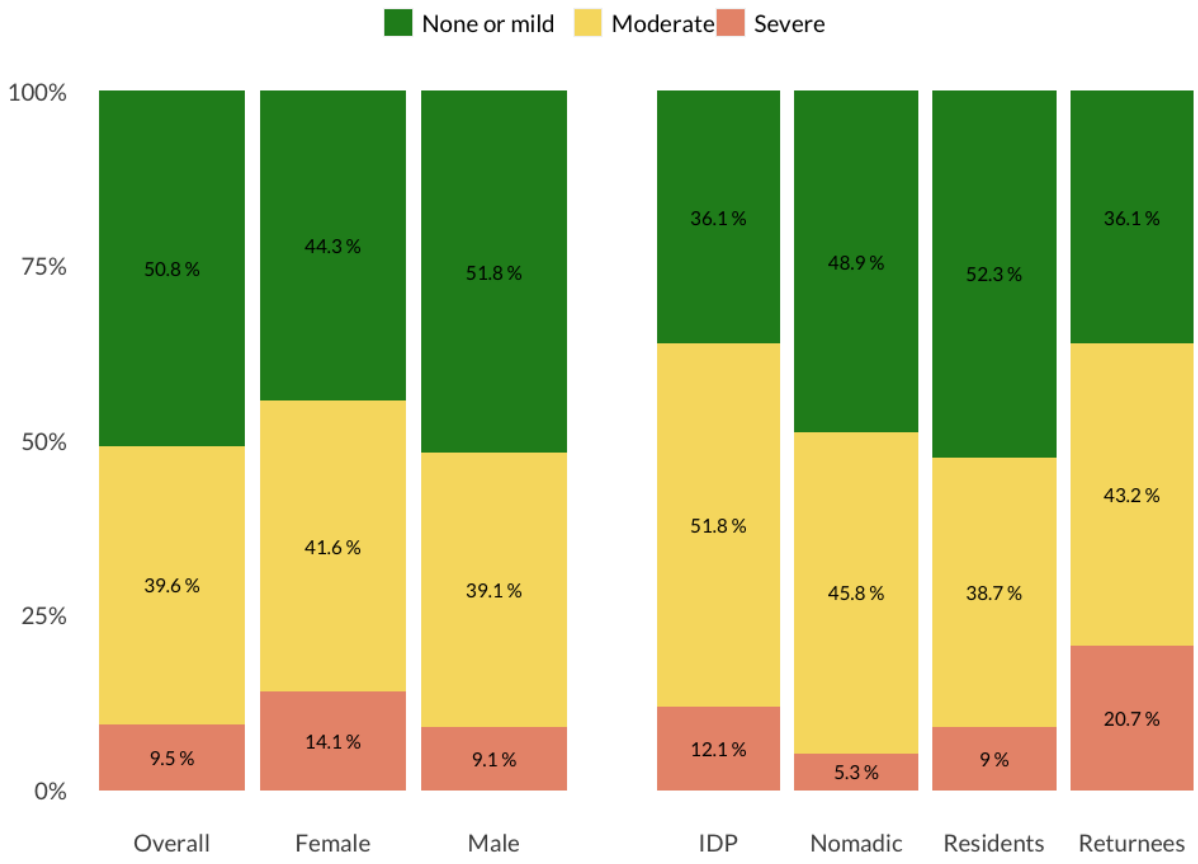
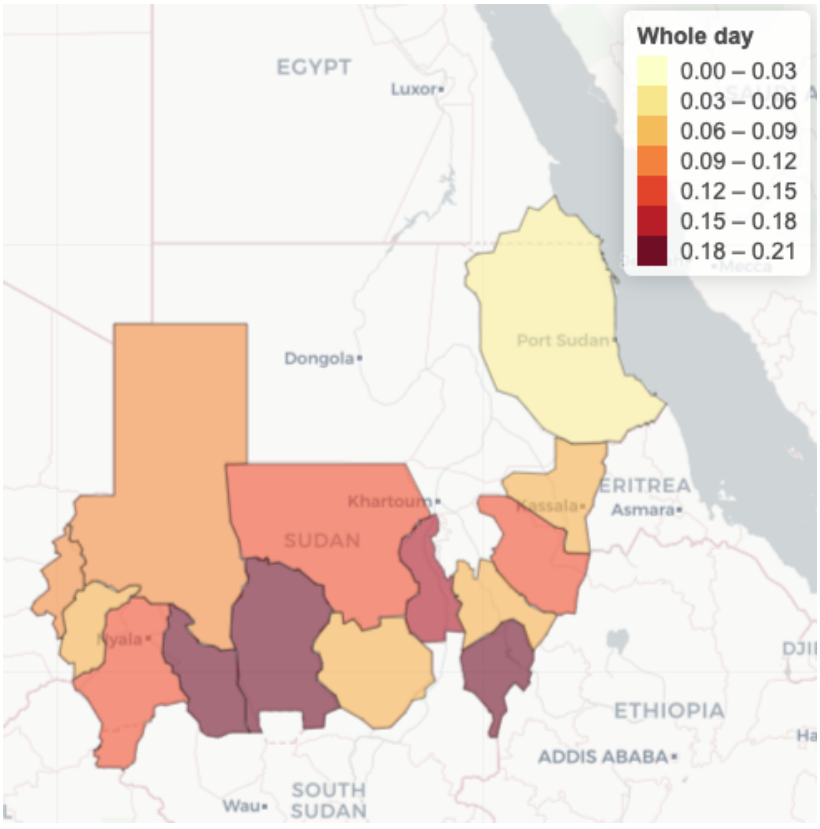


Figure 24 displays the shares of households per state that experienced the most severe FIES item in the past 30 days: going a whole day without food. The figure shows that, especially in the **Southern states, the incidence of not eating for a whole day is high.** In Blue Nile and East Darfur, 20% of the households report at least one whole day without food, followed by West Kordofan (19%). The lowest incidence of 4% is reported in the Red Sea. Households from West Darfur which have the lowest share of acceptable food security according to FCS, show a lower than average share of households spending at least one day without eating any food.

Figure 24. *Share of households who went hungry for whole day disaggregated by state*



Household Hunger Scale (HHS)

Third, the Household Hunger Scale (HHS) is based on the severe cases of the FIES. The HHS is a measure of the frequency of household hunger over the past four weeks. It is

based on several questions that ask how often in the past 30 days have household members experienced any of the following: a) ran out of food because of a lack of money or other resources; b) were hungry but did not eat because of a lack of money or other resources; c) went without eating for a whole day because of a lack of money or other resources. The HHS ranges from 1 to 3, with higher scores indicating greater frequency of household hunger (1 = 1 - 2 times (rarely); 2 = 3 - 10 times (sometimes); 3 = more than 10 times (often)). To combine the frequencies of the three most severe indicators, we grouped "rarely" and "sometimes" into a single answer choice of "1", and "often" as "2". This means that the maximum severity score based on the three questions can be 6, if the maximum score of 2 is answered for each question. After assigning severity scores, we categorized the scores into HHS classes: a severity score of 0-1 indicates little or no hunger in the household, a score of 2-3 indicates moderate hunger, and a score of more than 3 indicates severe hunger.[6]

Figure 25 presents the HHS across states. First, for the overall sample we find that **77% of the households experienced little or no hunger in the past 30 days, while 19% report moderate hunger and 4% severe hunger.** We observe that Red Sea has the highest share of households with little or no hunger (92%) but also has one of the highest shares of households with severe hunger. The total share of moderate and severe hunger is highest in Blue Nile (32%), West Darfur (31%) and North Kordofan (30%). Compared to the state-level statistics of food security as measured by the FCS in Figure 21, we find notable differences. South Darfur has the highest share of households with poor FCS (24%), but less than 1% are classified as having severe hunger. We find, on average, a smaller share of households have moderate levels of food security in HHS compared to the borderline category in FCS.

[6]https://www.fantaproject.org/sites/default/files/resources/HHS-Indicator-Guide-Aug2011.pdf, accessed on 02.05.2023

Figure 25. *Household Hunger Score (HHS) disaggregated by state*

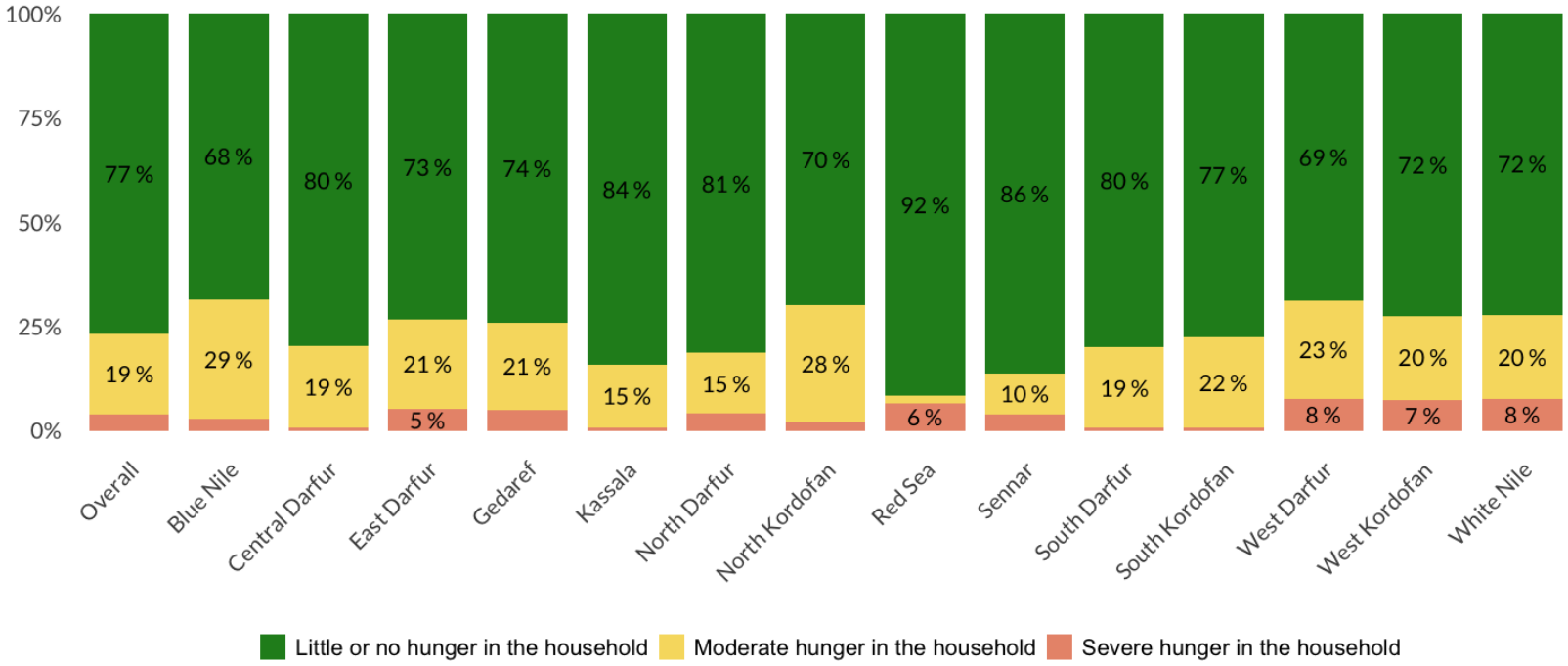
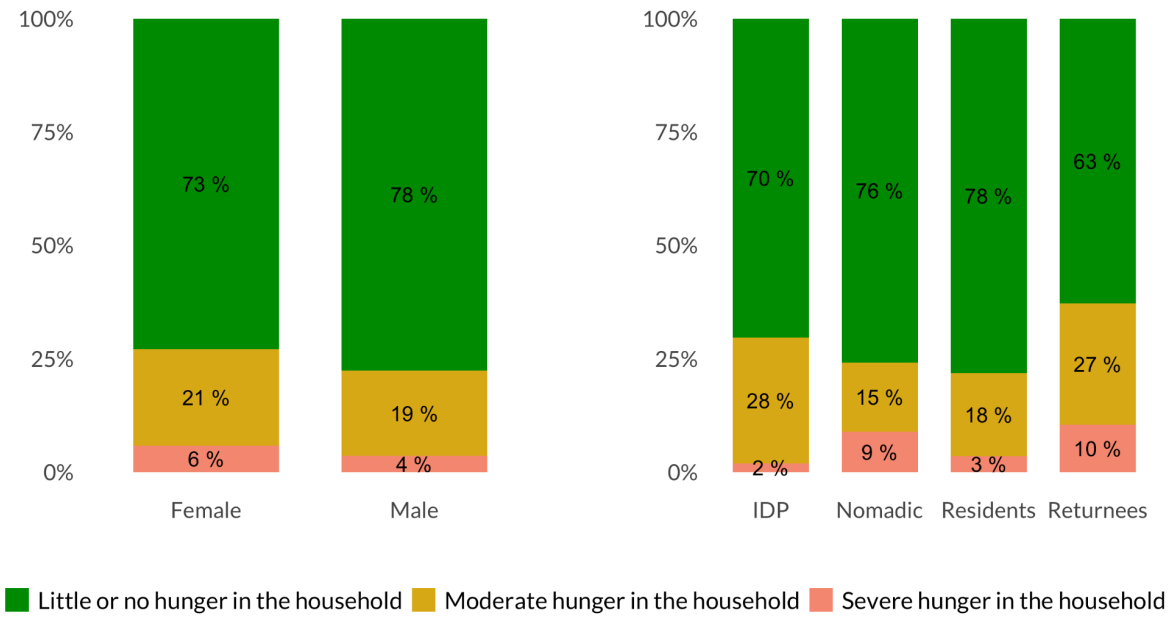


