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International Institute of Tropical Agriculture – Institut international d'agriculture tropicale – www.iita.org

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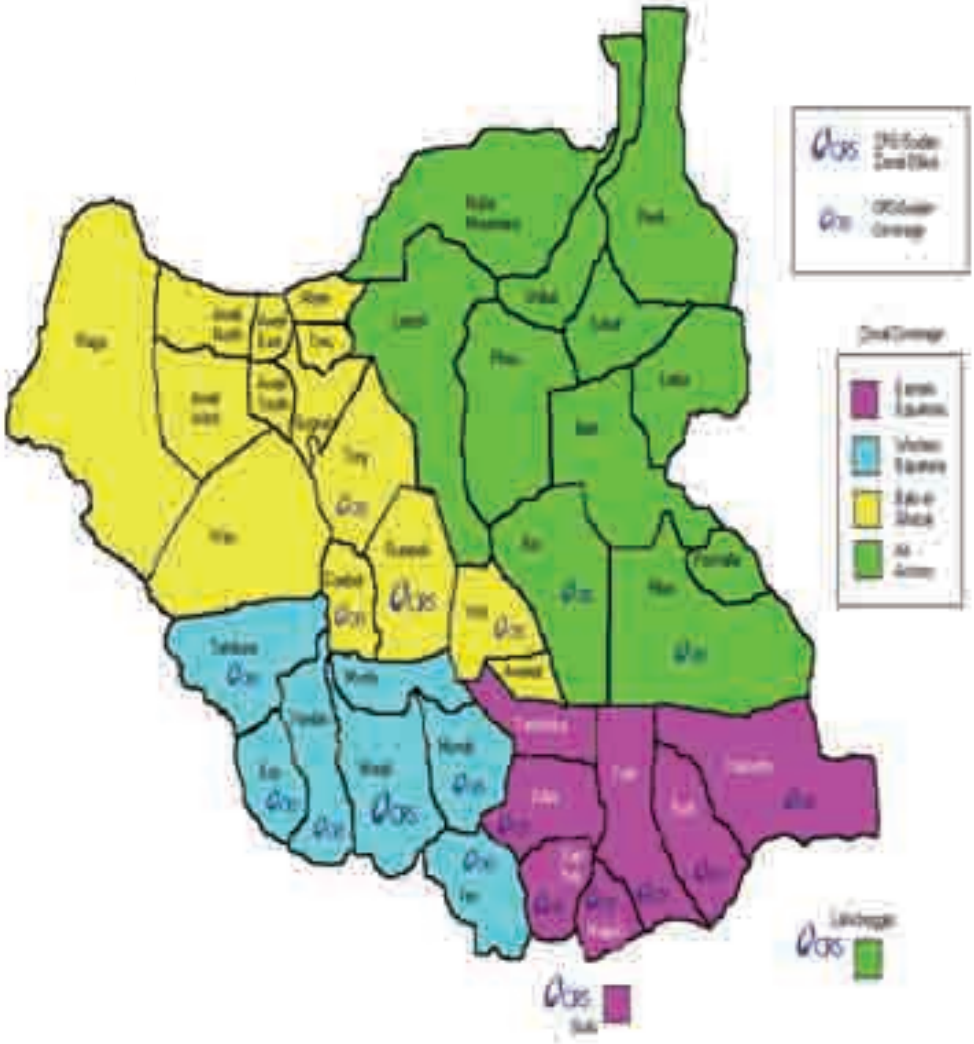

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Executive Summary

In an earlier visit by IITA and CIP scientists to Lobone in April 2005 to evaluate the improved cassava and sweetpotato varieties introduced to Eastern Equatoria by CRS over the years, it was proposed that a baseline study be conducted in Southern Sudan to determine the status of cassava and sweetpotato production with specific objectives. These objectives are: a) understanding the production systems; b) identifying cassava and sweetpotato varieties being grown and farmers' preferences; c) determining constraints and opportunities; d) establishing pest and disease incidence and severity on the two crops; e) testing farmers' knowledge and understanding of these crops in various aspects such as production, preservation/processing, utilization, and marketing and; f) assessing yield levels.

A baseline study was therefore conducted between October and November 2005 using a questionnaire and field observation techniques developed by IITA. The study covered two counties (Magwi and Ikotos) in Eastern Equatoria and four (Yambio, Ezo, Tambura and Maridi) in Western Equatoria. From each county, 4–6 extension agents who were familiar with the local language were trained on the techniques of administering the questionnaire, and a total of 226 farmers were interviewed. Field observations and assessments were carried out in 52 farmers' fields from the six counties. Cassava fields, between 3–6 months old were sampled for disease and pest incidence and severity. From each field, leaf samples were collected from CMD-infected plants and later used for DNA extraction and virus diagnostics. Cassava fields of more than 10 months of age were sampled for yield assessments. An area of 2 x 5(10m^2) was measured within each field from which yield parameters and CMD status were recorded.

Following the implementation of the baseline survey, the following results were obtained. The average household size in southern Sudan is 7.4 persons, Eastern Equatoria 7.0, and Western Equatoria 7.9. Southern Sudan has diverse cropping systems with over 30 crops grown either as sole or intercrops. Overall, the most widely grown crop in Southern Sudan is cassava (20.8%) followed by groundnut (14.4%), sweetpotato (13.8%), sorghum (9.1%), maize (8.4%), sesame (7.7%), rice (6.2%), finger millet (4.9%), cowpea (2.6%) and beans (1.9%). Farmers also ranked cassava (31.6%) as the most important crop, followed by

sorghum (24.0%), groundnut (14.2%), maize (9.3%), bull rush millet (5.8%), and rice (3.1%). Sweetpotato, sesame, and finger millet were placed at almost the same position (2.7%) after rice. Generally, farm sizes range from < 0.01 ha to 5 ha, in Equatoria Region.

Farmers from both Eastern and Western Equatoria differed in their choice of primary crops grown for sale. In Eastern Equatoria, 25.5% of the farmers ranked sesame as the most important crop from which they derive income, 18.6% reported cassava, 16.7% groundnuts, and only 6.9% rated maize and sweetpotato as their primary cash crop. On the other hand, in Western Equatoria, maize was the most important cash crop (30.2%) followed by cassava (29.3%), rice (16%), and groundnuts (14.2%). Cassava therefore, comes second as an income-generating crop after sesame and maize in Eastern and Western Equatoria, respectively.

Cassava is grown by about 85% of the farmers in the Equatoria States, with over 95% of farmers in Western Equatoria and about 57% in Eastern Equatoria. The average cassava field size ranges from 0.005 to 0.2 ha in the two states. Most farmers in the area plant their cassava in April. In Eastern Equatoria, cassava is predominantly grown as an intercrop, with about 81% of the farmers practicing intercropping with other crops compared to only 40% in Western Equatoria. The five commonest crops intercropped with cassava in Eastern Equatoria are maize (40.5%), beans (27%), groundnuts (18.9%), sorghum (5.4%), and sesame (2.7%). In Western Equatoria, the top five intercrops involved groundnuts (42%), maize (29.2%), sesame (11.8%), finger millet (4.1%), and sorghum (2.6%)

Cassava is mainly grown for food (37.8%), sales (29.9%), brewing (29.0%), and animal feed (2.4%). Other purposes for which cassava is grown include planting materials (seed) and firewood. More than 100 cassava varieties are being grown in Equatoria. The ten most preferred varieties in Eastern Equatoria are Oresto (28%), Abbey Ife (22%), SS4 (10%), Okonyo ladak (6%), Uku komaku (6%), TME 12 (4%), MM95/0414, TME 14, TME 5, and Bylaw (2.0% each). In Western Equatoria**,** the most preferred varieties are Baworoworo (35.0%), Tiara (20.2%), Karangba (20.3%), Adegude (7%), Okonyo Ladak (2%), Oresto, MM95/0414, Abirika, Mbara, and Zangoze (1% each) (Fig, 9). In assigning attributes to the these varieties, farmers ranked early maturity as the most positive attribute (22.0%), followed by high yield (17.4%), sweetness (15.0%), big tuberous roots (4.6%), good cooking quality (4.5%), good flour quality

(3.9%), good field storage (3.4%), and good for brewing (2.23%). Other positive attributes include palatable leaves, drought resistance, resistance to diseases and pests, good aroma, ability to suppress weeds, and good sprouting ability. Of the negative attributes, bitterness came out strongly (10.0%), followed by long maturity period (5.1%), poor field storage (2.4%), low yield (1.3%), and change in taste when left for long periods in the field (1.0%). Other negative attributes given by the farmers include long cooking duration, production of less planting material, difficulty in eating when cooked, and high fiber content in the roots.

About 85% in Eastern and 7.8% of the farmers in Western Equatoria reported having enough planting materials. In both States, it was reported that the most important sources of cassava planting materials were the neighbors and own farms. Other sources of planting materials included NGOs, relatives, local markets, and sources from Uganda. About 98% of farmers in Eastern Equatoria compared to 86% in Western Equatoria have some knowledge of storing cassava planting materials. In Eastern Equatoria, 22% of farmers recognized storage under shade as one way of prolonging the shelf-life of their planting materials, 21.1% reported field storage as another way of storing planting materials while 13.3% keep the stems near water. In Western Equatoria, most farmers (59.2%) use field storage, 13.6% store under shade, while 10.4% keep stems near swamps or streams. Other storage methods mentioned include keeping underground and watering, bundling, and watering, in the house and along river banks. Among the different methods for storing planting materials, field storage was reported best with a mean storage time of 19.6 weeks while storage in a cool dry place gave a storage period of 16.4 weeks. These were followed by storage along riverbanks (7.6 weeks), bundling and watering (4.4 weeks), keeping near swamp/ stream (4.1 weeks), and in house/under a shelter (4.0 weeks).

Only 24% of farmers in Equatoria were able to recognize cassava diseases as one of the most limiting biotic constraints to cassava production. Of these, 68% ranked cassava mosaic disease (CMD) as the most limiting factor, followed by root rots (17.5%), fungal diseases (3.5%), and other leaf diseases (1.8%). More than 50% of the farmers interviewed recognized cassava pests as constraints to cassava production in the Equatoria States. Among the pests identified, porcupines were ranked as the most destructive (23.8%), followed by mole rats (21.4%), termites (9.5%), and wild pigs (6.3%). Other pests

mentioned by farmers included, grasshoppers, millipedes, bush rats, monkeys, and domestic animals. Theft was also recorded as a problem. About 85% of the farmers who know cassava diseases do not control them in any way. Few farmers (15%) have adopted a number of control measures. The commonest method of disease control is crop rotation (35.3%), followed by roguing (17.5%), timely weeding (11.8%), and field clearing (11.8%). At least 45% of the farmers who know pests were able to institute some control measures such as the use of traps or nets (54.4%), physical scaring (12.4%), hunting (10.7%), field clearing (5.3%), and fencing off (4.1%). Other methods used against domestic and wild animals include fencing, digging, and use of fire/smoking.

Harvesting of cassava is done either piecemeal or harvesting entire plants. More farmers (71.4%) in Eastern Equatoria used the piecemeal method than in Western Equatoria (67.9%). Of all the harvested cassava roots in Eastern Equatoria, 37.7% was eaten in boiled form, 30.3% for sale, and 19.8% for brewing, while 9.9% dried into chips for storage. Other methods of utilization in Eastern Equatoria included livestock feed (1.8%) and sale of fresh tuberous roots (0.6%). In Western Equatoria, 31.1% of tuberous roots were eaten boiled, 19.7% sold, 18.1% used in brewing, and 7.7% roasted. Other utilization methods in Western Equatoria included, fermentation, making flour, selling fresh roots, giving out to others, making chips and drying, feeding livestock and making *tamia*. Cassava leaf is widely eaten in the Equatoria States, especially in Western Equatoria where it is the main vegetable. Cassava leaves are also used for feeding animals and some farmers reported cassava leaves to be of medicinal value, especially in treating skin diseases in children and headache in adults.

In the Equatoria States, about 85% of the farmers sell their cassava in the form of fresh and boiled roots, fermented cassava flour, and cassava leaves. Alcoholic products from cassava are also a source of income. *Tamia* is a popular cassava derivative sold mainly in Western Equatoria. Marketing outlets for these products are neighbors, local nearby markets, and to a very limited extent, local traders. In Eastern Equatoria, 49.4% of the farmers sold their cassava to their neighbors, 46.1% in the nearby local markets while 3.4% sold to local traders. Only 1.1% of the farmers sold their cassava to traders from neighboring countries. In Western Equatoria, nearby local markets (49.5%), are the main avenues for selling cassava, followed by neighbors (39.5%), and local traders (9.5%).

The biggest constraints to cassava production as viewed by the farmers in Eastern Equatoria are pest attack (29.2%) followed by drought (22.9%), perennial weeds (14.6%), diseases (10.4%), and shortage of planting materials (10.4%). In Western Equatoria, the major constraint was also pest attack (23.7%), followed by perennial weeds (13.2%), lack of labor, and diseases (7.9% each).

