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CROP CRISIS CONTROL PROJECT

C3P

Implemented by

FOOD SECURITY IN EASTERN AFRICA AND THE GREAT LAKES

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Cover picture: Steffen Abele. The photo shows children in Sud Kivu, DRC.

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EXECUTIVE SUMMARY

The study's objective is to provide a food security assessment of six countries, namely Tanzania, Kenya, Uganda, Rwanda, Burundi and DRC. This assessment is not a stand-alone assessment, but is made in close relation to cropping and farming systems, in particular the impact of Cassava Mosaic Disease (CMD) and Banana Xanthomonas Wilt (BXW). It should allow targeting of both food relief and longer term development measures in the region with respect to these two diseases. The project on Crop Crisis Control (C3P), funded by USAID and carried out by CRS, IITA and national partners aims at mitigating the effect of these two crop diseases in the six countries, by introducing disease resistant planting material and propagating agronomic measures to counter banana bacterial wilt. One of the project's objectives was to establish the relationship between the two crops affected by the diseases, cassava and banana, and food security in the region, both in terms of geographical information systems and econometric models that would allow us to select regions in need of urgent measures and long-term development efforts.

The analysis follows a three step approach: Data on crop production, household characteristics, including income and social parameters, food security and perceived incidence and severity of the two diseases where obtained from completed studies and field surveys, whereas the field surveys finally covered all the countries, updating the secondary data. These surveys were undertaken in all the six countries, covering the period from 2004 to 2007, as the first databases were from 2004 (Kenya, Uganda) and the final surveys and updates were made in 2007 (Tanzania, Kenya, DRC). Uganda, Burundi and Rwanda were surveyed in 2006.

The major differences to other studies were the relatively short time in which these surveys were conducted and the short analysis turnover. This was partially due to the project duration of only 18 months and the resulting operating time of 16 months, for both data surveying and analysis. Although this can be seen as a constraint, we also consider it as a model for other project, where turnover times for analysing and decision making are similarly short. It is thus our objective to provide tools and assessment models for such short term projects and their targeting. It should be noted that a turnover time of 16 month and a data age from three years to actually three months (Western Kenya and Eastern DRC respectively) are extremely low. FAO data on caloric intake are usually two to three years back in time, while a recent more comprehensive study done by IFPRI is based on data that are between seven and 13 years old.

The second step is the GIS mapping with respect to food security, depicted as the actual intake from own crop production, the potential intake from total crop production, and the potential caloric intake from cash income (both crop sales and other incomes). Further, the dependence on the two target crops, banana and cassava, was mapped. Figures that were also taken but not mapped in the GIS were Household Dietary Diversity (HDD) indices and self-perceptions of food security.

The GIS mapping showed that there is a gradient of overall food security, declining from East to West. While Uganda and Kenya are food secure by all means, with a slightly lower tendency in Kenya, Tanzania is somehow at the edge, whereas Rwanda, Burundi and Eastern DRC are food insecure, sometimes to a very large extent, where the majority of households is food insecure. Along with this goes a respective dietary diversity. The dependence on bananas varies across countries and regions, it is expectedly highest in Western Uganda, but also considerably high in Rwanda, Burundi and some places of Eastern DRC. Bananas play a minor role in people's diets in Western Kenya and most of the area surveyed in Tanzania, except for the Western region of Tanzania. Dependence on cassava is significantly high in all the places surveyed, and reaches its peaks in Eastern DRC and in the Central and Northern regions of Uganda.

The third and final step of the study was an econometric model for each country that depicts the dependence of food intake from own production on various variables, both related to income and therefore markets, and to the different social strata. Again, there are significant differences between countries. It is interesting to see that due to their market access and income, the "better off" countries can cope well with diseases, namely Uganda and Western Kenya. Uganda, Tanzania and Kenya have a high level of food production and food security, as well as a good stability and level of purchasing power and market access. These countries will be more affected by price fluctuations and dynamics on labour markets in terms of their caloric intake from own production. Nonetheless, Northwestern Tanzania, Western Kenya and Uganda have suffered and still suffer a lot from Cassava mosaic, whereas Uganda also suffers from BXW, which calls for continuous action in this respect. Tanzania shows a high effect of CMD losses on food security, and so does DRC, which means that with growing intensity and severity of diseases, in particular CMD, the situation in these two countries will worsen quickly, which calls for quick interventions. Overall, DRC, Burundi and Rwanda rank first in a "potential food insecurity ranking", followed by Kenya, Tanzania, and Uganda with the lowest urgency to intervene.