Figure 26 breaks down the HHS by household head gender and residency status. In line with the previous food security indicators, the **share of female-headed households with moderate or severe hunger is 5% points higher than for male-headed households.** Likewise, the share of households with little or no hunger is highest among resident households (78%) and lowest among returnees (63%) nomadic households (76%). **76% of nomadic households have adequate food security but also the share of households with severe hunger is 9% - which is double the overall average.** The differences indicate a high degree of heterogeneity in food security within the nomadic population. More interestingly, we find that only 2% of IDPs are classified as having severe hunger, which could be explained by having more access to food aid, which reduces the frequency of going long periods without enough food.

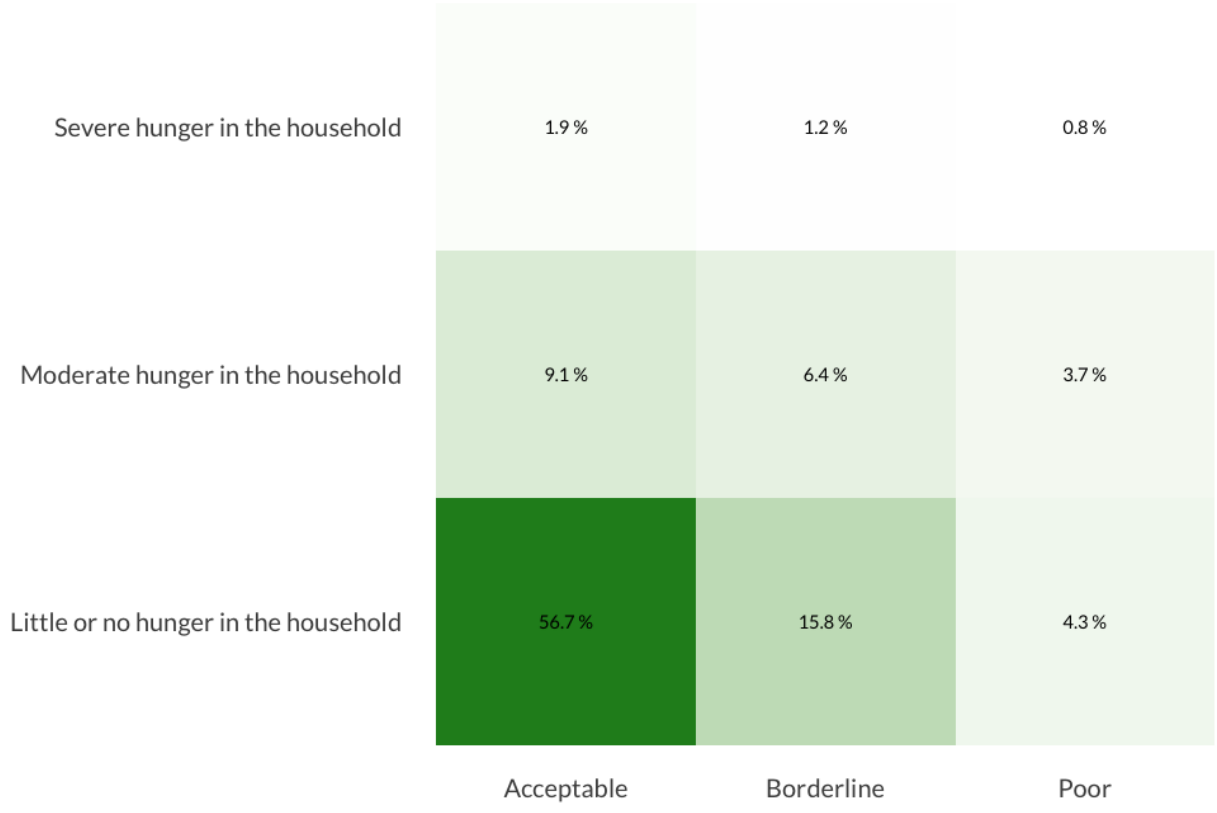
Figure 26. *HHS disaggregated by household head gender and residency status*



The three food security indicators assess different facets of food insecurity. While FIES/HHS focus more on the ability of households to access food, the FCS captures the frequency and diversity of food consumed. **Still, the results of all three indicators are highly correlated** (not displayed). For a final food security classification, Figure 27

connects the FCS categories (x-axis) with the HHS categories (y-axis), showing the percentage of households classified by each scale. First, the figure reveals that **57% of the sample is classified to have an acceptable food consumption while experiencing little or no hunger** according to HHS. This is slightly higher than the 51% categorized as food secure or mildly food insecure by FIES (see Figure 23). Second, 25% of the sample can be regarded as moderately food insecure, still having one of the indicators in an uncritical state while the other one is on a moderate/borderline food insecurity level. Lastly, 18% of the sample have a critical food security status showing at least one alarming classification or both indicators in a moderate/borderline state. 6% of the households belong to opposite categories, which shows that one indicator is not sufficient to provide a complete picture on the prevalence of food insecurity.

Figure 27. *Food security prevalence based on both FCS and HHS*



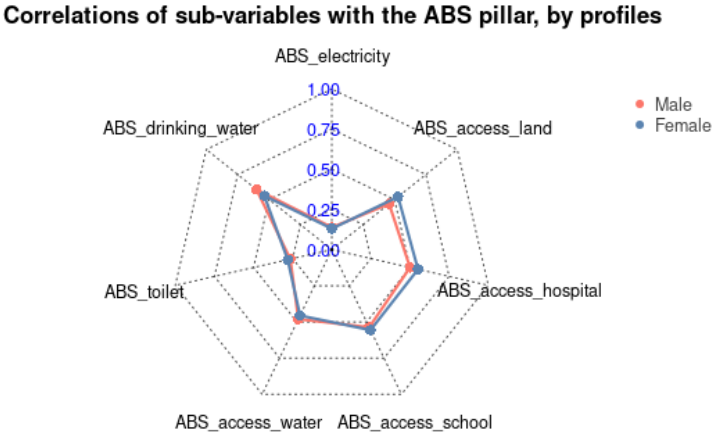
4.8. Resilience

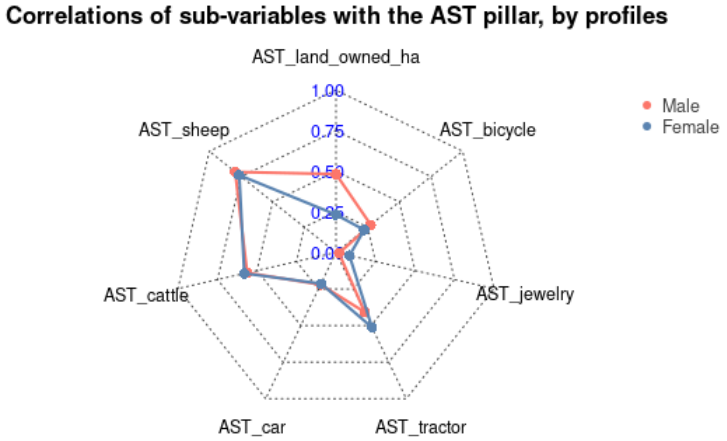
To assess a household's resilience to food insecurity, we use the FAO's RIMA[7] II Resilience Coping Index (RCI) which is based on four main pillars: Adaptive Capacity (AC), Access to Basic Services (ABS), Assets (AST), and Social Safety Nets (SSN). Additionally, the RCI incorporates two variables to measure food security - we include the FIES and FCS. To calculate the AC pillar, we use the following variables: education level of the respondent, literacy of the household head, share of income from agricultural produce, paid labor, off-farm business, and livestock produce. The ABS pillar includes access to electricity, primary source of drinking water and toilet, access to services (school, hospital, drinking water, land) in minutes. The AST pillar includes ownership of cattle, sheep, land, jewelry, cars, and tractors. The SSN pillar includes belonging to youth groups, women's groups, farmers' associations, access to loans, extension services and food aid. These variables were then inputted through the RIMA Shiny app tool provided by FAO, which employs factor analysis to calculate a sub-index for each of the four pillars and construct the final index.[8] The final RCI score ranges from 0 to 100, with higher scores indicating stronger resilience.

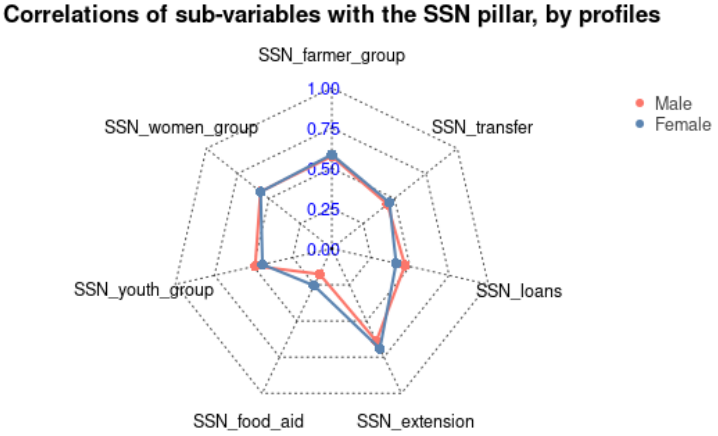
Figure 28 illustrates the correlations of sub-variables within the four RCI pillars, categorized by HHH gender. The primary source of drinking water in the household has the strongest correlation with the resilience within the ABS pillar. We also do not find any notable differences in access by gender of the household head. In the AST pillar, resilience exhibits the strongest correlation with owned land size for male-headed households and with jewelry for households led by females (although the overall correlation is too small). Moreover, we find that the ownership of livestock and cattle are key for both female- and male-headed households, and less so for the ownership of cars and bicycles.

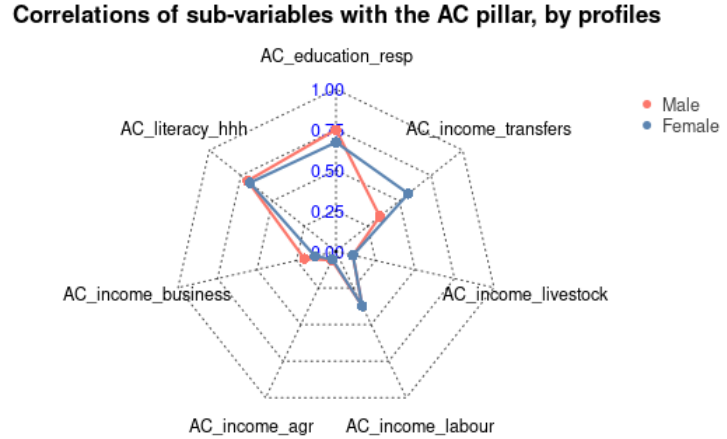
[7] Resilience Index Measurement and Analysis (RIMA)
[8] https://www.fao.org/agrifood-economics/areas-of-work/rima/shiny/en/

Figure 28. Correlations of the variables of the four RCI pillars stratified by household-head gender









In the SSN pillar, extension services provided by the government/other agencies exhibit the highest correlation with resilience capacity, for both male and female HHHs. In the AC pillar, female-headed households show a stronger correlation between income from transfers with RCI compared to men. Education levels and literacy rates are also strongly correlated with resilience capacity.