The average plant population recorded in Eastern Equatoria was 5800 plants/ha and in Western Equatoria and 5400 plants/ha. On average, yields of cassava was 35.8 t/ha in Western Equatoria and 14.9 t/ha in Eastern Equatoria.

The most common disease of cassava encountered in southern Sudan was cassava mosaic disease (CMD). The overall CMD incidence was 69.4 %, of which 53.9 % was cutting-borne and 15.5 % whitefly-borne infection. CMD incidence was highest in Ibba (78.4%) and lowest in Magwi County (56.5 %). All the counties surveyed had average CMD incidences over 55%. CMD severity was moderate with a mean score of 2.8, and the most frequent severity score was 3 (29.7%) indicating moderate disease. Yambio County had the highest mean score at 3.3 and the lowest was Ibba County at 2.6. Of the 49 total DNA extracts from leaf samples analyzed, 48 (98%) gave positive results of which 7 (14.7%) had *African cassava mosaic virus* (ACMV) alone, 13 (27.0%) had only *East African cassava mosaic virus-Uganda* (EACMV-UG), and 7 (14.7%) had both EACMV-UG and ACMV viruses in dual infections. Other forms of *East African cassava mosaic virus* (EACMV) were detected in 8 (16.7%) samples while dual infections of EACMV and ACMV occurred in 13 (27.0%) of the samples analyzed. Overall, the prevalence of virus types was ACMV (56.4%), EACMV (43.7%), and EACMV-UG (41.7%).

Cassava bacterial blight (CBB) was present, but incidence (5.6%) and severity (2.0%) were generally low. CBB was recorded only in Magwi and Ezo counties, and did not occur at all in the other counties. The highest incidence was in Magwi County (10.8%).

Cassava green mite (CGM) was recorded throughout the surveyed areas but severity was low averaging 2.2. Cassava mealybug (CM) was recorded in only one field in Ikotos County with a mean severity of 2.9.

Whitefly population ranged from 0.6 to 2.6, with a mean of 1.7 adult whiteflies per shoot tip. The nymph population ranged from 0.5 to 3.5 individuals per leaf. *Typhlodromalus aripo*, the predatory mite of CGM, occurred in all the counties in Western Equatoria but was not seen in Eastern Equatoria. The mean incidence was 7.4%, with the highest incidence recorded in Ibba (25%) and the lowest in Yambio (1.1%).

There are diverse challenges in cassava production, utilization, and trade in Southern Sudan. In order to address these, collaborative effort by all concerned stakeholders is required; putting in place a system that is productive, sustainable and profitable in long term. This can be done through:

A. Technical requirement
   a) Germplasm collection, conservation, and evaluation/ characterization for both local and improved varieties
   b) Screening of planting materials
   c) Development of appropriate crop improvement strategy
   d) Introduction of appropriate crop production and processing technologies
   e) Introduction, evaluation, and dissemination of CMD-resistant varieties
   f) CMD mitigation program.

B. Infrastructural and capacity requirement
   a) Capacity building and trainings
   b) Consolidating collaborative networking
   c) Improvement in infrastructure
   d) Security enhancement

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Last but not least, we would like to acknowledge the financial support from the United State Agency for International Development (USAID) through CRS East Africa Regional Office, Nairobi.

Abbreviations

AAH	Action Africa Help
ACMV	African Cassava Mosaic Virus
CBB	Cassava Bacterial Blight
CGM	Cassava Green Mite
CIP	International Potato Centre (Spanish acronym)
CM	cassava mealybug
CMD	Cassava Mosaic Disease
CRS	Catholic Relief Services
DNA	deoxyribonucleic acid
EACMV	East African cassava mosaic virus
EACMV-UG	East African cassava mosaic virus-Uganda
EARRNET	Eastern Africa Root Crops Research Network
FAO	Food and Agriculture Organization
IDPs	internally displaced persons
IFAD	International Fund for Agricultural Development
IITA	International Institute of Tropical Agriculture
NGOs	nongovernmental organizations
PCR	polymerase chain reaction
SPLA	Sudan People's Liberation Army
USAID	United States Agency for International Development
WV	World Vision

Introduction

1

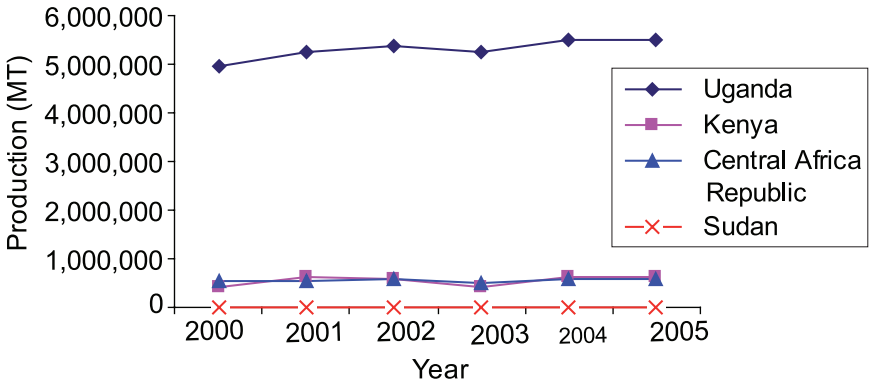
Cassava in the livelihood of African people

Cassava (*Manihot esculenta* Crantz) is a major source of food for more than 500 million people in Africa, Latin America, and Asia. It is considered second in importance to maize as a major source of carbohydrates, accounting for more than 200 calories/day / person. About 53.4% of world cassava production comes from Africa where about 40% of the population in sub-Saharan Africa depends on it as staple food (Nweke *et al*., 2002).

The ability to adapt to marginal environments and its contribution to household food security and income makes cassava important in improving the livelihoods of the rural poor (Nweke and Ezumah, 1992; Dahniya, 1994; FAO and IFAD, 2000; Kebe *et al*., 2001). Presently, many of the world's poorest developing countries and most food-insecure households see cassava as the principal source of food security, nutrition, and income.

In Africa, many cassava farmers derive income through traditional processing and sale of fresh roots, leaves, chips, flour, and/or alcoholic beverages at small-scale level. Women are more involved in processing and sale of these products (Nweke, 1994), although the biggest share of the sale often goes to men.

Despite the numerous advantages and great potential for utilization, cassava farmers in Africa are faced with a number of constraints, among which are biotic and abiotic stresses, a narrow range of existing processed products, a lack of improved processing technologies, a lack of technical know-how and the lack of a supportive policy for commercialization of cassava. Furthermore, the absence of a clear marketing chain for cassava and cassava-based products, lack of entrepreneurship skills among farmers and processors, as well as the scattered nature of cassava producers also contribute to the low production and utilization of cassava and cassava-based products in the region.



Source: FAOSTAT (2006)

Figure 1. Cassava production in some countries in East and Central Africa.

Cassava production in Sudan

Sudan is the largest country in Africa, but since achieving independence from Britain in 1956, the country has known only 11 years of peace, between 1972 and 1983. About two million people are estimated to have been killed and four million more displaced by the civil war that has been going on for three decades. The war has impacted negatively on the productive capacities of communities in Southern Sudan in particular. Social and economic developments have been critically impaired and this has resulted in the disintegration of family and social structures. Communities are vulnerable to food insecurity and malnutrition, which contributed to the high death rates recorded.

Catholic Relief Service (CRS), an American NGO supported by USAID, has, in recent years, been promoting the cultivation of cassava and sweetpotato in Eastern Equatoria, in order to build local capacity for livelihood recovery through a project that is contributing to household food security, socioeconomic growth and development among internally displaced persons (IDPs), returnees, and resident communities in Nimule, Lobone, and Ikotos. As a consequence of the insecurity, there is no proper knowledge of the farming system and particularly of cassava and sweetpotato cultivation in the region. Cassava production in Sudan is still very low compared to other countries within the East and Central Africa (ECA) region (Fig. 1). According to FAO statistics, annual cassava production is estimated at less than 100 000 tons at a yield level of less than 2 t/ha (Fig. 2). In Sudan, cassava is grown widely in Western and Eastern Equatoria and in some parts of Bahr el Ghazal and Upper Nile. The production is still subsistence in nature.

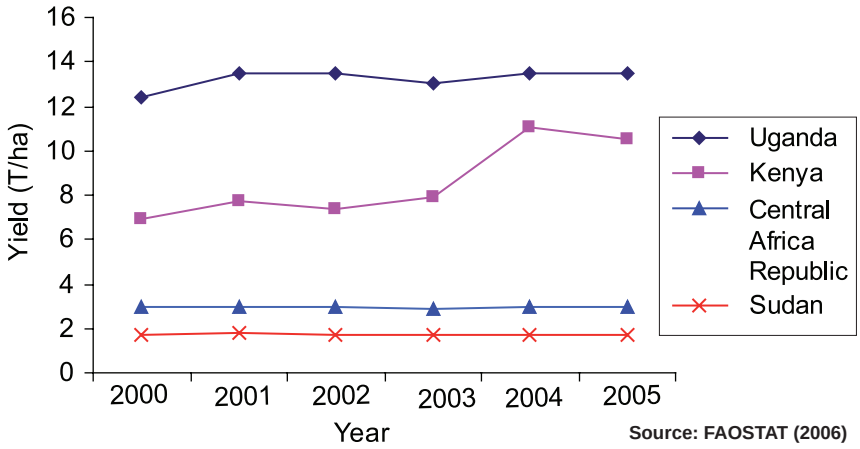


Figure 2. Yield (t/ha) of cassava in some countries in East and Central Africa.

With financial support from USAID, CRS facilitated introduction of ten improved cassava varieties into Eastern Equatoria in 2001. These varieties originated from the International Institute for Tropical Agriculture (IITA) Uganda. The 10 varieties were SS 4, TME 5, TMS 30572, TME 12, TME 14, MH95/0414, ABBEY-IFE, I92/0057, I92/0067, and 192/0427. Each variety was planted in a 0.15ha controlled demonstration plot and evaluated for agronomic characteristics, diseases, and pests. Some of the materials were later given out to farmers in project areas. CRS is currently operating in almost all counties in Eastern and Western Equatoria and in some parts of Bahr el Ghazal. Other NGOs carrying out agricultural activities in Southern Sudan include World Vision and Action Africa Help (AAH) based in Western Equatoria.

Objectives of the study

Based on an earlier visit by IITA and CIP scientists to Lobone in April 2005 to evaluate the improved cassava and sweetpotato varieties introduced to Eastern Equatoria by CRS over the years, one of the recommendations made was to carry out a baseline study in the whole of Southern Sudan. To fulfill the recommendation, the baseline study was carried out between October and November 2005 to determine the status of cassava and sweetpotato production in Equatoria with the following specific objectives:

a) Understand the production systems in Southern Sudan
b) Find out how cassava and sweetpotatoes are grown, and farmers' preferences
c) Determine constraints and opportunities available
d) Establish pest and disease incidence and severity on the two crops
e) Test farmers' knowledge and understanding of these crops in various aspects such as production, preservation, utilization, and marketing
f) Assess yield levels of both cassava and sweetpotato in Southern Sudan

Materials and Methods

2

The study was conducted in Equatoria region (Southern Sudan) using a questionnaire and field observation techniques developed by IITA and CIP. The questionnaire targeted farmers selected at random while field observations were made in fields with specific crop age categories.

The team moved to pre-determined locations in Eastern Equatoria (Ikotos and Magwi counties) and Western Equatoria (Yambio, Ezo, Tambura, and Maridi counties) (Fig. 3). These areas were considered to be secure and had relatively easy road access. In Eastern Equatoria, payams were selected also based on accessibility and security considerations while in Western Equatoria payams were randomly selected after screening out those that were inaccessible.

From each of the locations visited, 4–6 extension agents who were familiar with the local language were trained on the techniques of administering the questionnaire (Annex 1). The questionnaire was administered to about 30 farmers from each county, randomly selected along a transect, A total of 226 farmers were interviewed. Cross-checking was done in the field by an IITA staff to ensure that information collected was accurate.

Figure 3. Counties in Eastern and Western Equatoria, Southern Sudan.

Field observations and assessments were carried out in 52 farmers' fields from the six counties. Information on the exact location of the fields was obtained using a Global Positioning System (GPS) handset. During the survey, cassava fields between 3–6 months old were sampled for pest and disease incidence and severity. Thirty plants were assessed along two diagonals of each field and leaf samples were collected from a CMD-infected plant showing symptoms representing the general situation in the field. These were used for subsequent DNA extraction and virus diagnostics. The samples were kept in a cool box containing frozen ice brix. A total of 49 CMD symptomatic leaf samples were collected, and DNA was extracted at the end of each day from the plant tissues collected using the IITA–Uganda protocol modified from that described by Dellaporta *et al* (1983).