Further differences between the countries are the social groups that are particularly vulnerable to food insecurity. Again, a slight gradient between regions can be observed. In Uganda, there are not much differences between social strata, neither are there in Tanzania, which are actually the two countries with the highest per capita subsistence food production. In Kenya, potential social target groups or households are those headed by low-educated individuals, as well as labour constraint households, whereas in Tanzania the most vulnerable households are those with a low labour endowment. In Rwanda, the households headed by younger persons are most vulnerable. In Burundi, the highest number of social criteria could be identified, such as low education, low age, large household size, and female headed households. In DRC, targeting should be concentrated on younger-led households with lower education, and should take into account that, for whatever social or economic reasons, male headed households, probably mainly children and women in these households, are at risk.

In summary, the documentation provided from this study can be used to target zones of intervention, as the study provides evidence on all the socio-economic and agronomic patterns across the region. Combined with geographic information on disease incidence and severity, both long and short term targeting is possible, including the social and overall economic structure of the target groups.

INTRODUCTION

BACKGROUND OF THE STUDY

Background

Food security assessment in Eastern Africa is of major interest to the public, given the recent problems with cropping systems being affected by plant diseases and drought, in particular banana bacterial wilt (BXW) and cassava mosaic (CMD).

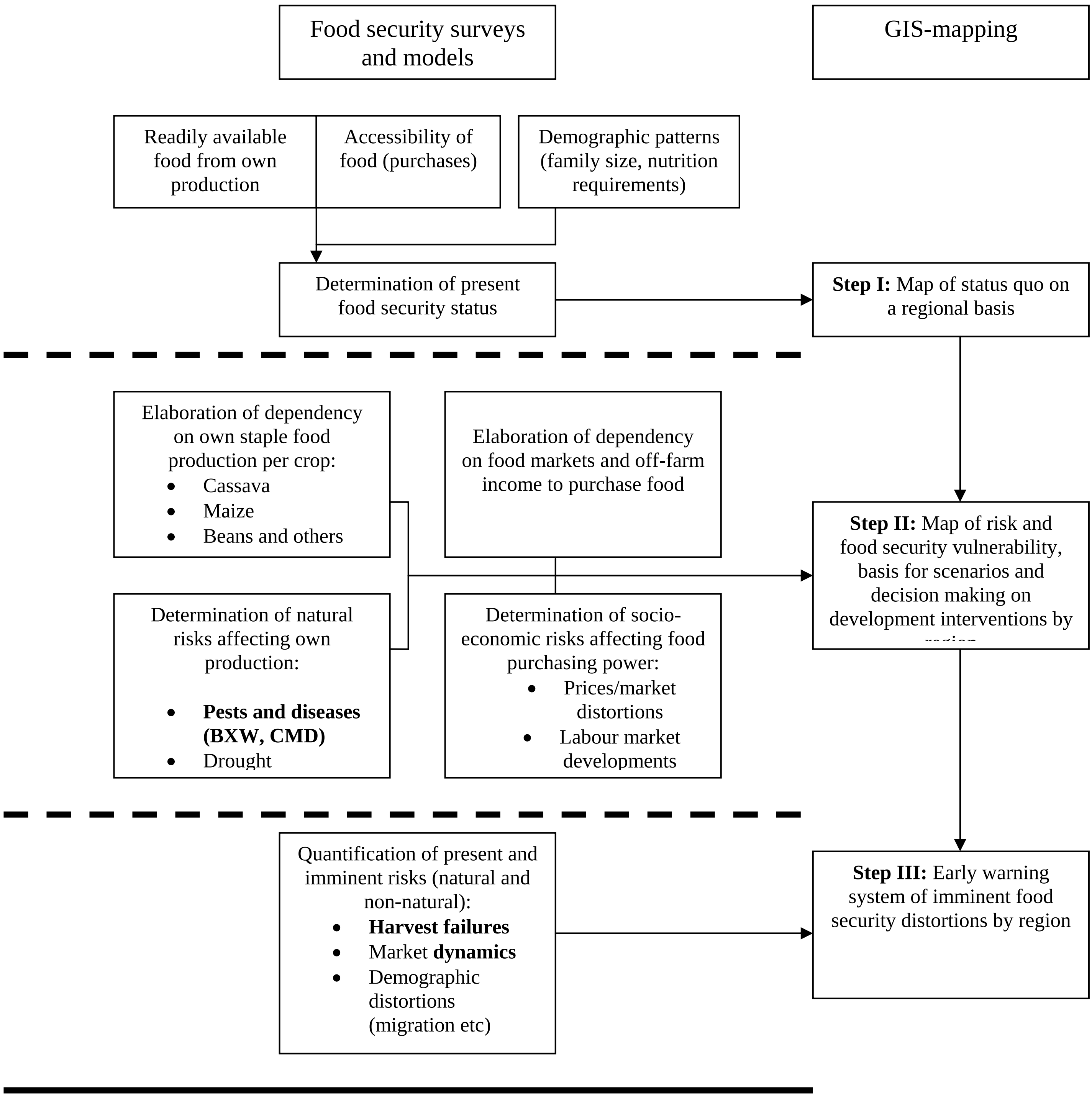
The overall objective of this module is to create an early warning system for food insecurity in six East African countries, Kenya, Uganda, Tanzania, Burundi, Rwanda and DRC. It aims at consolidating information on food security vulnerability, relating it to the above mentioned diseases and supply information on the status and dynamics of food security of small scale farmers and their households.

