

FOOD SECURITY IN THE WHITE NILE STATE OF SUDAN

ANALYSIS OF 2010 STATE LEVEL BASELINE HOUSEHOLD SURVEY

This study is one of the papers selected for funding by SIFSIA for the support of food security research and capacity building initiatives identified at the local/state level. The main purpose of the research is to improve understanding of food security issues in Sudan and inform decision makers about the evolving food security situation in the selected States. The main expected outcome of such studies should be an enhanced decentralized capacity in food security analysis and in food security policy and planning.

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PREFACE

The Sudan Integrated Food Security Information for Action (SIFSIA) is a GoNU/GoSS programme funded by EU STABEX funds and implemented by the Food and Agriculture Organisation of the UN (FAO). This study is selected for funding by SIFSIA for the support of food security research and capacity building initiatives identified at the state/locality level. The study was done with an agreement signed between SIFSIA and the Agricultural Economics and Policy Research Centre (AEPRC), Agricultural Research Corporation (ARC), Federal Ministry of Science and Technology (MOST), Khartoum, Sudan. The paper has been conducted by group of research team including Prof. Hamid Faki, and Abdelaziz Hashim (from Agricultural Economics and Policy Research Center, Agricultural Research Corporation) and Eltahir M. Nur (Department of Economics, University of Khartoum).

The main purpose of the research is to improve understanding of food security issues in Sudan and inform decision makers about the evolving food security situation in the selected States. The main expected outcome of the study should be an enhanced decentralized capacity in food security analysis and in food security policy and planning which will help to develop an overall framework for food security analysis in Sudan. The White Nile indepth study is expected to be replicated in other States of Sudan.

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EXECUTIVE SUMMARY

Food insecurity situation in the White Nile State is addressed via outcomes of a household survey conducted in the State in 2010 supported by available secondary information to understand underlying causes and glean policies that might reduce food insecurity. Food insecurity measures of incidence, depth, and severity are analyzed along with interconnected economic and social variables.

Information at the state level reveals variable per capita cereal production dominated by sorghum, substantial contribution of livestock and unstable food availability. Volatile and declining productivity and frequent crop failures are sources of risks with a series of consequences on food security; calling for appropriate actions at household and State level to address overall cereals supply.

Geographically oriented quantification of food security particulars is anchored on the results of the household survey. A high portion of the sampled household heads are farmers, being higher in Tandalti, Kosti, Alsalam and Algabalain localities. Wage labor ranks second, with particular importance in Rabak, Umrimta and Alquiteina. Various other relatively limited livelihood activities are reported in different localities. Characterized by high departure from farming and enormous unemployment ratios, livelihood requires improvement via geographical targeting, with focus on agriculture and due consideration to promoting wage, skilled-labor and other jobs.

Overall average cereal consumption is decent in most states but that of vegetables, fruits and animal products is low. Sorghum, being pivotal in consumption, is widely grown, while other crops are thinly spread. Household sorghum consumption is on average more than covered by own production indicating a proxy for some surpluses in Aldueim, Kosti, Tandalti and Umrimta, while for wheat, household domestic coverage is reasonable in Kosti and Aldueim. Otherwise, domestic production runs short of consumption at varying degrees for the range of crops grown in most localities. With average household surpluses in some localities and deficits in others, most households resort to the market for meeting their food requirements. Depending on price levels, the limited crop sales would put many households at the margin of reliable food access.

Average per capita dietary energy intake is higher than minimum requirements in all localities though with differences. But disaggregating by households, the incidence of food deprivation is generally considerable, being more acute in Alsalam and notable in Rabak, Aldueim and Umrimta. Kosti, Alquiteina and Tandalti accommodate comparable percentages of food-insecure, while Algabalain is somehow in a better position. On average, 36% of the State's rural population, ranging from 25% to 68%, is subject to food deprivation, yet neither depth nor severity is high, except for Alsalam locality. This means high similarity of the nutritionally insecure in their deprivation level; with the implication that policies to reduce inequity would apply to all. Further, differences in dietary energy intake between the food-secure and food-deprived are enormous; averaging 50%. The gap

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of deprivation, defined as difference between the average dietary energy intake of an undernourished population and its average minimum energy requirement is high; ranging from 392 to 502 kcal per capita per day.

The contribution of different food sources to the total energy intake is quite homogeneous reflecting meager food quality differences and suggesting that intervention improvements might be directed primarily to the quantity issue. However, due consideration should be given to critical imbalances due to low intake of high-quality sources of energy in contrast to the dominant calorie intake from cereals.

Differences in physical consumption of cereals, often an important proxy for food security, between the nutritionally food secure and food-deprived reveals a rather similar and fragile situation for the latter and extravagant consumption of the former. Low per capita consumption of other food groups is as well evident for the food deprived, forming 29% to 53% of that of the food secure and confirming food access as the major factor contributing to food insecurity.

Assessment of a family of agents that form food security correlates would provide insight as to the types of interventions for improvement:

- Awareness of household heads about own food security situation is rather modest, suggesting the need for education expansion and awareness-raising on nutrition.
- Average dietary energy intake according to household-head occupation places farmers in a middle rank: higher than the labor group but lower than those having other occupations. Within the food-deprived group the majority are farmers in most localities, particularly in Alsalam, Algabalain, Kosti and Tandalti while food deprivation for wage and skilled labor are important in Alquiteina, Rabak, Umrimta and Aldueim. This calls for policies appropriate for geographical and occupational food-security targeting.
- Comparison of nutritional status with crop areas, production and crop yields reveals that food-deprived households have limited per capita home-produced foods and particularly low production of cash crops with a negative effect on food access due to limited grown areas and land holdings and lower yields. This reflects poorer land access and limited capabilities curbing full utilization of the available land potential.
- The portions of crop sales out of production are almost similar for the food-secure and food-deprived, but the actual marketed amounts are trivial for the latter group. Such meager crop sales - also associated with low production - are both a result and a cause of food-deprivation linked to poor food access.
- Overall, per capita income of the food secure is more than twice that of food insecure. Algabalain has the lowest food-insecure income followed by Rabak, and Alquiteina has the highest. For both food-secure and insecure, non-agricultural activities mostly form the highest income source while agriculture contributes less than half with substantial share of livestock in some localities. Income of male-headed is higher than of female headed households on average, but slightly lower among the food-insecure.
- Dependency is correlated with nutritional security; consistently higher dependency levels are reported for the food-deprived while regression coefficients are negative and significant where nutritional status deteriorates with higher dependency ratio.
- Regarding the household sex, female-headed households are, contrary to the expectations, less food-deprived than the male-headed ones, taking into consideration their

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small weight in the sample. This is justified by the engagement of their high majority in some type of income-earning activity and their lower dependency ratio.

Results provide evidence for prevalence of substantial recurring food crisis for most households in most localities; driven mainly by drought and price surges. Floods are of importance in some localities, while conflict forms a minor cause. Various but roughly similar coping strategies are reported of which income-generating responses of borrowing and exerting more work as are the most important while reliance on own household resources is lowly ranked. Other numerous negative options include reducing the number of meals, shift to cheaper foods and the like.

The asset base of households (with a high livestock component) is weak on average and consistently lower but variable by locality for food-deprived households, posing an element of vulnerability and calling for the need to enhance capital formation. The asset base of female-headed households is way below that of male-headed, indicating that if the reported substantial economic engagement of the female-headed households is supported by an improved asset base, their food-security situation will highly improve.

Information on social services displays prevalence of primary schools but with lack in some localities and population-related congestion in others. Secondary schools are scanty with high intensity of served population. Medical centers have reasonable distribution, yet a high portion of villages are still deprived thereof, while hospitals are scarce. Midwives seem also better distributed, but again a high portion of villages has no trained midwives. In general, the rural areas of Algalain, Alsalam and Tandalti suffer from high deprivation in educational and health services.

Health has links to nutritional security, whereby schooling is associated with higher percentages of nutritionally the food-secure, attesting the importance of education for food-security improvement. On the health side assessed indicators portray high infection of children under five with cough and fever during the two weeks preceding the survey and high percentages of adolescents catching malaria over the preceding year. Under-five infection with diarrhea and vomiting is nevertheless sizeable and bilharzias infection is reported, but mortality rates of various age groups are rather limited. Similar to education, health link to nutritional insecurity is verified by common association of nutritional insecurity with higher disease incidence suggesting that even under low level of nutrition food utilization and accordingly food security is more jeopardized by health hazards. Strengthening social services, namely health and education will be instrumental in improving food security.

Other explored food security interrelating agents are water, sanitation and energy. Drinking water sources are diverse with dominance of wells, rivers and '*hafirs*' but also canals, pumps and taps. With possible hazards, clean water is not guaranteed. This means that a sizeable part of the rural population lacks a dependably clean water supply. Health hazards are also evident from high deprivation of sanitation means in most localities. On the energy side, cooking energy is highly dependent on biomass, mainly wood and coal, and negligible use of cooking gas. Such a tendency is a major cause of impoverishment of land resources

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and ever-declining productivity with negative consequences on food security, calling for the need to promote and supporting non-biomass energy sources.

Focusing on the food-deprived households, quantitative assessment of vulnerability is variable among localities. It is significant in five out of the State's eight localities, namely Alsalam, Kosti, Umrimta, Rabak abd Aldueim, while it is rather mild in the remaining three localities (Algabalain, Tandalti and Alquiteina). Beside vulnerability, the bulk of households in Alsalam are farmers with low land access, extremely poor productivity and high food and social deprivation. The situation in Kosti portrays high income disparities between the food-secure and food-deprived and in Umrimta poor income-generating activities along with limited land access are encountered. Rabak hosts a high portion of food-deprived households, high unemployed and low land productivity and Aldueim is characterized by enormous income and wealth disparities between food-secure and food-deprived, with poor land access for the latter. The three localities with mild vulnerability portray high deprivation in Algabalain in all social services, high biomass dependence in Tandalti, and low crop productivity and poor sanitation in Alquiteina. Priority shortcomings require matching interventions according to their nature in each locality.

Household heads mentioned a host of plausible interventions required for improving their food-security situation. Priorities are assigned to finance provision, employment expansion, reduced food prices and expansion of drinking water supply. However, improvement needs that target agriculture are paramount, including inputs-provisions, agricultural expansion, support to small family farms, livestock improvement, crop protection, and storage facilities.

PART I: INTRODUCTION

1.1 General

Sudan is endowed with vast and diverse agricultural resource base that provides various means of sustaining a livelihood. Sudan irrigated schemes are the largest in the world. Water resources include the Blue, the White, other large rivers, lakes, and swamps. Annual rainfall can reach as high as 2,200mm in Equatoria. Rainfed areas produce livestock, lumber, grain, tree crops, along with rivers, lakes, and coastal areas with rich fishing opportunities. There are significant amounts of forestry resources, including large teak plantations, extensive gum Arabic groves, and many national parks and forest reserves. These forestry resources can provide the basis for a sustainable timber and wild life tourism industry. These natural endowments are not equally distributed over the 2.5 million square kilometers of the Sudan. The quality of soil and availability of water varies, large areas require careful management for sustained production, climate varies from the extreme dry in the far northwest to the tropical in the south with substantial rainfalls. Some parts of the country are susceptible to periodic droughts of long duration, and most of the country is sparsely populated because of the arid conditions and the heavy rural urban migration. In spite of its wide and diverse agricultural resource base relative to population size, Sudan's economic performance is substantially below its potentials. This provides a general expiation to the puzzle that the majority of its population have no reliable accessibility to sufficient quantity and quality of nutritious food.

1.2 The concept of food security

A myriad of definitions exist for food security. Following the work of Amartya Sen (1981), the distinction between country level availability of food (whether home grown, imported, or donated), and people's access to food has been widely recognized. Sen argued that people's entitlements to food arise from their assets, stores, network, and skills, from their own production, from selling their labour and produce, and from transfers. In view of this concept, a household is food secure when the total sum of its entitlements is sufficient to enable its members to acquire the minimum food to meet their nutritional requirements all the time; otherwise that household is destined to be food insecure. With this concept in mind, one can say that the majority of the people of Sudan, though sitting on a vast and diverse agricultural base, are food insecure.

Besides, with time and across a series of developments, a concept of Food and Nutrition Security (FNS) had gradually evolved that combines both food and nutrition (Lioba Weingärtner 2005). According to Weingärtner *"food and Nutrition Security is achieved, if adequate food (quantity, quality, safety, socio-cultural acceptability) is available and accessible for and satisfactorily utilized by all individuals at all times to live a healthy and happy life."* The concept emphasizes not only availability and accessibility, but also 'Use and Utilization' of food. Yet, a widely accepted definition, which is adopted by FAO, states that *"Food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an*

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active and healthy life".(World Food Summit, 1996). From this definition, four dimensions of food security can be identified (FAO, 2006):

- Food availability: The availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports (including food aid)
- Food access: Access by individuals to adequate resources (entitlements) for acquiring appropriate foods for a nutritious diet.
- Utilization: Utilization of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met.
- Stability: To be food secure, a population, household or individual must have access to adequate food at all times. Inadequate access to food on periodic basis is still considered a status of food insecurity. Adverse weather conditions, political instability, or economic factors (unemployment, rising food prices) may have an impact on food security status.

To ensure food security, the Food and Agriculture Organization (FAO), and the World Health Organization (WHO) recommend a minimum calorie intake of 2100 Kcal per person per day or 3000 Kcal per adult equivalent per day (Steffan Abelle et al., 2007). Based on the duration of food insecurity, two general types are defined: Chronic food insecurity and transitory food insecurity. Chronic food insecurity refers to a continuously inadequate diet caused by the inability to acquire food. It is long-term or persistent, and occurs when people are unable to meet their minimum food requirements over a sustained period of time. It results from extended periods of poverty, lack of assets and inadequate access to productive or financial resources (FAO, 2008). On the other hand, transitory food insecurity refers to short-term household inability to access enough food. It is temporary and occurs when there is a sudden drop in the ability to produce or access enough food to maintain a good nutritional status. It results from short-term shocks and fluctuations in food availability and food access, including year-to-year variations in domestic food production, food prices and household incomes (FAO, 2008). Transitory food insecurity can be further divided into two sub-categories namely cyclical and temporary (Steffan Abelle et al., 2007). Cyclical food insecurity is where there is a regular pattern of food insecurity such as in periods before harvest. Temporary food insecurity is a result of short-term shocks such as droughts, floods or conflict.

1.3 Approaches to studying and measuring food security

Since food insecurity is a complex concept, several measures of food insecurity are available, each capturing a different aspect of the problem. The main indicators employed in the food security discourse included anthropometric measurement, minimum dietary energy requirements and factors affecting vulnerability of the people (Stamoulis and Zezza, 2003). In the context of food insecurity, it is important to note that food insecurity, malnutrition and poverty are deeply interrelated. When one attempts to define, conceptualize, measure, or combat them with policy measures, the relationship between them should be explicitly taken into account (Stamoulis and Zezza, 2003).

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Food security can be measured at the national, household, and individual level. Food security is measured at the national level by determining the amount of food available in the country and the extent to which it provides the minimum calorie intake per person per day. Information on supply and availability of food are obtained from food balance sheets which contain statistics on agricultural production and trade, stocks, agricultural and industrial usage in the country. Total energy available for human consumption can thus be obtained and the level of food security at national level can be measured. Availability of food at national level is a necessary condition for achieving food security but it is not sufficient. This has given importance to assessments of food security at household level which are usually done in the form of food expenditure surveys, which allows capturing issues of food accessibility hence enabling more accurate identification of food insecure households, social groups and regions. In some cases data are collected on expenditures rather than the amount of food purchased. Quantities are then derived from these expenditures based on appropriate prices at the time of acquisition. Using food composition tables, the amount of calories, protein and other nutrients are computed. The major drawback of this approach is its inability to capture intra-household distribution and consumption of food. Hence food security at household level does not guarantee its occurrence at individual level. This leads to the employment of special dietary surveys in order to understand intra-household distribution of food. The use of such surveys is however limited because of their high costs.

In addition to the quantitative measures of food insecurity, qualitative measures were also developed and used. These measures are subjective and based on households' perception of their food security status.

1.4 Rationale and objectives of the study

In the study the issues of both food and nutritional security in the White Nile State are addressed based on first, available data and information from literature sources and second, on outcomes of a household survey conducted in the State in 2010.

The rationale for the study is anchored on postulated livelihood conditions in the State. As shown by reported poverty indicators (for example Faki, Nur and Abdelfattah 2009), the livelihood situation in White Nile is one that deserves further investigations although it is not the worst among the states of the country. Income poverty in 1996 in three localities, namely Elquiteina, Eldueim and Kosti of the then Central Region that currently accommodates the White Nile State ranged from 89% to 98% in terms of incidence, from 73% to 83% in depth and from 59% to 71% in severity (Mahran 2005). The region as a whole ranked second among the country's six regions in rural income poverty (incidence about 88%) after Kordofan in 1990. Although its rank improved drastically as per the assessment in 1996, rural poverty incidence increased (91%). Further, with a rural human poverty index of 58 in 2000, rural White Nile was the fifth poorer among the rural areas of the 25 Northern states of the country. As in many parts of the country where dependence on rainfall is high and most people earn their living from agriculture, substantial annual variation in agricultural production (as will come later) is a threat to food security. White Nile state is among few states in North Sudan that are likely to face chronic food insecurity. The precarious situation of livelihood in the State's rural areas provided the drive to

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conduct a food-security study there, matching the initiative by SIFSIA to monitor the situation in a few states with similar conditions in the country.

The primary objective is to use the concept outlined above to measure the incidence, depth, and severity of food insecurity in the White Nile State and show how food insecurity relates to household entitlements with the view to glean a set of policies that if enacted may reduce the level of food insecurity in the State. The proposed research addresses key questions closely related to food insecurity, measured in terms of consumed major food quantities and dietary energy intake as well as assessment of a set of related issues including household incomes and social services. The research aims at sketching a spatial numerical view of food insecurity in the White Nile State and attempts to shed light on the underlying causes of food insecurity in each segment of the area. The research is expected to be replicated in other states. Utilizing the research results are intermediate objectives, the ultimate objective of the proposed research is to gather knowledge that would be useful for informing decision makers about the state of food insecurity in the State and suggest ways on how to break the intergenerational transmission pattern of food insecurity there. The main key questions addressed include:

- (1) How many are food insecure?
- (2) How insecure are the food insecure?
- (3) Are the food insecure equal in being insecure?
- (4) Where are the food insecure people in the White Nile State?
- (5) What are the food insecure people doing for a living?
- (6) What are the socioeconomic characteristics of the food insecure people?
- (7) Do food insecure people recognize themselves as food insecure?
- (8) How food insecure people cope with their food insecurity?
- (9) Do food insecure people have visions to empower themselves?
- (10) How are agricultural resources used?

While answers to critical questions (1) – (3) serve deriving the aggregate measures of the incidence, depth, and severity of food insecurity, the geographical information provided by question (4) sets the stage for the numerical spatial view of food insecurity. Answers to questions (5) – (6) are used to characterize food insecurity for policy derivation, while answers to question (7) – (9) provide grass-root information about food insecure people's own strategies and visions to assist in directing agricultural policy. Information on agricultural land and other household assets, crop mixes, productivity and other factors provide information on how resources are managed and linked to food security.

1.5 Methodology

a) Analysis methods

A major concern in the analysis is to base food security on nutritional status depending on deriving dietary intake of people in terms of Kcal per capita, which forms the yardstick for nutritional insecurity; often referred to in the text as food deprivation. This entails quantifying food types utilized in households and computing dietary energy intake using

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food composition tables. Yet, the traditional food security issue based on consumption of cereals is also considered while social factors related to health and education as well as many food-insecurity correlates is derived to provide a wide food security spectrum in the State. Answers to questions (4) to (10) are illustrated using various simple analysis procedures such as frequency distributions, descriptive statistics, cross tables and mean comparisons, while regression analysis is used for certain purposes; all using SPSS.

Regarding questions (1) to (3) a methodology similar to the one used for measuring aggregate measures of poverty is used, which is now being increasingly applied in food security analyses. In measuring food security in the USA, Gundersen (2007) utilized a theoretical framework based on similar constructions within the income poverty literature, making reference to many literature sources as well as to Dutta and Gundersen (2007) for more information on the particular method of application to food insecurity. Similar procedures were applied by Khatri-Chhetri and Maharjan (2009) for food insecurity and coping strategies in rural areas of Nepal, and Orewa and Iyangbe (2009) on food insecurity of rural and low-income urban dwellers in Nigeria. The method used here follows Faki, Nur and Abdelfattah (2009) where computations for nutritional insecurity are made using the following family of aggregate measures:

$$N_{\alpha} = 1/n \sum [(Z - Y_j)/Z]^{\alpha} \text{ For all } j \text{ s that belong to } q \text{ (1),}$$

where N_{α} is a nutritional insecurity index, n is total population, Z is the minimum calorie requirements per person per day (food deprivation line). Y_j is the calorie intake of nutritionally insecure person j , and q is the number of persons whose individual calorie intake is less than the minimum calorie requirements (i.e. number of nutritionally insecure). Finally, α is the nutritional insecurity aversion parameter. When $\alpha = 0$, equation (1) is reduced to q/n as given by the following expression:

$$N_0 = q/n = H \text{ (2)}$$

N_0 is the incidence of nutritional insecurity (food deprivation) measured by the number of the nutritionally insecure as a ratio of total population. This measure may be denoted as the head count index of nutritional insecurity and this is why it is denoted by (**H**). Therefore, when $\alpha = 0$, the nutritional insecurity measure in equation (1) averts both the depth and severity of nutritional insecurity and focuses on its head count index.

$$N_1 = q/n (1 - \mu/Z) = HI \text{ (3),}$$

where $(1 - \mu/Z)$ is the dietary calorie-gap index denoted by **I** and measures the depth of nutritional insecurity among the nutritionally insecure. Therefore, when $\alpha = 1$, the nutritional insecurity measure in equation (1) takes into account the incidence (**H**) as well as the depth (**I**) of nutritional insecurity but averts the severity of nutritional insecurity.

$$N_2 = q/n (1 - \mu/Z) + q/n (\mu/Z)G = H [I + (1 - I) G] \text{ (4).}$$

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While μ is the mean calorie intake of the poor, G measures the degree of inequality of calorie intake among the nutritionally insecure $0 < G < 2$. It is noted from measure (4) that when $\alpha = 2$, the nutritional insecurity measure in (1) captures the three dimensions of nutritional insecurity, namely its incidence (N_0), its depth (N_1), and its severity (N_2). It is also noted that N_2 , which might be called total nutritional deprivation has two terms. The first term is the absolute deprivation and the second term is the relative deprivation, which is governed by the degree of inequality among the nutritionally insecure. If the nutritionally insecure are equal in their nutritional level, the inequality index (G) will be equal to zero and consequently, the second term $H(\mu/Z)G$ will vanish indicating that there is no relative food deprivation. If they are unequal, the inequality index (G) will be greater than zero and consequently, the second term $H(\mu/Z)G$ shall remain positive indicating that there is a degree of relative deprivation in energy intake.

$$G = 1 + 1/n - (2/n^2 \mu) \sum r_i y_i, 0 < G < 1 \dots\dots\dots (5),$$

where G is the inequality index among the nutritionally insecure, n is the population size, μ is the mean calorie intake, Y_j is the calorie intake of person i , and r_i is the rank of calorie intake i when energy figures are ranked in a descending order. When G is equal to zero, food energy is equally distributed, when G is greater than zero but less than one, there is a degree of nutritional inequality, and when G is equal to one there is complete inequality. Since the extreme situations of complete equality and inequality do not exist in real life, the numerical value of G is always greater than zero but less than one.