Cassava mosaic disease (CMD): The parameters taken for CMD were symptom severity and infection type. Severity was scored on a scale of 1–5, where 1 represented no symptoms and 5 the most severe symptoms. Infection types were categorized as "C" (cutting-borne) and "W" (whitefly-borne) infections. Where the lower first formed leaves showed symptoms, infection was assumed to be cutting-borne, while where only upper leaves showed symptoms, infection was considered as whitefly-borne.

Whitefly abundance: Adult whitefly (*Bemisia tabaci*) were counted on the top five fully-expanded apical leaves and nymphs were counted on the 14th leaf of the tallest shoot on 15 of the 30 plants sampled per field and the totals were recorded separately.

Cassava bacterial blight (CBB): Cassava bacterial blight (CBB) severity was assessed by scoring severity of the disease on the 30 sampled plants using a scale of 1–5, where 1 represented no symptoms and 5 the most severe symptom.

Cassava green mite (CGM) and cassava mealybug (CM) assessment: The severity of these was assessed on a scale of 1–5, where 1 represented no symptoms and 5 the most severe symptom.

***Typhlodromalus aripo* (*T. aripo*), predatory mite of CGM**: The occurrence and incidence was assessed by carefully opening the shoot tip of the tallest shoot of 10 plants at random along the diagonals of sampled fields and indicating presence by '+' and absence by '–'.

Cassava yield assessment: Cassava fields of more than 10 months old were sampled to assess yield. An area (2 x 5)m^2 was measured within each field and the number of stands and CMD status of all the plants enclosed within the area were taken, plants harvested and yield parameters (tuberous root numbers and weights) recorded for each plant separately.

Laboratory diagnosis of cassava mosaic geminiviruses (CMGs) through PCR amplification: Primer pairs specific for ACMV (AL1/F and ARO/R), EACMV-UG (UV-ALI/F1 and ACMV-CP/R3), and EACMV (UV-AL1/F and UV-AL1/R) were used to amplify fragments of DNA-A of cassava mosaic geminiviruses (CMGs) in the reaction mixture as shown below:

a)	Water	10.6µl
b)	PCR buffer (x10)	2.5µl
c)	$MgCl_2$ (25mM)	1.5µl
d)	DNTPs (2.5mM)	1.0µl
e)	Primer 1 (20µM)	0.2µl
f)	Primer 2 (20µM)	0.2µl
g)	Taq polymerase (1unit)	0.25µl
h)	DNA Template	5µl

Two drops of mineral oil were layered on top of each tube to stop evaporation. The viral DNA was amplified Hybaid thermal cycler under the conditions below:

Initially:	(94ºC for 1 min, 55ºC for 1.30 min, and 72ºC for 2 min) for 1 cycle
Then:	(94ºC for 1 min, 55ºC for 1.30 min, and 72ºC for 2 min) for 30 cycles
Finally:	(94ºC for 1 min, 55ºC for 1.30 min, and 72ºC for 10 min) for 1 cycle

The amplified DNA fragments were electrophoresed in a 1.2% agarose gel stained with ethidium bromide and run at 80 volts for 45 minutes in x1 Tris-Acetate-EDTA (TAE) buffer of pH 8. The gel was then visualized under UV light and photographed using an Olympus digital camera with the Digi Doc-IT gel imaging system.

Results and Discussion

3

Gender of respondents

From the 226 farmers interviewed, 109 were from Western Equatoria where 77 farmers (70.6%) were male and 32 farmers (29.4%) were female. In Eastern Equatoria, more females (68) corresponding to 58.1% were interviewed and 49 males corresponding to 41.9% (Fig. 4.).

Size of the farm household

The household size in Equatoria ranged from 1 to 33 persons per household with an average of 7.4. Eastern Equatoria had an average of 7.0 persons and Western Equatoria 7.9 persons per household (Table 1). Western Equatoria is relatively stable and had more productive resources which could explain a slightly higher number of persons per household in a typical African setting.

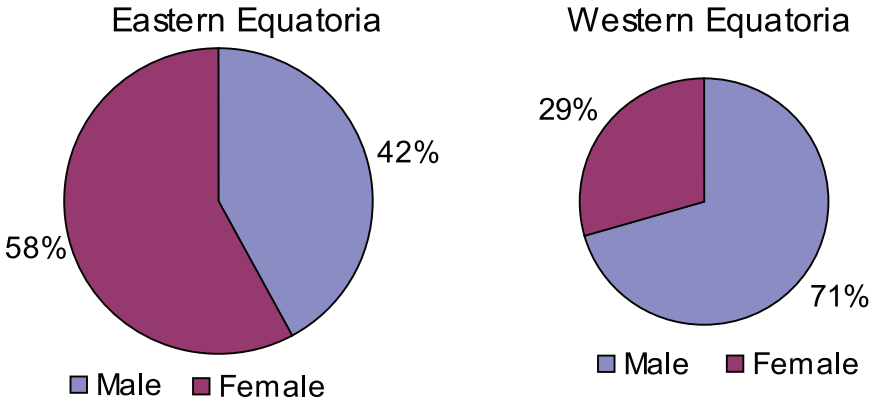


Figure 4. Sex of the interviewed respondents by State.

Table 1. Household size in Equatoria region.

State	Observation	Mean
E. Equatoria	117	7.0
W. Equatoria	108	7.9
Total	225	7.5

Table 2. Average farm size (hectares) for all the crops.

Region	Obs	Mean	Std. Dev.
Average farm size (E. Equatoria)	111	0.2	0.41
Average farm size (W. Equatoria)	107	0.1	0.50
Average farm size (whole sample)	218	0.1	0.46

Cropping system and crop production

Southern Sudan has diverse cropping systems with over 30 crops grown either as sole or intercrops in both systematic and unsystematic patterns, whereby one of the component crops is planted in lines and the other broadcast. Crops being grown in the area include cereals (maize, rice, sorghum, finger millet, and bulrush millet), oil seeds (groundnut, sesame, soybean, and sunflower), root crops (cassava, sweetpotato, yams, and coco yams), legumes (beans, cowpea, pigeon pea, bambara nuts, and green grams), tree crops (mangoes, citrus, coffee, palm trees, avocados, passion fruits, etc.), and vegetables (onions, cabbages, okra, etc.). Generally, farm sizes range from < 0.01 ha to 5 ha. Farms in Western Equatoria are generally larger than those in Eastern Equatoria (Table 2.). Farmers in Eastern and Western Equatoria allocate 20–30% of the annual cultivable land to cassava and sweetpotato. Field sizes of cassava were larger than those of sweetpotato for most of the households visited.

Widely grown crops in Southern Sudan

Overall, the most widely grown crops in the Equatoria State of Southern Sudan are cassava (20.8%), followed by groundnut (14.4%), sweetpotato (13.8%), sorghum (9.1), maize (8.4%), sesame (7.7%), rice (6.2%), finger millet (4.9%), cowpea (2.6%), and beans (1.9%).

In Eastern Equatoria, the most widely grown crop is sorghum (17.2%) followed by cassava (15.6%), sweetpotato (15.3%), groundnut (12.6%), sesame (11.0%), maize (7.6%), cowpea (5.8%), bull rush millet (BRM) (3.9%) beans (2.8%), finger millet (2.0%), and okra (1.8%). In Western Equatoria, cassava takes an upper hand with 23.4%. This is followed by groundnut with 15.6%, sweetpotato (12.7%), rice (10.2%), maize (9.0%), finger millet (7.0%), sesame (5.5%), sorghum (3.5), banana (2.3%) and okra (1.8%) (Fig.5).

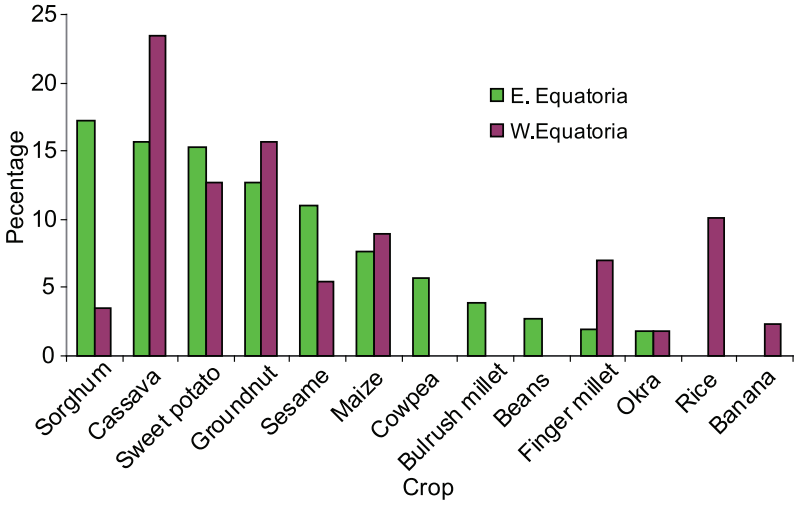


Figure 5. Crop widely grown in Eastern and Western Equatoria.

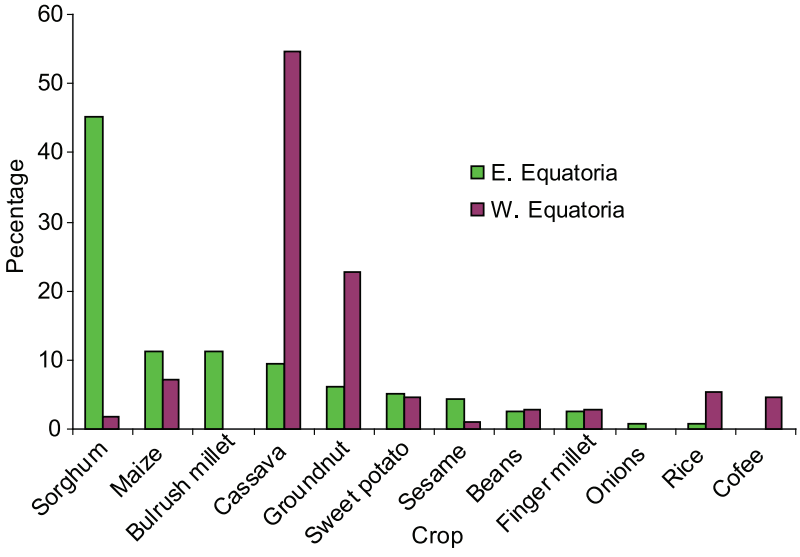


Figure 6. First priority crops in Eastern and Western Equatoria.

Importance of the crops to households in Eastern and Western Equatoria

Overall, the most important crops, as ranked by farmers, are cassava (31.6%), followed by sorghum (24.0%), groundnut (14.2%), maize (9.3%), bull rush millet (5.7%), and rice (3.1%). Sweetpotato, sesame, and finger millet were placed at almost the same position (2.7%) after rice.

The most important crops in Eastern Equatoria are sorghum (45.2%), followed by maize (11.3%) and bull rush millet (BMR) (11.3%), cassava (9.57%), groundnut (6.1), sweetpotato (5.2), beans (2.6%), and finger millet (2.6%); while in Western Equatoria, cassava is ranked as the most important crop (54.6%), followed by groundnut (22.7%), maize (7.3%), rice (5.5%), coffee and sweetpotato (4.6%), finger millet (2.73%), and sorghum (1.8) (Fig. 6).

Market-oriented crop production

Farmers from the two states differed in their choice of primary crops grown for sales. In Eastern Equatoria, 25.5% of the farmers interviewed ranked sesame as the most important crop from which they derive income, 18.6% reported cassava, 16.7% groundnuts, and 6.9% planted maize and potato as their primary cash crop (Table 2). On the other hand, in Western Equatoria, maize was the primary cash crop grown (30.2%) followed by cassava (29.3%), rice (16%), groundnuts (14.2%), and coffee (4.7%). Cassava therefore comes second as an income-generating crop after sesame and maize in Eastern and Western Equatoria, respectively (Fig. 7).

Cassava production and utilization

In Equatoria region, about 85% of the farmers grow cassava comprising over 95% of farmers in Western Equatoria and about 57% in Eastern Equatoria. The average cassava field size ranges from 0.005 to 0.2 ha (Table 3).

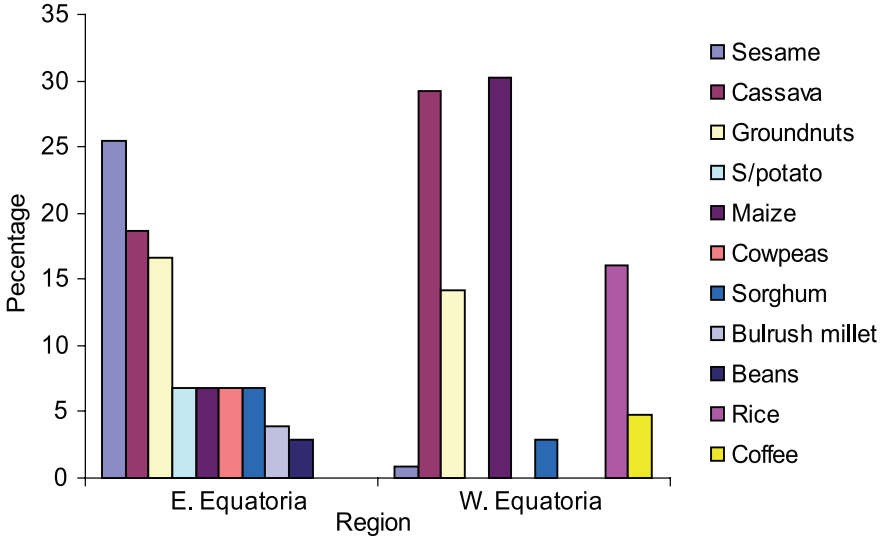


Figure 7. Income generating crops.