Figure 29 shows that the composite RCI for our overall sample is 41.6. In line with our previous findings, **female-headed households are on average more vulnerable with a lower resilience capacity index (36.8) compared to male-headed households (42.6 points).** Moreover, as expected, returnee and IDP households also have lower RCI (33.4 and 34.8 points respectively) compared to resident and nomadic households (42.5 and 42.6, respectively).

Figure 29. *RCI by household head gender and the residency status*

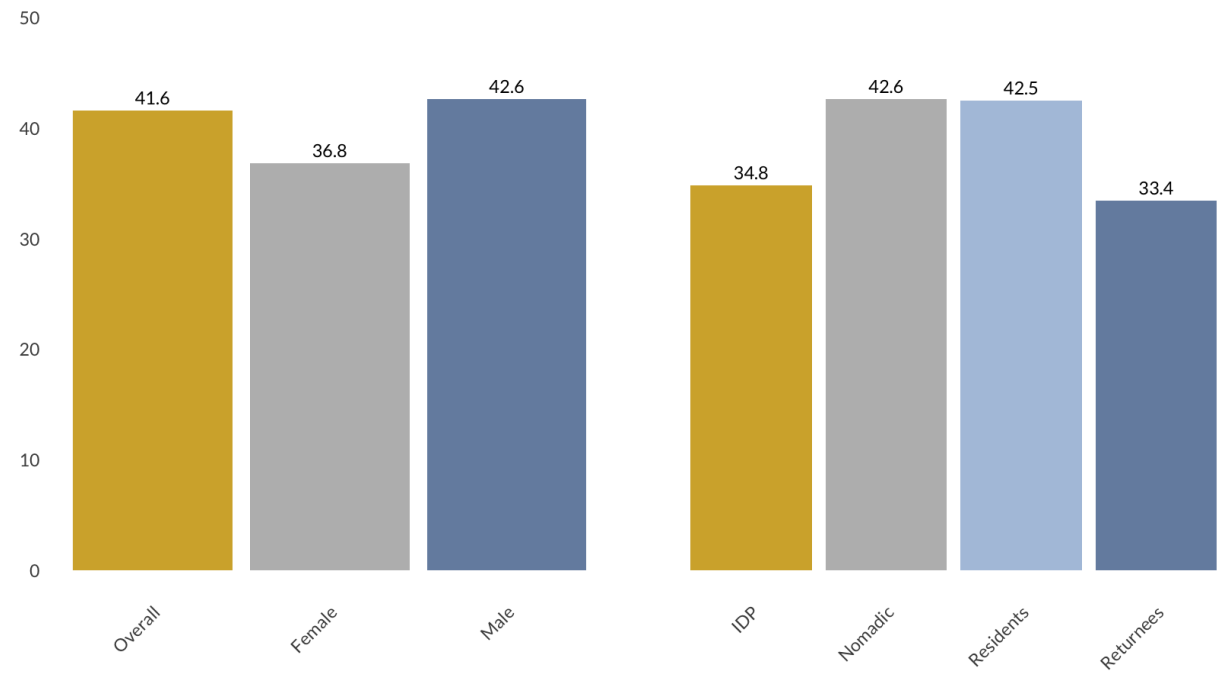
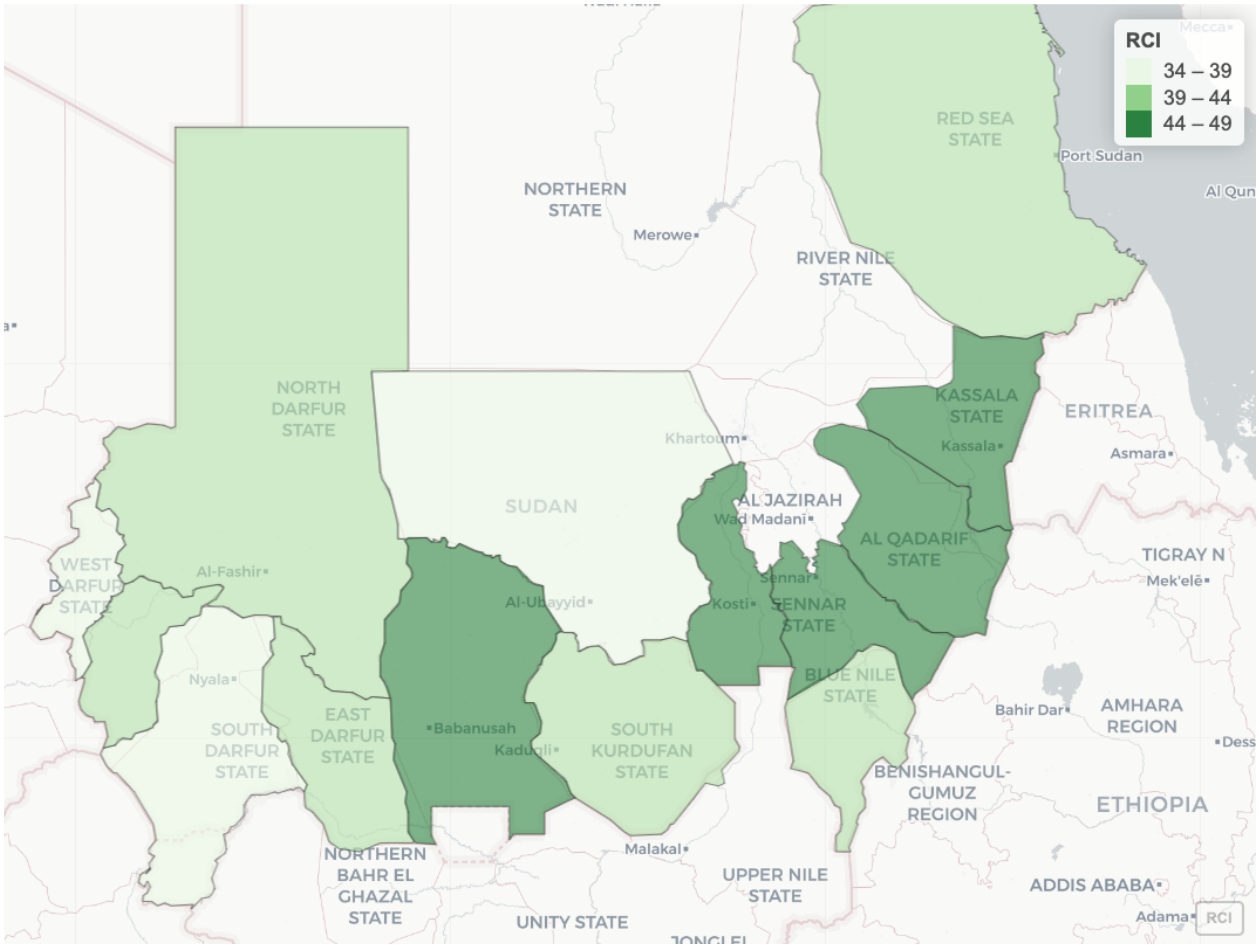


Figure 30 shows the geographical distribution of the RCI across the 14 states in Sudan. In **western and south Darfur, where we have the largest shares of IDPs reside, show the lowest RCI** with under 39 points. Likewise, households in North Kordofan have low levels of RCI of 38.4 points. The highest resilience capacity is measured in the central Eastern States with up to 49. The figure underlines that people in the Darfur states, which are particularly affected by recurrent conflict, are the least resilient and, hence, particularly prone to adverse shocks.

Figure 30. *Resilience Capacity Index (RCI) by state*

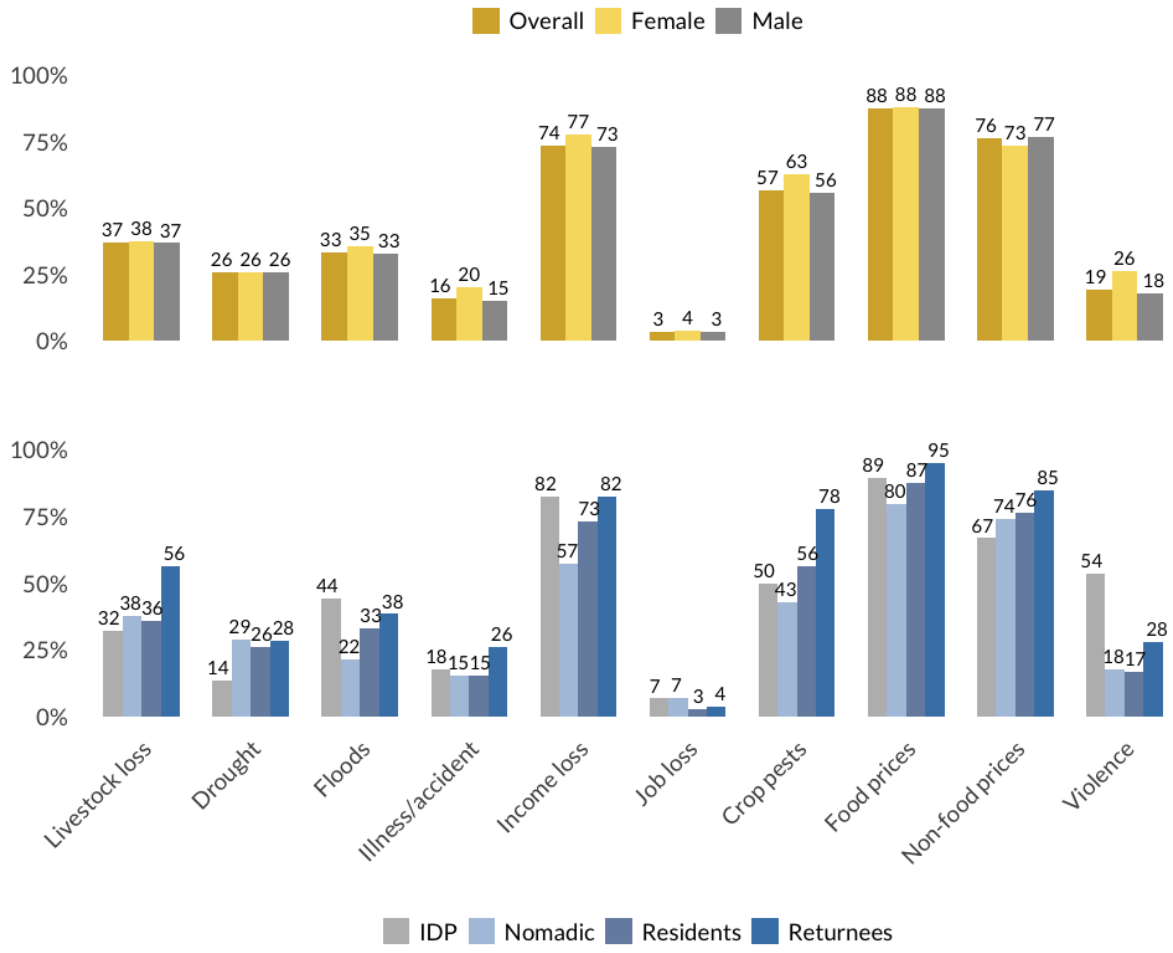


4.9. Exposure to shocks

Next, we present the prevalence of various shocks experienced by the households. As our impact evaluation will be focusing on very short-run changes in household outcomes, we asked households about their exposure to shocks experienced in the last 3 months. Figure 31 shows the share of households who reported to have experienced shocks, disaggregated by the gender of the household head and residency status of the household. First, **only 4% of the households do not report to be exposed to any of these shocks**, which underlines the high vulnerability of the sampled households. Second, we find that on average, **88% and 76% of all households experienced unusually high levels of inflation for food and non-food items**, respectively. Sudden income losses and unusually high levels of crop pests and diseases were also highly prevalent, where respectively 74% and 57% of households across our total sample reported experiencing these shocks in the past three months. Job loss is reported by only 3% of households, which can be attributed to the fact that employment is not a primary source of livelihoods for our sampled households.