While the policy contents of the measures mentioned above include direct food transfers through for example food aid and Zakat, it more importantly address empowering the nutritionally-deprived via better targeting to ensure sustainable food supply (production), improve food access (i.e. making growth pro-food insecure), and foster better social services; all converging to enhance nutritional food security.

b) Sampling

It is obvious that fresh and reliable answers to the critical policy questions can only be obtained by interviewing a sizeable and representative sample of households carefully drawn from an up-to-date sampling frame of the White Nile. For the sake of good sample representation and high data quality, the sampling frame is stratified to cover the distribution of both geographical dispersion and households' variability. Stratification is based on the eight localities of the State (Alquiteina, Aldueim, Rabak, Kosti, Umrimita, Algabalein, Alsalam, and Tendelti), which have a natural distribution east and west of the White Nile banks. From each locality a number of villages are selected at random to form a total sample of 600 households, which, although constrained by the level of available funding, is nevertheless thought adequate to pursue the objectives of the study. The number of villages in each locality is linked to the number of households, which is determined in proportion to the locality population according to the Sudan Population Census of 2008. Then the number of villages is assigned such that approximately 20 households are selected from each. The sample structure is shown as follows:

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Table 1: Sampling structure

| Locality | % Population | Villages | Households |
|--------------|--------------|-----------|------------|
| Alquiteina | 14.2 | 4 | 85 |
| Umrimita | 6.9 | 2 | 41 |
| Aldueim | 17.1 | 5 | 103 |
| Rabak | 13.8 | 4 | 83 |
| Algabalain | 10.3 | 3 | 62 |
| Kosti | 23.4 | 8 | 140 |
| Alsalam | 6.1 | 2 | 37 |
| Tandalti | 8.2 | 2 | 49 |
| Total | 100 | 30 | 600 |

However, due to practical field requirements, the number of villages increased by including an additional one to Aldueim Locality bringing the total village number to 30 and the total households to 606 (see Appendix 2 for the selected villages). Although sampling is basically geared towards geographical distribution, the random sampling procedure at both village and household level has, as expected, captures clusters according to socioeconomic factors such as various livelihood profiles, female-headed households, farming systems, and the like. All households are selected from rural areas, and accordingly the food security assessment is strictly rural-based.

c) Questionnaire design

The household questionnaire is so designed as to capture the needed information for the foreseen objectives. The broad contents (sections) of the questionnaire are as follows (see questionnaire in Appendix 3):

- 1) Households' socioeconomic characteristics.
- 2) Housing characteristics and main facilities.
- 3) Household assets and their current value (land, livestock, equipment, various capital goods, appliances, buildings and others).
- 4) Ranked livelihood engagements of the household head.
- 5) Household's descriptive valuation about own food-security status.
- 6) Economic activities of the household (crop areas, production, crop sales, incomes, consumption, other crop disposal ways, crop residues, livestock products and sales, fish production and incomes, non-agricultural incomes of family members).
- 7) Borrowed cash for agriculture and consumption, family savings.
- 8) Food consumption quantities and expenditure by time period.
- 9) Other non-food household expenditure.
- 10) Information on migration, food crisis, shocks, coping actions, food aid, needed interventions for improvement.
- 11) Health characteristics of the household (children and adults infections with main diseases and deaths).

Items 1) to 5), 10) and 11) are related to the current status of the households, most of which are less likely to change in the short period. Items 6) and 7) relate to the household

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agricultural production, crop disposal, incomes by source and consumption from own produce in season 2009/10. Item 8), on the other hand monitors food consumption variables that the households usually consume at present. Options are given to the household head to identify the period of consumption for each food item and the quantity consumed in that period; i.e., per day, week, month or year. This is thought to ease free expression of consumption depending on the nature of food items.

The household questionnaire is augmented by a short village-leaders questionnaire on village characteristics, services and problems filled-in via interviews with village leaders.

Field work

The field work comprised three field trips by the research team to Kosti for preparations, enumerators' training, amendments in the questionnaire and commencement of the field work. The State Ministry of Agriculture at Kosti showed high interest in and provided great assistance for the conduct of the field work. The field staff comprised 26 enumerators and five supervisors from the Ministry (working in different localities in the State) in addition to an overall supervisor from AEPRC to follow-up on the logistical and technical conduct of the survey. A one-day enumerators' training was conducted at the premises of the State Ministry of Agriculture in Kosti where enumerators were given a PPT presentation (in Arabic) comprising basic information on food security, its major methodological aspects and information compiled on the White Nile State. A handout on these topics was prepared in Arabic and distributed to the enumerators. Then detailed presentation of the questionnaire was given with explanation and discussion on each question. The group provided good feedback according to which some amendments in the questionnaire were made and its final version and multiplication was prepared in Khartoum. Logistical preparations and assignment of survey locations to the enumerators were made in collaboration with the staff of the State Ministry.

**PART II: OVERVIEW OF FOOD SECURITY IN
White Nile STATE**

2.1 Basic characteristics of the White Nile State

The White Nile State lies between latitudes 12° and 13.3° N and longitudes 31° and 33.3° E, straddles the White Nile South of Khartoum and borders six states (Fig.1). It has a population of about 2.731 million growing at a 2.5% rate and distributed over eight localities, namely Rabak, Kosti, Alquiteina, Aldueim, Umrimta, Algabalain, Alsalam, and Tendelti (Table 1). With a total area of 39,704 km², the average population density can be computed at 44 persons/km². Kosti is the most populated locality followed by Aldueim, Alquiteina and Rabak, but Kosti and Rabak are the most densely populated localities. The State is home to significant numbers of refugees of about 153,000 in 2006 forming nearly 10% of the population and also a transit point for IDPs returning to the south and South Kordofan. Most of these IDPs have been settled in, around Kosti and in many other camps.

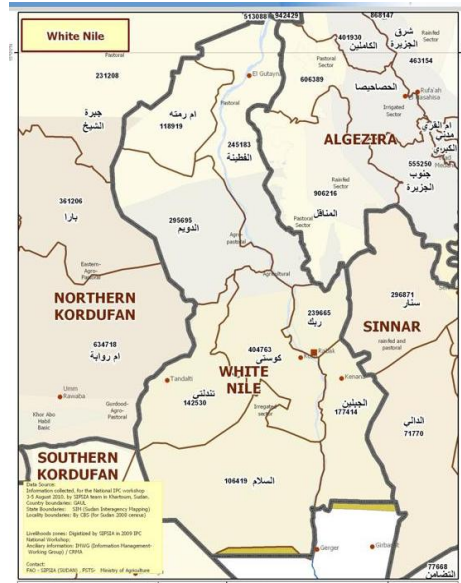


Figure 1: White Nile State

Table 2: Population and administrative characteristic of White Nile State

| Locality | Area (km ²) | Population (2003) | Pop Density | No Admin Units | No of Townships | No of villages |
|--------------|-------------------------|-------------------|-------------|----------------|-----------------|----------------|
| Rabak | 1589 | 239665 | 151 | 3 | 65 | 73 |
| Kosti | 3383 | 404763 | 120 | 5 | 83 | 133 |
| Alquiteina | 3266 | 245183 | 75 | 4 | | |
| Aldueim | 7437 | 295695 | 40 | 4 | 23 | 218 |
| Umrimta | 3345 | 118919 | 36 | 3 | | 72 |
| Algabalain | 4841 | 177414 | 37 | 3 | 54 | 71 |
| Alsalam | 6919 | 106419 | 15 | 5 | | 98 |
| Tendelti | 8924 | 142530 | 16 | 3 | 20 | 86 |
| Total | 39704 | 1,730,588 | 44 | 30 | 245 | 751 |

Source: Central Bureau of Statistics, Sudan 2003; 2008

Agro-ecologically, the State is within the semi-desert zone, characterized by sandy areas in various areas and with annual rainfall varying from 300 mm in the north to 600 mm in the south. Transport connections to other parts of the country are reasonable where accessibility is enabled year-round with road and railway means as well as river links to South Sudan. Industry is largely agro-based dominated by sugar factories and a number of

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small food processing industries producing vegetable oils and sweets. About 70% of the population is rural and agriculture is the main source of livelihood for residents and IDPs who offer their labor, particularly in mechanized agricultural schemes and sugar plantations (WFP 2006).

2.2 The agricultural setup

Field crops and plantations

The White Nile State accommodates both rainfed and irrigated farming dominated by the former under a mechanized mode having high growth. Traditional rainfed agriculture has rather humble growth while irrigated farming has remained almost stagnant (see Appendix 4). This pattern has implications for food security as will come later. The rainfed crop mix has sorghum as the major crop, which together with sesame and millet, form about 97% of the total area under this system. There are also other crops grown on a limited scale such as groundnut, water melon and guar (see Appendix 5). Irrigated farming is concentrated in agricultural schemes and small ones along the White Nile; both irrigated by pumps from the Nile. Crops there are again dominated by sorghum that occupies close to three quarters of the area, followed by wheat (18%) and cotton (8%). Groundnut existed till the late 1970s but has almost vanished since then.

Major food security crops are sorghum, wheat and to a much lower extent millet. Total annual average cereal production was 464,000 tons over the past five years, with sorghum contributing 57%, wheat 39% and millet 4%. Per capita cereal production is variable, ranging from 134 to 389 kg over the past five years of which sorghum and millet, the main staple foods, ranged from 43 to 295 kg. These are indicators of unstable food availability from own production. Yet, the State produces cash crops, which provide job opportunities. As the biggest sugar producing part of the country, the State accommodates the huge Kenana and the smaller Asalaya sugar plants having an area of 221 thousand feddans, but new sugar expansions are envisaged to more than triple this area. The sugar plants, although not of direct farming engagement of the population, yet offer considerable employment opportunities. The new planned sugar schemes are thought to be based on some sort of partnership with farmers, in which case the livelihood dimension is expected to widen through both cropping and employment opportunities.

Livestock and fishery

Along with crops, livestock is an important livelihood undertaking. The State accommodates about 6% of Sudan's livestock wealth and ranks fourth in the total livestock numbers and livestock density (7.1 TLU/ km²) among the 15 Northern states. Reported information (WFP 2006), however, indicate that livestock ownership is primarily restricted to resident households who own limited numbers of small ruminants and poultry that nevertheless confer sales to pay for food and medical expenses. On the other hand dairy farming is expanding in the State and the area is famous for cheese making especially in and around Eldueim and Kawwa towns. The contribution of livestock to livelihoods will be more explored within the planned household survey in the State. Fishery is another livelihood means for close to 1,500 fishermen in the State. Along with Blue Nile, the White Nile is a major source

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of fish among the fish producing areas of the country, being preceded only by Southern Sudan (UNDP, FAO, UNIDO 2003). Fish is sold fresh or subjected to traditional simple processing; suggesting that advanced fish processing can offer tremendous opportunities as an additional income-earning activity.

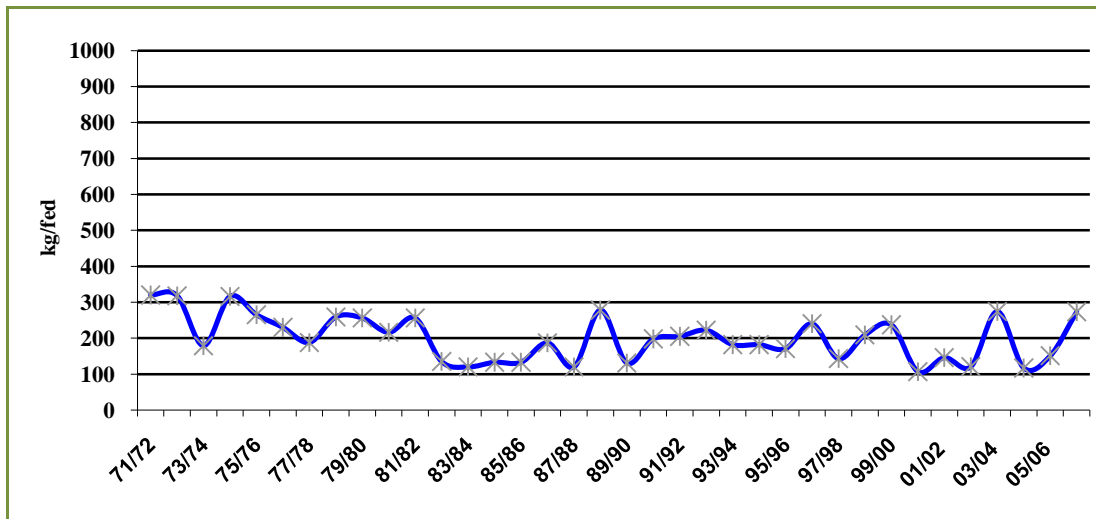
2.3 Cropping and food security

Within an overall food security context in the State, the crop mix comprises a sizeable portion of cereal foods (sorghum, millet and wheat) and a considerable part of a limited number of cash crops (sesame and cotton). The existing setup seems to portray certain levels of food availability and access. While such levels are yet to be sorted out, a number of issues concerning cropping systems and crop situations remain of concern as to the status of food security. These include productivity levels of both food and cash crops, and crop failures that impair production levels and production stability (vulnerability).

2.3.1 Productivity

Figure 2, illustrating average weighted long-term pattern of productivity of cereal crops, is indicative of both fluctuating and declining average trend of cereals of 2.4 kg per feddan in the State (see Appendix 6 for individual crops). The coefficient of variation is 32% over the whole period and 41% over the last six seasons. The combination of high variability and declining productivity are sources of risks and accordingly vulnerability at household and state levels depending on coping mechanisms at the former level and policies at state and national levels to respond to variable yields and overall cereals supply.

Figure 2: Weighted average yield of cereals (sorghum, millet, wheat)

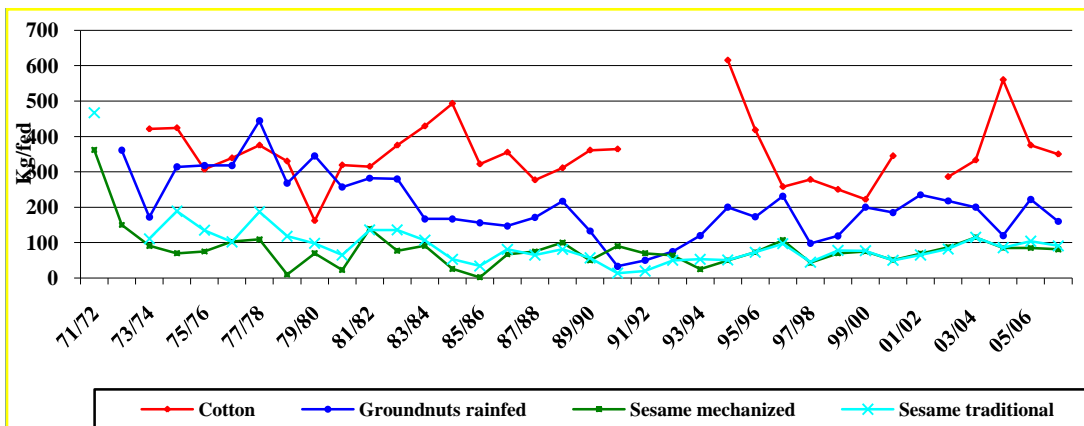


Source: Derived from data of the Federal Ministry of Agriculture and Forests

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The area of cash crops is largely determined by the area of mechanized and traditional rainfed sesame, which witnessed successive and high expansions over time. Both cotton (irrigated) and groundnuts (rainfed) areas are relatively small and their trend seems to be declining. Like the case of cereals, small-holder producers are characterized by smaller areas and less expansions; a situation that limits cash proceeds and accordingly narrows opportunities for food access. Average yields - plotted in Fig. 3 - reveal that cotton yields are highly variable while the trends for rainfed groundnuts and both traditional and mechanized sesame assume declining modes. Overall productivity is low, with respective averages of 381, 193, 87 and 91 kg per feddan for irrigated cotton, rainfed groundnuts, rainfed mechanized sesame and rainfed traditional sesame.

Figure 3: Development of average yields of cash crops 1971/72-2006/07



Source: Derived from data of the Federal Ministry of Agriculture and Forests

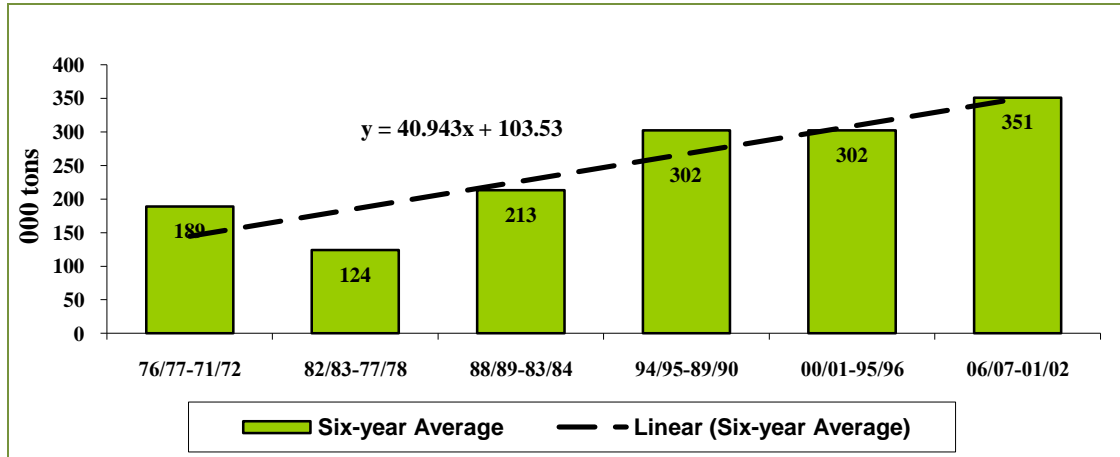
The combined effect of low productivity and high variability reflects negatively on producers' incomes. The effect is expected to be more harmful for traditional producers in lieu of their smaller areas as compared with large mechanized farms which understandably benefit from economies to scale. Unstable and low cash incomes of the small producers obviously count as a threat to food access and eventually food security.

2.3.2 Production of cereal foods

Own State's production of cereals is detrimental to food security since the produced cereals, especially sorghum, form staple foods there as it is in the country as a whole. Development in production of the three main cereal crops (sorghum, millet and wheat) over the past four decades or so is presented in Fig. 4.

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Figure 4: Development of total cereal production 1971/72-2006/07



Source: Derived from statistics of the Federal Ministry of Agriculture and Forests

Increases have been considerable, but probably not to the extent expected over such a long period of 36 years. Production has less than doubled and is further characterized by notable fluctuations. The coefficient of variation among individual seasons amounts to 54% and risks of extremely low production are evident even among the aggregated six-year periods shown by the figure. Depending on the shares of production released by producers in the market, market supply is expected to be highly variable influencing food availability at the State level while availability at the household level is expected to reflect tangible vulnerability.

The average annual production growth rate is 3.4% - higher than the average population growth rate in the country and the State (2.5%). However, sorghum forms the bulk of cereal production (87% over the whole period and 86% over the last six years). Mechanized sorghum production is the major mode contributing 59% to the total sorghum production over the whole period and 53% over the last six years. Since most of the crop produced under this mode is undertaken by a limited number of commercial well-off farmers and a considerable part of the produce is likely traded in other areas of the country, availability in the State would be expected to be notably less than the total amount produced. This would indicate a threat to availability when it is based on traditional and irrigated sorghum production. If average annual per capita availability is calculated based on two assumptions, namely full sorghum availability including mechanized production on the one hand, and only traditional and irrigated production on the other hand, the range of per capita availability could be derived. Based on the last six-year production averages and the population figures of the 2008 population census, the range of per capita availability varies from 143 kg in the first scenario to 69 kg in the second scenario. While the first scenario entails an average cereals availability a little above the commonly used requirements of 120 kg per capita per year, food availability in the second scenario is way below, indicating perceptible risks of food availability from own production.

Estimating variable food deficits in the State in the period 2003-2006 (WFP 2004; WFP 2006), WFP (2007) postulated that among all states of the country, Kassala and White Nile were the most likely to report food aid as their source of food, although in both States fewer

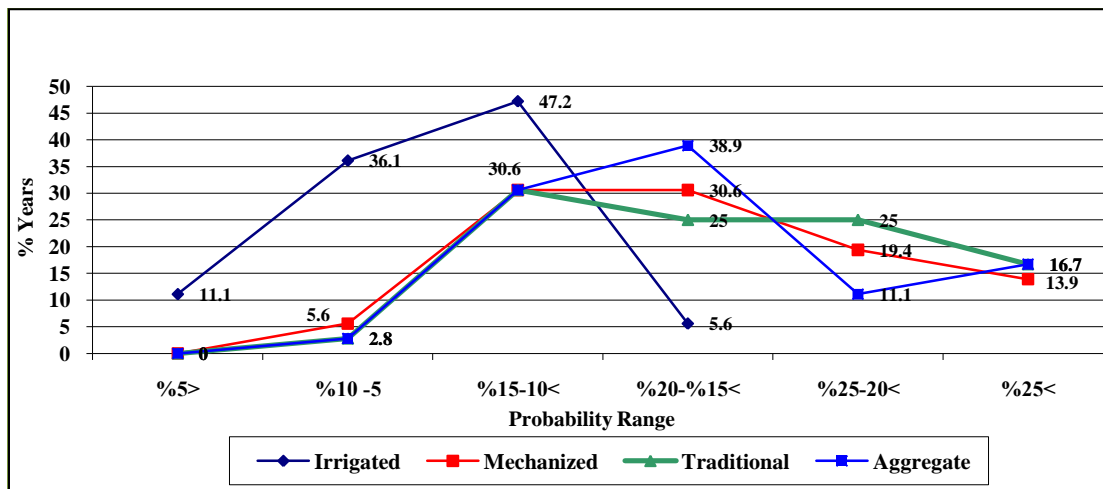
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than 5 percent of households reported this. In 2007, the cereal balance in the State recorded an 82% surplus (275 thousand tons) over consumption (MoARF 2009). However for both 2008 and 2009 deficits of 23,000 and 48,000 tons are reported. In spite of frequent deficits, their levels are modest compared to those at the national level. For example the 2006 needs for 27,100 estimated beneficiaries are quite small compared with the needs of 800,000 tons of emergency food assistance estimated by the WFP to meet the needs of 6.71 million people in the whole country. Yet in that year the White Nile along with Abyei had the highest percentage of households reporting food insecurity in northern Sudan and the Three Areas.

2.3.3 Risks of crop failure

Risks of crop failure are induced by erratic rainfall in rainfed farming, water shortages or flooding in irrigated production, and pests and diseases for both modes. A useful measure for risks faced by producers is the relation of harvested to planted areas on which data is available under each system. Crop failure is measured by the percentage decrease in the total harvested over planted area and the incidence of occurrence is derived under a range of probability levels over the period 1971/72 – 2006/07 (Fig. 5). In the irrigated sector, in as high as close to half of the number of seasons crop failure ranges between 10% and 15%, which means that in one in every two years producers incur losses to this extent. Higher losses are infrequent but losses of 5-10% are considerable (36%). In the rainfed sector with both its traditional and mechanized modes high crop failures at high frequency are to be expected. The two modes are considerably similar in their risk exposure where in 31% of the seasons, crop losses of 10-15% are expected and in 25-31% of the seasons losses are higher ranging from 15-20%. Higher failures of 20-25% are likely in 11-19% of the seasons and even much higher losses of over 25% are possible at lower probabilities in the range of 14-17%.

Figure 5: Incidence of crop failure 1971/72-2006/07



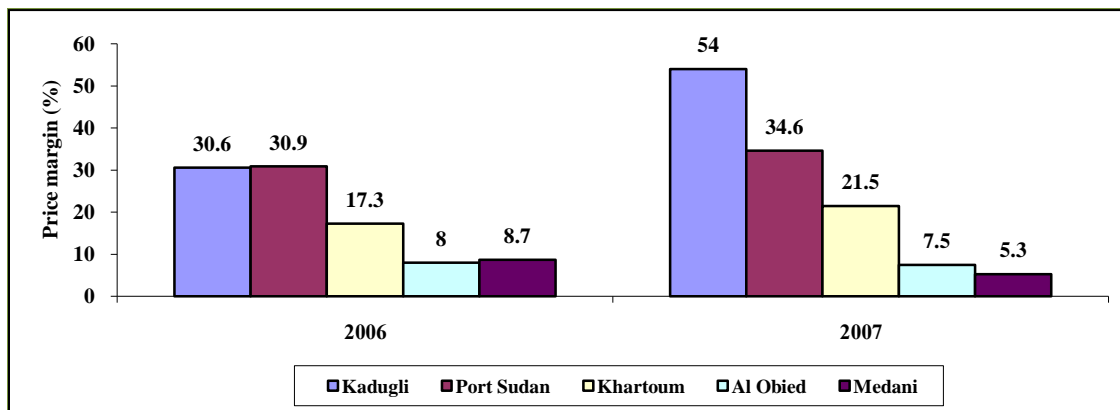
Source: computed from data of the Federal Ministry of Agriculture and Forests

Crop failures do not only threaten supply stability, but also access to food; first through reduced amounts and second through loss of expenditure on crop establishment that entails reductions in producers' disposable incomes. In all cases there is considerable jeopardy to food security.

2.3.4 Sorghum tradability

Tradability of sorghum outside the White Nile depends on price differentials in other potential accessible markets in the country in relation to transfer costs. Figure 6, showing wholesale price margins of sorghum in selected markets, depict considerable price differentials, especially in Kadugli, Port Sudan and Khartoum that would be attractive 'importing' markets. Price margins in Al Obeid and Medani are lower, but their proximity and easy accessibility may provide a good incentive. Other potential markets on which price data are not available are those in South Sudan, especially the bordering Upper Nile State, which is accessible through river and road transport.

Figure 6: Sorghum price differential in selected markets over Kosti price



Source: Drawn from data of the Ministry of Agriculture and Forests

It is evident from the foregoing discussion that agriculture, in spite of its frequent precarious situation, plays an important role in people's livelihoods in the State. However, given this precarious situation, rural people are engaged in other livelihood alternatives and face different food insecurity levels. Given the objectives of the study, quantification of such levels by geographical traits, their associations with various socioeconomic correlates and the state of vulnerability form main issues that are anchored on the results of the household survey and discussed in the following part.

PART III: SURVEY RESULTS

This part portrays the results of data analysis stemming from the household survey. First, major socioeconomic characteristics that influence the livelihood of the households are addressed, followed by food and nutritional security quantification and related agricultural production parameters. Dietary energy intake corresponding to nutritional security at the household level is then analyzed forming the base for identifying various food security correlates. Subsequently, food shocks and coping strategies of households of socioeconomic nature are examined and main social services that feature to influence food security are delineated, according to which vulnerability estimates are drawn.