Table 3. Cassava and sweetpotato field size (ha).

Variable	Obs	Mean	Std. Dev.
Eastern Equatoria			
Cassava farm size (ha)	48	0.06	0.05
Sweetpotato farm size (ha)	54	0.03	0.03
Western Equatoria			
Cassava farm size (ha)	75	0.07	0.02
Sweetpotato farm size (ha)	66	0.02	0.02

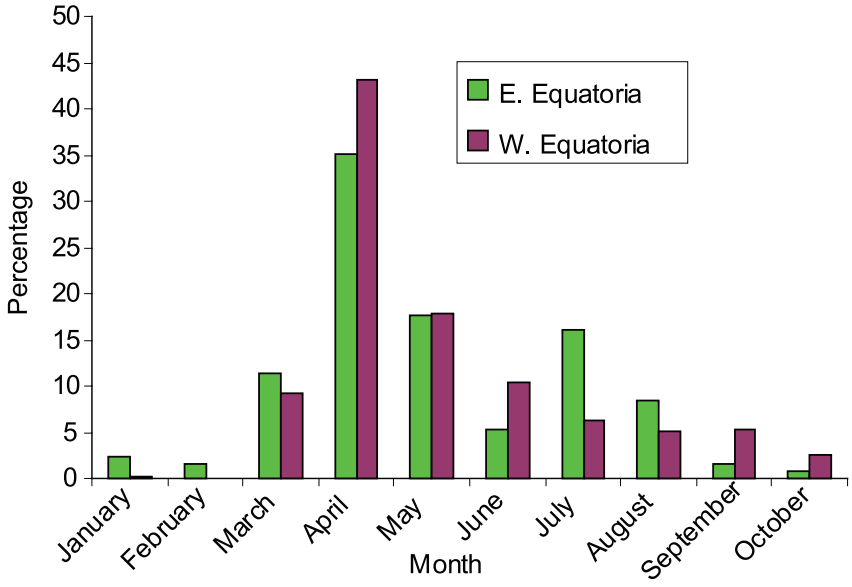


Figure 8. Months preferred for planting cassava by farmers.

Table 4. Crops commonly intercropped with cassava.

	Crop	Eastern Equatoria %	Western Equatoria %
a)	Maize	40.5	29.2
b)	Beans	27.0	2.6
c)	Groundnuts	18.9	42.1
d)	Sorghum	5.4	2.6
e)	Sesame	2.7	11.8
f)	Soybean	2.7	0.00
g)	Finger millet	2.7	4.1
h)	Cowpea	0.00	2.1
i)	Okra	0.00	2.1
j)	Rice	0.00	2.1
k)	Others	0.00	2
Total		100	100

Planting of cassava

The majority of farmers in the Equatoria region prefer planting their cassava in April. Some cassava growers start planting as early as March and others extend their planting up to August through May, June, and July (Fig. 8).

Cassava cropping system

Only 19 %of the households in Eastern Equatoria grow cassava as a sole crop while 81% grow it as an intercrop. In Western Equatoria, 60% grow cassava as a sole crop while for 40% it is an intercrop.

Table 5. Purpose for growing cassava in Equatoria region.

Purpose	Percent
Food	37.8
For sale	29.9
Brewing	29.0
Animal feed	2.4
For cuttings	0.4
Firewood	0.4
Total	100

In Eastern Equatoria, up to seven crops were reported being intercropped with cassava at any one time. The commonest five were maize (40.5%), beans (27%), groundnuts (18.9%), sorghum (5.4%), and sesame (2.7%). In Western Equatoria, 12 crops were being intercropped with cassava, of which the top five comprised groundnuts (42%), maize (29.2%), sesame (11.8%), finger millet (4.1%), and sorghum (2.6%) (Table 4). Other intercrops less frequently intercropped with cassava were sweetpotato and pumpkin.

Purpose for which cassava is grown

Cassava is mainly grown for food, sale, brewing alcoholic products, animal feed, planting materials (seed), and firewood. In both States, 37.8% of the farmers grow cassava for food, 29.9% for sale, another 29.0% grow cassava for brewing, 2.4% for animal feeds while the rest grow cassava for cuttings and firewood (Table 5).

Popular cassava varieties grown in Equatoria region

A number of cassava varieties, both local and improved, are being cultivated across the region. A total of 198 cultivars were named by farmers in the surveyed areas of Southern Sudan. The following were the ten most preferred varieties in Eastern Equatoria: Oresto (28%), Abbey Ife (22%), SS4 (10%), Okonyo ladak (Bao) (6%), Uku komaku (6%), TME 12 (4%), MM95/0414, TME 14, TME 5,, and By law (2.0% each). In Western Equatoria, the most preferred varieties included Baworoworo (35.0%), Tiara (20.2%), Karangba (Aringa) (20.3%), Adegude (7%), Okonyo ladak (Bao) (2%), Oresto (Bukalasa), MM95/0414, Abirika, Mbara and Zangoze(1% each) (Fig. 9). In most cases, farmers plant mixtures of two or more cassava varieties in an unsystematic pattern.

More improved varieties (Abbey Ife, SS4, TME 5, TME 12, TME 14, and MM95/0414) were found in Eastern Equatoria, probably due to the efforts of CRS-Sudan which has a strong extension base in the region. Most of these improved materials were introduced from Namulonge Agricultural and Animal

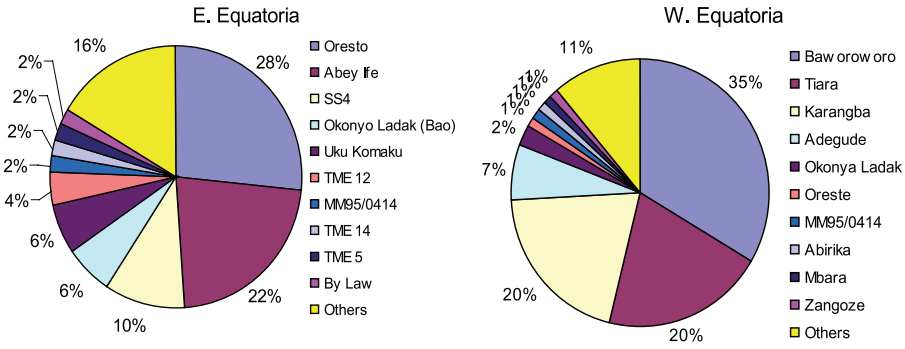


Figure 9. Popular cassava varieties in Equatoria Region.

Production Research Institute (NAARI-Uganda) in 2001. The varieties in Western Equatoria are predominantly local varieties.

Farmers' preferences for the different cassava varieties

Over 20 attributes were reported on the different varieties by farmers in Equatoria region. Early maturity came out as the most striking positive attribute (22.0%), followed by high yield (17.4%), sweetness (15.0%), big tuberous roots (4.6%), good cooking quality (4.5%), good flour quality (3.9%), good field storage (3.4%) and brewing characteristics (2.2%). Other positive attributes included palatable leaves, drought resistance, resistance to diseases and pests, good aroma, ability to suppress weeds,, and good sprouting ability.

Of the negative attributes, bitterness (10.0%) came out strongly, followed by long maturity period (5.1%), poor field storage (2.4%), low yield (1.3%), and change in taste when left for a long period in the field (1.1%). Other negative attributes given by the farmers included long cooking duration, production of less planting material, hard to eat when cooked and high fiber content. Although bitterness is often seen as a negative attribute, some farmers preferred those bitter varieties because of other attributes associated with them such as high and good flour production and resistance to attack by pests. Table 6 lists the ten most popular varieties in both Eastern and Western Equatoria with their attributes.

Table 6. Attributes of popular cassava varieties in Southern Sudan.

Variety	Attributes	
	Positive	Negative
Karangba (Aringa)	• Early maturing • High yielding • Good for making flour	• Bitter • Changes taste when left in the field for long
Okonyo ladak (Bao)	• Early maturing • Sweet/palatable • High yielding	
Oreste (Bukalasa)	• Early maturing • Sweet/palatable • High yielding • Big tuberous roots • Has good aroma • Cooks well	
Abbey Ife	• Early maturing • Sweet/palatable • High yielding • Big sized tuberous roots • Easily gets ready when cooked	
MM95/0414	• Early maturity period • Suppresses weeds	• Easily changes taste when left in the field
TME 14	• High yielding	
TME 5	• Early maturing • Sweet/palatable	
By law	• Cooks well	
TME 12	• Early maturing • Sweet/palatable • Big tuberous roots • Cook well	
Kara	• Sweet/palatable	
SS4 (NASE 1)	• Early maturing • High yielding	
Baworoworo/ Unduko	• Early maturing • Sweet/palatable • High yielding • Resistant to diseases • Cooks well	• Easily changes taste when left in the field
Abirika	• Take long to mature	
Mbara	• High yielding	
Zangoze	• High yielding • Big tuberous roots	

Table 6 (continued). Attributes of popular cassava varieties.

Variety	Attributes	
	Positive	Negative
Adegudegingara	• Early maturing • Sweet/palatable • High yielding • Cooks well	
Tiara	• Sweet/palatable • High yielding • Big tuberous roots • Good cooking quality • Cooks well • Good for making flour • Drought resistant • Leaves are palatable	• Bitter • Takes long to mature
Trakada	• Early maturing • Sweet/palatable • High yielding	
Gurumbe	• Early maturing • Sweet/palatable • High yielding • Drought resistant	
Aringa	• Early maturing • High yielding • Makes good local brew • Good for making flour • Leaves are palatable	• Bitter • Rots quickly in the field
Bakamal	• Early maturing	
Uku Kumaku (Kumkomaku)	• Early maturing • Sweet/palatable • High yielding • Cooks well • Good for making flour	
Joe gbwada	• High yielding	
Pisitoro/pusitara	• Sweet/palatable • High yielding	
Khartoum	• Sweet/palatable • High yielding	
Bazia		• Bitter
Zambia tora	• Early maturing • High yielding	

Table 7. Availability of cassava planting materials in Equatoria states.

Availability of planting materials	Percent	
	Eastern Equatoria	Western Equatoria
Inadequate planting materials	14.4	21.3
Adequate planting materials	85.6	78.7
Total	100	100

Table 8. Farmers' sources of cassava planting materials in Equatoria States.

Source	Percent	
	Eastern Equatoria	Western Equatoria
Neighbor	31.7	33.3
Own farm	28.9	43.6
NGO	15.4	2.0
Relative	13.5	18.6
Local market	9.6	2.5
Uganda	1.0	0
Total	100	100

Availability and sourcing of cassava planting materials

About 85% and 78% of the farmers in Eastern and Western Equatoria, respectively, reported having enough planting materials (Table 7). In both States, it was reported that the most important sources of cassava planting materials were the neighbors and own farms. In Eastern Equatoria, most farmers (31.7%) got their planting materials from their neighbors, while 28.9% got the materials from their own farms. Other sources of planting materials included NGOs, relatives, local markets and sources from Uganda. In Western Equatoria, the most important source of planting materials were own farms (43.6%) followed by the neighbors' farms (33.3%) and relatives (18.6%), while other sources included NGOs and local markets (Table 8).

While some farmers from Eastern Equatoria got some of their planting materials from sources within Uganda, none of the farmers from Western Equatoria reported getting any materials from Uganda. NGOs contribute significantly to the dissemination of improved planting materials in Eastern Equatoria. Purchase of planting materials is still very minimal and sometimes the trade is by barter.

Table 9. Methods of storing cassava planting materials.

Storage method	Percent	
	Eastern Equatoria	Western Equatoria
Leave in the field/field storage	21.1	59.2
Under shade	24.4	13.6
Keep near swamp/stream	25.6	10.4
In house/under a shelter	0	6.4
In cool dry place	0	5.6
Bundle and keep watering	0	3.2
Underground and water them	8.9	0.8
Put along riverbank	0	0.8
Total	100	100

Storage of cassava planting materials

Farmers sometimes acquire planting materials before the start of the rainy season. Under such circumstances, farmers must devise means of storing these stems in a way that maintains their viability. About 91% of the farmers in surveyed areas of Southern Sudan reported having knowledge on how to store cassava planting materials in one or more ways. In Eastern Equatoria, up to 98% of the farmers know how to store planting materials while in Western Equatoria, the percentage is slightly lower (86%). Differences in climatic condition in the two regions could have contributed to the differences in knowledge. Eastern Equatoria has a harsher climate, especially in the dry season, compared to Western Equatoria which has more rainfall and greater humidity. This could have conditioned the farmers in Eastern Equatoria to seek for more methods of preserving their planting materials in dry weather.