Third, we observe that female-headed households experience sudden income losses, unusually high levels of crop pests and diseases and violence/conflict more than male-headed households. **26% of female-headed households reported experiencing violent conflict in the past 3 months,** compared to 18% of male-headed households. This difference in exposure to violent conflict is also evident by the residency status of households. **54% of IDPs and 28% of returnee households were exposed to violence, compared to 18% of nomadic households and 19% of residents.** Overall, every fifth household in our sample reported being exposed to some form of violent conflict in the past three months (period of August - November 2022). However, exposure to other shocks are largely similar across male- and female-headed households. As for natural and climatic hazards, we find that 33% of households were affected by floods where IDP communities face higher exposure to floods (44%) compared to nomadic households (22%). 26% of households were affected by drought, and we find no notable gender differences in the exposure of these climatic shocks.

Figure 31. Shock exposure by household head gender and residency status

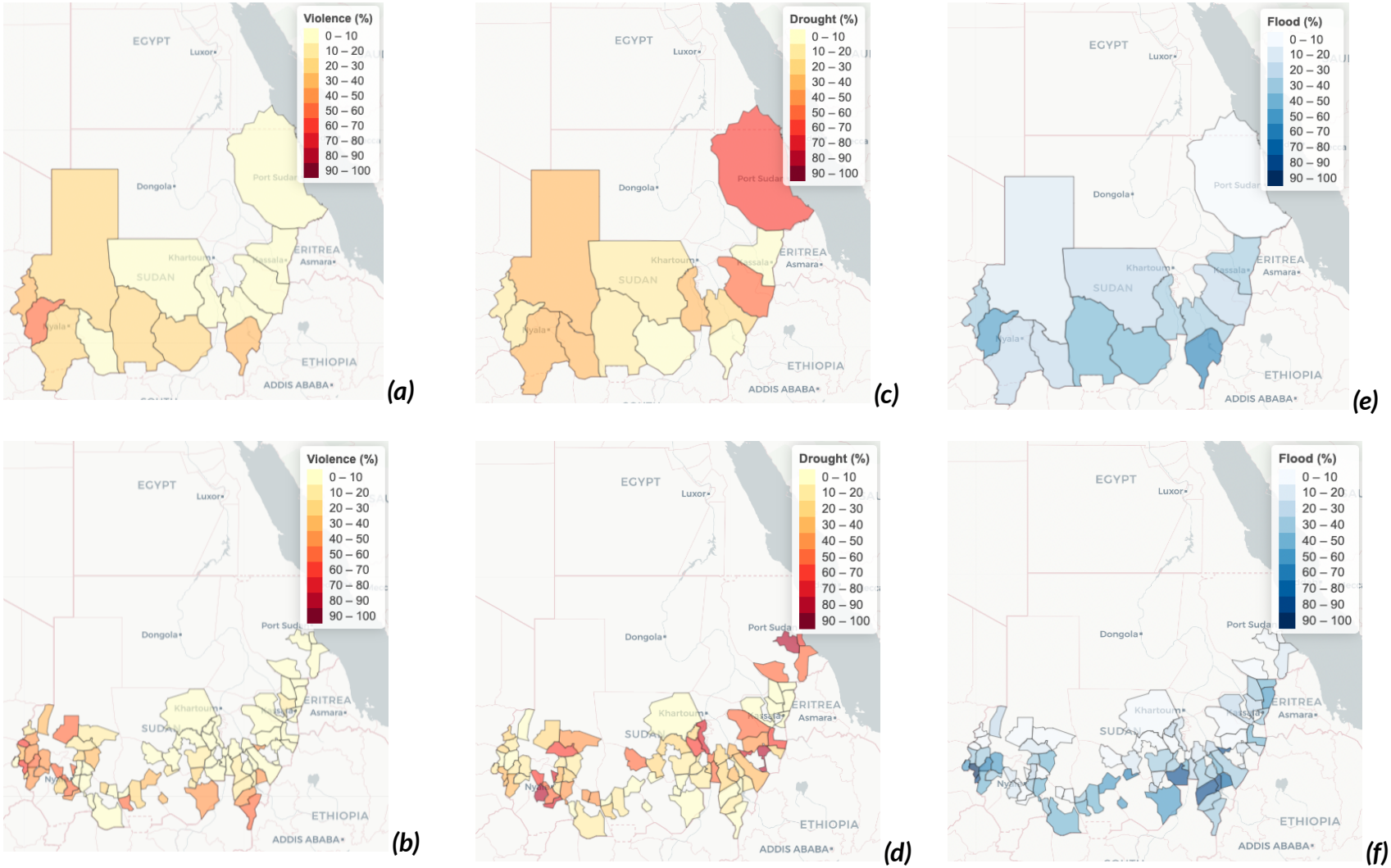


Overall, we find **greater variation between gender and residency statuses in the experiences and exposure to idiosyncratic shocks**, such as illnesses or income loss, which have an individual- or household-level impact. In contrast, we find that covariate shocks, particularly economic shocks affect the majority of households equally. Climatic shocks such as flood and drought although considered as covariate shocks, their effects are usually concentrated to specific geographic areas and households are able to use coping strategies to reduce their negative impact.

Figure 32 presents the geographical distribution at both the state and locality levels of the share of households that experienced drought, violent conflict and floods in the past 3 months prior to the survey. First, panels (a) and (b) show that exposure to violent events in the August-November 2022 period was highest in the western and southern part of Sudan with up to 50% of the sample reporting exposure to violence in Central Darfur, followed by Blue Nile and West Darfur with 38% and 39% of the households reporting violence, respectively.

Second, droughts, on the other hand, are experienced by 65% of the households in the Red Sea region where 18% of the households are nomadic. Panels (c) and (d) show that there are also localities exposed to prolonged dry spells and irregular rainfall in the Gedaref, South, East and North Darfur. Knowing that 98% of households use rainfall for irrigation, this makes these households very vulnerable to agricultural production losses in addition to other shocks. Third, panels (e) and (f) show the share of households who were impacted by floods between August and November 2022. We see that households living in Blue Nile experienced more floods compared to other states with 66% of the households reporting floods. In Central Darfur 52% of the households report exposure to floods in the past three months. Even in the highly desertified states of Red Sea, North Kordofan and North Darfur, up to 25% of the households report floods.

Figure 32. Exposure to drought, violent conflict and flood across state and locality levels



4.10. Gender norms and agricultural knowledge

In this section, we present the gender norms at the household level. We decided to include this section in our questionnaires because we are aware that the impacts of food insecurity, conflict and natural crises are gendered, and we wanted to understand how the gender norms in households play a role in agricultural production and management in addition to household food insecurity and resilience. Knowing that we had to also keep our questionnaire short as much as possible, we asked the views of respondents to 14 statements to understand women empowerment and gender equality in the households.[9]

Sudanese woman at work (image provided by the enumerators)

Gender norms in the household

We first want to understand the household bargaining power of women and assume that it is higher if the gender norms of respondents (around 80% of them are household heads) are in favor of women. In order to understand the perceptions of women empowerment in households, we ask the views of respondents for the following eight statements which are

[9] Around 78% of all respondents are household heads. For non-household head respondents, 70% are spouses, 17% are children of the head, and 9% are parents.

answered using a 5-Likert scale from “strongly disagree” to “strongly agree” or using the “no answer” option:

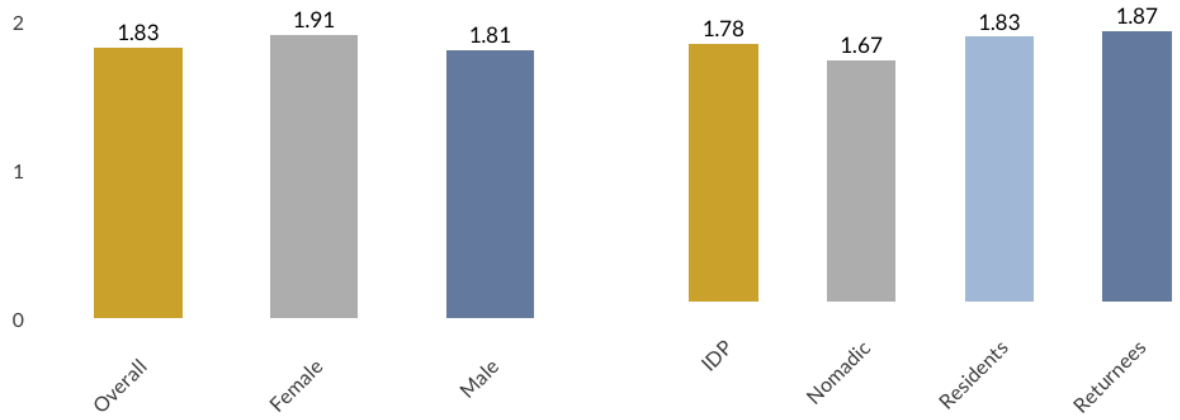
1. The woman should make decisions on her own regarding children's health
2. The man should make decisions by himself on how to spend the household money
3. The woman should tell the man what food to buy, and the man should do this
4. The woman does not have to consult the man on what to cook for dinner
5. The woman should always ask the man for permission to go outside the compound
6. The man has the right to angrily scold his wife if she does something wrong
7. The man should have the final word when making joint decisions in the household
8. The woman should always do what the man thinks is best.

To calculate the degree of women empowerment in the household, we first inverted the scales of the answer choices for negatively phrased questions, such that all answer choices have a scale of 0 to 4, where 4 implies stronger perceptions of women’s roles. We divided the sum of the responses by the number questions which gave us an index that ranges from 0 to 4.

Figure 33 shows the average score for the overall sample is 1.83 points, below the 2-point threshold, which implies that, on average, **perceptions on gender norms are not in favor of women,** and there are no exceptions to this finding by either the gender of the household head or the residency status of the household. As expected, **respondents from female-headed households show a significantly higher perception of gender norms in favor of women.** This signals that gender norms of respondents are affected towards more female empowerment by seeing that women have a leading role in the household, but they are still not strong enough to exceed the critical threshold. Replacing the household head gender with the gender of respondents delivers similar scores of 1.9 for female respondents and 1.8 for male respondents (not displayed). Lastly, the women

empowerment score is lowest in nomadic households (1.67), while it is highest among returnees (1.87).

Figure 33. Women empowerment score by household head gender and residency status



Women decision-making power in agriculture

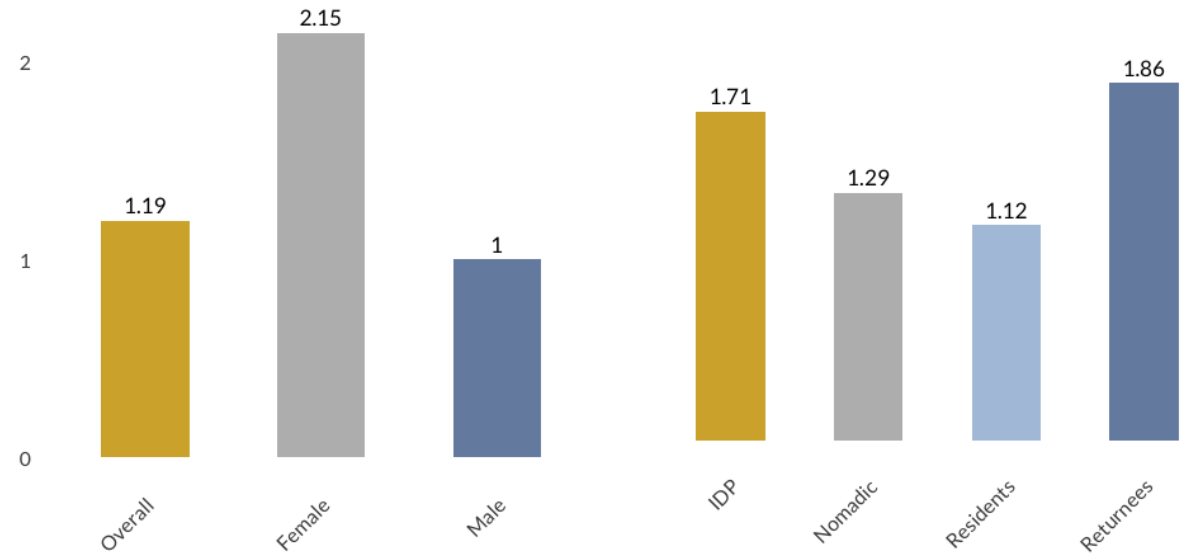
Next, we check the gender norms regarding agricultural production management as women have crucial roles in household food security in Sudan. We asked the views of respondents for the following statements using a 5-Likert scale answer option from "always men" to "always women":

1. Who makes the decision about how much land is used for agricultural production?
2. Who makes the decision about what crops to plant in agricultural production?
3. Who makes the decision about what inputs to use in agricultural production?
4. Who makes the decision about who does the work on the farm?
5. Who makes the decision about how much product to use from agricultural production for own consumption?