3.1 Occupation in households

Engagement of household heads in different major occupations among the sampled households is shown by Table 2. A high portion of the total sampled households are farmers at the household head level, reaching 64% on average but with high percentages in Tandalti, Kosti, Alsalam and Algabalain localities. In Aldueim, Rabak and Umrimta, around half of the sampled household heads are farmers, while the ratio is much smaller in Alquiteina. Wage labor is the second important livelihood activity that is spread over all localities, but with particular importance in Rabak, Umrimta and Alquiteina. With its general low share in household's head livelihood, trading is more of an activity in Alquiteina, Aldueim and Umrimta. The other proportionally higher livelihood engagements in Alquiteina and Aldueim comprise various levels of employees, unemployed, and fishermen.

Table 3: Distribution of household heads (%) according to major occupation

| Locality | Farmer | Wage & Skilled Labor | Trader | Other | Total |
|-----------------|---------------|---------------------------------|---------------|--------------|--------------|
| Tandalti | 90.0 | 4.0 | 2.0 | 4.0 | 100 |
| Kosti | 85.7 | 8.6 | 5.0 | 0.7 | 100 |
| Alsalam | 78.4 | 16.2 | 2.7 | 2.7 | 100 |
| Algabalain | 77.8 | 15.9 | 0.0 | 6.3 | 100 |
| Aldueim | 55.3 | 26.2 | 7.8 | 10.7 | 100 |
| Rabak | 54.0 | 39.1 | 0.0 | 6.9 | 100 |
| Umrimta | 46.3 | 41.5 | 7.3 | 4.9 | 100 |
| Alquiteina | 22.4 | 45.9 | 10.6 | 21.2 | 100 |
| Average | 63.5 | 24.3 | 4.8 | 7.4 | 100 |

For livelihood improvement, these figures may imply the need for different intervention in different areas. Since agriculture generally remains the major activity of household heads, it deserves utmost attention for livelihood improvement. Nevertheless, promotion of wage and skilled-labor jobs will be justified on account of their contribution to a diversified mode of livelihood. These are of particular importance in Tandalti, Kosti, Alsalam and Algabalain. Probably in the same manner, interventions for improving trading engagements will be of

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importance for the same cause, in addition to their contribution to an effective market system.

While the above analysis focuses on household heads, it is important to consider the whole spectrum of the rural family members. Here, by excluding children and the schooling segments of family members, the working force is derived and classified according to performed livelihood activities (Table 3) (see Appendix 7 for details). Housewives are included in the working force in lieu of their known productive and reproductive roles, given their hidden contribution to the income-generating activities. The Table takes account of a total working force of 2832 family members in the whole sample, excluding 1908 children and students (40% of the whole family size).

Unlike the situation with household heads, farming acquires a substantially lower position, but it is still markedly higher than other income-generating activities. This is indicative of a wide departure from farming of family members, which could nevertheless be suggestive of a healthy situation. Notable are the enormous unemployment ratios that range between 25% and 45% and average about 36%. Job creation then becomes of urgent need especially in Alsalam, Algabalain and Rabak, including widening of the wage and skilled labor opportunities. Further, on account of the importance of the housewives' segment, creation of income-generating opportunities for them and technology facilitation of their work will be supportive to their diversified activities and income improvement.

Table 4: Distribution (%) of family working force by type of activity by locality

| Locality | Farmer | Wage & skilled labor | Trader | Housewife | Unemployed | Other | Total |
|----------------|-------------|----------------------|------------|-------------|-------------|------------|------------|
| Tandalti | 42.3 | 4.2 | 2.7 | 15.3 | 33.9 | 1.6 | 100 |
| Kosti | 29.3 | 8.9 | 2.1 | 24.8 | 33.3 | 1.6 | 100 |
| Alsalam | 30.2 | 8.0 | 1.5 | 14.6 | 45.2 | 0.5 | 100 |
| Algabalain | 21.6 | 6.8 | 0.0 | 24.3 | 42.0 | 5.3 | 100 |
| Aldueim | 15.2 | 13.2 | 2.8 | 29.5 | 35.0 | 4.3 | 100 |
| Rabak | 15.6 | 14.0 | 0.0 | 26.4 | 42.1 | 1.9 | 100 |
| Umrmta | 11.8 | 17.5 | 3.1 | 28.9 | 36.1 | 2.6 | 100 |
| Alquiteina | 5.8 | 24.5 | 3.6 | 34.4 | 25.3 | 6.4 | 100 |
| Average | 20.9 | 12.4 | 1.9 | 25.9 | 35.8 | 3.1 | 100 |

3.2 Food and nutritional security

Analysis of the detailed data collected at the household level is carried out to derive a number of indicators that would assist in gleaning the status of food and nutritional insecurity. One of these indicators is the per capita consumption of different food groups depicted in Table 4. Overall average consumption of cereals (sorghum, millet and wheat), which forms a suitable indicator for food security portrays decent levels in most states, except for Alsalam where levels are rather lower. Ignoring the composition of these food groups, some comparison is provided in the Table with the world averages and those in North Africa. Levels in White Nile Sate are generally similar or above those in the selected regions, except for vegetables and fruits that are far below the North Africa level and animal

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products that are less than in the two regions. Consumption of cereals is substantially higher than the world average but similar to that of North Africa. The average consumed quantities in some localities are however lower for most food groups. It is yet to be mentioned that the consumption figures given by the households might reflect some wasteful use of food; common within the Sudanese culture.

Table 5: Per capita annual consumption (kg) of different food groups by locality

| Locality | Cereal Grains ¹ | Legume Grains ² | Vegetables & Fruits ³ | Animal Products ⁴ | Sugar & Sweets ⁵ | Other ⁶ |
|------------------------------|----------------------------|----------------------------|----------------------------------|------------------------------|-----------------------------|--------------------|
| Alsalam | 170.3 | 8.4 | 63.6 | 23.7 | 29.8 | 10.6 |
| Aldueim | 253.6 | 9.4 | 92.5 | 78.1 | 49.9 | 4.0 |
| Algabalain | 244.0 | 5.8 | 68.9 | 45.4 | 34.1 | 10.2 |
| Kosti | 237.8 | 20.8 | 92.8 | 29.5 | 36.6 | 15.3 |
| Alquiteina | 213.1 | 10.1 | 114.4 | 58.9 | 38.7 | 13.8 |
| Rabak | 251.1 | 10.7 | 97.6 | 45.8 | 37.7 | 12.8 |
| Tandalti | 233.1 | 8.8 | 109.5 | 42.6 | 40.3 | 12.7 |
| Umrimita | 223.1 | 14.7 | 94.9 | 102.1 | 40.6 | 3.9 |
| Total | 234.0 | 12.2 | 93.7 | 52.5 | 39.2 | 10.9 |
| World⁷ | 147.1 | 6.1 | 76.8 | 75.2 | 23.9 | |
| N. Africa⁷ | 212.3 | 7.5 | 212.8 | 83.5 | 28.0 | |

1: Sorghum, wheat, millet & rice and processed cereals (bread, noodles and macaroni); 2: Faba bean, dry bean, lentil and cowpea; 3: A range of 18 usually consumed vegetable and fruits; 4: Mutton, beef, fish, eggs, cheese and milk; 5: sugar, jam and biscuits; 6: Beverages, vegetable oil, out-of-home food (estimated according to value in terms of sorghum); 7: Food supply average of 2003-2007 (from FAO statistics), excluding processed cereals.

Disaggregation of the consumption of cereals (Table 5) clearly reveals a huge contribution of sorghum in food consumption in all states. At an average of 71%, sorghum is followed way below by wheat (12%) and manufactured cereals (10%) of which wheat bread form the major part. Each of millet and rice has low contribution to the total intake of cereals in all localities.

Table 6: Shares of cereal components in per capita consumption of cereals (%)

| Locality | Sorghum | Wheat | Millet | Rice | Manufactured Cereals* |
|--------------|-------------|-------------|------------|------------|-----------------------|
| Alsalam | 92.9 | 1.5 | 1.5 | 2.6 | 2.5 |
| Aldueim | 66.9 | 14.0 | 1.9 | 3.3 | 13.9 |
| Algabalain | 77.7 | 6.9 | 4.2 | 1.6 | 9.6 |
| Kosti | 69.1 | 17.1 | 4.8 | 2.4 | 6.6 |
| Alquiteina | 69.8 | 10.7 | 1.5 | 1.6 | 16.4 |
| Rabak | 65.8 | 15.6 | 6.5 | 2.2 | 9.9 |
| Tandalti | 85.9 | 0.2 | 3.4 | 2.6 | 7.9 |
| Umrimita | 64.3 | 16.5 | 7.0 | 2.6 | 9.6 |
| Total | 71.3 | 12.2 | 4.1 | 2.3 | 10.1 |

* Bread, macaroni and noodles.

3.3 Extent of households' food production and disposal

Within the food security domain, it will be interesting to single out farming households based on the occupation of the farming household head and trace the extent to which they produce their own food. First, Table 6 shows the ratio of the number of households growing different crops to the number of households whose household heads pursue farming as their main occupation. The table shows the enormous importance of sorghum; being grown by more than farming households as evident from the percentage values exceeding 100%. This is due to the situation that numerous non-farming households engage in sorghum production as usual in many parts of Sudan. Cultivation of other crops has a much narrower spread. The most important of these is sesame, grown by an average of 22% of the farming households, but by almost half of those in Kosti and Tandalti localities. Groundnuts - at 12% at the state level – finds more room in Tandalti and Kosti localities. Wheat, millet and okra have similar low figures, while the remaining crops are grown by minorities of farming household heads. Nevertheless, okra finds relatively more focus in Alsalam and Alquiteina, and tomato in Umrimita. Notable is the low spread of cotton, which used to be of historical importance in the White Nile State (now under limited cultivation in Algabalain), and wheat of which the State is seen as an important producing area (now relatively more in Aldueim, Alquiteina and Umrimita).

Table 7: Households growing different crops as % of farming households by locality

| Crop | Alsalam | Aldueim | Algabalain | Kosti | Alquiteina | Rabak | Tandalti | Umrimita | Average |
|-----------|---------|---------|------------|-------|------------|-------|----------|----------|---------|
| Sorghum | 110 | 123 | 114 | 103 | 184 | 113 | 100 | 116 | 114 |
| Wheat | 0 | 18 | 2 | 8 | 21 | 6 | 0 | 16 | 8 |
| Millet | 0 | 2 | 2 | 12 | 5 | 26 | 4 | 11 | 9 |
| Cotton | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 2 |
| Sesame | 7 | 2 | 8 | 45 | 0 | 9 | 47 | 0 | 22 |
| Groundnut | 17 | 7 | 0 | 18 | 5 | 0 | 33 | 5 | 12 |
| Okra | 24 | 0 | 0 | 6 | 26 | 9 | 4 | 11 | 7 |
| Karkadeh | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 1 |
| Onion | 0 | 0 | 4 | 0 | 11 | 0 | 0 | 5 | 1 |
| Tomato | 0 | 0 | 2 | 0 | 5 | 0 | 0 | 16 | 1 |
| Lubia | 0 | 0 | 0 | 4 | 0 | 0 | 7 | 0 | 2 |

Second, the amount of produced crops (food and non-food) at the household level will provide information on the level of own coverage of consumed food amounts and/or have access through cash purchases. The average household production of different crops (for all households) shown by Table 7 reveals cereals production to levels roughly matching the spread of their cultivation presented in Table 6.

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Table 8: Average production (kg) of crops per household 2009/10

| Locality | Alsalam | Aldueim | Algabalain | Kosti | Alquiteina | Rabak | Tandalti | Umrimita | Total |
|-------------|---------|---------|------------|--------|------------|-------|----------|----------|--------|
| Sorghum | 288.4 | 1525.8 | 544.6 | 1560.7 | 338.8 | 242.6 | 1769.6 | 1182.0 | 1002.5 |
| Wheat | | 263.4 | 1 | 312.9 | 92.1 | 10.4 | | 175.6 | 144.0 |
| Millet | | 3.7 | 22.6 | 4.3 | 14.5 | 32.8 | 7.6 | 18.5 | 12.6 |
| Cotton | | | 62.6 | | | | | | 6.4 |
| Sesame | 3.5 | 12.8 | 27.9 | 68.7 | | | 182.8 | | 36.0 |
| Groundnuts | 12.4 | 28.2 | | 18.1 | | | 222.0 | 6.6 | 28.5 |
| Okra | 0.7 | | | 0.5 | 19.1 | 47.6 | 2.5 | 9.9 | 10.5 |
| Karkadeh | | | | | | | 4.5 | | 0.4 |
| Onion | | | 15.6 | | 123.5 | | | 85.4 | 24.8 |
| Tomato | | | 0.6 | | 35.3 | | | 50.2 | 8.4 |
| Kidney Bean | | | | 2.7 | | | 6.3 | | 2.2 |

Considerable amounts of sorghum are produced in all localities, especially in Eldueim, Kosti, Tandalti and Umrimita, while wheat production is notable in Kosti and Aldueim, and to a lesser level in Umrimita. Millet production, similar to its consumption situation, is limited in all localities. Other crops, which are largely cash crops, are scattered and produced in small amounts, probably except for sesame and groundnuts in Tandalti and onion in Alquiteina. Variations in the amounts produced of all crops are however quite large on account of differences in the areas and unit area productivity. For example, while the bulk of crop areas are small, a number of households own farms in the mechanized farming sector where sorghum and sesame areas are quite large. Similarly, some households grow relatively big areas of wheat in spite of the limited spread of the crop.

Thirdly, the contribution of household production to household consumption offers a useful indicator of how far households could resort to their own production to meet their consumption requirements as reported from the survey. From Table 8, surpluses are evident for sorghum in Aldueim, Kosti, Tandalti and Umrimita and for okra (in spite of its small consumption) in Rabak. On the other hand, household domestic coverage is reasonable for wheat in Kosti and Aldueim. Otherwise, domestic production runs short of consumption at varying degrees for the range of crops grown in most localities. On average in the State, consumption needs of sorghum are covered to a substantial level (84%) but those of wheat are low (about 30%).

Table 9: Contribution (%) of average own food production to consumption of grown crops – average of all households

| Locality | Sorghum | Wheat | Millet | Okra | Onion | Tomato | Kidney Bean |
|--------------|-------------|-------------|------------|-------------|------------|-------------|-------------|
| Alsalam | 29.4 | | | 2.2 | | | |
| Aldueim | 125.3 | 44.6 | 0.7 | | | | |
| Algabalain | 34.8 | 2.5 | 4.8 | | 7.5 | 0.3 | |
| Kosti | 133.0 | 65.5 | 2.0 | 2.2 | | | 2.2 |
| Alquiteina | 32.2 | 29.4 | 7.0 | 29.8 | 36.1 | | |
| Rabak | 18.5 | 0.5 | 4.1 | 155.3 | | | |
| Tandalti | 166.8 | | 4.1 | 2.8 | | | |
| Umrimita | 109.0 | 32.1 | 3.6 | 32.1 | 29.0 | | |
| Total | 83.8 | 29.5 | 3.2 | 25.4 | 9.5 | 12.3 | 0.6 |

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The above situation is derived on average basis across the whole sample in rural areas. But considering the farming households, specifically those who produce the food crops under consideration, the situation is different. Table 9 depicts the consumption coverage of own production of this group for sorghum, wheat and millet. Production has high coverage of, often exceeding consumption needs of these households whose numbers producing wheat and millet are nevertheless low.

Fourth, the above analysis is indicative for the presence of average household surpluses in some localities and deficits in others for the limited range of food and cash crops grown in the State. While this reflects a situation whereby most households (including farming ones) resort to the market for meeting their food demand, it directs attention to the issue of likely marketable surpluses.

Table 10: Contribution (%) of average own food production to consumption of grown crops – average of crop-producing households

| Locality | Sorghum | Wheat | Millet |
|---------------|------------------|-----------------|-----------------|
| Alsalam | 35 | | |
| Aldueim | 192 | 363 | |
| Algabalain | 48 | | |
| Kosti | 210 | 585 | 36 |
| Alquiteina | 128 | 323 | 186 |
| Rabak | 89 | 74 | |
| Tandalti | 218 | | 1583 |
| Umrinmta | 210 | 234 | |
| Total* | 153 (324) | 391 (30) | 166 (12) |

* Figures in brackets are the number of households producing the crop

Table 10 illustrates crop sales by household in season 2009/10 derived as averages for all sampled households. The most significant of these are sorghum sales, particularly in Tandalti, Kosti, Aldueim and Umrinmta that nevertheless denote modest levels ranging from an equivalent of about 6.5 to 12.6 sacks per household with an overall sample average of 6.4 sacks. Sales of other crops are rather weak; led by groundnuts and sesame in Tandalti and onion in Alquiteina. Depending on crop prices, such levels of sales would put many households at the margin for reliable food access. Yet, it is to be noted that farming households would be expected to have higher marketable surpluses on as apparent from the earlier comparison (Tables 8 and 9). According to the estimates from the survey, and with an average family size from the survey of 7.89, the likely total marketable surplus from cereals at the state level would amount to about 162,425 tons from an estimated total production of about 251,000 tons; a share of 65%. Given the annual variations in production and associated patterns of surpluses and deficits, the figures lie well within those reported at the national level (refer to Section 2.7).

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Table 11: Average crop sales (kg) per household by locality 2009/10

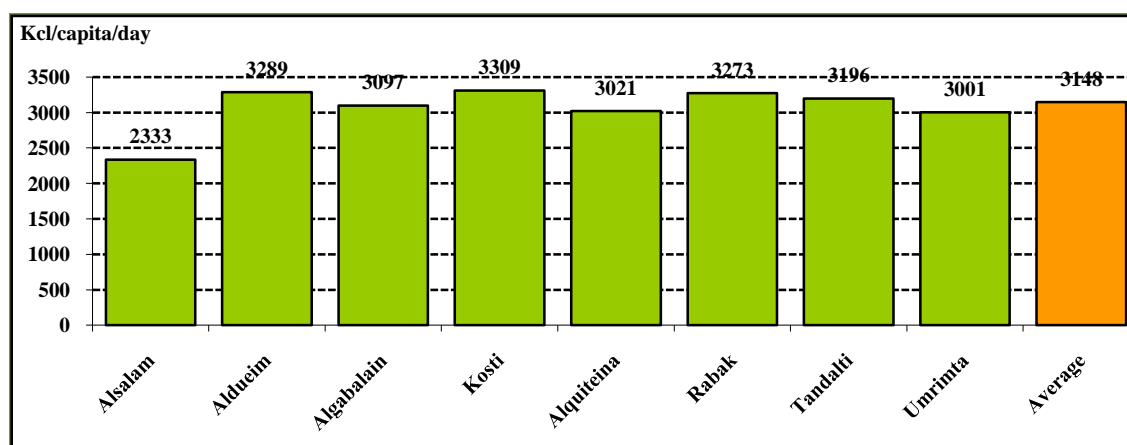
| Locality | Alsalam | Aldueim | Algabalain | Kosti | Alquiteina | Rabak | Tandalti | Umrimita | Total* |
|-----------|---------|---------|------------|-------|------------|-------|----------|----------|-----------|
| Sorghum | 132 | 830 | 266 | 1196 | 135 | 109 | 1256 | 653 | 636 (62) |
| Wheat | 0 | 178 | 9 | 202 | 72 | 0 | 0 | 143 | 98 (68) |
| Millet | 0 | 0 | 23 | 0.7 | 7 | 22 | 6 | 5 | 7 (58) |
| Cotton | 0 | 0 | 62 | 0 | 0 | 0 | 0 | 0 | 6 (100) |
| Sesame | 4 | 4 | 28 | 67 | 0 | 0 | 175 | 0 | 34 (94) |
| Groundnut | 5 | 14 | 0 | 28 | 0 | 0 | 182 | 7 | 25 (86) |
| Okra | 0 | 0 | 0 | 0.2 | 18 | 47 | 0.6 | 9 | 10 (95) |
| Karkadeh | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0.4 (100) |
| Onion | 0 | 0 | 14 | 0 | 124 | 0 | 0 | 85 | 25 (99) |
| Tomato | 0 | 0 | 0.6 | 0 | 35 | 0 | 0 | 45 | 8 (96) |
| Cowpea | 0 | 0 | 0 | 2 | 0 | 0 | 5 | 0 | 1 (79) |

* Italic figures in brackets are percent sales out of production.

3.4 Nutritional Security

Nutritional food security is considered in terms of dietary energy intake measured in calories per person per day. This is derived by multiplying the range of foods consumed by the households by the calorie content of each, then generating per capita energy intake as compared with the minimum dietary energy requirements taken here as 2100 Kcal/person/day, which is a widely accepted norm (see for example FAO 2009). The average dietary energy consumption by locality shown by Fig. 7 reveals calorie intake higher than the minimum requirements in all localities in spite of the somehow closer level in Alsalam. This means that households are on average nutritionally secure in spite of some observed exaggeration of some of the households in reporting their periodic consumption of various foods. But disaggregating by food security level, the situation is different.

Figure 7: Average energy intake by locality (Kcal/capita/day)



While Fig. 7 shows average per capita dietary energy intake for all households in each locality, it becomes important to differentiate between the nutritionally secure and

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nutritionally deprived population. According to the procedure shown in the methodology part, Table 11 depicts the status of nutritional insecurity with its three dimensions: incidence, severity and depth. The second column shows the average dietary energy intake for the nutritionally food-insecure population while the third column shows their percentage, i.e., the number of the nutritionally insecure defined by those who have a calorie intake of less than 2100 Kcal as a ratio of total population (incidence of nutritional food-insecurity or food-deprivation). Then singling out the food-deprived group analysis is made to derive the depth, severity and the related inequality index (Gini coefficient) of their nutritional situation depicted in the last three columns. The nutritional depth refers to the nutritional gap to the minimum dietary energy requirements, while the severity reflects the level of inequality among the poor. Both indicators, as well as the Gini coefficient have a range from zero to one, where higher ratios mean higher depth and inequality.

From the table, the incidence of food deprivation is generally considerable, but is more acute in Alsalam locality and notable in Rabak, Aldueim and Umrimta. Yet Kosti, Alquiteina and Tandalti accommodate comparable percentages of food-insecure, while Algabalain is somehow in a better position. On average, 36% of the State's rural population is subject to food deprivation, ranging from 25% to 68% in different localities. However, neither depth nor severity is high, except for Alsalam locality. The low G-term means that the nutritionally insecure are fairly equal in their nutritional level. This means that the nutritionally insecure are largely similar in their level of deprivation; with the implication that policies to reduce inequity would apply to all.

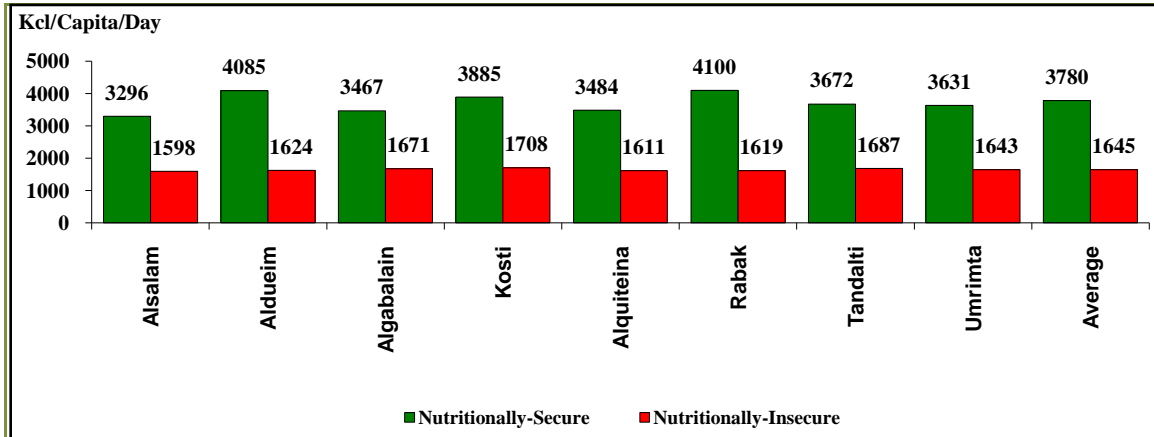
Table 12: Nutritional security indicators by locality in the White Nile State

| Locality | Average Kcal/capita/day of Food-Deprived | Incidence (%) | Depth (%) | Severity (%) | G (%) |
|----------------|--|------------------|--------------|-----------------|-----------|
| Alsalam | 1598 | 68 | 16 | 21 | 10.3 |
| Rabak | 1619 | 42 | 10 | 13 | 10.5 |
| Umrimta | 1643 | 37 | 8 | 11 | 12.6 |
| Aldueim | 1624 | 36 | 8 | 11 | 10.4 |
| Tandalti | 1687 | 35 | 7 | 9 | 9.5 |
| Kosti | 1708 | 32 | 6 | 9 | 8.5 |
| Alquiteina | 1611 | 31 | 7 | 10 | 9 |
| Algabalain | 1671 | 25 | 5 | 6 | 5.2 |
| Average | 1642 | 36 | 8 | 11 | 10 |

Comparison of the nutritionally-secure and nutritionally-insecure groups with respect to their average energy intake is shown in Fig. 8, which is a disaggregation of the overall average nutritional status displayed in Fig. 7 for food-secure and food-deprived population. The figure is indicative of the substantial differences between the two groups. Taking into consideration the likely exaggerated figures of the nutritionally food-secure, differences are enormous with an overall average gap of over 2100 Kcal indicating 50% more energy intake by the nutritionally-secure population. On the other hand, compared with the stated minimum dietary energy requirements, the gap of deprivation, defined as difference between the average dietary energy intake of an undernourished population and its average minimum energy requirement (see FAO 2010), ranges between 392 and 502 kcal per capita per day.