In Eastern Equatoria, 22% of farmers recognized storage under shade as one way of prolonging viability of planting materials, and 21.1% reported field storage as another way of storing planting materials, while 13.3% keep the stems near water. In Western Equatoria, most farmers (59.2%) use field storage, 13.6% store under shade, while 10.4% keep stems near swamps or streams. Other storage methods mentioned include keeping underground and watering, bundling and watering, keeping in the house and along river banks (Table 9).

Table 10. Duration of storage of planting materials by different methods.

Variable	Obs	Mean	Std. Dev.
Field storage	44	19.6	19.3
In cool dry place	7	16.5	35.2
Put along riverbank	7	7.6	4.9
Bundle and keep watering	8	4.4	5.4
Keep near swamp/stream	22	4.1	4.5
In house/under a shelter	7	4.0	8.8
Keep near water	11	3.3	3.7
Under shade	37	3.0	3.7
Underground and water them	7	2.1	0.9

Table 11. Cassava diseases as reported and ranked by farmers in Equatoria States.

Disease	Frequency	Percent
Cassava mosaic	39	68.4
Root rot	10	17.5
Fungal disease	2	3.5
Other leaf diseases	1	1.8
Total	57	100

Different methods were reported to effectively store planting materials for different durations. Field storage gave the longest mean storage time of 19.6 weeks while storage in a cool dry place gave an average storage period of 16.4 weeks. These were followed by storage along riverbanks (7.6 weeks), bundling and watering (4.4 weeks), keeping near a swamp/stream (4.1 weeks), and in house/under a shelter (4.0 weeks) (Table 10).

Cassava diseases, pests and control methods

Cassava pests and diseases

Most farmers fail to recognize pest/disease problems, yet field observations revealed a number of diseases and pests. Only 24% of farmers in Equatoria States were able to recognize cassava diseases as one of the most limiting biotic constraints to cassava production. Of all the farmers who were able to recognize diseases, 68% ranked cassava mosaic disease (CMD) as the most limiting, followed by root rots (17.5%), fungal diseases (3.5%),, and other leaf diseases (1.8%) (Table 11).

More than 50% of the farmers interviewed recognized cassava pests as constraints to cassava production in Southern Sudan. Among the pests identified, porcupines were ranked as the most destructive (23.8%), followed by mole rats (21.4%), termites (9.5%),, and wild pigs 6.3%

Table 12. Cassava pests as reported and ranked by farmers.

Crop pest	Frequency	Percent
Porcupine	30	23.8
Mole rats/bush rats	27	21.4
Termites	12	9.5
Wild pigs	8	6.3
Other wild animals and pest	8	6.3
Total	126	100

Table 13 . Cassava disease control measures.

Control method	Frequency	Percent
Crop rotation	6	35.3
Rouging	3	17.5
Timely weeding	2	11.8
No control	4	23.3
Clearing around the field	2	11.8
Total	17	100

(Table 12). Other pests mentioned by farmers included grasshoppers, millipedes, bush rats, monkeys,, and domestic animals. Theft was also recorded as a problem. To farmers, field pests are mainly those that inflict physical damage to harvestable parts and that explains why more than 50% were able to report pests as one of the biological constraints in their fields. Other pests such as mealybugs and cassava green mite were not easily recognized by farmers.

Control of cassava pests and diseases

About 85% of the farmers who recognized cassava diseases did not control them in any way. Few farmers (15%) adopted a number of control measures. The commonest method of disease control practiced by farmers in the two States is crop rotation. It is practiced by 35.3% of the farmers, followed by roguing of infected plants (17.5%), timely weeding (11.8%), and clearing around the field (11.8%) (Table 13).

At least 45% of the farmers who recognized pests were able to institute some control measures. For pest control, the most common method is use of traps or nets (54.4%) followed by physical scaring (12.4%), hunting (10.7%), field clearing (5.3%), and fencing off (4.1%) (Table 14). Fencing off is mainly used against wild and domestic animals in areas where cattle and goat rearing is common. Digging up wild animals such as bush rats, porcupines and squirrels is practiced in areas where they have become threats to cassava production. Use of fire/smoking is another way of hunting these animals from their hideouts.

Table 14. Cassava pest control measures.

Control method	Percent
Traps/nets	54.4
Scaring away	12.4
Hunting	10.7
Field clearing/weeding	5.3
Fencing off	4.1
Digging up of wild animals	1.9
Spraying/poisoning	1.8
Use of fire/smoking	1.8
Tethering domestic animals	1.8
Early planting	1.2
Timely harvesting	1.2
Use ash	0.6
Use dogs in field	0.6
Hand picking	0.6
Total	100

Table 15. Method used by farmers to harvest cassava roots.

Harvesting method	Eastern Equatoria		Western Equatoria	
	Freq.	Percent	Freq.	Percent
Piecemeal method	55	71.4	89	67.9
Uproot the whole plant	22	28.6	42	32.1
Total	77	100	131	100

Harvesting and utilization of cassava roots

Harvesting

Harvesting of cassava is done either by piecemeal or by harvesting entire plants (uprooting). More farmers (71.4%) in Eastern Equatoria used the piecemeal method than in Western Equatoria (67.9%). In Eastern Equatoria, 28.5% of the farmers harvest entire plants, compared to 32% of the farmers in Western Equatoria (Table 15). The commonest reasons given for using piecemeal methods included field storage for future consumption at home (49.4%), to reserve planting material (17.1%), to store for future sale, and to allow small tuberous roots to grow in size (12.7% each) (Table 16). On the other hand, whole plant harvesting was done because farmers needed to create space for the next cropping (19.4%), harvest in bulk to ferment (18.4%), and for slicing and drying (13.3%) (Table 17).

Table 16. Reasons for using the piecemeal harvesting method.

Reason	Percent
Field storage for future home consumption	49.4
To store reserve material	17.1
To store for future marketing	12.2
To allow small tubers to grow in size	12.2
To avoid field losses in terms of rotting	4.2
To stimulate growth and development of young tuberous roots	3.4
Other reasons	1.6
Total	100

Table 17. Reasons for uprooting the whole plant during harvesting.

Reason for uprooting	Percent
To create space for the next cropping	19.4
Harvest in bulk to ferment	18.4
For slicing and drying	13.3
For consumption at home	11.2
When there is ready market for sale	11.2
To conserve the field under fallow	6.1
After it has overstayed in the field	6.1
To avoid field losses in terms of rotting	5.1
To preserve for future marketing	5.1
For brewing	1.0
To plant for commercial purposes only	1.0
To allow small tuberous roots to grow in size	1.0
To control field theft	1.0
Total	100

Utilization of cassava

In the Equatoria States the roots of sweet varieties are boiled or roasted for domestic consumption.

Bitter varieties are mainly used for alcohol brewing but some are processed into flour. The predominant method of processing cassava into flour is through fermentation in water for 3–5 days. Fermentation is mainly done in nearby streams and for those who are far from a stream, fermentation is sometimes done in gunny bags.

Of all the harvested cassava roots, 37.7% is eaten n boiled in Eastern Equatoria, 30.1% is for sale, 19.8% is used for brewing, while 9.9% is dried into chips for storage. Other methods of cassava utilization in Eastern Equatoria include for livestock feeds (1.8%) and sale of fresh tuberous roots (0.6%). In Western Equatoria, boiled and roasted cassava

Table 18. Modes of utilization of cassava roots.

Root use	Eastern Equatoria		Western Equatoria	
	Freq.	Percent	Freq.	Percent
Boiled and eaten	61	37.7	93	31.1
For sale	50	30.9	66	22.1
Brewing	32	19.8	54	18.1
Eaten roasted	0	0.0	23	7.7
Eaten as cassava bread	0	0.0	21	7.0
Fermented and made into flour	0	0.0	30	10.0
Make chips and dry	16	9.9	3	1.0
Feed livestock	3	1.9	2	0.7
Making Tamia	0	0.0	1	0.3
Total	162	100	299	100

Table 19. Cassava household consumption.

Variable	E. Equatoria		W. Equatoria	
	Obs	Mean	Obs	Mean
Meals of cassava eaten per week	59	2.5	55	6.0
Cassava quantity (kg) eaten per week	58	6.8	52	21.8
Cassava quantity (kg) eaten per meal	56	2.7	51	3.9

made up 31.1% of the total cassava harvested followed by selling (19.7%), brewing (18.1%), and roasting 7.7%. Other utilization methods in Western Equatoria included eating as cassava pottage, fermenting, flour, selling fresh tuberous roots, giving out to others, making chips, feeding livestock, and making tamia (Table 18).

The culture of eating cassava is stronger in Western Equatoria than in Eastern Equatoria. In Western Equatoria, cassava is eaten 6 times a week with an average of 3.4 kg per meal compared to Eastern Equatoria where it is eaten only 2.4 times a week with an average of 2.7 kg per meal. In Western Equatoria, about 21 kg of cassava is eaten per household per week while 6 kg is consumed in Eastern Equatoria (Table 19).

Cassava leaves are widely eaten in the Equatoria region, especially in Western Equatoria where it is the main vegetable. Leaves are prepared in two forms: *Pasipasigadia* and *Huhungadia*. *Pasipasigadia* is prepared in a similar way to other vegetables while *Huhungadia* is a sort of cassava leaf cake (cassava leaf mixed with groundnut paste to form the cake) eaten by people on long journeys. Cassava leaves are also used as animal feed, and some farmers reported cassava leaves to be of medicinal value, especially in treating skin disease inchildren and headache in adults (Fig. 10).

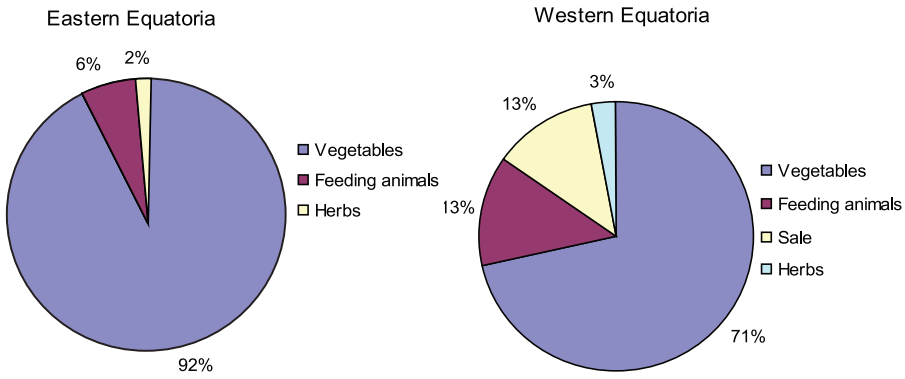


Figure 10. Proportions of cassava leaf used in Equatoria States.

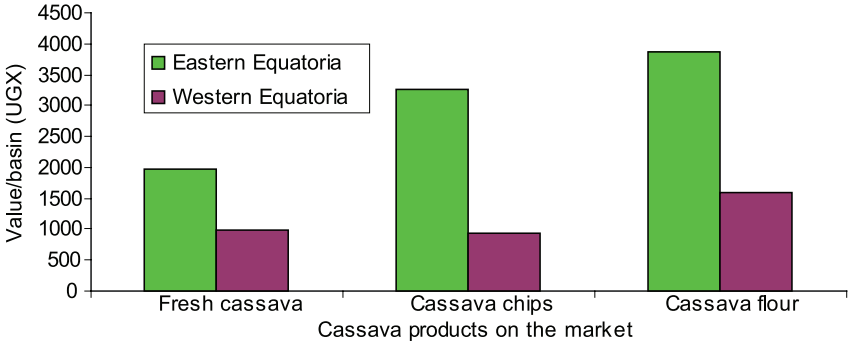


Figure 11. Prices of cassava and cassava-based products.

Marketing of cassava and cassava-based products

Sale of cassava

About 85% of the farmers in Southern Sudan sell their cassava in the form of fresh and boiled roots, fermented cassava flour, and cassava leaves. Alcoholic products from cassava are also a source of income for the farmers. *Tamia* (cassava oil-fried cake) is a popular cassava derivative sold mainly in Western Equatoria. Marketing outlets for these products are neighbors, local nearby markets, and to a very limited extent, local traders.

Prices of cassava (fresh roots, chips, and flour) in Eastern Equatoria are almost twice the prices in Western Equatoria. The price of the same volume of cassava flour is almost twice the price of fresh tuberous roots in both States (Fig. 11). Currently, the currency being used in Eastern and Western Equatoria is the Uganda Shilling.

Table 20. Marketing avenues for cassava in Eastern and Western Equatoria.

Market	Eastern Equatoria		Western Equatoria	
	Frequency	Percent	Frequency	Percent
Neighbors	44	49.4	83	39.5
Nearby local market	41	46.1	106	50.5
Local traders	3	3.4	20	9.5
Traders from neighboring countries	1	1.1	1	0.5
Total	89	100	210	100

Table 21. Reasons why some farmers do not sell their cassava.