6. Who makes the decision about who keeps the money from selling produce from agricultural production?

If these statements are answered as “always women” then we assign a score of 4, while it is 0 for “always man”. Taking the sum of the responses, dividing them by six, we derive a score from 0 to 4. Figure 34 shows the overall average score, which is then stratified by gender of household head and residency status. First, the overall average of the decision-making in agriculture is 1.2, emphasizing that the **decision-making power is generally concentrated towards men.** We observe that the decision making power of women is remarkably higher in female-headed households with 2.2 points versus 1 point in male-headed households. Still, the score for female-headed households is close to the threshold for a neutral division of decision making power in agriculture. Hence**, even in female-headed households, women do not have a clearly higher decision-making power than men in the household about agricultural production and finance management.** Moreover, women in resident and nomadic households have lower decision-making power in agricultural production management compared to IDP and returnee families.

Figure 34. *Women decision-making in agriculture by household head gender and residency status*



Gender Equality

Finally, we want to understand the level of gender equality in decision-making on agricultural production and management. We calculate the gender equality score based on the responses to six variables: decision on land, crops, inputs, farmwork, home consumption, and money from selling farm produce. We first transform the Likert scale responses of the six decision-making questions into a scale from 1 to 3 where 1 indicates full concentrated decision-making by women/men, 2 indicates mostly decision-making power by women/men, and 3 indicates equal decision-making power. After transforming the responses, we calculate the Gender Equality Score by summing responses across all decision-making questions and dividing them by six. Higher values indicate overall a greater gender equality in the household decision-making in production and finance management, with maximum 3 on the scale.

Figure 35. *Gender equality score by household head gender and residency status*

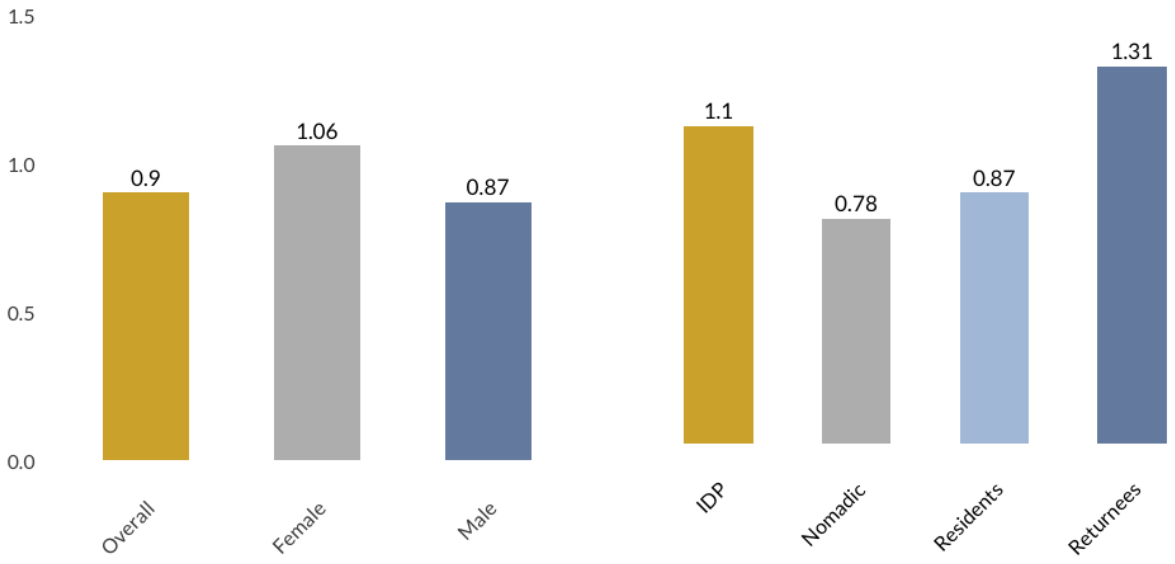


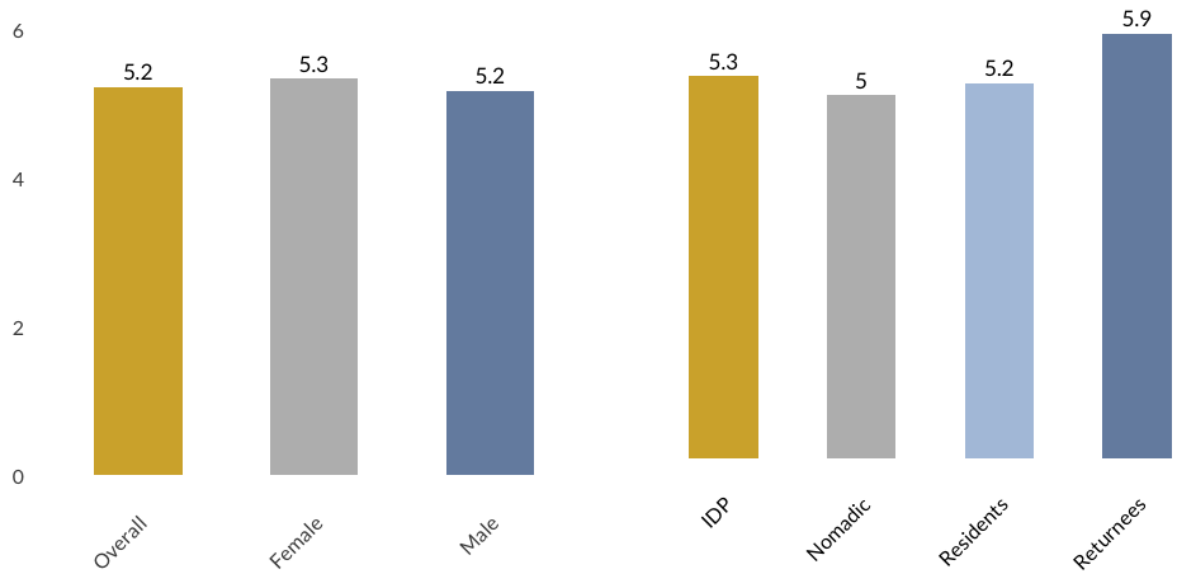
Figure 35 indicates that the overall gender equality score is 0.9 points, where **returnees exhibit the highest gender equality score (1.3 points), followed by IDPs (1.1 points)**. As expected, the disparity between male-headed households (0.9 points) and female-headed households (1.1 points) is significant, however, the equality score for female-headed households is smaller than for IDP or returnee households. Taking together the two

agricultural scores for decision making and gender equality, **returnee and IDP households consistently have higher scores.**

Agricultural knowledge

As part of the CERF FAO program, on-the-job training is provided to beneficiary villages with an aim to improve the knowledge of beneficiaries in crop production and animal husbandry. We ask respondents their opinions for eight statements on these topics. This way we check if agricultural knowledge of beneficiaries were better than non-beneficiary households as a result of refresher training provided under the program. We find that **agricultural knowledge scores between beneficiaries and non-beneficiaries are not significantly different from each other** (not displayed)**.**

Figure 36. *Agricultural knowledge by respondent gender and residency status*

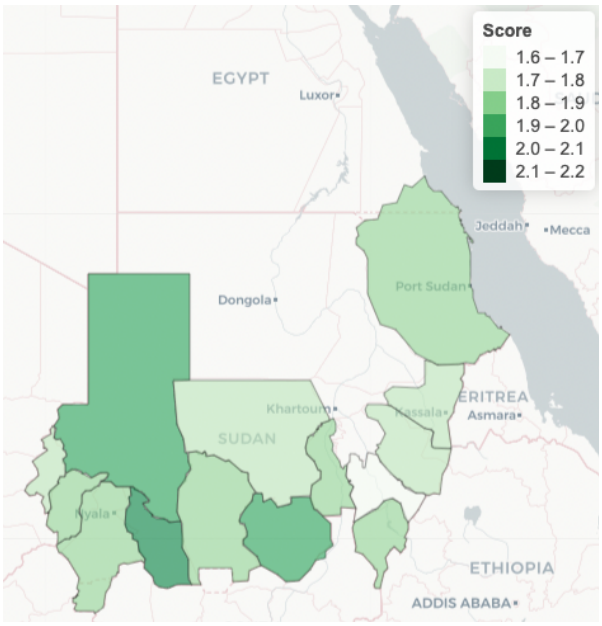


We show in Figure 36 that there are **no significant differences in agricultural knowledge across gender of the respondent or the household head** (the latter is not displayed). This is indeed an important finding because we also find that female-headed households have much lower shares of household assets including mobile phones and radio. Indifference in agricultural knowledge across the gender rather implies that female household heads rely on their social networks to gather information and knowledge. We find **women social**

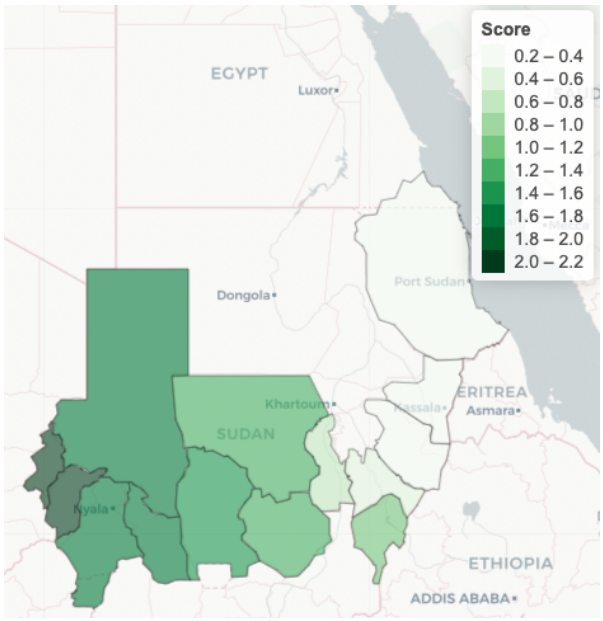
network groups to be significantly associated with higher knowledge scores (not displayed)**.** Moreover, we see that returnee households have a significantly higher knowledge score, even though they farm on average at a smaller scale.