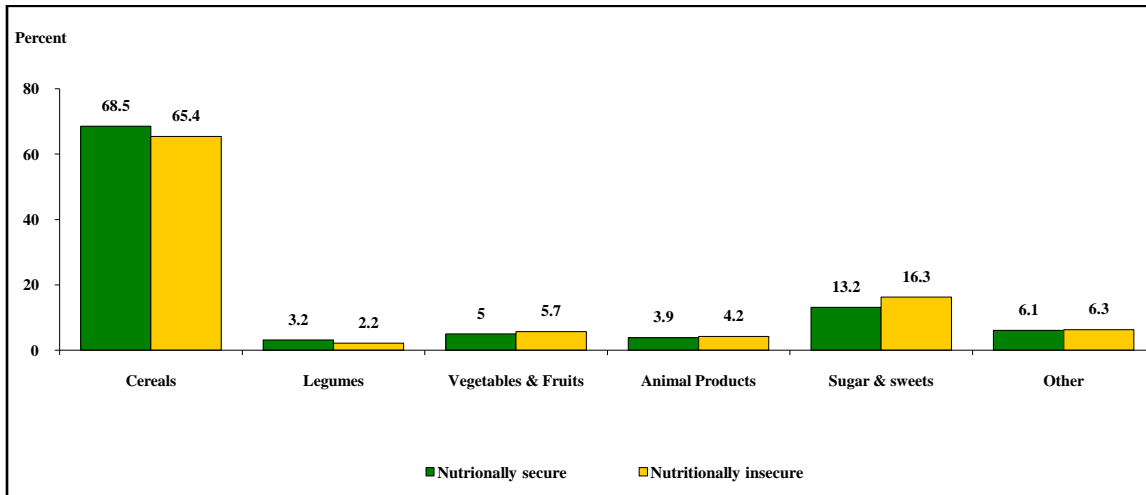
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Figure 8: Average energy intake of food-secure and food-deprived population by locality



Despite the big differences in the energy intake between the two groups, the contribution of different food sources to the total energy intake is quite similar (Fig. 9). This means that there are hardly any food quality differences and all population generally consumes the same types of food. Accordingly, interventions to improve the nutritional situation might be directed to the quantity issue, with due consideration to quality as indicated earlier by the low intake of high-quality sources of energy such as those supplying plant and animal proteins and those rich in vitamins of plant origin.

Figure 9: Distribution of energy sources of nutritionally secure and insecure population (%)



The energy sources from different food groups portrayed in Table 12 show that cereals account for the bulk of calorie intake with fairly similar contributions. This is in congruent with the weight of cereals in per capita consumed quantities presented earlier. Sugar and sweets form the second important source. The calorie intake from either of legumes, vegetables and fruits, or animal products is quite low, suggesting dietary imbalances.

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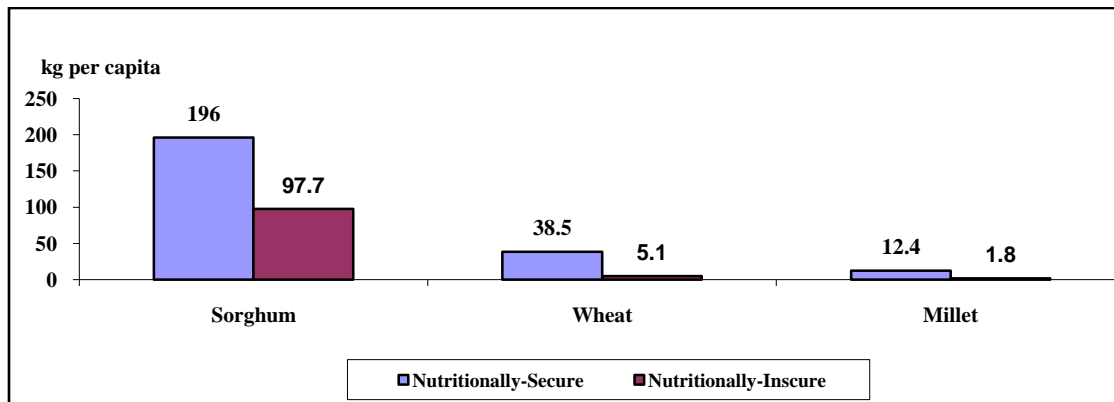
Table 13: Contribution of food groups* to energy intake by locality (%)

| Locality | Cereals | Legumes | Vegetables & Fruits | Animal Products | Sugar & Sweets | Other | Total |
|--------------|-------------|------------|---------------------|-----------------|----------------|------------|------------|
| Alsalam | 67.9 | 2.9 | 5.2 | 2.5 | 14.1 | 7.5 | 100 |
| Aldueim | 69.7 | 2.3 | 5.1 | 5.7 | 16.7 | 0.6 | 100 |
| Algabalain | 72.3 | 2.6 | 4.0 | 3.5 | 12.1 | 6.4 | 100 |
| Kosti | 66.2 | 5.4 | 4.8 | 2.2 | 12.2 | 9.2 | 100 |
| Alquiteina | 63.6 | 2.4 | 5.9 | 4.8 | 14.1 | 9.2 | 100 |
| Rabak | 70.7 | 2.4 | 4.6 | 3.3 | 12.6 | 6.4 | 100 |
| Tandalti | 67.2 | 2.0 | 6.5 | 3.3 | 13.9 | 7.2 | 100 |
| Umrimita | 67.9 | 3.1 | 5.7 | 8.1 | 14.9 | 0.3 | 100 |
| Total | 68.0 | 3.1 | 5.1 | 4.0 | 13.7 | 6.2 | 100 |

* Food items in each group are as given in Table 4.

Along with the consideration of energy intake, it is relevant to compare the nutritionally secure and insecure population according to their total consumption of the three cereal foods (sorghum, millet and wheat), which is indicative of the status of food security. This is shown by Fig. 10, which reveals a rather similar and fragile food security for the nutritionally insecure population and a rather extravagant consumption of the nutritionally food secure. It confirms the statement mentioned above that food access is the major factor contributing to food insecurity.

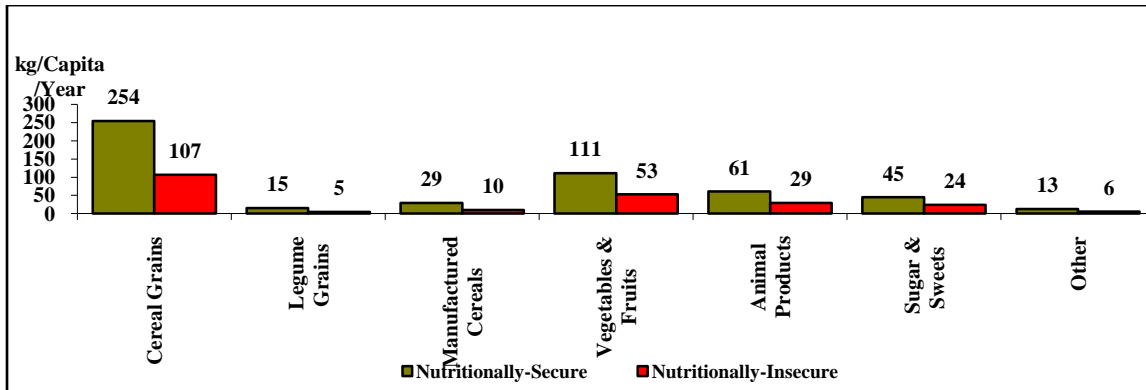
Figure 10: Per capita consumption of main cereal crops



Another indicator for the disparity between the food secure and food deprived is annual per capita consumption of different food groups illustrated by Fig. 11. Big gaps are evident where consumption of different food groups by the deprived population forms percentages ranging from 29% to 53% of the food consumed by the food secure population (see details of consumed food items in Appendix 8).

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Figure 11: Average consumption of different food groups by Nutritionally-secure and nutritionally-insecure population



3.5 Food security correlates

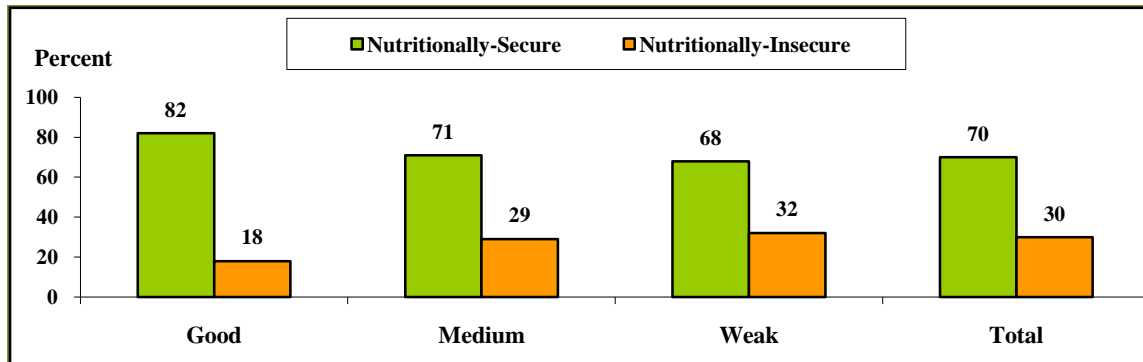
Consideration of a number of factors that might be associated with the food security status of households would provide insight as to the types of interventions for improvement. The range of such food security correlates comprise awareness about one’s food security status, occupation of the household head, crop production levels, crop productivity, marketable surpluses, household incomes, dependency, and sex of the household head.

3.5.1 Awareness about food security

Awareness of about one’s own food security situation can form an important drive for changing a negative status. Household heads were requested to evaluate their own food security condition by rating it as good, medium or weak. Relating their responses to their categorization as food-secure or food-deprived provides a useful indicator to their level of self awareness. This is presented in Figure 12 where 82% of those who mentioned that their food security situation is good and 68% of those reporting weak food security are in fact nutritionally-secure. The medium case is in-between and has high match if we consider that medium is close to a food-secure situation. On the other hand, 18% and 29% reporting good and medium food security, respectively are actually food-insecure. This indicates that an appreciable percentage of the food-deprived have no proper objective valuation of their situation, which might partially be attributed to religious and social considerations that might hinder declaration of a negative situation.

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Figure 12: Relationship between households' ratings of their food security condition and computed food security status



3.5.2 Deprivation by household-head occupation

One correlate of the food security status is the occupation of the household head. In the analysis, household heads are aggregated according to the frequency of occurrence of their main occupation. The high majority of such occupations are farmers (63%) and wage and skilled labor (24%). A diversity of other occupations dominated by traders including few pastoralists, fishermen, unemployed and housewives are grouped together due to their small frequencies (12%). The average dietary intake shown in Table 13 places farmers in a middle rank: with higher energy intake than the labor group but lower than those having other occupations. Yet, the difference between the farmers' and labor' averages are not significant.

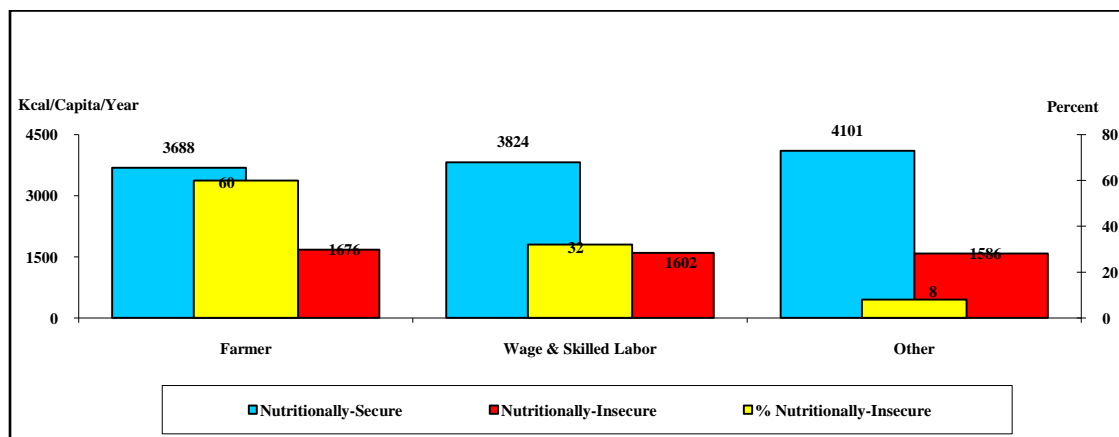
Table 14: Average energy intake per capita per day by household's head occupation and their frequency

| Household Occupation | Energy Intake (Kcal) | Households' Frequency | |
|----------------------|----------------------|-----------------------|-------------|
| | | Number | Percent |
| Farmer | 3127 | 384 | 63% |
| Wage & Skilled Labor | 2962 | 147 | 24% |
| Other | 3626 | 74 | 12% |
| All | 3148 | 605 | 100% |

On the other hand, the above-sated average dietary figures hide substantial differences revealed by Fig. 13 which differentiates between the food-secure and food-deprived for each type of occupation and provides the frequency of population for the nutritionally insecure in each occupation (the yellow bars). Within each type of occupation, food deprivation is evident with enormous average gaps. However, the frequencies of deprived households within each occupation are largely dissimilar. This is depicted in Table 14 (see more details in Appendix 9); classifying the food-deprived households with respect to the type of household-head's occupation in each locality.

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Figure 13: Average energy intake by occupation for food-secure and food-deprived



In most of locations, the majority of the food-deprived are farmers with predominant occurrence in Alsalam, Algabalain, Kosti and Tandalti. Food deprivation for wage and skilled labor are of particular significance in Alquiteina, Rabak, Umrimita and Aldueim while deprived households engaged in other jobs are of concern in Elquiteina, although food deprivation there is anyway quite low. All these results are indispensable for policies appropriate for geographical and occupational food-security targeting.

Table 15: Distribution (%) of the food-deprived by occupation by locality

| Locality | Farmer | Wage and Skilled labor | Other | Total |
|--------------|-----------|------------------------|----------|------------|
| Alsalam | 86 | 14 | | 100 |
| Aldueim | 42 | 39 | 18 | 100 |
| Algabalain | 85 | 15 | | 100 |
| Kosti | 81 | 19 | | 100 |
| Alquiteina | 10 | 52 | 38 | 100 |
| Rabak | 52 | 48 | | 100 |
| Tandalti | 100 | | | 100 |
| Umrimita | 38 | 54 | 8 | 100 |
| Total | 60 | 32 | 8 | 100 |

3.5.3 Household crop production and agricultural areas

Food deprivation is also most likely associated with home production of food and cash crops; the former assures food availability and the latter enables food access. Production levels are also partly dependent on the areas under these crops. Comparison of the nutritionally-secure and insecure farming households with respect to their average per capita household production and crop areas (see Appendix 10) illustrates that the latter group of households encounter limited home-produced foods and low production of cash crops in relation to their family sizes on account of the limited grown areas. Their total home-available cereals

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amounts to an average of 89.3 kg/capita/year compared with 170.5 kg for the nutritionally-secure population. A similar situation is revealed by other studies such as WFP (2007) whereby own food production in the State lasts for only six months and three months are considered a hunger season. Notable are the meager produced quantities of cash crops; a situation that is expected to have a negative effect on food access. One factor contributing to poor production is the areas grown; the other one is crop yields. The figures indicate that the smaller areas available to the food-deprived; which are indicative for low land access could be responsible for their low per capita production.

Considering average per capita grown areas by locality, big but variable gaps exist between the nutritionally-secure and insecure households where the former have an average over all localities of 3.7 feddans compared to 2.3 feddans for the latter, indicating a difference of 62% at the state level (see Appendix 11). Further, comparison of owned farm area and actually grown area in 2009/10 provides more insight into the agricultural situation as a factor related to nutritional-insecurity. This is exemplified in Table 15 in which the ratios of land ownership of nutritionally-insecure and secure households are presented by locality along with a comparison between the two groups with respect to the ratios of grown to owned area. Total land areas of the food-deprived represent fractions of that owned by the food-secure ranging from 0.38 to 0.84 and averaging 0.62 indicating significantly low land access to the latter group. Along with the relatively small areas under crops for the food-deprived farming households, these areas represented modest fractions of their owned areas in season 2009/10 and were mostly lower than the grown-to-owned areas by the food-secure (Table 15). The ratios exceeding unity are due to land hire, mainly in the rain-fed mechanized schemes that however hardly produced any significant harvest in that season. The whole state of affairs reflects that, while land access is relatively limited for the food-deprived, poor capabilities hinder full utilization of the available land.

Table 16: Ratios of per capita agricultural land for food-secure and food-deprived farm households

| Locality | Agric. Land Ratio of Food- deprived to Food-secure | Ratio of Grown to Owned land | | |
|--------------|---|------------------------------|---------------|-------------|
| | | Food-Secure | Food-Deprived | All |
| Alsalam | 0.46 | 0.68 | 0.67 | 0.67 |
| Aldueim | 0.42 | 0.83 | 0.83 | 0.83 |
| Algabalain | 0.84 | 0.61 | 0.48 | 0.58 |
| Kosti | 0.58 | 2.49 | 0.95 | 2.35 |
| Alquiteina | 0.74 | 0.60 | 2.10 | 0.65 |
| Rabak | 0.63 | 2.48 | 2.14 | 2.69 |
| Tandalti | 0.38 | 2.30 | 0.97 | 2.21 |
| Umrmta | 0.54 | 2.48 | 0.65 | 2.00 |
| Total | 0.62 | 2.21 | 2.00 | 2.15 |

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3.5.4 Crop yields

Beside cultivated areas, a variable influencing production level of crops is obviously land productivity. Generally, low productivity is evident from Table 16. Given a considerable variation, overall yields per feddan are merely 131 kg for sorghum and 431 kg for wheat, while those of millet and sesame are miserable. Per unit area harvests of all other crops are unsatisfactorily small including cotton, groundnut and vegetables that along with sesame should be supportive for food access. But it is to be borne in mind that the frequency of cultivation of these crops is also limited (refer to Table 6). Although the stated low productivity in the State could be typical for the poor agricultural performance in the whole country (SIFSIA 2010), recurrence of similar conditions are not uncommon; jeopardizing food security. Recalling that Alsalam and, to a lesser extent, Rabak have high food-deprivation incidences, this might logically be related to the low productivity there as well as to the narrow range of crops grown.

Table 17: Average crop yields (kg/fed) of farming households by locality, 2009/10*

| Locality | Alsalam | Aldueim | Algabalain | Kosti | Alquiteina | Rabak | Tandalti | Umrimta | Average |
|---------------------|---------|---------|------------|-------|------------|-------|----------|---------|---------|
| Sorghum (irrigated) | | 499 | 165 | 271 | 205 | 205 | | 377 | 311 |
| Sorghum (Rain-fed) | 49 | 139 | 57 | 49 | 72 | 26 | 127 | 124 | 71 |
| Wheat | | 510 | 252 | 415 | 376 | 48 | | 450 | 414 |
| Millet | | 38 | 95 | 7 | 49 | 5 | 190 | 38 | 27 |
| Cotton | | | 191 | | | | | | 191 |
| Sesame | 24 | 40 | 44 | 33 | | 0 | 44 | | 34 |
| Groundnut | 98 | 0 | | 26 | | | 187 | 54 | 87 |
| Okra | 13 | | | 5 | 117 | 439 | 45 | 41 | 101 |
| Karkadeh | | | | | | | 64 | | 64 |
| Onion | | | 560 | | 3500 | | | 700 | 1330 |
| Tomato | | | 20 | | 1000 | | | 138 | 287 |
| Cowpea | | | | 39 | | | 165 | | 86 |

* Blank cells mean that the crop is not grown.

Comparison of crop productivity between food-secure and food-deprived population produced mixed results (Table 17). Three of the highly-frequent grown crops mostly produced lower yields for the food-deprived, namely rain-fed sorghum, wheat and sesame although gaps are small except for wheat. However, the groundnut average for the food-insecure exceeds that for the food-deprived.

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Table 18: Average crop yields (kg/fed)* of farm households by poverty status, 2009/10

| Crop | Food-Secure | Food-Deprived | All |
|-------------------|-------------|---------------|----------|
| Sorghum Irrigated | 292 (70) | 366 (25) | 311 (95) |
| Sorghum Rain-fed | 73 (241) | 64 (98) | 71 (339) |
| Wheat | 456 (24) | 331 (6) | 431 (30) |
| Millet | 24 (22) | 24 (11) | 24 (33) |
| Cotton | 164 (5) | 324 (1) | 191 (6) |
| Sesame | 34 (65) | 31 (21) | 33 (86) |
| Groundnut | 80 (37) | 128 (10) | 90 (47) |
| Okra | 90 (19) | 115 (8) | 97 (27) |
| Karkadeh | 64 (2) | | 64 (2) |
| Onion | 1330 (4) | 1750 (1) | 1414 (5) |
| Tomato | 287 (5) | | 287 (5) |
| Cowpea | 47 (7) | 360 (1) | 86 (8) |

* Italic figures in parenthesis are the number of households growing the crop.

Other crops have lower yields for the food-secure but their extent of cultivation is small, while karkadeh and tomato production is confined to the food-secure. It can therefore be said that the small grown areas, supported by a general tendency for lower yields of major agricultural activities of the food-deprived, is one important cause of a likely frequent low per capita production that in turn contributes to food deprivation.

3.5.5 Crop sales by deprivation status

Given sales of almost all produce of the predominantly cash crops (crops other than cereals) (see Table 10), per capita sales of cereals are disaggregated according to the nutritional security status of their producers (Table 18). While the portions of sales out of production are almost similar for the food-secure and food-deprived, the actual marketed amounts are trivial for the latter group relative to the former. Such meager crop sales, which are also associated with low production, are both a result and a cause of food-deprivation linked to poor food access.

Table 19: Per capita production and sales of food grains by growers of each crop, 2009/10

| Crop | Item | Food-Secure | Food-deprived | All |
|---------|------------------------------------|-------------|---------------|------------|
| Sorghum | Per capita production (kg) | 187 | 113 | 166 |
| | Per capita sales (kg) | 112 | 63 | 98 |
| | <i>Percent sales to production</i> | <i>60%</i> | <i>55%</i> | <i>59%</i> |
| Wheat | Per capita production (kg) | 415 | 101 | 354 |
| | Per capita sales (kg) | 336 | 92 | 289 |
| | <i>Percent sales to production</i> | <i>81%</i> | <i>91%</i> | <i>82%</i> |
| Millet | Per capita production (kg) | 35 | 6 | 25 |
| | Per capita sales (kg) | 21 | 1 | 14 |
| | <i>Percent sales to production</i> | <i>60%</i> | <i>9%</i> | <i>56%</i> |

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3.5.6 Household incomes

Income is a major determinant of food security. Household incomes are computed from the survey data as comprising returns from: a) crop and crop residue; b) value of home-consumed farm products; c) sales of livestock and livestock products; d) incomes from activities of all family members including household-heads' off-farm activities; e) remittances income; and f) household savings and received credit. Data on each of these items is collected according to its period of occurrence and then converted to annual income from which per capita income is computed with reference to family size. Overall, per capita income of food secure households is more than two folds of that of insecure households (Table 19).