Reason	Freq.	Percent
No market	1	10
Very low prices	1	10
Only grow for consumption	8	80
Total	10	100

Market outlets

In Eastern Equatoria, 49.4% of the farmers sold their cassava to their neighbors, 46.1% in the nearby local markets, while 3.4% is sold to local traders. Only 1.1% of the farmers sold their cassava to traders from neighboring countries. In Western Equatoria, nearby local markets are the main avenues for selling cassava as reported by 49.5% of the farmers interviewed, followed by neighbors (39.5%), and local traders (9.5%). None of the farmers from this State sold cassava to traders from neighboring countries (Table 20). Some farmers, however, do not sell any of their cassava at all. About 10% of the farmers did not sell any cassava due to the lack of a market; another 10% did not sell due to low market prices, while 80% of the farmers who do not sell cassava said they only produced for home consumption (Table 21).

Constraints to cassava production, utilization and marketing

Farmers in Eastern Equatoria reported their biggest production constraint as pest attacks (29.2%) followed by drought (22.9%), perennial weeds (14.6%), diseases, and shortage of planting materials with 10.4% each. In Western Equatoria, the biggest constraint was also pest attacks (23.7%) followed by perennial weeds (13.2%), and lack of labor and diseases with 7.9% each (Table 21).

Table 22. Constraints to cassava production.

Constraint	E. Equatoria		W. Equatoria	
	Frequency	Percent	Frequency	Percent
Pests attacks	14	29.2	9	23.7
Drought	11	22.9	5	13.2
Perennial weeds	7	14.6	5	13.2
Diseases	5	10.4	3	7.9
Shortage of planting materials	5	10.4	3	7.9
Labour intensive/lack of labor	2	4.2	3	7.9
Low produce prices	0	0	2	5.3
Rotting of roots	0	0	1	2.6
Heavy rains during drying	0	0	1	2.6
Thefts	0	0	1	2.6
High labor costs	0	0	1	2.6
Poor transport facilities	0	0	1	2.1
Lack of capital	0	0	1	2.1
Bulkiness to transport	0	0	1	2.1
Lack of capital	0	0	1	2.6
Lack of farm tools/hoes	0	0	1	2.6
Lack of processing facilities	0	0	1	2.6
Insecurity	1	2.1	1	2.6
Total	48	100	38	100

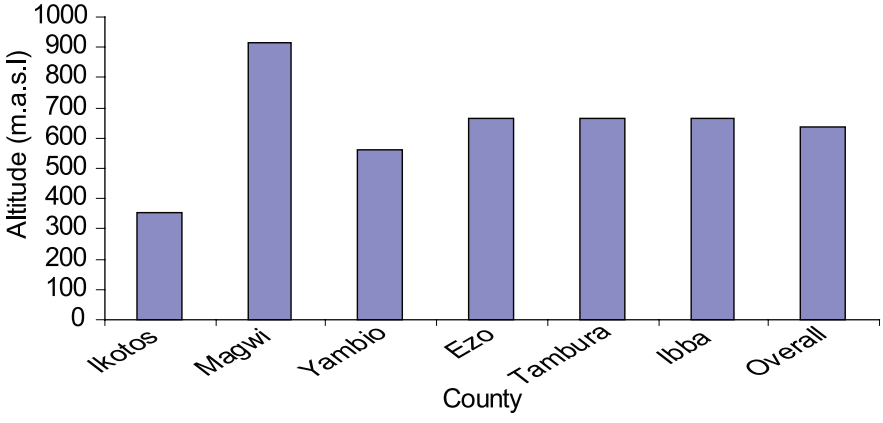


Figure 12. Altitudes of the areas visited during the baseline survey.

Field Observations

Altitude

Generally, the Equatoria States lie at relatively low altitudes, ranging from 356 in Ikotos to 915 meters above sea level (masl) in Magwi (Fig. 12). This great variation was noted in Eastern Equatoria (Ikotos and Magwi). Western Equatoria had less variation in altitude with an average of 562 m.a.s.l in Yambio to 665 m.a.s.l in Tambura (Fig. 12).

Table 23. Cassava field size, number of nearby plots and incidence of improved varieties.

	E. Equatoria		W. Equatoria counties				
	Ikotos	Magwi	Yambio	Ezo	Tambura	Ibba	Overall
Field size (hectares)	0.08	0.12	0.12	0.12	0.20	0.12	0.12
Number of nearby plots	2.5	1.9	1.0	1.6	1.4	2	1.7
Crops age (months)	4.6	4.9	4.8	4.9	5.6	5.0	5.0
Improved variety (%)	48	55.6	12	–	–	–	38.5

Cassava field size, crop abundance, varieties, and yield

Field size: Field sizes ranged from 0.2 to 0.5 acres in areas visited with an average of 1–2 nearby cassava fields. The age of cassava fields sampled for disease and pest incidence and severity ranged from 4.6 to 5 months. More improved varieties were found in all the counties visited in Eastern Equatoria with prevalence of 48.0% in Ikotos and 55.6% in Magwi. In Western Equatoria, improved varieties were only recorded in Yambio with a prevalence of 12.0% (Table 23).

Cassava crop abundance: Cassava plots close to the sampled fields ranged from 1–2.5 in the surveyed areas. Ikotos had the highest number (2.5) of nearby cassava fields to the sampled ones while Yambio had the least (Table 23).

Cassava varieties: The most commonly grown cassava varieties in all the surveyed counties were local cultivars. However, in Magwi County, improved varieties predominated (55.6%) (Table 22). Improved varieties made up 38.5% of the varieties, with Magwi County having 9 of these varieties. The most predominant improved varieties were TME 14 (35.5%), Number 8 (16.0%),, and NASE 3 (15.5%), which were introduced from Uganda (Table 24). All the counties except Ezo, Ibba, and Tambura were growing improved varieties. This observation concurs with what was reported by the farmers.

Local varieties were still widely grown in most counties and Karangba and Woroworo were the first and second most frequently encountered local varieties in the surveyed areas. Karangba was frequent in both Eastern and Western Equatoria, while Baworoworo was mainly encountered in Western Equatoria as the leading variety (Table 25).

Table 24. Improved cassava varieties encountered during the field survey.

Variety	Eastern Equatoria (%)		Western Equatoria (%)			
	Ikotos	Magwi	Yambio	Ezo	Tambura	Ibba
TMS I 92/0057	4.0	-	-	-	-	-
TMS I 92/ 0067	-	5.8	-	-	-	-
MM96/ 0427	4.0	-	-	-	-	-
Number 8	16.0	-	-	-	-	-
TME 5	4.0	3.8	-	-	-	-
TME 12	-	7.6	4.0	-	-	-
TME 14	20.0	11.5	4.0	-	-	-
TME 204	-	5.8	-	-	-	-
Abey Iffe	-	5.8	-	-	-	-
IC 2	-	1.9	-	-	-	-
NASE 3	-	11.5	4.0	-	-	-
NASE 12	-	1.9	-	-	-	-
Total	48	55.6	12.0	-	-	-

Table 25. Local cassava varieties encountered most in each county.

	E. Equatoria		W. Equatoria			
	Ikotos	Magwi	Yambio	Ezo	Tambura	Ibba
1st	Karangba	Karangba	Tiara	Woroworo	Woroworo	Karangba
2nd	Bao	Oreste	Woroworo	Karangba	Karangba	Tiara
3rd	Akeja	Bao	Karangba	Mape	Getenge	Gurungbe
4th	Lalengo	Aboke	Gurumbe	Akamisaki	Mbirambira	Adagudegegara
5th	Teso	Kukomaku	Adegudegigara	Adagudegegara	Babua	-
6th	Others	Amua	Aringa	-	Abirika	-
7th	-	Aulindi	Bangasugu	-	-	-
8th	-	Alpasia	Mbirambira	-	-	-
9th	-	Lenget	Mbirambira	-	-	-
10th	-	Paingwe	Mbutuko	-	-	-
11th	-	-	Bitara	-	-	-

Cassava production practice: The assessment of production capacity revealed that most farmers do not use the recommended spacing of 1m x 1m giving 10 000 plants/ha and they plant less cassava plants per unit area in their fields. The number of plants per hectare was moderate in both Eastern (5800) and Western Equatoria (5400) (Table 25). This low plant population could partly be attributed to the intercropping practices and/or lack of knowledge on appropriate production practices.

Table 26. Cassava yields and yield parameters.

Parameter	Eastern Equatoria	Western Equatoria	Overall
Age of crop (months) harvested	14	16	15
Number of plants harvested in 10 m^2	5.8	5.4	5.6
Number of tuberous roots/plant	7.4	9.3	8.4
Weight of tuberous roots/plant (kg)	2.8	6.7	4.8
Weight of each tuber (kg)	0.4	0.8	0.6
Number of plants/ha	5,800	5,400	5,600
Number of marketable tuberous roots/ha	30,800	42,500	36,650
Number of non-marketable tuberous roots/ha	9,200	6,625	7,913
Total number of tuberous roots/ha	40,000	49,125	44,563
Yield of marketable tuberous roots (t/ha)	14.2	35.3	24. 7
Yield of non-marketable tuberous roots(t/ha)	0.74	0.56	0.65
Total Yield (t/ha)	14. 91	35.84	25.4

Cassava yields: The average age of the fields harvested was 15 months old. The number of tuberous roots per hectare was higher in Western Equatoria at 49 125 compared to Eastern Equatoria which had 40 000. The total weight of tuberous roots per hectare was higher in Western Equatoria (35.8 tons) than in Eastern Equatoria (14.9 tons). The average weight per tuberous root was 0.38 kg in Eastern and 0.75 kg in Western Equatoria (Table 6). The number of tuberous roots per plant averaged 7.4 in Eastern Equatoria and 9.3 in Western Equatoria (Table 26). The average weight per tuberous root, number of tuberous roots per plant, and yield per hectare was higher in Western Equatoria than in Eastern Equatoria.

Cassava disease incidence and severity

The most common disease encountered in the Equatoria States is cassava mosaic disease (CMD). Another disease with lower incidence is cassava bacterial blight (CBB).

Cassava mosaic disease (CMD): The results showed that of the 52 sites (fields) sampled, CMD was present in 49 (94%), while 3 (6%) of the sites had no disease. The overall CMD incidence was 69.4%, of which 53.9% was cutting-borne and 15.5% whitefly-borne infections. CMD incidence was highest in Ibba (78.4%) and lowest in Magwi County (56.5 %). All the counties surveyed had average CMD incidences greater than 55% (Table 27).

Table 27. Cassava disease incidence and severity.

Diseases	E. Equatoria		W. Equatoria				
	Ikotos	Magwi	Yambio	Ezo	Tambura	Ibba	Overall
CMD incidence (%)	59.1	56.5	74.4	71.7	76.0	78.4	69.4
CMD Severity			3.3			2.4	2.8
Cutting infection (%)	57.9	50.4	50.0	56.3	42.0	66.7	53.9
Whitefly infection (%)	1.2	6.1	24.4	15.4	34.0	11.7	15.5
CBB incidence (%)	-	10.8	-	0.4	-	-	5.6
CBB severity	-	2.0	-	2.0	-	-	2.0

Table 28. Number of plants and % with different CMD severity scores (scale 1 5).

Severity score	Eastern Equatoria (%)		Western Equatoria (%)				Total
	Ikotos	Magwi	Yambio	Ezo	Tambura	Ibba	
1	135(41.0)	222(44.0)	69(26.0)	68(28.0)	36(24)	13(22.0)	543(34.8)
2	63 (19.0)	63 (12.0)	30(11.0)	73(30.0)	48(32.0)	20(33.0)	297(19.1)
3	100(30.0)	133(26.0)	72(27.0)	8 (34.0)	54(36.0)	24(40.0)	464(29.7)
4	32 (10.0)	82 (16.0)	81(30.0)	18 (8.0)	12(8.0)	3 (5.0)	228 (14.6)
5	0 (0)	10 (2.0)	18 (7.0)	0 (0)	0 (0)	0(0)	28 (1.8)
Total	330 (100)	510 (100)	270(100)	240(100)	150(100)	60 (100)	1560(100)

CMD severity was moderate with a mean score of 2.8, and the most frequent severity score was 3 (29.7%) indicating moderate disease. Yambio County had the highest mean score at 3.3 and the lowest was Ibba County at 2.4. The most severe symptoms were seen in Yambio County where severity scores of 4 and 5 were prevalent with a total of 37% (24). The pressure of CMD was high in Western Equatoria due to high prevalence of local cultivars, most of which were highly susceptible to the disease.