Figure 37. Geographic differences in the gender and agricultural knowledge scores

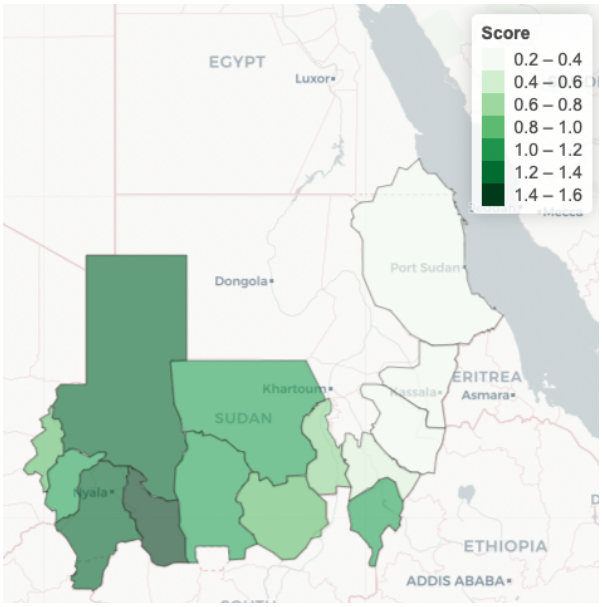
a) Women Empowerment Score



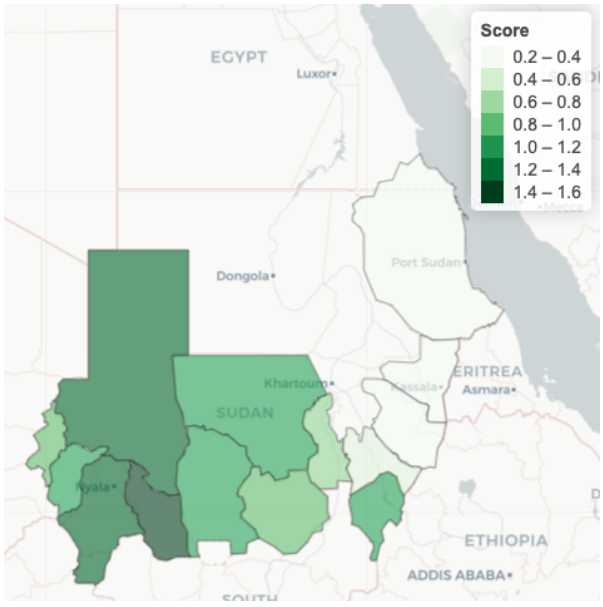
b) Decision-making score in agriculture



c) Gender Equality Score



d) Agricultural Knowledge Score



In Figure 37, we show how the scores for women empowerment (panel a), women decision-making in agriculture (panel b), gender equality (panel c) and agricultural knowledge (panel d) are distributed across the 14 states. We find that states with lower decision-making power of women in agricultural production also have lower gender equality scores and agriculture knowledge scores. **Darfur states have on average better scores in terms of gender equality.** Agricultural knowledge score is lowest in Red Sea, North Kordofan, West Kordofan, South Kordofan, White Nile and Sennar states. This implies that future training in agricultural knowledge should particularly focus on households living in these regions.

5. Analytical Baseline Findings

In this section, we provide a more in-depth analytical outlook on how our key variables relate to one another, mainly focusing on how household characteristics and exposure to shocks relate to food insecurity and the use of harmful coping strategies.

5.1 Household characteristics, shocks, and food insecurity

Table 13 presents the results of the multivariate regression analyses of Food Consumption Scores (FCS) with respect to the basic characteristics of households (columns 1 and 2), the socioeconomic status of households (columns 3 and 4), women's empowerment and decision-making power in agriculture (column 5) and the shocks households experienced in the last three months (column 6). Each column of the table represents an analytical model specification, which accounts for state fixed effects and clusters the standard error at the village level.

First, in Model (1) of Table 13, we find that **female-headed households have, on average, a 3.6 lower FCS score than male-headed households** when we control for state fixed effects. This gender gap decreases when we control for the age and education level of household heads, as can be seen in Model (2) of Table 13. More importantly, we find that the **educational level of household heads significantly improves food security in households**. Every additional degree completed by the household head improves the FCS, on average, by 6.6%, thus offsetting the negative impact of being in a female-headed household. This implies that the education of children in the household is crucial for the long-term welfare of households.

In Model (3), we analyze if this disadvantageous situation of female-headed households still holds when we also account for the economic conditions at the household level. We find that **a higher income share from crop production does not improve FCS in households, while higher income shares from livestock production significantly increase FCS.**

Table 13. Association of FCS with household characteristics and shock exposure

	(1)	(2)	(3)	(4)	(5)	(6)
Female-headed HH	-3.646***	-2.256***	-1.579**	-.305	-.143	-.139
	(.662)	(.698)	(.664)	(.643)	(.7)	(.757)
Age of HHH		.062***	.073***	.02	.015	.02
		(.019)	(.018)	(.017)	(.018)	(.018)
Educ of HHH		3.334***	3.767***	2.084***	2.04***	1.954***
		(.365)	(.341)	(.309)	(.323)	(.334)
Income shares from crop			.014	.007	.003	.003
			(.01)	(.01)	(.009)	(.009)
Income shares from livestock			.145***	.131***	.138***	.109***
			(.018)	(.016)	(.015)	(.014)
Livelihood diversification				.213	.347	.281
				(.477)	(.482)	(.52)
Non-productive assets				3.315***	3.197***	2.862***
				(.274)	(.274)	(.28)
Productive assets				2.519***	2.466***	2.358***
				(.218)	(.232)	(.222)
Dependency ratio					-.108	.03
					(.112)	(.118)
Women empowerment in HH decision-making					1.084**	1.307**
					(.509)	(.557)
Women empowerment in agricultural production					.07	.317
					(.306)	(.309)
Shock: job loss						-.747
						(1.33)
Shock: income loss						-5.974***
						(.767)
Shock: illness						-1.946**
						(.766)
Shock: high food prices						2.529**
						(1.153)
Shock: high non-food prices						2.112**
						(.865)
Shock: drought						.881
						(.932)
Shock: flood						-.395
						(.737)
Shock: pest						-1.884***
						(.71)
Shock: animal loss						2.604***
						(.685)
Shock: violence and conflict						-4.067***
						(.816)
Constant	54.229***	45.994***	43.365***	39.239***	37.502***	40.84***
	(2.097)	(2.413)	(2.311)	(2.212)	(2.512)	(2.885)
Observations	8146	8146	8146	8146	7031	6016
R-squared	.079	.097	.12	.202	.201	.229
State fixed effects	YES	YES	YES	YES	YES	YES

Notes. Clustered standard errors at the village level are in parantheses. The dependent variable is the food consumption score.
**** p<.01, ** p<.05, * p<0.1*

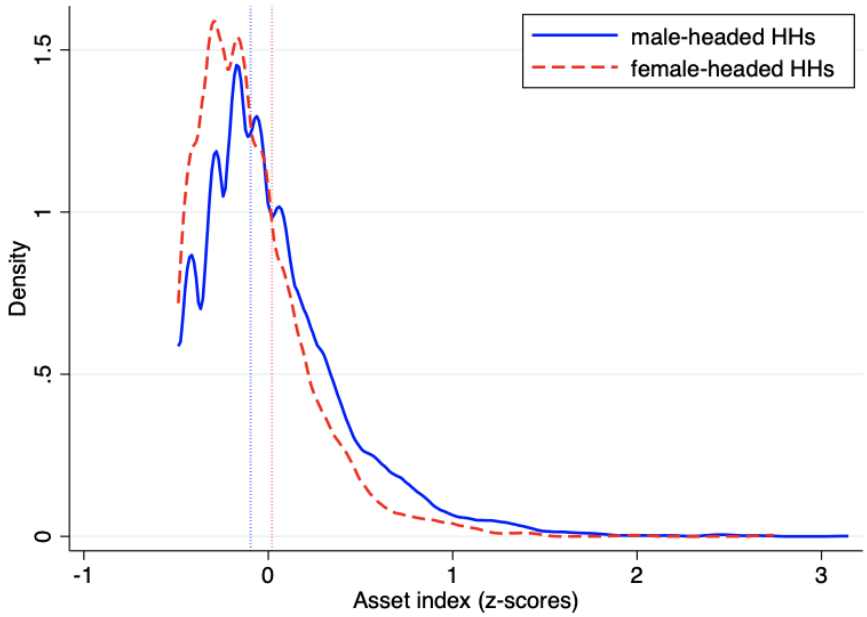
In Model (4), we account for income diversification, which counts the total number of income-generating or livelihood activities (crop farming, livestock keeping, wage work, off-farm business, regular employment, transfers, and remittances) that are pursued in a household. It takes values from 1 to 8, and a higher number implies a better diversification of livelihood activities. We also control for the asset index in Model (4). We divided assets into two groups, namely non-productive and productive assets. Non-productive assets

include food stations, refrigerators, mobile phones, stoves, TVs, radios, jewelry, and washing machines. Although we designated this group of assets as non-productive, we are aware that these assets indirectly increase the labor supply for agricultural production. The productive asset category includes those that directly contribute to agricultural production, such as bicycles, cars, carts, water tanks, wheelbarrows, hoes, machetes, ox plows, and tractors. In order to calculate these asset indices, we first checked if a household has any of these assets using binary variables (yes or no) and then summed up the total number of assets owned by households for each category separately. Thus, a 1 unit increase implies having 1 more asset type in a specific category, whether productive or non-productive.

Our results in Model (4) of Table 13 show, we find a very strong association between food security and the ownership of both productive and non-productive assets. **Owning one additional productive asset is associated with a 2.5 point increase in the FCS, and a 3.3 point increase for each additional non-productive asset.** These findings show the importance of the relationship between wealth and food security in Sudan. Interestingly, we also find that the statistically significant relationship between the gender of the household head and FCS does not hold when we account for the economic welfare of households, particularly asset ownership. However, the role of education is still significant. Moreover, although the relationship between gender of household head and food security is negative, **improving the asset capacity of households headed by females will improve their food security levels to a similar level to those of male-headed households**, with everything else held constant. Given that a large share of females do not have any formal education (see Table 7 above), **investing in the education of females in Sudan will also contribute to stronger food security, regardless of wealth levels**.

Figure 38 shows that asset ownership (both productive and non-productive) varies significantly depending on the gender of the household head. When we present the asset index as a z-score, a significantly large proportion of female-headed households have lower asset ownership compared to the average asset ownership in the sample (z-score = 0).

Figure 38. Asset ownership by gender of household head



In addition to the socioeconomic characteristics of households, we also checked if women's empowerment and decision-making in production management have any association with food security. Model (5) in Table 13 indicates that **households have stronger food security if women are socially and economically more empowered in the household**. The women's empowerment score is an index from 0 to 5, with a mean of 2.63 and a standard deviation of 0.61. Thus, our findings imply that a 1 unit increase in the women's decision making score increases the FCS, on average, by 1.04 when we control for other household head and household characteristics, including education and asset ownership. However, we find no statistically significant relationship between women having higher decision-making power in agricultural production and food security. To sum up, **women's empowerment in household decision-making significantly and positively correlates with household food security in Sudan**.

Finally, in Model (6) in Table 13, in addition to the main variables, we checked the association between various shocks experienced by households in the last three months

with food security level, which is calculated based on food consumption in the household in the last seven days of data collection. As can be seen, among various shocks, sudden income loss in households is associated with the largest decrease in household food security. It is then followed by exposure to violence and conflict, an unusually high level of crop pests and diseases, and serious illness among the income earner(s) in the household. Thus, **shocks that have direct and sudden impacts on household income are negatively correlated with household food security.** Moreover, after controlling for households and state characteristics, we see that inflation and unusual animal diseases and losses have a positive association with food security. The latter is expected because households with higher FCS have higher numbers of livestock, which increases the incidence of animal disease or loss. An explanation for the unexpected correlation between FCS and price inflation of food and non-food items could be related to better anticipation and, thus, consumption smoothing in households with respect to price increases.

5.2 Use of coping strategies and household characteristics

Next, we present the association between household characteristics and the use of coping strategies to deal with a lack of money or food. As households might try to address adverse shocks in their livelihoods by using not only one but several coping strategies simultaneously, the findings for a specific coping strategy should be interpreted in comparison with others. Moreover, we divided coping strategies into four categories:

1. **Non-food asset-based coping strategies**: spending savings (column 1), the sale of non-productive assets (column 2), and the sale of productive assets (column 3 of Table 14).
2. **Non-food agriculture-related coping strategies**: the sale of agricultural tools (column 1), the sale of seeds (column 2), the sale of non-productive livestock (column 3), and the sale of productive livestock (column 4 of Table 15), which have both short term and long term implications for the households' livelihoods.
3. **Non-food financial coping strategies**: taking credit or borrowing money (column 1), reducing expenditure on essential non-food items such as health and education

(column 2), reducing expenditure on productive assets such as seeds and livestock (column 3), and selling the house or land (column 4 of Table 16).

4. **Non-food harmful livelihood coping strategies** that affect both the short-term and long-term welfare of households, which include: women taking high-risk work (column 1), withdrawing children from school (column 2), child labor (column 3), child marriage (column 4), and begging (column 5 of Table 17).

All of the coping strategy variables are dummy variables and take a value of 1 if households employed a specific coping strategy to deal with the lack of money in the last 30 days of data collection and 0 if there was no need. We excluded households that were not able to use these strategies although they wanted to. Hence the results from this analysis only focus on the households that are able to employ these strategies.