Table 20: Average per capita annual income by locality and food security status (SDG)

| Locality | Food secure | Food insecure | Total |
|--------------|-------------|---------------|------------|
| Alsalam | 736 | 415 | 554 |
| Aldueim | 2818 | 523 | 2075 |
| Algabalain | 405 | 283 | 380 |
| Kosti | 954 | 404 | 809 |
| Alquiteina | 1110 | 949 | 1070 |
| Rabak | 381 | 361 | 374 |
| Tandalti | 1504 | 540 | 1273 |
| Umrimita | 1172 | 439 | 934 |
| Total | 1192 | 487 | 983 |

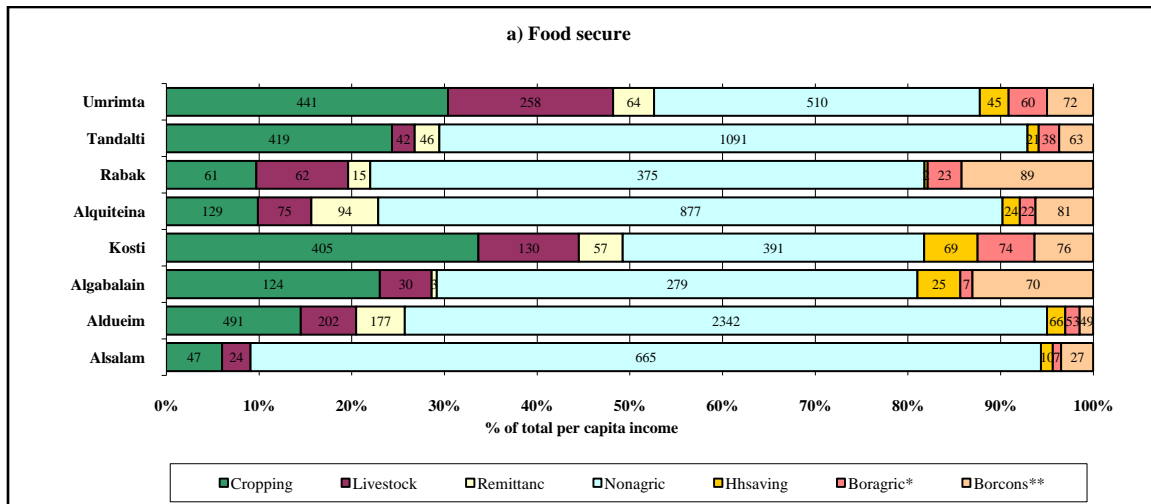
Algabalain has the lowest per capita income among food insecure group followed by Rabak. Annual per capita income was highest in Alquiteina for both secure and insecure households. Per capita income for the food insecure households in Alquiteina surpassed that of the food secure in Algabalain, Alsalam and Rabak localities. Again per capita income for the food insecure in Tandalti is greater than that of the food secure in Algabalain and Rabak locality. Apparently the higher income is not utilized to alleviate food insecurity or otherwise not evenly distributed among household members.

Households in the different localities of the White Nile State derive their income from various sources to meet their livelihood requirements. Per capita income from agriculture (including crops and livestock) represent less than half of the total annual per capita households' income for both secure and insecure families in all localities (Figure 14). The contribution of agriculture to total per capita income is extremely low in Alsalam for both secure and insecure households (less than 10% and slightly more than 10%). The share of livestock in agriculture per capita income is substantial in Alquiteina compared to crops for the food insecure, but per capita income from crops is much higher than that of livestock in

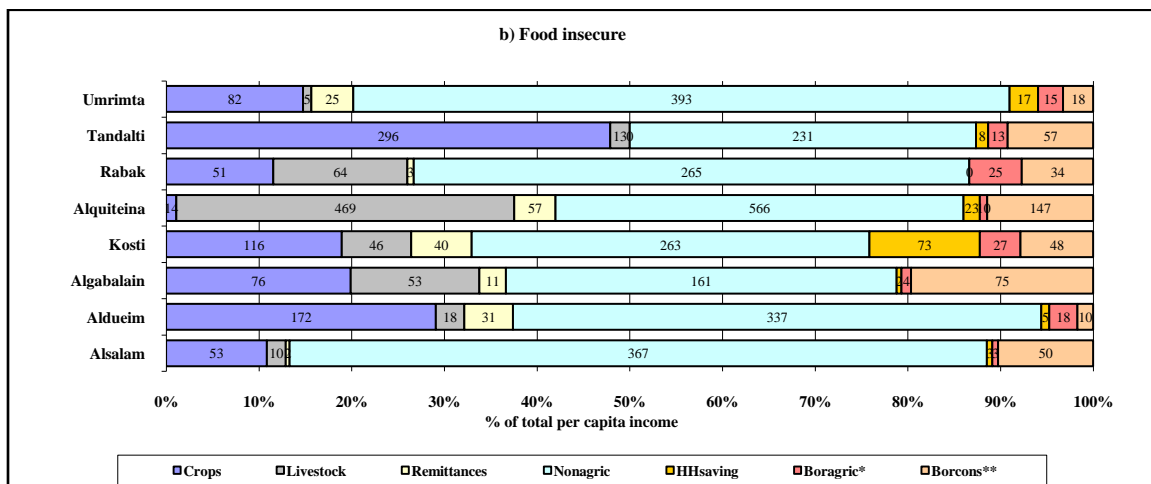
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Tandalti. For both secure and insecure households, non-agricultural activities represented an important source of income accounting for more than 80% of total annual per capita income for the food secure and more than 70% for the food insecure in Asslam locality. High dependence on non-agricultural income is also reported by FAO/WFP (2007) stating that agriculture forms the second most important livelihood activity in the State, being preceded by other activities.

Figure 14: Per capita annual income (SDG) by source for food-secure and food-deprived households



* Borrowing for agriculture; ** Borrowing for consumption

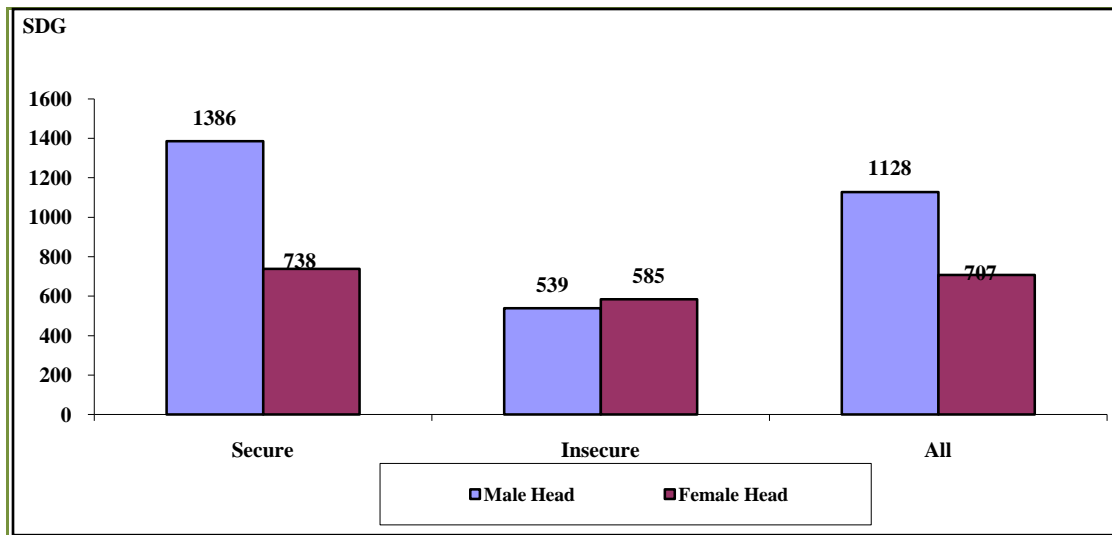


* Borrowing for agriculture; ** Borrowing for consumption

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Figure 15 indicates that per capita annual income for male headed households is higher than that of female headed households by about 37%. It is greater by about 47% of food secure households, but female headed households have per capita income that is higher by about 9% than male headed households among the food insecure households.

Figure 15: Per capita income by gender of household head



3.5.7 Dependency

The food-security situation is further analyzed with respect to the level of dependency among members of the households. This is performed at two levels: the first considers dependents as those unemployed who are capable of work among the family working force, i.e. excluding schooling members and children who are not yet eligible for schooling (refer to Table 20). The second is based on age where dependents are identified as those who are below 18 and over 60 years of age. The table presents averages of percent dependents relative to total household members for food-secure and food-deprived under each of the two dependency assumptions. Dependency within food-deprived households is consistently higher than within food-secure households under the two dependency assumptions and in all localities, except for the single case of dependency according to age in Alquiteina. On average, the dependency ratio is about 52% for the food-insecure population compared to about 45% under 'age-related' dependency and 80% compared to 74% under 'unemployment dependency'. The figures reveal that dependency ratios are positively associated with food deprivation.

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Table 21: Dependency levels (%) under two assumptions for food-secure and food-deprived population according to locality

| Locality | Dependency According to Age | | Dependency According to Unemployment | |
|--------------|-----------------------------|---------------|--------------------------------------|---------------|
| | Food-Secure | Food-Deprived | Food-Secure | Food-Deprived |
| Alsalam | 42.9 | 47.6 | 63.5 | 69.8 |
| Aldueim | 38.7 | 52.4 | 74.4 | 78.4 |
| Algabalain | 43.3 | 52.8 | 76.6 | 83.3 |
| Kosti | 46.1 | 49.2 | 68.5 | 79.5 |
| Alquiteina | 50.0 | 47.0 | 77.7 | 78.9 |
| Rabak | 49.5 | 58.0 | 77.3 | 89.8 |
| Tandalti | 40.9 | 62.9 | 57.5 | 75.0 |
| Umrimta | 42.3 | 45.5 | 74.3 | 80.2 |
| Total | 44.7 | 52.4 | 72.2 | 79.8 |

The above results are further verified by regression analysis with calorie intake as a dependent variable and percent dependent population and an independent variable shown by Table 21. Under both assumptions of dependency according to age and according to employment status, regression coefficients are negative and significant indicating that as dependency ratio increases, the nutritional status deteriorates.

Table 22: Regression results of calorie intake with dependents as % of family size

a) Percent dependents according to age

| | B | Std. Error | t | Sig. |
|--------------------|-------|------------|-------|------|
| Constant | 3584 | 193 | 18.54 | .000 |
| Percent dependents | -9.74 | 3.81 | -2.56 | .011 |

b) Percent dependents according to unemployment

| | B | Std. Error | t | Sig. |
|--------------------|--------|------------|-------|------|
| Constant | 4500 | 321 | 14.01 | .000 |
| Percent dependents | -18.82 | 4.29 | -4.39 | .000 |

3.5.8 Household Sex

Analysis of the household-head sex as a food-security correlate brought results that deviated from the expectation that female-headed households are more food-deprived than the male-headed ones. Taking into consideration that female-headed households were only 8% of the total sampled households, Table 22 depicts that the per capita calorie intake within this group is by far higher than that of male-headed households. Food deprivation is prevalent in only six out of the 47 female-headed households in the sample, or 13%.

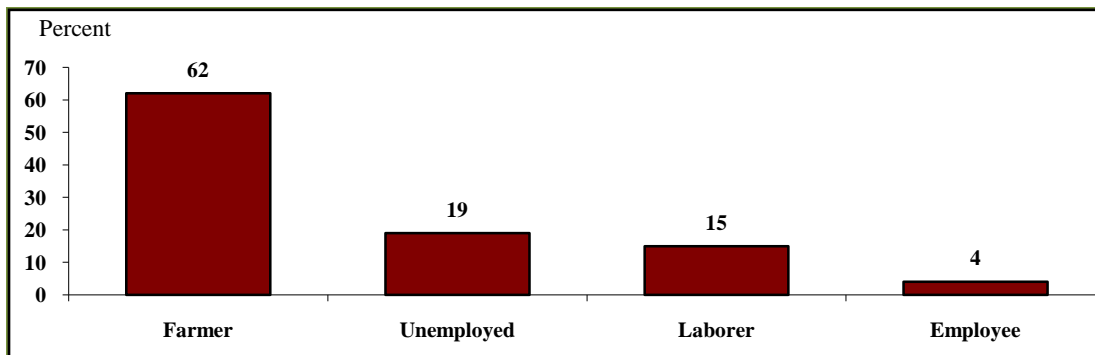
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Table 23: Average calories per person per day by sex of household head

| Sex of Household Head | Kcal/Capita/Day | Number of Households |
|-----------------------|-----------------|----------------------|
| Female | 4184 | 47 |
| Male | 3061 | 558 |
| Total | 3148 | 605 |

The absence of evidence of overall food deprivation among female-headed households is supported by the fact that the majority of them are engaged in some type of income-earning activity (Fig. 16). Only 19% of them are unemployed or assuming mere housewife functions while the majority (81%) is engaged in farming and some are laborers or employees. Obviously also, food security for female-headed households is influenced by the nature of engagement of other family members. On the other hand, the dependency ratio within these households that averages 39% is lower than that within the male-headed households of 49%; a situation that, in light of earlier results related to the dependency correlate, gives advantage of the former over the latter group. In fact, most of the female-headed households are reported in Alsalam (24%) and Tandalti where women engagement in agriculture is high.

Figure 16: Employment status of female-headed households



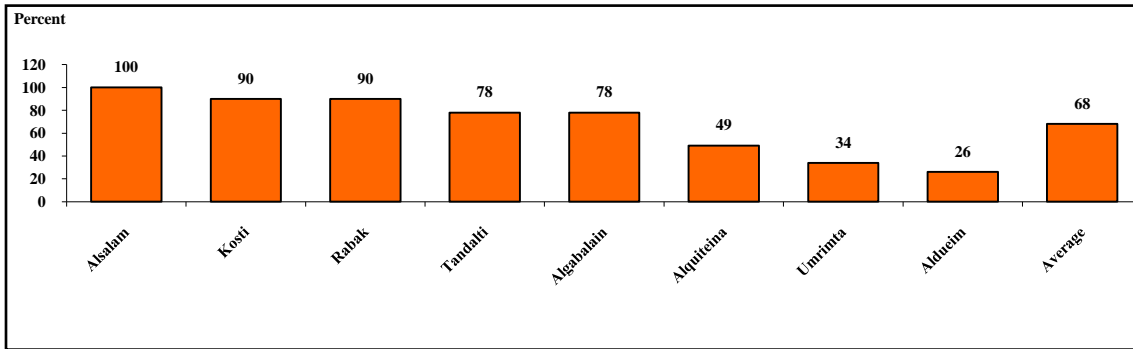
3.6 Food crisis and coping strategies

3.6.1 Risks and coping strategies

Respondents are asked about whether they faced food crisis that jeopardized their livelihoods over the past five years and what types of coping mechanisms they have followed in dealing with such a crisis. Responses provide evidence for the prevalence of food crisis for most households in most localities (Fig. 17). With an average of 68%, risks of food crisis are substantial. They are, however, ubiquitous in Alsalam, Kosti and Rabak, rather common in Tandalti and Algalabain and modest to low in Alquiteina, Umrimta and Aldueim. For comparison, the 2006 ANA survey (WFP 2006) reveals that 89% of assessed households reported experiencing some sort of shocks to food security in 2005.

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Figure 17: Percent of households facing food crisis over the past five years by locality



Frequency of occurrence of food crises by locality and their major causes, which are confined to four causes given to the respondents are presented in Table 23. Drought and price surges are two main causes of common occurrence, as also recorded by WFP (2007) in the State as a whole. However as revealed by the analysis here, the former is more encountered in Aldueim, Algabalain, Kosti and Rabak, and the latter finds more complaints in Alsalam, Aldueim, Alquiteina and Rabak. Floods are of a relatively higher importance in Algabalain, Kosti and Tandalti, while conflict forms a minor cause of food crisis.

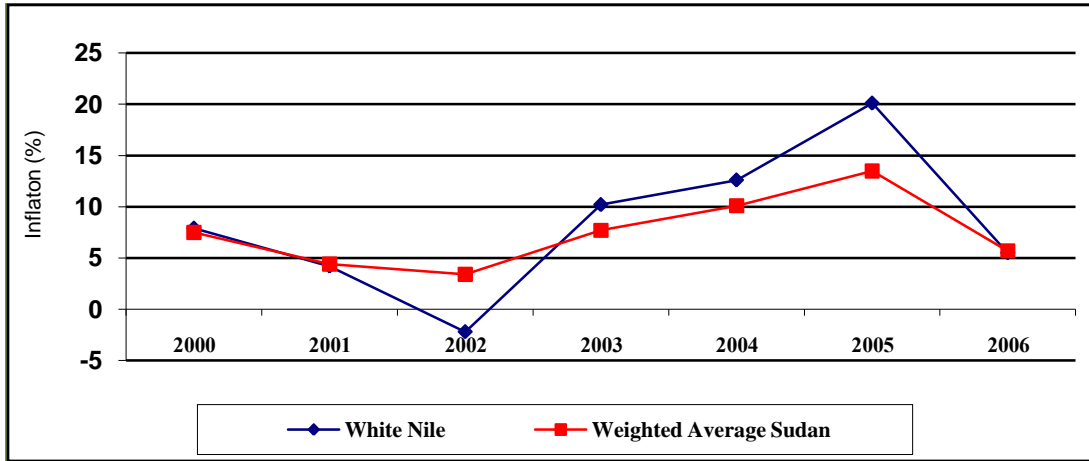
Table 24: Frequency of major causes of food crisis by locality

| Causes | Alsalam | Aldueim | Algabalain | Kosti | Alquiteina | Rabak | Tandalti | Umrimta |
|-----------------------------------|---------|---------|------------|-------|------------|-------|----------|---------|
| <i>Percent Occurrence</i> | | | | | | | | |
| Drought | 22.4 | 43.8 | 40.0 | 42.0 | 22.4 | 48.9 | 22.7 | 26.3 |
| Floods | 13.4 | | 25.6 | 32.2 | 2.7 | 5.8 | 36.4 | 22.1 |
| Price Rise | 49.3 | 43.8 | 32.2 | 25.6 | 43.1 | 45.3 | 30.3 | 32.6 |
| Conflict | | 3.1 | 2.1 | | 3.4 | | | |
| Other | 14.9 | 9.4 | 2.1 | 2.1 | 29.3 | | 10.6 | 22.1 |
| <i>Average Recurrence (Years)</i> | | | | | | | | |
| Drought | 2.53 | 2.29 | 2.81 | 2.18 | 2.31 | 2.65 | 2.53 | 2.00 |
| Floods | 2.22 | | 2.65 | 2.26 | 2.00 | 2.50 | 2.00 | 2.00 |
| Price Rise | 2.48 | 2.57 | 2.97 | 2.53 | 2.04 | 2.95 | 2.40 | 2.00 |
| Conflict | | 2.00 | 5.00 | | 2.00 | | | |
| Other | 2.00 | 2.67 | 3.00 | 2.00 | 2.24 | | 2.00 | 2.00 |

Price rises as a significant source of shocks goes in line with the relatively high inflation in the State (WFP 2007). Figure 18 traces inflation in the State compared to the Sudan's average. While in three out of the seven seasons similar inflation rates were reported, in another three seasons inflation was higher in the White Nile. This is likely to trigger serious risks in food access.

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Figure 18: Inflation in the White Nile compared to the national weighted average 2000-2006



Source: plotted from WFP (2007)

There are other various scattered causes mentioned by more respondents in Alquiteina. The occurrence (average years out of five) of the four designated causes indicate probabilities ranging in the majority of the situations from 20% to 50%. Such probabilities that reflect risks of food shortages are, except for drought, low for most causal agents in Alquiteina, Tandalti and Umrimta and indicate relatively higher risks in the remaining localities. The high temporal probability of conflict in Algabalain is obviously associated with very low presence among respondents, which means that a small part of the households faces risks of conflict all the time.

It is natural that household members try to mitigate the food shocks by various actions. According to WFP (2006), the main coping strategies in the face of these shocks in the State were eating less preferred food, eating fewer meals per day, going entire days without eating, purchasing food on credit, borrowing food from family members, and working for food only. In this study various but roughly similar coping strategies are reported and ranked by respondents to deal with food crisis. These are summarized in Table 24, which provides the number of respondents under each ranked coping strategy and an overall weighted average of these frequencies to provide a summary ranking of the coping options (see detailed coping strategies in Appendix 12). Borrowing and exerting more work are the most important coping strategies, which in addition to a sizably ranked resort to relatives and a low-ranked migration option, can be considered as income-generating strategies according to the classification by WFP (2007). On the other hand, reliance on own household resources as reflected by the strategy of selling animals, crops and assets is of a relatively low rank. Further, the remaining numerous options fall under the category of 'suffering the consequences of the shock' and are signaled by reducing the number of meals, shift to cheaper foods and the like.

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Table 25: Coping strategies during food crisis

| Item | Cope - 1* | Cope - 2* | Cope- 3* | Weighted Ranking** |
|-------------------------------|------------|------------|-----------|--------------------|
| Borrowing | 126 | 111 | 15 | 102.5 |
| More work | 141 | 74 | 17 | 98.0 |
| Reduce meals | 62 | 16 | 10 | 38.0 |
| Resort to relatives | 51 | 34 | 3 | 37.3 |
| Sell animals, crops & assets | 32 | 21 | 9 | 24.5 |
| Migrate | 16 | 8 | 4 | 12.3 |
| Shift to cheaper food | 12 | 12 | 2 | 10.3 |
| Consume less diversified food | 1 | 23 | | 8.2 |
| Adapt to situation | 7 | 8 | 5 | 7.0 |
| Reduce food amount | 4 | 3 | | 3.0 |
| Dispense with luxuries | 3 | 2 | | 2.2 |
| Other | 2 | 1 | | 2.3 |
| Total | 457 | 313 | 65 | 343.7 |

* Columns showing number of respondents ranking their coping strategies.

** Weighted averages derived by weighting the number of respondents by hypothetical weights of consecutive cropping strategies 1, 2 and 3 of 0.3, 0.2 and 0.2.

3.6.2 Households' asset base

The asset base of households derived as average number per capita for the food-secure and food-deprived groups is presented by Table 25 for all sampled households. Generally the asset base is weak matching its relatively rank in contributing to various coping strategies shown in the pervious table. It is however consistently lower for the food-deprived sector of households with regard to all types of assets, posing an element of vulnerability to shocks and calling for the need for enhancing capital formation.

Table 26: Average per capita levels (number) of main assets by food-security status

| Asset Type | Food-Secure | Food-Deprived | All |
|-----------------|-------------|---------------|------|
| Land Area (Fed) | 3.54 | 2.19 | 3.08 |
| Livestock (TLU) | 2.89 | 2.96 | 2.39 |
| Poultry | 0.71 | 0.48 | 0.59 |
| Tractors | 0.14 | 0.11 | 0.13 |
| Plough | 0.30 | 0.23 | 0.29 |
| Water Pumps | 0.14 | 0.11 | 0.13 |
| Water Tank | 0.14 | 0.10 | 0.13 |
| Cars | 0.15 | 0.11 | 0.14 |
| Flour Mills | 0.14 | 0.10 | 0.13 |
| Carts | 0.14 | 0.10 | 0.13 |
| Appliances | 0.42 | 0.31 | 0.38 |
| Buildings | 0.14 | 0.10 | 0.13 |

The asset weak base is further illustrated by the value per capita value of assets in the different localities (Table 26). Average asset values for the food-deprived are meager in

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Alsalam and Umrimta, low in Algabalain, Tandalti and Rabak, and modest in the remaining localities. They can be calculated to represent only about 33% of that of the food-secure at the average level. Overall per capita value of material assets for food secure households is higher by 67% compared to insecure households. However there are considerable variations across localities in each group. Duiem has the highest value of per capita assets for the secure group. This is may be explained by the great number of animal wealth owned by households as well as by ownership of vehicles and animal carts. Umrimta and Asslam localities have the lowest per capita value of assets among insecure households. The per capita value of assets in each of these two localities is almost about one quarter of the average per capita value of insecure households across all localities.

Table 27: Average per capita value of assets (SDG) by locality and food security status

| Locality | Food-Secure | Food-Deprived | All |
|----------------|-------------|---------------|------------|
| Alsalam | 271 | 88 | 167 |
| Aldueim | 2518 | 173 | 1759 |
| Algabalain | 668 | 199 | 571 |
| Kosti | 765 | 588 | 719 |
| Alquiteina | 662 | 586 | 643 |
| Rabak | 344 | 254 | 314 |
| Tandalti | 810 | 240 | 673 |
| Umrimta | 576 | 81 | 419 |
| Average | 938 | 309 | 752 |

The relative contribution of livestock to total per capita value of assets accounts for about 59% and 44% for the food secure and food insecure groups respectively (Table 27), reflecting the importance of animals in the livelihood of farmers in the White Nile State. Amongst the food insecure, contribution of livestock to total per capita value of assets ranges from as high as 95% in Asslam and Algabalain to as low as 22% in Tandalti.