Cassava mosaic geminivirus (CMG) diagnostics: Of the 49 total DNA extracts from leaf samples analyzed, 48 (98%) gave positive results of which 7 (14.7%) had *African cassava mosaic virus* (ACMV) alone, 13 (27.0%) had only *East African cassava mosaic virus-Uganda* (EACMV-UG) and 7 (14.7%) had both EACMV-UG and ACMV in dual infections. Other forms of *East African cassava mosaic virus* (EACMV) were detected in 8 (16.7%) samples while dual infections of EACMV and ACMV occurred in 13 (27.0%) of the samples analyzed (Table 29). Overall, the prevalence of viruses identified was ACMV (56.4%), EACMV (43.7%), and EACMV-UG (41.7%), including dual infections.

Table 29. Distribution of cassava mosaic geminiviruses (no. of plants; %).

County	Virus type					
	ACMV	EACMV	EACMV-UG	ACMV+ EACMV	ACMV+ EACMV-UG	Total
Ikotos	0 (0.0)	5(62.5)	3(37.5)	0 (0.0)	0 (0.0)	8 (100)
Magwi	4(25.0)	1 (6.3)	4 (25.0)	5 (31.2)	2 (12.5)	16 (100)
Yambio	1(11.1)	0 (0.0)	1 (11.1)	7 (77.8)	0 (0.0)	9 (100)
Ezo	1(12.5)	1(12.5)	2 (25.0)	1 (12.5)	3 (37.5)	8 (100)
Tam-bura	0 (0.0)	0 (0.0)	3 (60.0)	0(0.0)	2(40.0)	5(100)
Ibba	1(50.0)	1(50.0)	0 (0.0)	0 (0.0)	0 (0.0)	2(100)
Total	7(14.6)	8(16.7)	13 (27.0)	13(27.0)	7(14.6)	48(100)

Table 30. CMD symptom severity of plants infected with different viruses (no. of plants; %).

Severity	Virus type					
	ACMV	EACMV	EACMV-UG	ACMV +EACMV	ACMV +EACMV-UG	Total
2	0 (0)	0 (0)	1 (7.7)	0(0)	1(14.3)	2(100)
3	5(71.4)	7(87.5)	8(61.5)	3(23.1)	2(28.6)	25(100)
4	2(28.5)	1(12.5)	4(30.8)	7(53.8)	2(28.6)	16(100)
5	0 (0)	0(0)	0(0)	3(23.1)	2(28.6)	5(100)
Total	7(14.6)	8 (16.7)	13(27.0)	3(27.0)	7(14.6)	48(100)

Cassava bacterial blight (CBB): CBB incidence and severity was generally low, with an average of 5.6% and severity of 2.0. CBB was recorded only in Magwi and Ezo counties, and did not occur at all elsewhere. The highest incidence was in Magwi County (10.8%) (Table 27).

Cassava pest incidence and severity

Cassava green mite (CGM) and cassava mealybug (CM): CGM severity was mild throughout the surveyed areas; and averaged 2.2. All the counties surveyed had mild symptoms of CGM and the highest severity was recorded in Ezo (2.4) and lowest in Ibba (2.0) (Table 31). CM was recorded in only one field in Ikotos County (Idemele village, Idemele Boma, Ikotos Payam) with a mean severity of 2.9 (Table 31).

Table 31. Cassava pest incidence and severity.

Pests	E. Equatoria		W. Equatoria				
	Iko-tos	Mag-wi	Yam-bio	Ezo	Tam-bura	Ibba	Overall
CGM severity	2.2	2.4	2.1	2.4	2.1	2.0	2.2
CGM incidence (%)	49.6	60.6	14.8	7.5	34.0	6.7	28.9
CM incidence (%)	7.9	-	-	-	-	-	7.9
CM severity	2.9	-	-	-	-	-	2.9

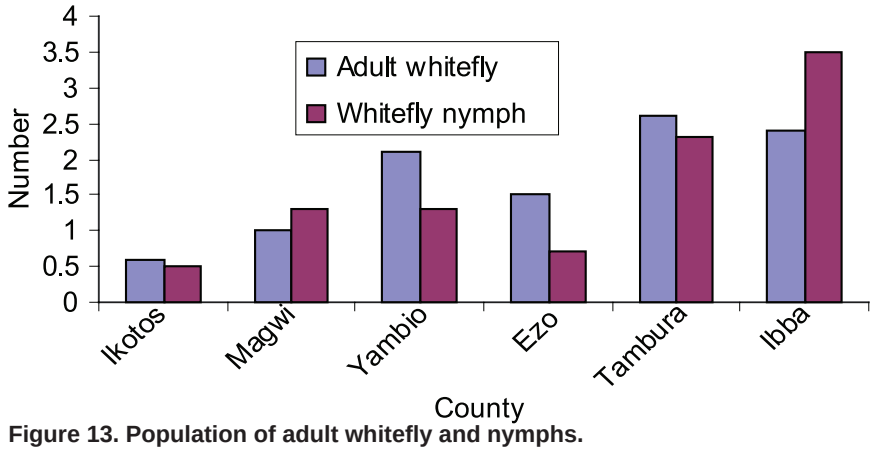


Figure 13. Population of adult whitefly and nymphs.

Adult whitefly and nymph abundance: The number of adult whitefly ranged from 0.6 in Ikotos to 2.6 in Tambura, with a mean of 1.7 adult whiteflies per plant (Fig. 13). The nymph population ranged from 0.5 in Ikotos to 3.5 individuals in Ibba per leaf. Nymph and adult whitefly abundance was generally low in the areas surveyed, especially in Eastern Equatoria. The overall average whitefly and nymph populations were 1.6 and 1.7 individuals, respectively. The low whitefly population explains why the average whitefly CMD infection (15.5%) was moderate. Figure 13. Population of adult whitefly and nymphs.

Typhlodromalus aripo (T.aripo), predatory mite of CGM: *T. aripo* occurred in all the counties in Western Equatoria (Yambio, Ezo, Tambura, and Ibba) but was not seen in Eastern Equatoria (Ikotos and Magwi). The mean incidence was 7.4%, with the highest incidence recorded in Ibba (25%) and the lowest in Yambio (1.1%) (Fig. 14). The high incidence of *T. aripo* in Ibba explains the low incidence of CGM in the county.

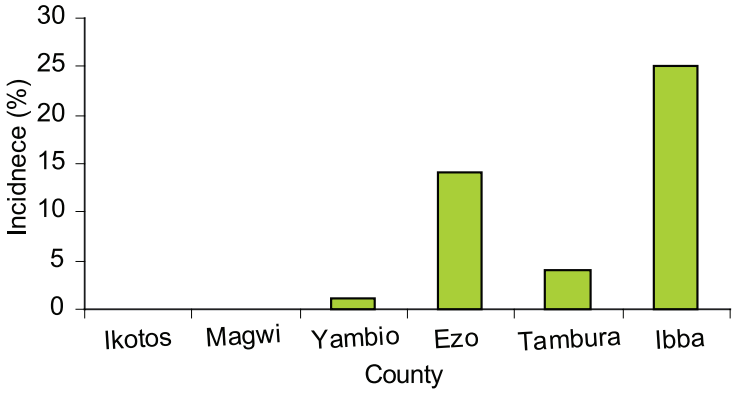


Figure 14. Incidence of *T. aripo,* predator of cassava green mite.

Other challenges noted in the fields

Poor processing technology: The majority of farmers still use traditional local methods of processing cassava. The popular method of making cassava flour is wet or dry fermentation. Wet fermentation is mainly done in streams for 3–5 days. After the fermentation, farmers normally peel and crush cassava and then dry it on compact smeared bare ground. The whole process generally compromises the quality of the final product. Dry fermentation is normally done in gunny bags after peeling. Still the quality of the final product gets compromised in many ways.

Limited farmers' knowledge: Generally, farmers have very limited knowledge on a number of issues such as pests and diseases and their control, appropriate cropping combinations, storage of planting materials, processing, and utilization of cassava.

Inadequate technology exposure at farmer and field staff level: Not only do the farmers lack knowledge but they also have limited exposure to technologies such as better irrigation techniques, processing machines, and utilization approaches for most crops.

Lack of market opportunities: Farmers have a very restricted market in the sense that most of them sell to either neighbors or a nearby local market (0.5–3 km away) within their villages. With this very limited market opportunity they are restricted to producing what they can consume locally and raise a modest income from it.

Poor road network and transport facilities: The problem of restricted market is aggravated by the poor road network in Southern Sudan.. In most cases people are restricted to using bicycles which have limited load capacity.

Insecurity and instability: With insecurity still lingering in the region, farmers are unlikely to expand on their production because of the fear of the crops being harvested by warring factions. Tribal clashes still occur among the local communities in the region. This will also have a negative impact on agricultural production and productivity in general.

Conclusions and Recommendations

4

Conclusions

The Equatoria region of Southern Sudan, has diverse cropping systems with over 30 crops grown either as sole or intercrops. The most important and widely grown crop in Equatoria is cassava. It is grown by about 85% of the farmers in the region and is th esecond most important income-generating crop after simsim and maize in Eastern and Western Equatoria, respectively.

Cassava is an important food and famine crop for the people of Equatoria. It is largely grown for food and as a food reserve crop with surplus going for sale, brewing and very little proportion for animal feed. It is predominantly grown as an intercrop in Eastern Equatoria, with about 81% of the farmers practicing intercropping with other crops while in Western Equatoria, only 40% of the framers practice intercropping. The commonest crops grown in association with cassava are groundnut, maize, beans, sorghum/finger millet, and simsim.

Over 100 varieties of cassava are being cultivated in Equatoria region of Southern Sudan, largely at subsistence levels on less than 1 acre per household. The spread of improved varieties is moving at faster rate in Eastern Equatoria than Western Equatoria.

Production, utilization, and marketing of cassava is constrained by a number of issues/problems such as pests and diseases, perennial weeds, lack of market, poor processing technologies, inadequate knowledge, poor infrastructures, and poor knowledge. This is aggravated by the prolong civil war and tribal clashes.

Farmers in Equatoria consider early maturity as the most striking positive attribute they would look for in a particular variety of cassava. Other positive attributes in descending order of importance are; high yield, sweetness, big tubers, good cooking quality, good flour quality, good field storage, good brewing quality, palatability of the leaves, drought

resistance, resistance to diseases and pests, good aroma, ability to suppress weeds, and good sprouting ability. Of the negative attributes, bitterness came out strongly, followed by long maturity period, poor field storage, low yield, and change in taste when left for long duration in the field. Other negative attributes given by the farmers include long cooking duration, production of less planting material, hard to eat when cooked and high fibres in the roots.

Lack of planting materials is not a big concern to most cassava farmers in Equatoria states, and the most important sources of cassava planting materials are the neighbors and farmers' own farms. Farmers also have some knowledge on how to store cassava planting materials in one or more ways. They recognized storage under shade as one way of prolonging shelf life of their planting materials. Others reported field storage as another way of storing planting materials while some recognized keeping the stems near water. Among the different methods for storing planting materials, farmers consider field storage as best method for storing their planting materials.

Although many farmers have knowledge on storage of planting materials, they had limited knowledge on diseases and pests of cassava. Very few farmers were able to recognize diseases such as cassava mosaic disease (CMD), root rots, fungal diseases, and other leaf diseases. Knowledge of cassava pests was basically restricted to those that inflict physical damages such as porcupines, mole rats, termites, and wild pigs. Other pests mentioned by farmers include, grasshoppers, millipede, bush rats, monkeys, domestic animals and human theft. Pests such as cassava green mite (CGM) and cassava mealybugs (CM) are nowhere near farmer's perception of the pests. Control of cassava pests and diseases is still a big challenge to the farmers in Southern Sudan. Very few farmers take control measures against pests and diseases and majority do not practice any control or have any clue about the control measures available.

The most common method of harvesting cassava in Southern Sudan, equatoria states, is piecemeal. Farmers do this because they prefer to keep some for future harvest (food security), store planting materials and to allow development of young tubers. Entire harvesting of the crop is either done when the crop has overstayed in the field and/or they would want to clear land for planting other crops or when they need to carry out fermentation for making cassava flour in addition to readiness of another cassava field.

Cassava for boiling and roasting take a larger share of the harvested roots. This is followed by brewing, processing into chips, and animal livestock feed. Other utilization methods in Southern Sudan Equatoria include eating as cassava bread, as fermented cassava flour, and for making tamia. Cassava leaves of cassava are widely eaten in Equatoria states, especially in Western Equatoria where it is the main vegetable. Cassava leaves are also used for feeding animals and some for medicinal purpose, especially in treating skin disease of children and headache in adults.

Trade in cassava and cassava-based products is still highly limited, and traded products are still restricted to fresh and boiled roots, fermented cassava flour, tamia, alcoholic derivatives, and cassava leaves. The market outlets for these products are restricted to neighbors, local nearby markets, and to a very limited extent, local traders.

Most farmers do not use the correct plant spacing of 1m x 1m giving 10 000 plants per hectare. The average plant population is relatively low and was found to be only 5800 in Eastern and 5400 plants/ha in Western Equatoria,. On average, the yield of cassava is fairly acceptable, 35.8 in Western Equatoria and 14.9 tons/ha in Eastern Equatoria.