Table 14 shows the findings from the first category of coping strategies. After controlling for state fixed effects and households' exposure to shocks, female-headed households have a lower propensity to sell assets as a coping mechanism to deal with shortages of money or food. However, as we showed above, female-headed households have lower levels of asset ownership, and that's why the incidence of selling their assets is found to be lower. Moreover, higher income shares from crops reduce the probability of using savings, although higher shares of income from livestock produce decrease the probability of selling both productive and non-productive assets. However, the magnitude of the effect is very small. Still, one can argue that **households that have higher incomes from livestock products have a lower propensity to sell assets as a coping mechanism**. Furthermore, the dependency ratio is positively related to the sale of non-productive assets. Another important finding is asset ownership's role in the use of non-food asset-based coping strategies. We show that households with a higher level of productive asset ownership have a higher propensity to spend their savings if there is a lack of money, while households with a higher level of productive assets use coping strategies that can harm their future well-being such as the sale of productive and non-productive assets.

Table 14. Non-food asset-based coping strategies

	(1) Spending savings	(2) Sale of non-productive assets	(3) Sale of productive assets
Female-headed HH	-.017	-.037*	-.057***
	(.031)	(.021)	(.02)
Age of HHH	0	0	0
	(.001)	(.001)	(0)
Educ of HHH	-.009	.002	-.009
	(.012)	(.009)	(.007)
Income shares from crop	-.001**	0**	0
	(0)	(0)	(0)
Income shares from livestock	.001	-.001**	-.001***
	(0)	(0)	(0)
Non-productive assets	-.011	.017***	.011**
	(.009)	(.006)	(.005)
Productive assets	.022***	-.002	-.001
	(.008)	(.005)	(.005)
Livelihood diversification	.004	.009	.01
	(.012)	(.008)	(.007)
Dependency ratio	-.001	.008**	.003
	(.006)	(.004)	(.003)
Women empowerment in HH decision-making	.005	-.003	.006
	(.019)	(.012)	(.011)
Women empowerment in agricultural production	.018	.001	.005
	(.011)	(.008)	(.007)
Constant	.182*	-.052	-.047
	(.103)	(.057)	(.046)
Observations	3966	3285	2957
R-squared	.176	.09	.097
Shock dummies	YES	YES	YES
State fixed effects	YES	YES	YES

*Notes. Clustered standard errors at the village level are in parantheses. The dependent variable is the food consumption score. *** p<.01, ** p<.05, * p<.1*

It is also important to understand which households are inclined to use non-food agricultural production-based coping strategies, as they directly affect their long-term livelihoods, particularly to crop farming and livestock keeping households as represented in our sample. Table 15 presents the results. Firstly, we find that controlling for various household characteristics, state fixed effects, and exposure to shocks, female-headed households have a lower propensity to sell agricultural tools and livestock. As we will see in Table 17, **female-headed households force themselves not to deteriorate the long-term livelihoods of households and instead use individual-level harmful coping mechanisms, such as begging**. Moreover, we find that households with better livelihood

diversification are more likely to use non-food agricultural production-based coping strategies and this could be due to their higher expectations to replace sold assets later.

Table 15. Non-food agricultural production-based coping strategies

	(1) Sale of agricultural tools	(2) Sale of seeds	(3) Sale of non-productive livestock	(4) Sale of productive livestock
Female-headed HH	-.029*	.011	-.056*	-.055**
	(.017)	(.027)	(.029)	(.024)
Age of HHH	0	0	0	.001
	(0)	(.001)	(.001)	(.001)
Educ of HHH	-.012*	.017	-.003	.003
	(.007)	(.011)	(.011)	(.008)
Income shares from crop	0	.001***	0	0**
	(0)	(0)	(0)	(0)
Income shares from livestock	0	0	.006***	.001**
	(0)	(0)	(0)	(0)
Non-productive assets	.008*	-.018**	-.017**	-.016***
	(.004)	(.007)	(.008)	(.006)
Productive assets	-.006	.022***	.009	.008
	(.004)	(.007)	(.007)	(.006)
Livelihood diversification	.012*	.083***	.064***	.024***
	(.007)	(.011)	(.011)	(.008)
Dependency ratio	.008**	0	.002	.01**
	(.003)	(.005)	(.005)	(.004)
Women empowerment in HH decision-making	.02**	-.003	.004	-.009
	(.009)	(.016)	(.015)	(.013)
Women empowerment in agricultural production	0	.013	0	.01
	(.006)	(.01)	(.009)	(.007)
Constant	-.091**	-.153*	-.057	-.111**
	(.043)	(.083)	(.087)	(.055)
Observations	3297	3830	3655	3499
R-squared	.087	.169	.201	.113
Shock dummies	YES	YES	YES	YES
State fixed effects	YES	YES	YES	YES

*Notes. Clustered standard errors at the village level are in parantheses. The dependent variable is the food consumption score. *** p<.01, ** p<.05, * p<.1*

When we look at the use of non-food financial coping strategies, we see in Table 16 that asset ownership is highly correlated with them. **Households with a higher level of non-productive and productive assets have lower probabilities of taking credit or borrowing money, reducing expenditures on essential items or productive assets**. Thus, it is important to improve asset ownership to overcome poverty traps for rural households in Sudan. As expected, there are positive correlations between the dependency ratio and taking credit or reducing expenditure on essential non-food items. Finally, we find that

women empowerment is negatively related to reducing expenditure on health and education. However, once women have higher decision-making power in agricultural production, reducing expenditure on these essential items also increases.

Table 16. Non-food financial coping strategies

	(1) Take credit	(2) Reducing expenditure on essential non-food items	(3) Reducing expenditure on productive assets	(4) Sale of house or land
Female-headed HH	-.043	-.03	-.028	.007
	(.027)	(.027)	(.027)	(.012)
Age of HHH	0	0	0	0*
	(.001)	(.001)	(.001)	(0)
Educ of HHH	-.002	-.008	-.011	.004
	(.012)	(.01)	(.01)	(.004)
Income shares from crop	0	-.001***	-.001***	0
	(0)	(0)	(0)	(0)
Income shares from livestock	0	.001	.001***	0
	(0)	(0)	(0)	(0)
Non-productive assets	-.016*	-.011	-.006	.006**
	(.009)	(.008)	(.009)	(.003)
Productive assets	-.004	-.017**	-.017**	-.003
	(.008)	(.008)	(.008)	(.003)
Livelihood diversification	.003	.036***	.033***	.005
	(.012)	(.011)	(.012)	(.005)
Dependency ratio	.01*	.016***	.012**	.002
	(.006)	(.005)	(.005)	(.002)
Women empowerment in HH decision-making	.007	-.04**	-.016	.003
	(.019)	(.017)	(.017)	(.006)
Women empowerment in agricultural production	-.008	.038***	.038***	-.002
	(.01)	(.009)	(.01)	(.004)
Constant	.265***	.059	.032	-.076**
	(.078)	(.083)	(.087)	(.032)
Observations	3866	4615	4329	3824
R-squared	.127	.162	.179	.062
Shock dummies	YES	YES	YES	YES
State fixed effects	YES	YES	YES	YES

*Notes. Clustered standard errors at the village level are in parantheses. The dependent variable is the food consumption score. *** p<.01, ** p<.05, * p<.1*

Finally, we look at the relationship between household characteristics and non-food harmful livelihood coping strategies such as child labor and child marriage. Table 17 presents the results. First, we find that female-headed households have a higher likelihood of begging when there is a lack of money in the household. Second, **the higher the educational level of the household head, the lower the probability of withdrawing children from school to deal with money shortages**. Importantly, there is no statistically

significant relationship between women empowerment and child marriage or child labor. In other words, when households are in dire need of livelihoods, women's empowerment or education of household heads does not decrease child marriage or child labor. Yet **female-headed households are more likely to have women take high-risk jobs or send their children to work to cope with money shortages or lack of food.**

Table 17. Non-food harmful livelihood coping strategies

	(1) Women in high-risk work	(2) Withdrew children from school	(3) Child Labor	(4) Child Marriage	(5) Begging
Female-headed HH	.104***	.007	.041	.063**	.057***
	(.024)	(.024)	(.027)	(.026)	(.016)
Age of HHH	0	.001**	0	0	0
	(0)	(0)	(0)	(0)	(0)
Educ of HHH	-.001	-.023***	-.01	-.009	-.005
	(.008)	(.008)	(.009)	(.008)	(.004)
Income shares from crop	0	-.001*	-.001**	0*	0***
	(0)	(0)	(0)	(0)	(0)
Income shares from livestock	0	0	.001**	0	0
	(0)	(0)	(0)	(0)	(0)
Non-productive assets	-.003	-.019***	-.019***	.004	-.001
	(.005)	(.006)	(.006)	(.007)	(.003)
Productive assets	-.016***	-.011*	.016***	.005	0
	(.005)	(.006)	(.006)	(.006)	(.002)
Livelihood diversification	.026***	.032***	.044***	.034***	-.002
	(.01)	(.009)	(.011)	(.011)	(.005)
Dependency ratio	.002	.004	.002	-.001	.001
	(.004)	(.004)	(.004)	(.004)	(.002)
Women empowerment in HH decision-making	.021*	.018	.015	.009	.008
	(.012)	(.012)	(.013)	(.014)	(.005)
Women empowerment in agricultural production	.017*	-.001	.005	0	.001
	(.01)	(.007)	(.008)	(.008)	(.005)
Constant	-.17***	-.109*	-.114*	-.096	.018
	(.054)	(.062)	(.064)	(.061)	(.03)
Observations	4063	4043	3996	3495	4059
R-squared	.157	.134	.118	.096	.046
Shock exposure dummies	YES	YES	YES	YES	YES
State fixed effects	YES	YES	YES	YES	YES

*Notes. Clustered standard errors at the village level are in parantheses. The dependent variable is the food consumption score. *** p<.01, ** p<.05, * p<.1*

Moreover, we find that **higher levels of productive assets are significantly and negatively correlated with women working in high-risk jobs and the withdrawal of children from school**, although it is positively correlated with child labor. **A higher level of non-productive assets, on the other hand, has a negative correlation with child labor and school dropouts among children.**

5.3 Use of coping strategies and exposure to shocks

This section presents our findings about how exposure to different shocks is associated with the use of coping strategies, after controlling for household characteristics. Again, we should keep in mind that the use of coping strategies is not mutually exclusive; hence, the **correlations presented in this section signify the relative role of each shock in the choice of a specific coping strategy.** Therefore, rows in Table 18 should be interpreted together. That said, we discuss how a specific shock is associated with the use of coping strategies evaluated together. First, we find that a sudden job loss is positively correlated with the use of financial coping strategies such as asset or livestock sales. Moreover, we also observe a positive correlation between sudden job loss and school dropouts among children in the household. In other words, an **unexpected decrease in income due to a sudden job loss is more likely to be dealt with by the sale of productive and non-productive assets,** and income loss is usually compensated via these options. However, **if there is a significant reduction in household income, then all the available options are utilized.** Table 18 shows that a significant income loss is significantly and positively associated with almost all of the coping strategies, including harmful livelihood coping strategies such as child labor and child marriage. Relatedly, if there is a serious illness of the main income earner in the household, then we find that households either sell assets such as household furniture, agricultural tools, productive livestock, or even the house or land. In addition, we also find that begging and the withdrawal of children from school are also used to deal with the lack of money in such circumstances.

As we know, rapid inflation of prices is one of the major problems facing everyday Sudanese. We find that unusually high food prices increase the use of savings, the sale of non-productive livestock, taking credit, or reducing the expenditure on non-food essential items such as health and education and on productive assets. Furthermore, in response to inflation in non-food items, households mainly reduce their expenditures on both essentials and productive assets and also take credits. In addition, there is a high probability that households will sell their assets or land. The latter might also benefit from the high prices of assets and land in such an environment, but it certainly decreases the

chance of households buying those assets back as their prices keep increasing. Moreover, under high inflation, we see that households do not just use consumption smoothing or sell assets; they are also prone to using harmful livelihood coping strategies, such as **women working in high-risk jobs.**

We also test the correlation between exogenous climate shocks and the use of coping strategies. We find that households internalize the effect of drought on their incomes, and only reduce expenditures on non-food essential items. However, exposure to drought is positively associated with women's work in high-risk jobs and school dropouts. **Knowing that rainfed irrigation is commonly used in agricultural production, interventions related to irrigation systems are hence key to improve the well-being of women and children in Sudan.** Moreover, we find that exposure to floods is more detrimental as it also increases the probability of selling productive and non-productive assets, agricultural tools and seeds, as well as women taking up work in high-risk jobs. Thus, **anticipatory interventions for floods are needed to improve the livelihoods of households in Sudan**.