Table 28: Percent contribution of per capita value of livestock to total per capita value of assets

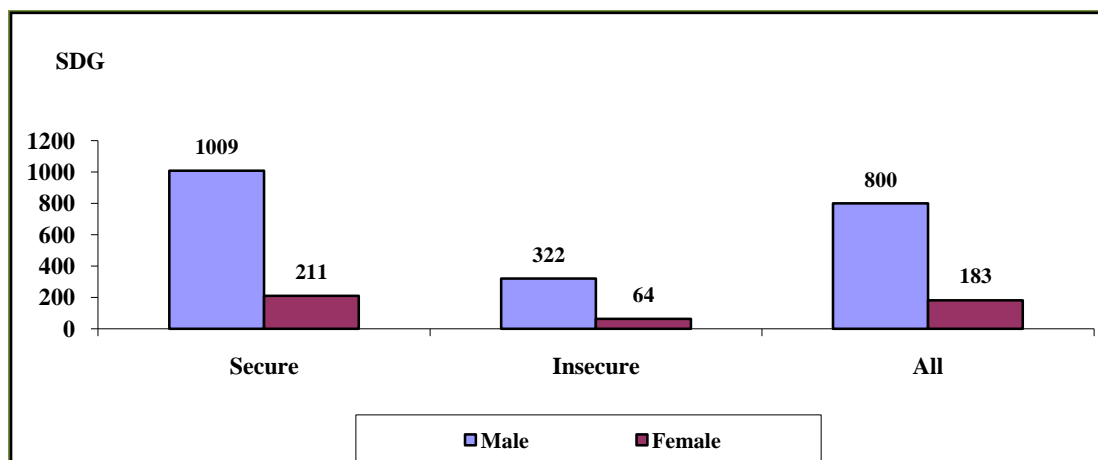
| Locality | Food secure | Food Deprived | All |
|------------|-------------|---------------|-----|
| Alsalam | 27 | 95 | 47 |
| Aldueim | 61 | 31 | 60 |
| Algabalain | 23 | 95 | 28 |
| Kosti | 82 | 30 | 71 |
| Alquiteina | 33 | 63 | 40 |
| Rabak | 40 | 35 | 39 |
| Tandalti | 63 | 22 | 60 |
| Umrimta | 88 | 70 | 86 |
| All | 59 | 44 | 57 |

Figure 19 shows that per capita value of assets is much higher for male headed households than in female headed households, amounting to about five times in each of the food secure and insecure households. An interesting feature is that, in spite of the absence of evidence of food deprivation among at least a major part of the female-headed households, their asset base is much lower than that of the male-headed households. The message from this is that

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if the reported substantial economic engagement of the female-headed households is supported by an improved asset base, their food-security situation will accordingly improve.

Figure 19: Per capita value of assets by gender



3.7. Social services

3.7.1 Education and health

Education and health services can be considered as having a two-way links to food security; influencing it and being influenced by it. The approach for assessing these two variables in the study is based on the data collected through the household questionnaire and another simplified questionnaire directed to village leaders to provide basic information on these services. Beginning with the village-leaders' information, Table 28 shows in its upper part the number of amenities by locality based on the data from each of 28 out of the 30 villages covered. In the lower part, the population size served by each amenity is derived based on population estimates by village leaders, which is nevertheless cannot be considered accurate but it gives a good grasp of the general directions.

Primary schooling is prevalent, although five of the villages (18%) still lack primary schools. There is also high primary school pressures in Kosti, Algabalain and Umrimita as can be discerned from the high population served. Secondary schools are on the other hand scanty; five in all 28 villages and reveal much high intensity of served population. Medical centers seem to have a better distribution but the rate per 1000 population served is low and 19 out of the 28 villages (68%) are still deprived of such a service. Hospitals are scarce; the only one in close reach for some rural communities is Kosti hospital, although some may have relatively easy access to other hospitals in main urban centers. Like medical centers, midwives seem to have a better distribution at the locality level, but it has to be taken into consideration that 12 of the villages (43%) have no trained midwives leading to suffering and pressure on neighboring ones. Generally, the rural areas of Algabalain, Alsalam and Tandalti suffer from high deprivation in the educational and health services in question.

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Table 29: Educational and health situation based on village-leaders' information

| Locality | Estimated Population | Primary Schools | Secondary Schools | Medical Centers | Hospitals | Midwives |
|---|----------------------|-----------------|-------------------|-----------------|-----------|----------|
| a) Distribution by number | | | | | | |
| Alsalam | 4250 | 2 | 0 | 0 | 0 | 0 |
| Aldueim | 13500 | 4 | 1 | 2 | 0 | 5 |
| Algabalain | 8900 | 2 | 0 | 0 | 0 | 3 |
| Kosti | 27355 | 4 | 2 | 2 | 1 | 3 |
| Umrimita | 8360 | 2 | 1 | 2 | 0 | 2 |
| Alquiteina | 9743 | 5 | 0 | 2 | 0 | 5 |
| Rabak | 13945 | 4 | 1 | 2 | 0 | 2 |
| Tandalti | 6000 | 2 | 0 | 1 | 0 | 1 |
| b) Average amenities per 10,000 population | | | | | | |
| Alsalam | 4250 | 4.71 | ** | ** | ** | ** |
| Aldueim | 13500 | 2.96 | 0.74 | 2.48 | ** | 3.70 |
| Algabalain | 8900 | 2.25 | ** | ** | ** | 3.37 |
| Kosti | 27355 | 2.46 | 0.73 | 0.73 | 0.37 | 2.10 |
| Umrimita | 8360 | 2.39 | 2.20 | 2.39 | ** | 2.39 |
| Alquiteina | 9743 | 5.13 | ** | 2.05 | ** | 5.13 |
| Rabak | 13945 | 2.87 | 0.72 | 2.43 | ** | 2.43 |
| Tandalti | 6000 | 3.33 | ** | 2.67 | ** | 2.67 |

** No services available

Given the above estimates of the level of services in various localities, the education levels of the household heads shown by Table 29 portray substantial illiteracy rates, especially in rural Alsalam and to a lesser extent in most other localities. Primary schooling is considerable and high education is more prominent in Alquiteina, Umrimita and Aldueim. Other studies of a similar nature (WFP 2007; Ministry of Health 2007) generating different indicators place the State higher than the average of the Sudan as reflected by a schooling net attendance rate of 76.4% for males, 72.2% for females and an overall net attendance rate of 73.8%. For comparison, the respective rates for Sudan were 55.7%, 52.7% and 53.7%.

Table 30: Distribution of household heads (%) according to education level

| Locality | Illiterate | Khalwa* (Quran) | Adult Education | Primary | Secondary | High |
|--------------|------------|-----------------|-----------------|-----------|-----------|----------|
| Alsalam | 70 | 11 | 0 | 16 | 3 | 0 |
| Aldueim | 40 | 3 | 8 | 36 | 5 | 9 |
| Algabalain | 32 | 6 | 0 | 46 | 11 | 5 |
| Kosti | 51 | 3 | 0 | 39 | 4 | 2 |
| Alquiteina | 33 | 6 | 4 | 34 | 5 | 19 |
| Rabak | 44 | 7 | 0 | 40 | 6 | 3 |
| Tandalti | 46 | 6 | 0 | 36 | 8 | 4 |
| Umrimita | 42 | 2 | 17 | 24 | 5 | 10 |
| Total | 44 | 5 | 3 | 36 | 6 | 7 |

The relationship of nutritional insecurity to education is exposed by delineating frequencies of household heads under each level of education by their nutritional security status (Table 30). The nutritionally secure household heads have a much higher illiteracy rate, a situation

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that could be attributed to the basically high illiteracy rate in the State that historically does not necessarily correlate with food security. But then with all education levels, including the traditional religion schools and adult education, schooling is associated with higher percentages of nutritionally food-secure households. The message is that education could form an important factor for food-security improvement.

Table 31: Frequency (%) of household heads at different education levels according to their nutritional-security status

| Education Level | Nutritionally Secure | Nutritionally Insecure | Total |
|------------------------|----------------------|------------------------|-------|
| Illiterate | 74.5 | 25.5 | 100 |
| Adult Education | 61.1 | 38.9 | 100 |
| Khalwa* (Quran school) | 76.7 | 23.3 | 100 |
| Primary | 66.2 | 33.8 | 100 |
| Secondary | 70.6 | 29.4 | 100 |
| High Education | 67.5 | 32.5 | 100 |

The health situation is assessed from the household-survey data by deriving percentages of infected children and adolescents with the most common diseases as well as mortality rates at various ages. The figures in Table 31 portray quite high infection of children under five years of age with cough and fever during the two weeks preceding the survey and high percentages of adolescents catching malaria over the preceding year. Under-five children's infection with diarrhea and vomiting is nevertheless sizeable and bilharzias infection is reported, but mortality rates of various age groups are rather limited. Some of these health indicators such as child infection with cough and fever are somehow higher than those reported WFP (2007) and Sudan Household Health Survey (SHHS) in 2006 (Ministry of Health 2007), probably due to the timing of the survey during early June, which falls within a hardship period. Others are lower but comparable such as infection of children under-five with diarrhea reported here as 17.9% compared to 22.1% by the mentioned sources.

Table 32: Health variables

| Item | Percent |
|--|---------|
| <i>Infected Children < 5 years over past 14 days (% of children under 5):</i> | |
| Cough | 42.3 |
| Fever | 42.0 |
| Diarrhea | 17.9 |
| Vomiting | 13.9 |
| <i>Child Deaths over past three months (% of all children under 5):</i> | |
| Less than one month | 2.1 |
| One month to one year | 2.0 |
| One year to less than 5 years | 2.5 |
| <i>Adolescents over the past three months (% of persons over 18 years):</i> | |
| Adolescents deaths | 2.1 |
| <i>Adolescents infected during 2009/10:</i> | |
| Malaria | 33.6 |
| Bilharzias | 4.3 |
| TB | 0.2 |
| Other diseases | 15.2 |

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Other health indicators according to these sources include neonatal mortality rate (per 1000 live births) of 34 compared to 32 in Khartoum and post neo-natal mortality rate (per 1000 live births) of 23 compared to 22 in North Sudan. Infant mortality rate recorded 57 compared to 52 in Gezira and child mortality rate amounted to 35 compared to only 11 in Gezira. Under-five mortality rate of 89 is substantially high compared with 63 in Gezira. On the whole, the study results are indicative of a situation of nutritional deprivation that, in spite of the relatively judicious average calorie intake, goes in line with the tangible rates of food deprivation.

Similar to the case of education the average number of children under five years of age suffering from main children infections over the two weeks preceding the survey are computed for each of the two levels of nutritional security (Table 32). It is evident from the table that nutritional insecurity is mostly associated with higher disease incidence suggesting that even under low level of nutrition food utilization and accordingly food security is more jeopardized by health hazards. Strengthening social services, namely health and education will be instrumental in improving food security.

Table 33: Average number of under-five children infected with child diseases according to the level of nutritional security

| Type of Infection | Nutritionally secure | Nutritionally Insecure | Total |
|-------------------|----------------------|------------------------|-------|
| Cough | 0.32 | 0.49 | 0.37 |
| Fever | 0.3 | 0.48 | 0.36 |
| Diarrhea | 0.14 | 0.2 | 0.16 |
| Vomiting | 0.09 | 0.19 | 0.12 |

3.7.2 Water, sanitation and energy

Diverse sources of drinking water are tapped by households with relatively high variation among localities as reported in the household survey (Table 33). On average, the most important sources are wells (water yards), rivers and '*hafirs*'¹, where wells are of high significance in the rural areas of Tandalti, Umrimta and Kosti localities, rivers are a major source in Algabalain, and *hafirs* are broadly scattered with more use in Aldueim, Kosti, Alsalam and Rabak. Alquiteina and Rabak are more blessed with the cleaner tap water, while the former additionally has a high concentration of pumps. Canal water forms a partial source in Algabalain and Rabak. Various diverse combinations of these sources occur in different locations with rather limited frequencies. In general, and in addition to tap water, water from wells and pumps, should form dependably clean sources of drinking water, but often hazards occur due to the nature of use and imposed regulatory and hygienic controls. Otherwise, clean water is not guaranteed from the other water sources, especially, *hafir*, rivers and canals. This means that a sizeable part of the rural population lacks a dependably clean water supply. With no clear disaggregation into rural and urban, WFP (2007) and Ministry of Health (2007) indicate modest water services in the State where the overall level of use of improved sources of drinking water is rated at 46.4% compared with 59.2 in the Sudan.

¹ Earth banking used for the collection and storage of rain water based on soil type and land contour.

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Table 34: Distribution (%) of households according to drinking-water sources by locality

| Type | Alsalam | Aldueim | Algabalain | Kosti | Alquiteina | Rabak | Tandalti | Umrimita | Average |
|--------------|---------|---------|------------|-------|------------|-------|----------|----------|---------|
| Well | 38 | 33 | | 53 | 35 | 1 | 90 | 76 | 38 |
| River | 3 | 17 | 76 | 9 | 1 | 31 | | 12 | 18 |
| Hafir | 24 | 33 | | 26 | | 17 | | 10 | 16 |
| Pump | | 9 | | 1 | 42 | 1 | | | 8 |
| Tap | | 1 | | 1 | 21 | 16 | | | 6 |
| Canal | | | 21 | | | 20 | | | 5 |
| Well+River | 19 | 7 | | 4 | | | | | 3 |
| Well+Hafir | 11 | | | 3 | | | 10 | 2 | 2 |
| Canal+Tap | | | | | | 14 | | | 2 |
| Canal+ Hafir | | | | 4 | | | | | 1 |
| Canal+River | | | 3 | | | | | | * |
| Hafir+River | 5 | | | | | | | | * |

* Negligible percentages

The distribution of waste disposal measures depicted in Table 34 is evident of a wide deprivation of sanitation means; 65% on average with lack thereof in Alsalam and high percentages in most of the other localities. Pits are common in almost all localities but with relatively higher importance in Alquiteina, Rabak, Tandalti and Umrimita, while siphons and wells are scarce. As also rated as poor in other studies (WFP 2007; Ministry of Health 2007), sanitation can be regarded as poor. The results are suggestive for the need for interventions for improving sanitation in the State's rural areas to upgrade health standards as a means of support to food security.

Table 35: Distribution (%) of households according to waste-disposal means by locality

| Locality | None | Pit | Siphon | Well |
|--------------|-----------|-----------|----------|----------|
| Alsalam | 100 | 0 | 0 | 0 |
| Aldueim | 65 | 31 | 0 | 4 |
| Algabalain | 67 | 33 | 0 | 0 |
| Kosti | 87 | 13 | 0 | 0 |
| Alquiteina | 46 | 54 | 0 | 0 |
| Rabak | 44 | 55 | 1 | 0 |
| Tandalti | 60 | 40 | 0 | 0 |
| Umrimita | 44 | 56 | 0 | 0 |
| Total | 65 | 34 | 0 | 1 |

Energy for cooking is highly sourced from biomass, mainly wood and coal, forming the main supply for at least 60% of the households (Table 35). This is in agreement with WFP (2007) stating that households resorting to solid fuel use as their primary source for domestic energy for cooking in the White Nile State reach 60% although this is markedly lower than the country's average of about 72%. Use of gas, which is a natural-resource saving means, is not as wide spread, except for a considerable intensity in Aldueim and modest utilization in Alquiteina and Umrimita. Otherwise, its use (19%) comes in combination with biomass sources. High resort to biomass energy is a major cause of deforestation and impoverishment of land cover leading to soil degradation and ever-declining productivity in

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the absence of use of modern plant nutrients with negative consequences on food security. Accordingly, the need for promoting and supporting non-biomass energy sources becomes obvious.

Table 36: Distribution (%) of households according to cooking-energy source by locality

| Locality | Alsalam | Aldueim | Algabalain | Kosti | Alquiteina | Rabak | Tandalti | Umrimita | Average |
|----------------|---------|---------|------------|-------|------------|-------|----------|----------|---------|
| Wood Coal | 11 | 10 | 67 | 31 | 4 | 33 | 26 | 12 | 25 |
| Wood | 89 | 4 | 19 | 24 | 5 | 25 | 70 | 5 | 24 |
| Gas | | 43 | 5 | 6 | 33 | 14 | | 34 | 18 |
| Gas Coal | | 15 | 2 | 4 | 28 | 2 | | 17 | 9 |
| Gas+Wood+Coal | | 7 | 3 | 6 | 29 | 7 | | 10 | 9 |
| Gas Wood | | 14 | 2 | 6 | 1 | 14 | | 5 | 6 |
| Coal | | 9 | 3 | 2 | | 5 | | 17 | 4 |
| Dung | | | | 11 | | | | | 3 |
| Wood Dung | | | | 6 | | | 2 | | 1 |
| Wood Coal-Dung | | | | 4 | | | | | 1 |
| Dung-Coal | | | | 1 | | | | | * |
| Wood Grass | | | | | | | 2 | | * |

* Negligible percentages

3.8 Vulnerability estimates

An attempt is made to analyze vulnerability based on quantitative assessment focusing on the food-deprived group of households. The bases for such simplified analysis are, on the one hand, the types of risk that contribute to food crisis, the households' asset value as proxy for the wealth status and education and health situations, and on the other hand the various coping mechanisms reported by households classified according to their influence on the households as mentioned earlier. To do that, the frequencies derived in earlier sections are transformed into scores ranging between zero and 5 where, the higher the score, the more negative is the situation. For deriving the scores of the external risk factors, the average occurrence of each factor (number reporting) is multiplied by the frequency of recurrence (number of years) provided by Table 23 and the resulting figure are transformed into scores.

Scores of the asset base are generated using the asset values of Table 26. For education and health, the average number of amenities reported in Table 28 is used to derive the required scores, but for sanitation, the evaluation is confined to frequency of households with no sanitation facilities reported in Table 34. With regard to scores for coping mechanisms, first weighted ranking is made by locality for households reporting the presence of food crisis similar to the one done for Table 24, and then the ranks are used to generate scores. But, while the score for the income-generation coping mechanism has a ceiling level of 5, those on assets and suffering the consequences are assigned a value of 3 due to the smaller number of cases. Coping items under 'other' are ignored as they are negligible. Score totals are then computed and ranking is done for each of the risk factors and coping mechanisms;

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summarized by Table 38 (based on Tables 36 and 37) where lower figures, in contrast to scores, are designated to indicate more advantageous situations than higher figures. It is to be mentioned that the down-listing of localities in the tables follow the sequence of high to low food-deprivation incidence.

The rank comparisons, coupled with many components from the past analyses would enable broad assessment of households' vulnerability. Generally, although the depth and severity of food-deprivation is modest, nutritional insecurity incidence is substantial and variable, rendering food deprivation of a likely variable nature. Furthermore, the wide occurrence of risks of household food shortages instigated by shocks of drought, floods and food price surges is associated with notable recurrence of such causal agents. Although many households' coping strategies are more on the proactive rather than on the passive side, other situations indicate poor coping strategies. Accordingly, the combined effect of all these constituents is indicative of variable vulnerability. Therefore, assessment of the situation in each locality is highlighted in the following:

- **Tandalti:** is among localities with the highest frequencies of households complaining from food crisis. Yet it has on the whole both low risk factors and favorable coping mechanisms rendering vulnerability assessment as relatively mild. It is the third locality in highest contribution of livestock to household incomes that also contributes to the high value of assets. It hosts the highest percentage of farming occupation mostly engaged in the production of sorghum, sesame and groundnuts with considerable marketed surplus. Unemployment rate in the locality is modest. Since all the food-deprived are farmers, policies that encourage expansion in areas under cropping for food-deprived households and interventions in productivity improvements in livestock and crops, especially sesame, are of relevance in addition to widening the employment opportunities. Further, the high use of biomass for energy will need to be rationalized.

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Table 37: Risk factors contributing to food deprivation by locality

| Locality | External Risk Factors | | | | | Per capita Asset Value | Education Facilities | | Health facilities | | | Sum | Rank |
|------------|-----------------------|--------|------------|----------|-------|------------------------|----------------------|-----------|-------------------|----------|-------------------|-------|------|
| | Drought | Floods | Price Rise | Conflict | Other | | Primary | Secondary | Medical Centers | Midwives | No waste Disposal | | |
| Alsalam | 2.92 | 0.91 | 4.08 | 0.00 | 0.83 | 4.60 | 2.55 | 5.00 | 5.00 | 5.00 | 2.20 | 32.10 | 7 |
| Rabak | 4.51 | 0.49 | 4.94 | 0.00 | 0.00 | 2.59 | 2.54 | 4.30 | 2.20 | 3.00 | 5.00 | 28.57 | 5 |
| Umrimita | 2.47 | 2.18 | 2.77 | 0.00 | 2.18 | 5.00 | 3.05 | 2.58 | 2.31 | 2.79 | 5.00 | 24.34 | 4 |
| Aldueim | 3.16 | 0.00 | 3.85 | 0.17 | 0.88 | 2.34 | 2.47 | 4.18 | 2.12 | 2.16 | 3.38 | 23.72 | 2 |
| Tandalti | 2.94 | 2.04 | 2.37 | 0.00 | 0.59 | 2.69 | 2.19 | 5.00 | 2.88 | 2.57 | 3.67 | 23.94 | 3 |
| Kosti | 5.00 | 2.27 | 3.62 | 0.00 | 0.06 | 0.69 | 5.00 | 4.24 | 4.30 | 3.90 | 2.53 | 32.61 | 8 |
| Alquiteina | 2.64 | 0.10 | 2.51 | 0.19 | 2.03 | 0.69 | 2.42 | 5.00 | 2.53 | 0.84 | 4.78 | 20.73 | 1 |
| Algabalain | 4.05 | 2.36 | 3.55 | 0.31 | 0.18 | 2.04 | 3.24 | 5.00 | 5.00 | 2.27 | 3.28 | 30.29 | 6 |

Table 38: Coping mechanisms according to their consequences on households by locality

| Locality | Risk Factors | Coping |
|------------|--------------|--------|
| Alsalam | 7 | 6 |
| Rabak | 5 | 4 |
| Umrimita | 4 | 8 |
| Aldueim | 2 | 7 |
| Tandalti | 3 | 1 |
| Kosti | 8 | 3 |
| Alquiteina | 1 | 5 |
| Algabalain | 6 | 2 |

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Table 39: Summary of ranks

| Locality | Income Generating | Asset Sales | Suffering Consequences | Total | Rank |
|------------|-------------------|-------------|------------------------|-------|------|
| Alsalam | 2.23 | 3.00 | 0.25 | 4.49 | 6 |
| Rabak | 0.86 | 0.43 | 2.00 | 3.29 | 4 |
| Umrimita | 5.00 | 3.00 | 0.12 | 8.12 | 8 |
| Aldueim | 2.94 | 2.80 | 0.53 | 5.27 | 7 |
| Tandalti | 2.07 | 0.31 | 0.78 | 2.16 | 1 |
| Kosti | 0.52 | 0.15 | 2.04 | 2.70 | 3 |
| Alquiteina | 2.10 | 2.25 | 0.65 | 4.00 | 5 |
| Algabalain | 2.23 | 0.38 | 0.98 | 2.58 | 2 |

- **Alquiteina:** the low coping strategies there are highly counterbalanced by the low risk factors faced resulting also in mild vulnerability. With high wage and skilled labor and less so trader occupations in addition to relatively low unemployment, farming is less important than in other localities, but production of some high-value crops is evident bringing cash returns. Food-deprivation incidence is relatively low and average per capita income of the food-deprived in the highest among localities. Yet for the farming community, crop yields are modest. Livestock forms an important livelihood activity. Education and health facilities, drinking water are relatively good compared to other localities but sanitation is rather poor.
- **Algabalain:** with high concentration of farmers, households there encounter high risk factors including some conflict but coping actions are appropriate with considerable income-generating activities and asset sales, suggesting somehow muted vulnerability. In addition to sorghum, cotton, some sesame and vegetables are produced with humble production, limited marketable surplus and low own food production to consumption. Yet the incidence of food-deprivation, depth and severity are lowest among localities. With high ratio of farmers among the food deprived, poor ratio of land under cultivation in relation to owned areas, meager crop yields and very poor per capita incomes of the food-secure group, improvement in agricultural production including livestock (with high contribution to asset value) will be conducive to even better mitigation of the high risk factors. Further, high deprivation in all social services is apparent, calling for needed interventions for improvement.
- **Aldueim:** low risk factors are encountered there but coping actions are rather miserable with high extent of suffering the consequences of food crisis. With average level of food deprivation, this put the locality under considerable vulnerability. Farming is moderately practiced with almost equal options of wage and skilled labor for the food-deprived sector, and coverage of consumption needs from own production is high for farming households. Given the general low productivity, crop yields in the locality are tangible. Yet, with substantial ratio of grown to own land and low grown areas in absolute terms, access to more land for the food deprived is of importance. In spite of the moderate depth and severity of food deprivation, which itself depicts high incidence, income and wealth disparities between the food-secure and food-deprived are enormous, a situation that needs more rewarding employment and capital formation targeting. So-

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cial services, including a diversified drinking-water source and high non-biomass energy consumption, are sizeable.

- **Rabak:** Both significant risk levels and inadequate coping practices render the food security situation in Rabak as tangibly vulnerable where food-deprivation incidence is also high with some medium-level depth and severity and generally low per capita incomes. While the majority of household heads are farmers, wage and skilled labor are of only slightly lower importance and unemployment is high. Average production per household is relatively low and so is the contribution of own production to consumption. The relatively high land access for food-deprived households is counteracted by low land productivity that needs interventions for improvement. On the other hand, social services are satisfactory in comparison to other localities.
- **Kosti:** with high-level risk factors and in spite of the favorable coping actions, vulnerability could be placed at an upper level where the dominant majority of the household heads are farmers. The ratio of households facing floods, drought and high prices is high with considerable recurrence levels. Crop diversification is somehow considerable with high coverage of farming families of their needs of main crops and relatively moderate yields, but income disparities between the food-secure and food-deprived are high. Social services are of relatively substantial availability. Counteracting the risk factors forms the main intervention required in Kosti Locality.
- **Umrimita:** facing moderate risk factors and miserable coping actions, food-insecure households in Umrimita suffer high vulnerability. Income-generating activities are poor and asset sales, which are themselves very meager in value, are the most common exit, although negative coping actions are low. Close to half of the households depend on agriculture for their livelihood, but those thriving on wage and skilled labor activities are comparable in magnitude and there are limited portion of traders. Although crop diversification, coverage of consumption from own production, and crop sales are generally substantial in the locality, the portion of food-insecure is on the high side relative to other localities. However, the bulk of the food-deprived are wage and skilled labor. For food-insecure farming households the ratio of cultivated to own land is meager and most of the per capita income of the food-deprived stems from non-agricultural activities. Social services provision is satisfactory compares with other localities. Better job opportunities, more land access and asset building are the most needed actions.
- **Alsalam:** harassed by both high risk factors and deficient coping strategies, high vulnerability is encountered in Alsalam locality. Having 90% of the households engaged in farming, food deprivation is highest among all localities of the State. Crop production per household is marginally low with low coverage of consumption from own production and low crop sales; a situation engendered by small grown areas and extremely poor productivity and associated with poor livestock-dependent asset base. High deprivation in social services is highly illustrated and households are highly dependent on biomass for energy. Land access enhancement, productivity improvement, and social-services reinforcement are urgently needed interventions.