The most common disease of cassava in Equatoria region of southern Sudan is cassava mosaic disease (CMD) and of Cassava Bacterial Blight (CBB). The spread of CMD in Southern Sudan is highly facilitated through the use of infested cassava cuttings and this is aggravated by limited farmers' knowledge on the disease and its control. The most prevalent CMD virus strain is African cassava mosaic virus (ACMV), followed by East African cassava mosaic virus (EACMV) and then East African cassava mosaic virus- Ugandan variant (EACMV-Ug). Some of these however occur as dual infections.

The results on disease reveal a potentially damaging status in the CMD situation in Equatoria states. It is apparent that EACMV-UG associated with severe disease and high yield losses have spread and affected virtually all the principal cassava-growing regions of Southern Sudan. In addition to virus spread, high CMD incidence of over 55% and moderate severity (2.8) in all the counties surveyed revealed a likely increase in disease occurrence and severity resulting into higher yield losses. These results represent a possible deterioration in the health status of cassava in Southern Sudan (Equatoria states).

CBB incidence and severity is generally low in Equatoria (southern Sudan) and therefore does not pose real danger to cassava production in the region. It is localized mainly in Magwi county in Eastern Equatoria and Ezo county in Western Equatoria.

Cassava green mite CGM also does not pose real danger to cassava production in Southern Sudan. Cassava mealybug (CM) is highly localised in only one field in Ikotos County. This can easily be handled. Presence of Typhlodromalus aripo, predatory mite of CGM in all the counties in Western Equatoria helps to lower incidence and severity of CGM in the region.

The low whitefly population in Equatoria, probably means that the spread of CMD is highly facilitated through use of infected planting materials. The population of the whitefly has not yet reached pest status as evidenced by absence of sooty mould in all the fields visited.

The adoption and cultivation of mosaic-resistant varieties was found higher in Equatoria due to introduction, evaluation, multiplication and promotion by CRS in collaboration with others institutions over the past five years.

Recommendations

Looking at the challenges facing cassava production to utilization system in Southern Sudan (Equatoria states), it is therefore of paramount importance that a concerted effort is required if major changes in production, utilization, and marketing are to be realized. There is therefore a need for collaborative work by all concerned stakeholders, i.e., farmers, processors, traders, researchers, development agencies, policymakers, and other government bodies to put in place a system that is productive, sustainable, and profitable in the long run.

The following are key areas that need due attention for improving the cassava production to utilization system.

Collection and identification of local varieties available: It is important that the Ministry of Agriculture and Forestry (MAF) - Southern Sudan institute a study aimed at collecting all the available planting materials and try to clean the most popular ones for distribution and/or promotion in the short run.

Screening of planting materials: Screening of planting materials, especially those coming from the neighboring countries such as Uganda, DR Congo, and Central African Republic. This will eliminate unintended introduction of pests, diseases, and unwanted materials.

Germplasm collection, conservation and evaluation/characterisation: This should institute a research agenda for the Ministry of Agriculture and Forestry (MAF), Southern Sudan for future cassava improvement programs. An inventory of available varieties needs to be taken through germplasm collected aimed at conserving and evaluating all the varieties available in the country.

Crop improvement strategy: Breeding for early maturity, high yield, sweetness, big tubers, good cooking quality, good flour quality, good field storage, good brewing quality, palatability of the leaves, drought resistance, resistance to diseases and pests, good aroma, ability to suppress weeds and good sprouting ability should institute a research agenda in cassava improvement programme in the whole South Sudan. Where possible, varieties with long maturity period, poor field storage, low yield, and change in taste when left for long duration in the field should be avoided or eliminated from any breeding lines.

Additional research efforts need to be directed at the cropping system to capture farmer's practices such as intercropping, with special interest of getting the right component crop and the agronomic package required for such practice.

Capacity building and trainings: Farmers and some field extension agents still have limited knowledge in agronomy, pests and disease identification and control, marketing and postharvest handling. Their capacity needs to be built through training in some of the areas outlined above. Training of highly qualified research scientists is a prerequisite for a sound cassava improvement program.

Introduction of appropriate production and processing technologies: Through extension agents, NGOs operating agricultural programs need to introduce appropriate production and processing technologies to the farmers to enable them maximally utilize the available limited resources.

Improvement in infrastructures/ capacity building: Government of Southern Sudan needs to put optimum efforts in establishing a functional road network to facilitate trade, not only in cassava but also other agriculture related sectors. In addition, efforts should be directed at re-opening research institutions and other training centers in Southern Sudan. Once these centers are opened, there is need for them to be well equipped with both human and physical quality resources to enable them function well.

Consolidating collaborative networking. Effort of CRS Sudan in promoting improved varieties appears to be progressing positively, especially in Eastern Equatoria. This needs to be consolidated through collaborative networking among NGOs, CBOs, international research bodies, and government institutions.

Security enhancement: The Government of Southern Sudan needs to stabilize security situation if crop production is to be strengthened. Both civil war and tribal clashes negatively affect cassava production and productivity.

CMD mitigation program: It is recommended that the regional CMD pandemic mitigation programs currently being undertaken in East and Central Africa regions should be extended to Southern Sudan immediately. There should be continued monitoring and diagnostics of CMD to target control and forecast pattern of spread and determine virus dynamics for effective control measures.

Introduction, evaluation and dissemination of CMD-resistant varieties: NGOs and CBOs in collaboration with government institutions and international research institutions should continue with evaluation program and dissemination of CMD resistant clones available at their disposal. More efforts should be directed in Western Equatoria since the predominant materials there are the local cassava varieties which are susceptible to CMD.

Further baseline study:

To have full understanding of cassava status in south Sudan, further survey is needed to be carried out in Bahr el Ghazel States, the remaining parts of Equatoria states, and Upper Nile States.

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Appendices

Appendix 1. Questionnaire for the acquisition of basic information from cassava/sweetpotato producers.

I. Interview data

1. Form No._____

2. Date : ____/ ____/ ____/
day month year

3. Interviewer:_____
__

4. Names (last, first) of interviewee:_____

5. Male (01)_____ Female (02) _____

6. How many people are in this home? _____

II. Geographical position

7. State _____county: _____

8. Payam_____Boma:_____

9. Village: _____

III. Cropping systems

10. What crops have you planted on your farm this year?

Crop	Rank	Variety	Field size		Month of planting	Rain fed (1) or Irrigated (2)
			Fedan	Ha		
1		1				
		2				
		3				
		4				
2		1				
		2				
		3				
		4				
3		1				
		2				
		3				
		4				
4		1				
		2				
		3				
		4				
5		1				
		2				
		3				
		4				
6		1				
		2				
		3				
		4				
7		1				
		2				
		3				
		4				
8		1				
		2				
		3				
		4				
Total						

Note:

- 1 katala = _____m^2
- Where there is intercropping, record the area of the major crop only.

11. Which of the above named crops do you sell?

Crop					
Rank					

12. What crops are planted in the nearby farms?

1	4	7
2	5	8
3	6	9

IV Cassava and Sweetpotato (where applicable)

13. For what purpose do you grow cassava/sweetpotato?

Crop	Food	Brewing	Animal feed	Sale	Other 1	Other 2	Other 3
Cassava							
Sweetpotato							

14a. Do you intercrop cassava/sweetpotato with any other crop?

Crop	Yes	No
Cassava		
Sweetpotato		

14b. If yes, with which crops?

Crop	Crop used in the intercrop			
Cassava				
Sweetpotato				

15a. Do you have adequate quantities of cassava/sweetpotato planting materials?

Crop	Yes	No
Cassava		
Sweetpotato		

15b. Where do you get your planting materials from?

Crop	Own farm	Neighbor	Rela-tive	NGO	Gov't	Market	Other
Cassava							
Sweetpotato							

15c. How much does the planting material cost? (Ask if market is also the source)

Crop	Value per bundle	Approx. number sticks per bundle (cassava)	Approx. No. of heaps it can plant (Sweetpotato)
Cassava			
Sweetpotato			

16a. Do you know how to store cassava/sweetpotato planting materials?

Crop	Yes	No
Cassava		
Sweetpotato		

16b. If yes, how do you store your planting materials?

Crop	Storage method	Duration of storage
Cassava	1	
	2	
	3	
Sweetpota-toes	1	
	2	
	3	

17. What are the main cassava/sweetpotato varieties that you grow, how do you rank them, and what are their attributes?

Crop	Variety	Rank	Attributes	
Cassava	1.		1. 2	3 4
	2.		1 2	3 4
	3.		1 2	3 4
	4.		1. 2	3 4
	5.		1 2	3 4
Sweetpo-tato	1.		1 2	3 4
	2.		1 2	3 4
	3.		1 2	3 4
	4.		1 2	3 4
	5.		1 2	3 4

18. What are the constraints you face in growing, processing, utilization and marketing cassava/sweetpotato? Rank these constraints.

Crops	Constraints	Rank
Cassava	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
Sweetpotato	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	

19a. What are the main pest and disease problems? Rank order

Crop	Disease	Rank	Pest	Rank
Cassava	1.			
	2.			
	3.			
	4.			
	5.			
Sweetpotato	1.			
	2.			
	3.			
	4.			
	5.			

19b. Do you control any of these pests and diseases on your farm?

	Disease		Pest	
Crop	Yes	No	Yes	No
Cassava				
Sweetpotato				

19c. If yes, list the pests and diseases and the control methods used for controlling them.

Crop	Disease	Control methods	Effective-ness	Pest	Control methods	Effective-ness
Cassava	1.	1. 2.		1.	1 2	
	2.	1. 2.		2.	1 2	
	3.	1. 2.		3.	1 2	
	4.	1. 2.		4.	1 2	
Sweetpo-tato	1.	1. 2.		1.	1 2	
	2.	1. 2.		2.	1 2	
	3.	1. 2.		3.	1 2	
	4.	1. 2.		4.	1 2	

Effectiveness score: (1) very effective; (2) partly affective; (3) not effective; (4) damaging

20. How is harvesting done?

Crop	Method			
	Piecemeal	Reason	Up root whole plant	Reason
Cassava				
Sweetpotato				

21. After harvesting, how do you use your cassava roots (rank uses, and for each use indicate the percentages of harvested roots that go towards that use)?

Crop	Use	Rank	Proportion
Cassava	1		
	2		
	3		
	4		
Sweetpotato	1		
	2		
	3		
	4		

22. How do you use cassava/sweetpotato leaves?

Crop	Vegetables	Feed-ing animals	Other 1	Other 1
Cassava				
Sweetpotato				

23a. Do you sell part of cassava /sweetpotato you grow?

Crop	Yes	No
Cassava		
Sweetpotato		

23b. If yes, where do you sell your cassava/sweetpotato.

Crop	Neigh-bor	Nearby local market	Local trad-ers	Other 1	Other 2
Cassava					
Sweetpotato					

23c. What is the estimated price of the cassava/sweetpotato that you sell?

Crop	Price per basin		
	Fresh roots	Chip	Flour
Cassava			
Sweetpotato			

23d. If no, why don't you sell?

Crop	No market	The price is very low	Only grown for consumption	Other 1	Other 2
Cassava					
Sweetpotato					

24. For cassava/sweetpotato eaten in the household, how much is eaten per week on average?

Crop	No. of time eaten per week	Quantity eaten per meal (kg)	Quantity eaten per week
Cassava			
Sweetpotato			

Note: You can estimate the quantity eaten per meal (in Kg) by looking at the saucepan used for preparing the meal

Other comments or observations:

a) ……
……
……

b) ……
……
……

c) ……
……
……

d) ……
……
……

e) ……

f) ……
……
……

g) ……
……
……

h) ……
……
……

i) ……
……
……

j) ……
……
……

k) ……
……
……

l) ……
……

Apendix 2. Pest abundance and disease scoring sheet, 3–6 months old plants

State:		Field size:	
County:		Crop mixture:	
Payam:		Cassava varieties:	
Boma:		Variety sampled:	
Village:		Age(months):	
Date:		No. nearby plots:	

Plant	Whitefly		CMD		Sooty	Wf	CGM	*T.aripo*	CM	CBB	CBSD
no	Adults	Nymphs	Infn.	Sev	mold	Damage	Sev	incd.	Sev	Sev	incd.
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											

CMD infection codes

W = whitefly infection

C = cutting infection

H = healthy/symptomless

GPS Reading	
Latitude	
Longitude	
Altitude	
Researcher	

Appendix 3. Cassava yield assessment data sheet

State:		Field size:	
County:		Crop mixture:	
Payam:		Cassava varieties:	
Boma:		Variety sampled:	
Village:		Age(months):	
Date:		No. nearby plots:	

Plant	CMD		Tuber number		Tuber weight		Total No.	Total Wt	Root rot	
no	Infn.	Sev	Mktable	N-Mktable	Mktable	N-Mktable	Tubers	Tubers		
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										

CMD infection codes

W = whitefly infection

C = cutting infection

H = healthy/symptomless

GPS Reading

Latitude	
Longitude	
Altitude	
Researcher	

Other comments