Moreover, we find that unusually high levels of crop pests and animal disease and losses have different associations with the use of coping strategies. We find that livestock loss increases the number of strategies used compared to exposure to pests. Although exposure to crop pests increases spending savings, animal losses increase the probability of households selling their productive and non-productive livestock, seeds and reducing their expenditure on essential non-food items and productive assets. Importantly, animal loss is also positively associated with the use of harmful strategies such as child labor, child marriage and school dropouts. Therefore, **veterinary interventions are crucial not only for the financial well-being of households but also for the long-term welfare of household members, particularly children**.

Finally, we find that exposure to violence and conflict is positively correlated with reduced expenditures on essential items and productive assets and, also positively associated with women working in high-risk jobs and school dropouts. Thus, **conflict also decreases both present and future household welfare**.

Table 18. Association between shock exposure and the use of negative coping strategies

a) asset-based, agriculture-related, and financial coping strategies

	(1) Spending savings	(2) Sale of non-productive assets	(3) Sale of productive assets	(4) Sale of agricultural tools	(5) Sale of seeds	(6) Sale of non-productive livestock	(7) Sale of productive livestock	(8) Take credit	(9) Reducing expenditure on essential non-food items	(10) Reducing expenditure on productive assets	(11) Sale of house or land
Shock: job loss	.047	.133***	.101**	.17***	.068	.092**	.127***	.047	.027	.033	.088***
Shock: income loss	.18***	.09***	.05***	.049***	.095***	.051**	.019	.223***	.163***	.147***	.018***
Shock: illness	.013	.04*	.034*	.045**	-.008	-.002	.054**	-.003	.006	-.034	.03**
Shock: high food prices	.091***	-.022	-.015	-.017	.021	.065**	.02	.06**	.056*	.078***	-.017
Shock: high non-food prices	.036	.001	-.028*	-.041**	.015	.012	-.007	.069**	.048*	.058**	.015*
Shock: drought	.001	.011	.005	.005	-.068***	-.016	.002	-.082***	.05*	.028	.005
Shock: flood	.036	.04**	.035**	.03**	.045*	-.012	-.017	.033	.062**	.063**	.009
Shock: pest	.059***	-.009	-.013	-.004	-.033	-.036	-.02	.024	-.027	-.048**	.011
Shock: animal loss	-.096***	.001	.009	.006	.061**	.132***	.099***	.012	.058**	.097***	0
Shock: violence and conflict	-.01	.016	.001	.023	.019	.02	-.011	.036	.075**	.079**	.012

Positive & significant	Positive & insignificant	Negative & insignificant	Negative & significant

*** p<.01, ** p<.05, * p<.1

b) harmful livelihood coping strategies

	(1) Women in high-risk work	(2) Withdrew children from school	(3) Child Labor	(4) Child Marriage	(5) Begging
Shock: job loss	-.075**	.084*	-.042	-.01	-.002
Shock: income loss	.065***	.076***	.045***	.05***	-.001
Shock: illness	-.027	.086***	.032	-.022	.018*
Shock: high food prices	-.028	-.038*	-.016	-.039*	-.015
Shock: high non-food prices	.052***	-.025	-.015	.021	.006
Shock: drought	.043**	.056***	.034	.033	-.012
Shock: flood	.062***	.009	.022	.01	.003
Shock: pest	-.004	.005	.008	.017	-.004
Shock: animal loss	.027	.087***	.06***	.046*	.008
Shock: violence and conflict	.126***	.074**	.013	.037	.009

Positive & significant	Positive & insignificant	Negative & insignificant	Negative & significant

*** p<.01, ** p<.05, * p<.1

6. Conclusion

As part of our quasi-experimental design for the impact evaluation of FAO Sudan CERF Program, we collected baseline data from 8,146 households in Sudan. Data collection took place simultaneously in 14 states in mid-November 2022. This report presents our findings from the descriptive and exploratory analysis of the baseline data. Our analyses show that there is a significant level of variation and heterogeneity in household characteristics and geo-spatial conditions in Sudan, which are crucial to know when developing tailored emergency and development support.

We first show that the average household size is 7-8, and 83% of them are male-headed. While, on average, 51% of household heads have no formal education, this rate is much lower for female household heads, 68% of whom have no formal education. The variation also exists among the marital statuses of household heads by gender. Although 91% of male household heads are married, this is only true for 55% of female household heads. Permanent health issues are also an important problem in Sudan. We find that **one out of every five household heads reported that at least one of their household members has a permanent health issue**. Moreover, the share of the non-working household members (aged below 15 or above 65) with respect to the working adult population is, on average, 2.7, which is a heavy burden on income-earning adults given the low education levels of household heads and the prevalence of high shares of permanent health problems.

Moreover, we observe **sharp differences in income sources across the gender of the household head and the residency status of the household**. The income share from crop farming is 23% in IDP households, while it is around 40% among returnees and residents, which is related to the lower land ownership among IDPs. Relatedly, wage work is a dominant income source for IDPs. As expected, nomadic households derive 33% of their incomes from livestock keeping, while this economic activity has, on average, a 9% share in the household incomes of all households in our sample. In addition to these differences across the residency status of households, we find that **female-headed households have significantly higher shares of transfers and remittances** compared to male-headed

households. This can be expected because only around half of the female household heads are married, and it is possible that those women have a higher possibility of receiving remittances from their husbands, knowing that male migration to urban areas is a well-known trend in Sudan.

When we look at asset ownership, we find that **asset ownership is low in general** and the most available asset is mobile phone (72%). However, only 5% of households have a refrigerator and only 11% have a stove. Thus, comparing household asset ownership according to the gender of household heads, we find that **female household heads have lower mobility and less available time for income generation**. However, asset ownership for agricultural goods is not very different across the gender of household heads. Importantly, **only two-thirds of rural households have their own land** (with around 3.7 ha of land per household), while 37% rent land for cultivation. **Land size is significantly smaller in female-headed households and in IDP and nomadic populations**.

The **five main cultivated crops are sorghum (58%), peanuts (57%), millet (52%), sesame (28%) and corn (25%)**. There are differences in cultivation choices by the gender of the household head. Sorghum is cultivated more in male-headed households, while peanuts and millet are cultivated more in female-headed households. Moreover, environmental conditions and, more specifically, precipitation levels are significant determinants of cultivation choices across states. Given the fact that almost all rural farmers in our sample use **rainfed irrigation** and crop production is the largest source of income for these families, their resilience against lower food supply and food insecurity can be improved by the construction of regular irrigation systems and providing incentives for their take-ups. Labor-saving irrigation systems can also increase the food productivity of female-headed households.

Furthermore, we examine livestock ownership as it is a key source of nutrition for families and is critical for household food security. Except in nomadic homes, **livestock ownership is at low levels** (on average, 13% own cattle and 44% own sheep/goats). Moreover, we find that **female-headed families had a lower share of livestock ownership**. In other words,

they are more reliant on crop production for a living, making their households more **vulnerable to food insecurity** in an environment fraught with climatic shock and conflict.

Large average distances to all essential services indicate the remoteness of most households and, as a result, fewer incentives for them to use these important services, such as accessing health facilities, schools, and even clean water sources. Furthermore, input, land, and output markets are all within a one-hour walking distance of houses. This might have a **severe impact on the agricultural output and revenue generation** of these rural households. Importantly, there are large disparities in access to essential services based on a household's residence status. **Except for land, nomadic and returnee households face greater challenges in acquiring all essential amenities, including drinking water**.

We also analyze the current conditions of households' food insecurity by focusing on three commonly used indicators in the welfare literature, namely Food Consumption Score (FCS), Food Insecurity Experience Scale (FIES), and Household Hunger Score (HHS). Our findings show that there is a **significant variation in food insecurity** in Sudan across states, gender of the household head and residential status of households. Overall, we show that **households living in South Darfur and West Darfur, with female household heads and those who are IDPs and returnees, have a higher prevalence and severity of food insecurity**.

As for the resilience of households, **ownership of assets demonstrates the highest correlation with the RCI for both male and female-headed households**. In terms of social security nets, extension services provided by the government/other agencies show the highest correlation with resilience. As an adaptive capacity sub-variable, female-headed households exhibit a stronger correlation between income from transfers and resilience. Overall, **female-headed households are more vulnerable, with a lower resilience capacity**. Geographically, areas with high IDP populations, like West Darfur and South Darfur, have the lowest resilience scores, while the central eastern states show the highest resilience capacity.

Furthermore, the exposure of households to shocks is critical for understanding household vulnerability and how to design humanitarian and development interventions for effective and efficient outcomes. Importantly, our findings demonstrate that **96% of Sudanese rural households are subject to at least one sort of negative shock**. At least two out of every three households have been exposed to exceptionally high food and non-food prices as well as sudden income losses. Crop pest levels that are unusually high, as experienced by 57% of homes, are likewise highly relevant. Importantly, **female-headed households, IDPs, and returnees are especially vulnerable to violence**. Moreover, **IDP and returnee households, irrespective of the gender of the household head, are more vulnerable to floods and sudden income losses** than the host community and nomadic households.

We want to investigate how gender norms in households shape agricultural productivity and management, as well as food security in the household and resilience, because the consequences of food insecurity, conflict, and natural disasters are gendered. We first show that the **gender norms of respondents are, on average, not in favor of women, and this result holds irrespective of the gender of household heads and the residential status of households**. In other words, the heterogeneity across all other welfare dimensions is no more seen when it comes to gender norms. Importantly, **the decision-making power of women in agricultural production is quite low and, strikingly, this is even the case in female-headed households** where the score for women's decision-making power in agriculture is only 2.2 out of 4.

In addition to the descriptive analysis, we also provide findings from the exploratory analysis regarding the relationships between household characteristics, food security, exposure to shocks and coping strategies of households. Even after accounting for numerous household variables and state fixed effects, **female-headed households had lower FCS**. Furthermore, enhancing the household's food security depends on the **education levels of the household heads**. Therefore, it is crucial to educate women and girls in order to lessen the vulnerability of households in rural Sudan that women head. Importantly, our analysis also demonstrates that FCS is not increased by agricultural

production but rather by the income from livestock keeping. Therefore, **households whose primary source of income is crop production are extremely vulnerable to shocks**. Moreover, we show that shocks that have direct and sudden impacts on household incomes are negatively correlated with the FCS. That said, we provide evidence about the **positive role of women's empowerment on food security** in households even after controlling for the socio-economic characteristics of households as well as state fixed effects. Finally, even after taking into account the characteristics of household and state fixed effects, our analysis demonstrates that **asset ownership (both non-productive and productive) is crucial for coping with adverse shocks and for possessing a higher FCS**.

Our findings also show that efforts to promote the well-being of women and children in Sudan must **focus on labor-saving irrigation systems** since rainfed irrigation is frequently employed in agricultural production, which makes households very vulnerable to climate shocks. In any case, we show that household livelihoods in Sudan can be improved by **proactive flood mitigation measures**. Additionally, **veterinary interventions** are essential for the long-term well-being of family members, especially children, as well as for the financial well-being of households. Our research also demonstrates a negative correlation between **conflict** and both current and future household welfare.

To that end, this comprehensive report provides a detailed descriptive and analytical snapshot of the lives and livelihoods of Sudanese crop farmers and livestock keepers living across 14 diverse States. As our data were collected in November 2022, a few months before the ongoing violent conflict in Sudan, our analysis provides important insights into the current needs of people and the ways to improve the food security of households that are exposed to conflict and conflict-related shocks. Moreover, we will build on these key results to generate novel learning on the impact of the CERF program and how it shapes these outcomes after the collection of the endline data from the same households.