3.9 Demanded interventions by households

Responses of households to a question on what three ranked types of improvements they see needed for preventing improving their food-security situation are analyzed by deriving weighted values based on the frequency of respondents and weights of 3, 2 and 1 assigned to the first, second and third ranks of responses. The reported intervention needs are presented in Table 39 in descending order according to their weighted values. A myriad of demands are reported by the households, with individual priorities given to finance provision, employment expansion, reduced food prices and expansion of drinking water supply. However, the sum of responses that target agricultural improvement interventions is paramount, including agricultural inputs' issues, agricultural expansion, support to small family farms, livestock concerns, crop protection, and storage facilities; among others. Including the need for social services, almost all of the aspired improvements are of high relevance as most of them have close links to the analyses in the study.

Table 40: Interventions for improvement

| Item | Interv 1 | Interv 2 | Interv 3 | Weighted |
|--|------------|------------|------------|--------------|
| Avail finance | 107 | 64 | 26 | 79.2 |
| Expand employment opportunities | 42 | 31 | 23 | 35.2 |
| Reduce food prices | 30 | 24 | 15 | 25.5 |
| Avail drinking water | 24 | 23 | 18 | 22.7 |
| Avail improved inputs | 20 | 29 | 10 | 22.3 |
| Expand agriculture | 32 | 11 | 5 | 20.5 |
| Shift from rainfed to irrigation | 29 | 14 | 8 | 20.5 |
| Small family farms | 22 | 13 | 14 | 17.7 |
| Attention to agriculture | 27 | 10 | 4 | 17.5 |
| Provide food aid | 20 | 16 | 7 | 16.5 |
| Encourage hard work | 20 | 13 | 10 | 16.0 |
| Provide water for agric | 13 | 13 | 5 | 12.7 |
| Attention to livestock | 9 | 11 | 3 | 8.7 |
| Early preparation for agriculture | 8 | 10 | 5 | 8.2 |
| Sorghum storage | 6 | 12 | 3 | 7.5 |
| Avail electricity | 5 | 8 | 8 | 6.5 |
| Avail consumer goods in rural areas | 9 | 3 | 0 | 5.5 |
| Reduce health costs | 4 | 6 | 7 | 5.2 |
| Establish fish farms | 3 | 7 | 6 | 4.8 |
| Build schools & free education | 3 | 4 | 11 | 4.7 |
| Pest control | 3 | 8 | 2 | 4.5 |
| Sell part of inputs | 4 | 6 | 0 | 4.0 |
| Migration | 6 | 1 | 1 | 3.5 |
| Exempt agric inputs from taxes | 1 | 5 | 2 | 2.5 |
| Crop diversification | 1 | 3 | 2 | 2.8 |
| Avail pastures | 3 | 1 | 0 | 2.8 |
| Build health centers | 1 | 3 | 1 | 2.7 |
| Link village to urban areas | 3 | 0 | 0 | 2.5 |
| Change policy of FDI | 1 | 1 | 2 | 2.2 |
| Give farmers rights from sugar company | 2 | 0 | 0 | 2.0 |
| Other | 2 | 1 | 1 | 2.5 |
| Total | 460 | 351 | 199 | 380.2 |

CONCLUSIONS AND RECOMMENDATIONS

Major conclusions and State's policy-oriented recommendations:

- At the state level per capita cereal supply from own production is variable due to highly variable and declining productivity caused by exogenous risk factors engendering frequent crop failures in both rainfed and irrigated agriculture. On the other hand, sorghum production from large rainfed mechanized schemes in the State could form surpluses in various seasons that can be traded outside the State.

Three interventions by the State are relevant: first, establishing a strong strategic reserve that would monitor supply and stabilize price fluctuations; second, promoting storage at the household level; and third, exerting efforts to improve irrigated production of food and cash crops with better dependable production for enhancing coverage of cereal deficits and improving access to food.

- Agriculture is important in rural livelihood in the State, yet people engage themselves in other livelihood alternatives, particularly wage and skilled labor along with high unemployment and high dependency rates. Agriculture and wage-earning jobs have different weights in different localities with different impacts on per capita incomes, calling for geographical targeting.

Priorities for interventions in agriculture should be directed to Tandalti, Kosti, Alsalam and Algabalain, off farm job opportunities become of pressing need in Rabak, Umrimta and Alquiteina, further in Alsalam and Algabalain due to high unemployment and particularly ear-marked to the high portion of housewives in all localities. The types of interventions would include provision of agricultural inputs, extension services and credit to promote improved technology use, widening of irrigation options and promotion of small-scale opportunities in and outside agriculture.

- Overall average cereal consumption portrays decent levels in most states but that of vegetables, fruits and animal products are low with homogeneity among localities, while some localities encounter low consumption of most food groups. Furthermore, objective valuation of own food security situation among people is modest.

Targeting production expansion of vegetables and fruits in all localities via provision of production-enhancing technology, credit and extension along with a sensitization campaign to raise awareness on nutrition and promote consumption of foods of high nutritive value.

- The incidence of food deprivation is generally considerable and varies among localities. *The aforementioned interventions for improving agricultural and non-agricultural livelihood activities are of relevance in the medium and long term, yet direct targeting through food aid and Zakat is needed in the short run. Priority targets should be directed*

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to the most food-insecure in Alsalam, Rabak, Aldueim and Umrimita, followed by Kosti, Alquiteina, Tandalti and Algabalain.

- Food-deprived households have limited per capita home-produced foods and particularly low production of cash crops due to limited grown areas and meager land holdings in addition to a general tendency for lower yields, while their asset base is especially weak.

The need is for facilitation of land access to the food-deprived, increasing their asset base both through land and livestock acquisition and empowering them to fully utilize the available land and livestock potential at their disposal.

- Social services in terms of education, health, medical services, water and sanitation are riddled with shortcomings. Numbers of villages are deprived of primary schools, medical centers and trained midwives. Secondary schools are scanty, clean water is not guaranteed, sanitation means are largely deficient, dependence is high on biomass energy sources, and congestions are evident for many of the social services when they exist. Health problems comprise child infection with cough, fever, diarrhea and vomiting, and malaria in adolescents while bilharzias infection is reported.

State's support to all social services is imperative for food-security improvement, with priority given to Algabalain, Alsalam and Tandalti in health and education services, Rabak, Algabalain, Alsalam, Kost and Alduim in clean water provision, and the State at large for provision of non-biomass energy sources and sanitation services.

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APPENDICES

Appendix 1: Sampled villages by locality

| Locality | Villages |
|------------|--|
| Alsalam | Gibeish; Albayyara |
| Aldueim | Alisheir Dakkoom; Alfilfila; Goz Aalahamer; Allmaleih; Wadalsubahi |
| Algabalain | Aladara; Alhabbania; Alhanfaria |
| Kosti | Abushama; Alsafa; Algeneiga; Goz Nimir; Kaakoal; Mabrouka; Alsafa; Umsheibat |
| Alquiteina | Abgurun; Aldebaiba; Kambo Awadalla; Abusneigid |
| Rabak | Fangouga; Sheikan; Alshareifia; Wadalfadul |
| Tandalti | Kataraya; Qozkharda |
| Umrimita | Eid Umeish; Alshati |

FOOD SECURITY IN THE WHITE NILE STATE OF SUDAN

Appendix 2: Household Questionnaire

Agricultural Economics and Policy Research Center (AEPRC)

Agricultural Research Corporation (ARC)

In Collaboration with

**Sudan Institutional Capacity Programme: Food Security Information for Action
(SIFSIA-GNU)**

FOOD SECURITY IN THE WHITE NILE STATE Household Questionnaire May 2010

Questionnaire No: _____ Date: _____ Enumerator: _____
State: _____ Locality: _____ Village: _____

I Family Information

| Family Members | Sex* (M/F) | Age | Occupation** | Years of Education |
|-----------------------|-----------------------|------------|---------------------|-------------------------------|
| Head of Family | | | | |
| Wife | | | | |
| Wife | | | | |
| Wife | | | | |
| Son/Daughter | | | | |
| Son/Daughter | | | | |
| Son/Daughter | | | | |
| Son/Daughter | | | | |
| Son/Daughter | | | | |
| Son/Daughter | | | | |
| Son/Daughter | | | | |
| Son/Daughter | | | | |
| Son/Daughter | | | | |
| Son/Daughter | | | | |
| Others | | | | |
| Others | | | | |
| Others | | | | |
| Others | | | | |
| Others | | | | |

* Male/Female

** Main Occupation: Farmer, laborer, employee, trader, skilled occupation, fisherman, student, unemployed, others (specify).

FOOD SECURITY IN THE WHITE NILE STATE OF SUDAN

II Characteristics of Family House

1. Building material _____ (straw, mats, mud, burnt bricks, raw bricks, other (specify)_____
2. Toilet facility (none, pit, soft tank, siphon, others) _____
3. Drinking water source (well, river, pipe, stream, borehole, other)_____
4. Cooking energy source (firewood, charcoal, grass, electricity, gas, paraffin)___
5. Lighting energy (oil lamp, electricity, others)_____

III Family belongings (for all family members)

1. Land

| Type | Area (feddan) | Estimated value per feddan (SDG) |
|-------------|----------------------|---|
| Irrigated | | |
| Rain-fed | | |
| Mechanized | | |

2. Animals

| Type | Number | Estimated value per animal (SDG) |
|-------------|---------------|---|
| Cow | | |
| Sheep | | |
| Goat | | |
| Camels | | |
| Poultry | | |
| Donkeys | | |

3. Assets

| Type | Number | Estimated value (SDG) |
|--------------------|---------------|------------------------------|
| Tractor | | |
| Plough* | | |
| Traditional plough | | |
| Water pump | | |
| Motor vehicle | | |
| Flour mill | | |
| Generator | | |
| Donkey drawn cart | | |
| Refrigerator | | |
| TV | | |
| Water tank | | |
| Warehouse (Shop) | | |
| Others----- | | |

FOOD SECURITY IN THE WHITE NILE STATE OF SUDAN

* Includes all types of ploughs (mallboard, disc, harrow etc)

4. Rank activities on which household head depends for livelihood

First: _____

Second: _____

Third: _____

Fourth: _____

5. How do you judge sustainable food availability situation of your family

(a) Good (adequate) (); (b) Medium (); (c) Weak ()

IV. Income Earning Activities of The Household

1 (a). Main crops produced in 2009/10 (including crops in summer and winter, and forestry products)

| Crop | Cultivated Area (Fed) | Quantity produced (enter unit) | Quantity Sold (enter unit) | Total Returns from Crop Sale (SDG) | Quantity Kept for Home Consumption (enter unit) | Quantity Kept for Seeds (enter unit) | Quantity Used as Feed (enter unit) |
|------|-----------------------|--------------------------------|----------------------------|------------------------------------|---|--------------------------------------|------------------------------------|
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |

(b) Returns from crop residues

| Crop Residue Type | Value (SDG) |
|-------------------|-------------|
| 1) | |
| 2) | |
| 3) | |
| 4) | |
| 5) | |
| 6) | |
| 7) | |

FOOD SECURITY IN THE WHITE NILE STATE OF SUDAN

2. Animal products sold in 2009

| Type of product | Frequency of sale* | Quantity Sold | Total Sum received (SDG) |
|------------------------|---------------------------|----------------------|---------------------------------|
| 1. Cows (No) | | | |
| 2. Sheep (No) | | | |
| 3. Goats (No) | | | |
| 4. Camels (No) | | | |
| 5. Chicken (No) | | | |
| 6. Milk (Lb) | | | |
| 7. Eggs (Dozens) | | | |
| 8. Cheese | | | |
| 9. Ghee | | | |
| 10. Other product | | | |
| 11. Other product | | | |

* Daily, weekly, monthly or annually.

3. Fish sales 2009/10

| Period of Sale* | Frequency of sale** | Quantity Sold (kg) | Average price (SDG/kg) |
|------------------------|----------------------------|---------------------------|-------------------------------|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |

* Summer; winter; autumn; other

** Daily, weekly, monthly or annually.

4. Non farm income from family members in 2009

| Family member* | Type of work | Period of Income** | Amount of Income (SDG) |
|-----------------------|---------------------|---------------------------|-------------------------------|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |

* Husband, wife, son, daughter, other family member (identify).

** Per annum, month, week or day.

5. Cash money borrowed in 2009/10

a) Amount borrowed for farm expenditure _____ (SDG)

b) Amount borrowed for family consumption expenditure _____ (SDG)

FOOD SECURITY IN THE WHITE NILE STATE OF SUDAN

5. Remittances from relatives inside or outside Sudan

| Source (Inside/outside Sudan) | Period of transfer* | Amount of Transferred (SDG) |
|--------------------------------------|----------------------------|------------------------------------|
| 1. | | |
| 2. | | |
| 3. | | |
| 4. | | |
| 5. | | |

* Annually, monthly, weekly, daily.

6. Estimated amount of family savings in 2009 _____ (SDG)

V. Family food expenditure in 2009

| Type of Food | Quantity Consumed | Unit | Period of Consumption* | Total Value (SDG) |
|---------------------|--------------------------|-------------|-------------------------------|--------------------------|
| Sorghum (dura) | | | | |
| Dukun | | | | |
| Wheat | | | | |
| Wheat Bread | | | | |
| Okra | | | | |
| Jewsmellow | | | | |
| Dry Okra | | | | |
| Rigla | | | | |
| Potato | | | | |
| Sweet Potato | | | | |
| Eggplant | | | | |
| Pumpkin | | | | |
| Cucumber | | | | |
| Carrot | | | | |

FOOD SECURITY IN THE WHITE NILE STATE OF SUDAN

| | | | | |
|--------------|--|--|--|--|
| Green Pepper | | | | |
| Rocket | | | | |
| Onion | | | | |
| Garlic | | | | |
| Banana | | | | |
| Orange | | | | |
| Mango | | | | |
| Beef | | | | |
| Mutton | | | | |
| Fish | | | | |
| Eggs | | | | |
| Cheese | | | | |
| Jam | | | | |
| Biscuits | | | | |
| Faba Bean | | | | |
| Dry Bean | | | | |
| Lentil | | | | |
| Rice | | | | |
| Macaroni | | | | |
| Shairia | | | | |
| Milk | | | | |
| Tea | | | | |
| Sugar | | | | |
| Coffee | | | | |
| Others | | | | |
| Others | | | | |
| Others | | | | |

* Daily, weekly, monthly or annually.

VI. Other Expenditure

FOOD SECURITY IN THE WHITE NILE STATE OF SUDAN

| Type | Quantity (Unit) | Period of Consumption* | Total Value (SDG) |
|------------------|------------------------|-------------------------------|--------------------------|
| Firewood | | | |
| Coal | | | |
| Gas | | | |
| Kerosene/Diesel | | | |
| Electricity | | | |
| Water | | | |
| Cloths | | | |
| Education | | | |
| Transport | | | |
| Social Occasions | | | |
| Outside Food | | | |
| Other ----- | | | |
| Other | | | |
| Other | | | |

* Daily, weekly, monthly or annually.

FOOD SECURITY IN THE WHITE NILE STATE OF SUDAN

VI. The Assessment of Nutritional Status for Children under five years of age

| Child | Gender | Age | Height (cm) | Weight (kg) |
|-------|--------|-----|-------------|-------------|
| 1. | | | | |
| 2. | | | | |
| 3. | | | | |
| 4. | | | | |
| 5. | | | | |
| 6. | | | | |
| 7. | | | | |
| 8. | | | | |

VII. Information on Household, Migration and Food

- 1) During the past five years, have you been subjected to food crises that severely affected your living and caused food shortages (yes/no) _____
If the answer is yes, for how many years have you been subjected to food crises because of the following (mention the number of years in each case):
 - a) Drought _____
 - b) Floods _____
 - c) Food-price surges _____
 - d) Conflict/wars _____
 - e) Other (identify) _____
- 2) What did you do in case of food crises?
 - a) _____
 - b) _____
 - c) _____
- 3) Mention three need interventions for preventing food crises:
 - a) _____
 - b) _____
 - c) _____
- 4) Have you received food aid during the last five-years? (yes/no) _____
If the answer is yes,

FOOD SECURITY IN THE WHITE NILE STATE OF SUDAN

- 5) For how many years? _____
- 6) What are the types of aid? _____
- 7) Is the family migrant? (yes/no) _____ If the answer is yes:
- 8) For how many years _____
- 9) Original home (state) _____
- 10) Reasons for migration
 - a) _____
 - b) _____
 - c) _____
 - d) _____
- 11) Do you intend to go back? (yes/no) _____
- 12) If yes, when _____
- 13) If no what are the reasons of your stay:
 - a) _____
 - b) _____
 - c) _____

VIII) Health Situation and Deaths in the Household

- 1) Children under five years of age having the following infections over the past two weeks:

| Type of Infection | No of Children |
|--------------------------|-----------------------|
| Cough | |
| Fever | |
| Diarrhea | |
| Vomiting | |

- 2) During the past three months, number of children died under 1 month of age: _____
- 3) During the past three months, number of children died 1 month – 1 year age: _____
- 4) During the past three months, number of children died over 1 year and less than 5: _____
- 5) During the past three months, number of adolescents (over 5 years) died: _____

- 6) What are the most important diseases that infected adults in 2009/10:

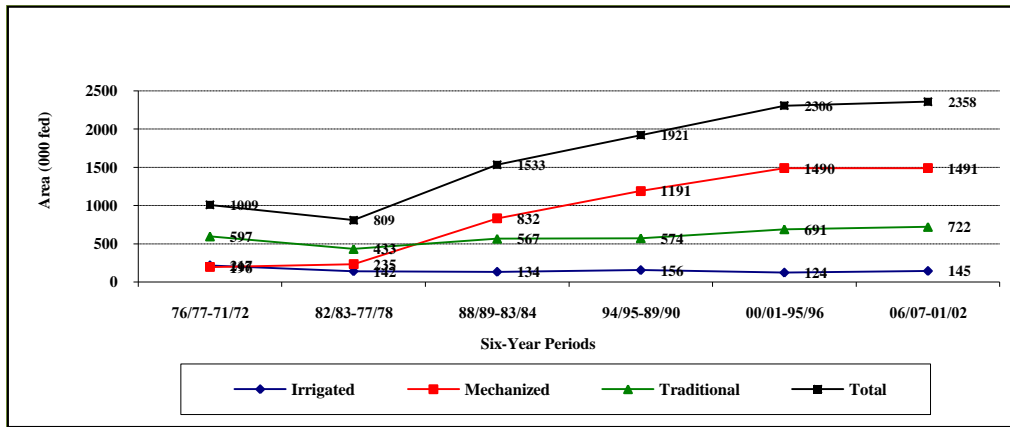
| Disease | Men | | Women | |
|----------------|------------|------------------|--------------|------------------|
| | No | Frequency | No | Frequency |
| Malaria | | | | |
| Bilharzia | | | | |
| TB | | | | |
| Firindit | | | | |

FOOD SECURITY IN THE WHITE NILE STATE OF SUDAN

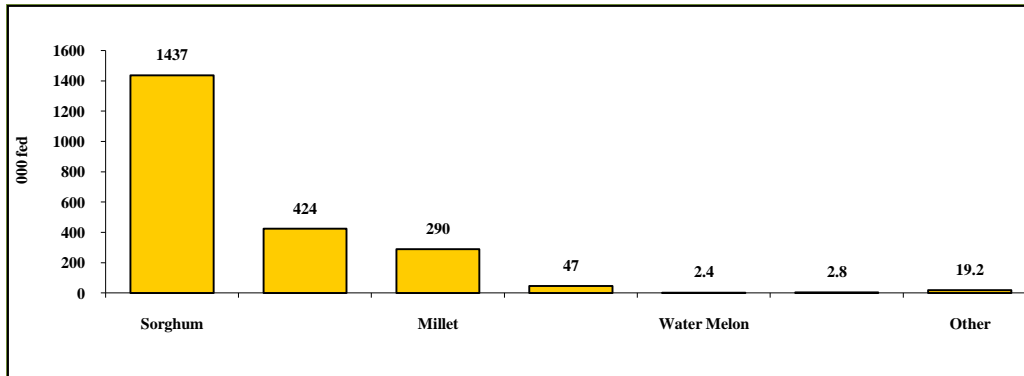
| | | | | |
|-------|--|--|--|--|
| Other | | | | |
| Other | | | | |

FOOD SECURITY IN THE WHITE NILE STATE OF SUDAN

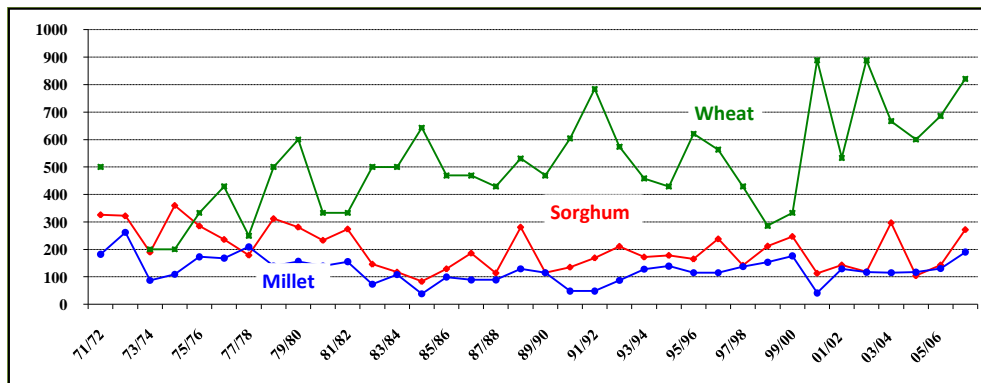
Appendix 3: Development of areas by system (six-year averages 1971/72-2006/2007)



Appendix 4: Average crop areas in White Nile's rainfed sector 2004-2008



Appendix 5: Average yields of cereal crops 1971/72-2006/07 (kg/fed)



FOOD SECURITY IN THE WHITE NILE STATE OF SUDAN

Appendix 6: Distribution of family members according to occupation by locality

| Locality | Child | Student | Hwife | Employ | Labor | Skilled | Trader | Farmer | Unempl | Pastoral | Expat | Fishman | Total |
|--------------|-------------|-------------|-------------|------------|------------|------------|------------|-------------|-------------|----------|------------|------------|------------|
| Tandalti | 16.9 | 20.3 | 9.6 | 1.0 | 2.7 | | 1.7 | 26.6 | 21.3 | | | | 100 |
| Kosti | 17.2 | 21.2 | 15.3 | 0.8 | 5.5 | | 1.3 | 18.1 | 20.5 | | 0.1 | 0.1 | 100 |
| Alsalam | 18.1 | 8.5 | 10.7 | 0.4 | 5.5 | 0.4 | 1.1 | 22.1 | 33.2 | | | | 100 |
| Algabalain | 15.5 | 23.1 | 14.9 | 3.3 | 4.2 | | | 13.3 | 25.8 | | | | 100 |
| Aldueim | 12.5 | 24.2 | 18.7 | 1.8 | 7.1 | 1.3 | 1.8 | 9.7 | 22.1 | 0.1 | 0.8 | | 100 |
| Rabak | 14.0 | 35.2 | 13.4 | 0.9 | 7.1 | | | 7.9 | 21.4 | | | | 100 |
| Umrmta | 13.2 | 24.4 | 18.0 | 1.6 | 9.6 | 1.3 | 1.9 | 7.4 | 22.5 | | | | 100 |
| Alquiteina | 16.5 | 30.6 | 18.2 | 2.9 | 11.6 | 1.3 | 1.9 | 3.1 | 13.4 | | 0.1 | 0.3 | 100 |
| Total | 15.4 | 24.9 | 15.5 | 1.6 | 6.8 | 0.5 | 1.2 | 12.5 | 21.4 | | 0.2 | 0.1 | 100 |

FOOD SECURITY IN THE WHITE NILE STATE OF SUDAN

Appendix 7: Reported consumption of different food types by food-security status by locality

a) Overall average (kg/capita/year)

| Food Type | Alsalam | Dueim | Gabalain | Kosti | Quiteina | Rabak | Tandalti | Umrimita | Average |
|---------------|---------|--------|----------|--------|----------|--------|----------|----------|---------|
| Sorghum | 158.19 | 169.64 | 189.70 | 164.28 | 148.71 | 165.29 | 200.19 | 142.74 | 166.92 |
| Millet | 2.61 | 4.89 | 10.09 | 11.69 | 3.29 | 16.27 | 7.89 | 15.64 | 9.25 |
| Wheat | 2.51 | 35.48 | 16.93 | 40.57 | 22.87 | 39.20 | .38 | 36.61 | 28.65 |
| Bread | 1.85 | 28.98 | 19.65 | 10.80 | 29.79 | 18.99 | 12.58 | 18.41 | 18.75 |
| Okra | 4.78 | 1.92 | 3.38 | 3.94 | 7.83 | 3.44 | 7.89 | 3.00 | 4.33 |
| Jewsmallow | 4.68 | 2.87 | 6.28 | 5.86 | 6.46 | 7.43 | 6.29 | 4.82 | 5.60 |
| Dry okra | 5.27 | 5.14 | 4.41 | 4.99 | 2.44 | 4.04 | 7.13 | 5.64 | 4.70 |
| Purslane | 1.25 | .84 | 2.53 | 2.88 | 2.72 | 6.47 | 1.29 | .95 | 2.63 |
| Potato | .41 | 4.80 | 2.11 | 3.23 | 6.48 | 4.59 | 3.17 | 5.94 | 4.04 |
| Sweet Potato | 3.40 | 3.86 | 3.55 | 6.29 | 6.91 | 5.44 | 7.21 | 2.88 | 5.23 |
| Eggplant | .65 | 1.44 | 1.71 | .70 | 2.64 | 3.31 | 1.33 | 1.05 | 1.65 |
| Pumpkin | .73 | .32 | 1.67 | 1.58 | .35 | 3.78 | 1.08 | .08 | 1.33 |
| Cucumber | 4.09 | 8.46 | 2.65 | 11.60 | 9.73 | 10.77 | 5.60 | 10.77 | 8.75 |
| Carrot | .35 | .18 | .47 | .75 | .93 | 1.02 | .31 | .12 | .59 |
| Pepper | .30 | .14 | .26 | .38 | .87 | 1.32 | .32 | .00 | .50 |
| Rockets | 1.31 | 1.45 | 2.01 | 3.12 | 3.15 | 2.10 | 2.41 | 1.46 | 2.30 |
| Onion | 26.63 | 47.65 | 24.46 | 34.94 | 44.04 | 23.72 | 40.01 | 35.60 | 35.61 |
| Garlic | .48 | .69 | 1.33 | 1.00 | .57 | 1.05 | .83 | .50 | .85 |
| Banana | 2.98 | 6.11 | 5.50 | 5.47 | 8.73 | 8.54 | 9.50 | 7.64 | 6.81 |
| Orange | 4.28 | 4.14 | 4.45 | 3.76 | 8.89 | 9.49 | 8.18 | 8.26 | 6.15 |
| Mango | 2.04 | 2.30 | 1.86 | 2.02 | 1.66 | 1.11 | 6.98 | 6.23 | 2.57 |
| Beef | 2.87 | 11.63 | 4.51 | 6.02 | 6.93 | 5.28 | 7.89 | 7.96 | 6.92 |
| Mutton | 1.84 | 4.52 | 2.88 | 1.96 | 3.43 | .99 | 3.34 | 8.25 | 3.09 |
| Fish | .33 | .21 | 3.48 | .29 | 2.08 | 1.93 | .00 | 1.15 | 1.13 |
| Eggs | .37 | .92 | .52 | .22 | 2.19 | 1.52 | .18 | 1.85 | .95 |
| Cheese | .06 | .39 | .14 | .19 | .27 | .33 | .00 | .32 | .24 |
| Jam | .03 | .23 | .10 | .63 | .35 | .83 | .00 | .14 | .37 |
| Biscuits | 2.51 | 4.53 | 2.96 | 4.13 | 3.47 | 2.93 | 3.77 | 3.09 | 3.61 |
| Soft drinks | .00 | .00 | .00 | .00 | .48 | .00 | .00 | .00 | .07 |
| Faba Bean | 1.79 | 2.40 | .95 | 2.46 | 3.49 | 3.53 | 3.23 | 7.55 | 2.96 |
| Dry Bean | .25 | .13 | .85 | 1.05 | .94 | 2.65 | .37 | .00 | .91 |
| Lentil | 3.66 | 5.59 | 3.98 | 4.67 | 3.47 | 4.48 | 5.19 | 7.19 | 4.71 |
| Rice | 2.66 | 8.35 | 4.00 | 5.66 | 3.32 | 5.48 | 6.15 | 5.85 | 5.46 |
| Marconi | .53 | 2.57 | 1.04 | 1.12 | 1.93 | 3.01 | .29 | .98 | 1.63 |
| Noodle | 1.93 | 3.63 | 2.64 | 3.71 | 3.13 | 2.91 | 5.62 | 1.90 | 3.31 |
| Milk | 18.20 | 60.42 | 33.85 | 20.82 | 43.97 | 35.80 | 31.14 | 82.54 | 39.13 |
| Tea | 1.43 | 1.43 | 1.02 | 1.77 | 1.43 | 1.12 | 1.45 | 1.32 | 1.42 |
| Sugar | 27.24 | 45.11 | 31.07 | 31.87 | 34.90 | 33.95 | 36.50 | 37.38 | 35.22 |
| Coffee | 2.62 | 2.30 | 2.13 | 2.67 | 1.50 | 2.59 | 2.92 | 2.61 | 2.39 |
| Cooking Oil | 6.50 | .29 | 7.02 | 10.34 | 10.34 | 7.88 | 8.36 | .00 | 6.85 |
| Tomato | .00 | .19 | .22 | .33 | .00 | .00 | .00 | .00 | .13 |
| Lubia | 2.70 | 1.28 | .00 | 12.60 | 2.19 | .06 | .00 | .00 | 3.61 |
| Outside food* | .00 | .00 | .03 | .55 | .02 | .25 | .00 | .00 | .17 |

* Rough estimate from expenditure

FOOD SECURITY IN THE WHITE NILE STATE OF SUDAN

b) Food-secure (kg/capita/year)

| Food Type | Alsalam | Dueim | Gabalain | Kosti | Quiteina | Rabak | Tandalti | Umrimta | Average |
|---------------|---------|--------|----------|--------|----------|--------|----------|---------|---------|
| Sorghum | 215.08 | 205.15 | 209.62 | 188.56 | 174.77 | 199.02 | 229.97 | 161.98 | 196.01 |
| Millet | 5.03 | 6.89 | 12.47 | 15.15 | 4.07 | 24.12 | 9.30 | 18.76 | 12.39 |
| Wheat | 5.58 | 48.95 | 21.13 | 52.49 | 27.12 | 56.34 | .51 | 52.12 | 38.52 |
| Bread | 3.35 | 37.80 | 23.00 | 12.72 | 32.44 | 26.53 | 15.43 | 24.20 | 23.48 |
| Okra | 7.00 | 2.16 | 3.81 | 4.58 | 9.48 | 4.12 | 8.56 | 4.00 | 5.18 |
| Jewsmallow | 7.34 | 3.12 | 6.27 | 7.07 | 7.69 | 8.90 | 6.99 | 6.04 | 6.61 |
| Dry okra | 6.97 | 5.96 | 4.69 | 5.70 | 2.84 | 4.52 | 8.07 | 6.45 | 5.34 |
| Purslane | 1.43 | 1.12 | 2.84 | 3.37 | 2.84 | 6.46 | 1.45 | 1.38 | 2.91 |
| Potato | .54 | 5.55 | 2.47 | 3.79 | 7.47 | 5.72 | 3.83 | 6.86 | 4.82 |
| Sweet Potato | 6.34 | 4.50 | 4.01 | 7.44 | 8.65 | 6.22 | 8.44 | 3.34 | 6.36 |
| Eggplant | 1.08 | 1.88 | 1.86 | .83 | 2.87 | 4.24 | 1.47 | 1.22 | 1.98 |
| Pumpkin | 1.27 | .38 | 2.03 | 2.06 | .30 | 4.53 | 1.14 | .12 | 1.62 |
| Cucumber | 7.76 | 10.34 | 2.80 | 13.56 | 11.24 | 11.66 | 6.77 | 12.53 | 10.28 |
| Carrot | .67 | .18 | .59 | .84 | .86 | 1.34 | .13 | .17 | .66 |
| Pepper | .54 | .09 | .33 | .41 | .99 | 1.77 | .22 | .00 | .58 |
| Rockets | 2.41 | 1.48 | 2.23 | 3.55 | 2.93 | 2.41 | 2.92 | 1.82 | 2.60 |
| Onion | 29.73 | 57.98 | 25.80 | 39.28 | 49.08 | 27.24 | 45.18 | 42.27 | 40.92 |
| Garlic | .77 | .92 | 1.25 | 1.13 | .62 | 1.27 | 1.01 | .51 | .99 |
| Banana | 5.41 | 7.67 | 5.69 | 6.50 | 9.90 | 11.70 | 11.15 | 10.23 | 8.43 |
| Orange | 9.32 | 5.08 | 4.98 | 4.67 | 10.91 | 13.06 | 10.19 | 12.00 | 8.00 |
| Mango | 4.00 | 3.39 | 2.18 | 2.57 | 2.02 | 1.49 | 8.31 | 8.94 | 3.41 |
| Beef | 4.74 | 14.18 | 4.85 | 7.07 | 7.78 | 5.52 | 9.05 | 9.75 | 8.12 |
| Mutton | 3.26 | 5.93 | 3.27 | 2.28 | 3.93 | 1.42 | 3.56 | 11.32 | 3.86 |
| Fish | .56 | .26 | 3.46 | .37 | 2.36 | 2.25 | .00 | 1.69 | 1.33 |
| Eggs | .76 | 1.32 | .65 | .23 | 2.66 | 2.17 | .11 | 2.72 | 1.26 |
| Cheese | .00 | .56 | .18 | .26 | .29 | .50 | .00 | .47 | .32 |
| Jam | .00 | .26 | .13 | .85 | .41 | 1.05 | .00 | .20 | .48 |
| Biscuits | 4.48 | 5.70 | 3.33 | 4.85 | 3.91 | 3.70 | 3.92 | 3.93 | 4.35 |
| Soft drinks | .00 | .00 | .00 | .00 | .46 | .00 | .00 | .00 | .07 |
| Faba Bean | 3.05 | 3.18 | 1.07 | 2.93 | 3.85 | 4.44 | 3.92 | 10.70 | 3.70 |
| Dry Bean | .54 | .17 | .95 | 1.33 | 1.05 | 3.75 | .43 | .00 | 1.19 |
| Lentil | 5.99 | 6.84 | 4.55 | 5.51 | 3.57 | 5.55 | 6.30 | 9.36 | 5.67 |
| Rice | 4.24 | 10.62 | 4.55 | 6.84 | 3.70 | 6.46 | 7.38 | 7.97 | 6.68 |
| Marconi | 1.08 | 3.27 | 1.25 | 1.28 | 2.50 | 3.82 | .14 | 1.20 | 2.01 |
| Noodle | 3.35 | 4.45 | 2.71 | 4.22 | 3.61 | 3.46 | 6.34 | 2.10 | 3.90 |
| Milk | 30.82 | 77.26 | 37.26 | 22.07 | 49.08 | 41.80 | 32.73 | 98.66 | 45.85 |
| Tea | 1.95 | 1.70 | 1.11 | 1.91 | 1.48 | 1.36 | 1.65 | 1.55 | 1.60 |
| Sugar | 35.31 | 53.98 | 33.93 | 35.33 | 39.09 | 40.73 | 41.29 | 44.24 | 40.60 |
| Coffee | 4.14 | 2.46 | 2.35 | 2.92 | 1.70 | 3.31 | 3.32 | 3.13 | 2.74 |
| Cooking Oil | 9.26 | .44 | 7.99 | 11.87 | 11.56 | 9.26 | 9.92 | .00 | 8.11 |
| Tomato | .00 | .28 | .28 | .39 | .00 | .00 | .00 | .00 | .17 |
| Lubia | 6.22 | 1.89 | .00 | 16.10 | 2.82 | .00 | .00 | .00 | 4.86 |
| Outside food* | .00 | .00 | .03 | .51 | .03 | .18 | .00 | .00 | .15 |

* Rough estimate from expenditure

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c) Food-insecure (kg/capita/year)

| Food Type | Alsalam | Dueim | Gabalain | Kosti | Quiteina | Rabak | Tandalti | Umrimita | Average |
|---------------|---------|-------|----------|-------|----------|-------|----------|----------|---------|
| Sorghum | 114.85 | 95.39 | 113.09 | 96.69 | 69.30 | 97.82 | 105.90 | 101.31 | 97.70 |
| Millet | .76 | .73 | .92 | 2.07 | .90 | .57 | 3.45 | 8.91 | 1.80 |
| Wheat | .16 | 7.31 | .79 | 7.41 | 9.89 | 4.93 | .00 | 3.21 | 5.15 |
| Bread | .70 | 10.53 | 6.77 | 5.45 | 21.70 | 3.91 | 3.57 | 5.94 | 7.49 |
| Okra | 3.09 | 1.42 | 1.73 | 2.16 | 2.81 | 2.09 | 5.75 | .86 | 2.31 |
| Jewsmallow | 2.66 | 2.37 | 6.33 | 2.51 | 2.69 | 4.51 | 4.08 | 2.18 | 3.20 |
| Dry okra | 3.98 | 3.43 | 3.33 | 3.02 | 1.24 | 3.08 | 4.14 | 3.88 | 3.17 |
| Purslane | 1.12 | .25 | 1.35 | 1.52 | 2.35 | 6.49 | .78 | .00 | 1.97 |
| Potato | .32 | 3.22 | .71 | 1.68 | 3.46 | 2.32 | 1.09 | 3.95 | 2.17 |
| Sweet Potato | 1.16 | 2.53 | 1.80 | 3.07 | 1.62 | 3.86 | 3.34 | 1.90 | 2.55 |
| Eggplant | .32 | .53 | 1.14 | .32 | 1.91 | 1.45 | .90 | .70 | .86 |
| Pumpkin | .32 | .21 | .30 | .25 | .47 | 2.26 | .90 | .00 | .63 |
| Cucumber | 1.30 | 4.53 | 2.06 | 6.16 | 5.14 | 9.00 | 1.88 | 6.97 | 5.10 |
| Carrot | .11 | .18 | .00 | .49 | 1.15 | .40 | .85 | .00 | .40 |
| Pepper | .11 | .26 | .00 | .27 | .48 | .41 | .64 | .00 | .28 |
| Rockets | .47 | 1.37 | 1.14 | 1.90 | 3.83 | 1.48 | .81 | .68 | 1.58 |
| Onion | 24.27 | 26.06 | 19.33 | 22.88 | 28.66 | 16.69 | 23.63 | 21.22 | 22.98 |
| Garlic | .25 | .21 | 1.64 | .62 | .42 | .61 | .25 | .47 | .51 |
| Banana | 1.13 | 2.85 | 4.76 | 2.59 | 5.16 | 2.22 | 4.27 | 2.06 | 2.94 |
| Orange | .44 | 2.19 | 2.41 | 1.24 | 2.74 | 2.37 | 1.82 | .20 | 1.73 |
| Mango | .55 | .02 | .65 | .47 | .58 | .35 | 2.75 | .40 | .55 |
| Beef | 1.45 | 6.29 | 3.22 | 3.10 | 4.36 | 4.78 | 4.24 | 4.10 | 4.07 |
| Mutton | .76 | 1.56 | 1.36 | 1.08 | 1.90 | .13 | 2.67 | 1.61 | 1.24 |
| Fish | .16 | .10 | 3.58 | .08 | 1.23 | 1.29 | .00 | .00 | .67 |
| Eggs | .08 | .09 | .00 | .20 | .76 | .20 | .40 | .00 | .21 |
| Cheese | .11 | .04 | .00 | .00 | .21 | .00 | .00 | .00 | .04 |
| Jam | .05 | .17 | .00 | .03 | .17 | .40 | .00 | .00 | .13 |
| Biscuits | 1.01 | 2.07 | 1.57 | 2.13 | 2.11 | 1.39 | 3.27 | 1.29 | 1.84 |
| Soft drinks | .00 | .00 | .00 | .00 | .55 | .00 | .00 | .00 | .06 |
| Faba Bean | .83 | .78 | .49 | 1.14 | 2.39 | 1.71 | 1.05 | .77 | 1.20 |
| Dry Bean | .03 | .05 | .46 | .27 | .62 | .44 | .17 | .00 | .26 |
| Lentil | 1.89 | 2.98 | 1.77 | 2.34 | 3.18 | 2.36 | 1.69 | 2.53 | 2.44 |
| Rice | 1.45 | 3.60 | 1.90 | 2.37 | 2.16 | 3.53 | 2.26 | 1.29 | 2.53 |
| Marconi | .11 | 1.13 | .21 | .65 | .19 | 1.38 | .76 | .50 | .70 |
| Noodle | .84 | 1.90 | 2.34 | 2.28 | 1.70 | 1.81 | 3.33 | 1.46 | 1.91 |
| Milk | 8.58 | 25.20 | 20.75 | 17.33 | 28.41 | 23.81 | 26.09 | 47.84 | 23.16 |
| Tea | 1.03 | .87 | .65 | 1.39 | 1.28 | .65 | .80 | .82 | .98 |
| Sugar | 21.09 | 26.56 | 20.04 | 22.26 | 22.15 | 20.38 | 21.31 | 22.61 | 22.40 |
| Coffee | 1.47 | 1.98 | 1.27 | 1.96 | .90 | 1.17 | 1.66 | 1.49 | 1.55 |
| Cooking Oil | 4.40 | .00 | 3.31 | 6.10 | 6.61 | 5.14 | 3.39 | .00 | 3.85 |
| Tomato | .00 | .00 | .00 | .15 | .00 | .00 | .00 | .00 | .03 |
| Lubia | .02 | .00 | .00 | 2.85 | .26 | .17 | .00 | .00 | .65 |
| Outside food* | .01 | .00 | .02 | .65 | .01 | .40 | .00 | .00 | .20 |

* Rough estimate from expenditure

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Appendix 8: Distribution of the food-deprived by occupation & locality

| Employment | Alsalam | Aldueim | Algabalain | Kosti | Alquiteina | Rabak | Tandalti | Umrimita | Total |
|---------------|---------|---------|------------|-------|------------|-------|----------|----------|-------|
| Employee | 0.0 | 6.1 | 0.0 | 0.0 | 14.3 | 0.0 | 0.0 | 0.0 | 2.8 |
| Farmer | 85.7 | 42.4 | 84.6 | 81.1 | 9.5 | 51.7 | 100.0 | 38.5 | 59.8 |
| Labor | 14.3 | 33.3 | 15.4 | 18.9 | 42.9 | 48.3 | 0.0 | 46.2 | 29.1 |
| Skilled Labor | 0.0 | 6.1 | 0.0 | 0.0 | 9.5 | 0.0 | 0.0 | 7.7 | 2.8 |
| Trader | 0.0 | 9.1 | 0.0 | 0.0 | 14.3 | 0.0 | 0.0 | 7.7 | 3.9 |
| Unemployed | 0.0 | 3.0 | 0.0 | 0.0 | 9.5 | 0.0 | 0.0 | 0.0 | 1.7 |

Appendix 9: Comparison of average per capita production (kg) and grown areas (feddans) of nutritionally-secure and insecure farming households, 2009/10

| Status | Sorghum | Wheat | Millet | Cotton | Sesame | Groundnut | Okra | Karkadeh | Onion | Tomato | Kidney Bean |
|---|---------|-------|--------|--------|--------|-----------|------|----------|-------|--------|-------------|
| Per Capita Production (kg) | | | | | | | | | | | |
| Secure | 170.5 | 24.6 | 2.5 | 2.7 | 8.9 | 8.6 | 2.4 | 0.1 | 4.5 | 2.0 | 0.2 |
| Insecure | 89.3 | 4.2 | 0.6 | 2.8 | 3.5 | 2.6 | 2.4 | 0.0 | 0.0 | 0.0 | 0.1 |
| All | 147.8 | 18.9 | 2.0 | 2.7 | 7.4 | 6.6 | 2.4 | 0.1 | 3.2 | 2.5 | 0.2 |
| Per Capita Grown Areas (feddans) | | | | | | | | | | | |
| Secure | 3.05 | 0.07 | 0.13 | 0.01 | 0.29 | 0.08 | 0.02 | 1 | | 0.01 | 0.01 |
| Insecure | 2.86 | 0.02 | 0.12 | 0.01 | 0.25 | 0.01 | 0.01 | 0 | | | |
| All | 2.72 | 0.05 | 0.13 | 0.01 | 0.28 | 0.06 | 0.02 | 1 | | 0.01 | |

Appendix 10: Average per capita grown areas (fed) of food-secure and food-deprived by locality

| Locality | Food-secure | Food-deprived | Gap (%) |
|--------------|-------------|---------------|-----------|
| Alsalam | 3.10 | 2.01 | 206 |
| Aldueim | 2.38 | 2.02 | 36 |
| Algabalain | 2.19 | 0.53 | 124 |
| Kosti | 6.09 | 2.64 | 130 |
| Alquiteina | 2.80 | 0.48 | 276 |
| Rabak | 3.14 | 6.36 | -51* |
| Tandalti | 5.45 | 2.25 | 142 |
| Umrimita | 2.62 | 0.28 | 483 |
| Total | 3.68 | 2.28 | 62 |

*The negative gap for Rabak is due to the confounding of the figures of both nutritionally-secure and insecure groups with big areas in large mechanized schemes.

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Appendix 11: Ranked Coping strategies of households by Locality

| Strategy | Alsalam | Aldueim | Algabalain | Kosti | Alquiteina | Rabak | Tandalti | Umrimita | Total |
|--|-----------|-----------|------------|------------|------------|-----------|-----------|-----------|------------|
| <i>Coping strategy - Rank 1</i> | | | | | | | | | |
| Reduce meals | 2 | 1 | 9 | 13 | 1 | 30 | 0 | 6 | 62 |
| Reduce food amount | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| shift to cheaper food | 0 | 0 | 1 | 8 | 0 | 2 | 1 | 0 | 12 |
| Work more | 10 | 13 | 18 | 38 | 17 | 31 | 9 | 5 | 141 |
| Resort to relatives | 6 | 4 | 1 | 10 | 22 | 0 | 3 | 5 | 51 |
| Borrow | 18 | 9 | 12 | 23 | 29 | 9 | 23 | 3 | 126 |
| Migrate | 0 | 0 | 0 | 12 | 2 | 1 | 0 | 1 | 16 |
| Sell assets | 1 | 1 | 7 | 12 | 0 | 3 | 8 | 0 | 32 |
| Adapt to situation | 0 | 1 | 1 | 2 | 3 | 0 | 0 | 0 | 7 |
| Dispense with luxuries | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 |
| Other | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| Total | 37 | 32 | 50 | 123 | 74 | 76 | 44 | 20 | 456 |
| <i>Coping strategy - Rank 2</i> | | | | | | | | | |
| Reduce meals | 2 | 0 | 10 | 2 | 0 | 1 | 1 | 0 | 16 |
| Reduce food amount | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 3 |
| shift to cheaper food | 1 | 0 | 0 | 9 | 0 | 2 | 0 | 0 | 12 |
| Work more | 14 | 4 | 8 | 10 | 17 | 7 | 11 | 3 | 74 |
| Resort to relatives | 2 | 2 | 2 | 12 | 13 | 2 | 1 | 0 | 34 |
| Borrow | 6 | 5 | 15 | 22 | 11 | 35 | 13 | 4 | 111 |
| Migrate | 0 | 2 | 0 | 3 | 0 | 0 | 0 | 3 | 8 |
| Sell assets | 0 | 1 | 1 | 13 | 0 | 6 | 0 | 0 | 21 |
| Less diversified food | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Adapt to situation | 0 | 2 | 0 | 3 | 3 | 0 | 0 | 0 | 8 |
| Dispense with luxuries | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| Other | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Total | 25 | 18 | 36 | 78 | 45 | 53 | 26 | 10 | 291 |
| <i>Coping strategy - Rank 3</i> | | | | | | | | | |
| Reduce meals | 0 | 0 | 8 | 2 | 0 | 0 | 0 | 0 | 10 |
| Shift to cheaper food | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| Work more | 3 | 3 | 4 | 3 | 1 | 0 | 3 | 0 | 17 |
| Resort to relatives | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 3 |
| Borrow | 0 | 0 | 1 | 5 | 1 | 8 | 0 | 0 | 15 |
| Migrate | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 4 |
| Sell assets | 0 | 0 | 0 | 4 | 0 | 4 | 0 | 1 | 9 |
| Less diversified food | 0 | 1 | 5 | 0 | 0 | 17 | 0 | 0 | 23 |
| Adapt to situation | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 1 | 5 |
| Total | 5 | 5 | 19 | 19 | 5 | 30 | 3 | 2 | 88 |