Objectives of the study

The methodology of this study is a sequence of steps with the objective to establish a geographical mapping system of food security including assessment tools for evaluating the impact of changes in factors determining food security on the short and long-term food security situation. The steps are listed below and represented schematically in Figure 1.

- Assess the status of food security by farm-household surveys that cover the above mentioned variables.
- Identify and quantify the magnitude of factors that affect food security.
- Identify and quantify food security scenarios
- Compute indicators of food security and vulnerability on a geographical basis (e.g. district or province units).
- Map indicators in a GIS system
- Forecast short term and medium/long term food security developments to guide food relief aid and development efforts.

Figure 1: Design of a food security GIS



Special characteristics of the study

The present study has some special characteristics which should be discussed before interpreting the results presented later. In detail, these characteristics are

- The specific linkages between food security and pests and diseases for two crops, bananas and cassava, which require an in depth assessment of cropping structures and patterns to determine the overall crop dependence, as well as the assessment of pests and diseases affecting these two crops. The simultaneous assessment of crop effects and the common food security indicators given in literature (Smith et al. 2006, FSAU 2006) both extend and restrict the scope of the study. While the methodology is extended to specific crops and cropping patterns, in particular banana and cassava and therefore has to capture both production and consumption, it is on the other hand restricted to one out of a number of food security criteria (FSAU 2006), which is basically food access and availability. Food access and availability is a composite of own food production and purchasing power.
- The dynamic nature of the study. In contrast to the above cited studies, which looked at food security as static variables, assessed as per their status quo, this study looks in large parts at the potential future food security risk, which changes the variables according to the changed research objectives. Whereas the common food security assessments ask the question whether entities (civil communities or individuals) are at present food secure, this study asks the question whether they will be food secure in the future under given conditions of uncertainty of food availability and access. For example, the study rather asks for the potential calorie intake from crop production and cash income than denoting the present status. The reason for this is the purpose of the study, which is basically to provide a model for targeting. It would make little sense to assess present food security only, when targeting of both short and long term relief and development measures (like providing improved crop varieties) should be rather dependent on future risks and vulnerability than present status. The only "static" approach we use is the analysis of vulnerability in terms of calorie demand, however, it will be made clear that such static approaches have to be combined with variables that are designed to depict the dynamics affecting the vulnerable households. For example, it does not make sense to target a socially or economically vulnerable household by the dissemination of disease resistant varieties, if there is no respective plant disease in the target areas, or the targeted crop is not present at all.
- The second main characteristic is the short term focus of the study, i.e. the need to assess food security in a short time due to the fact that the project is short term itself, and that there are only limited resources available. Although these characteristics were intrinsic to the project time setup itself as the whole project was only scheduled to run for 18 months, many development projects would face the same constraints, or at least need a short time-lag between a food security assessment and evaluation for targeting. Other food security assessments tend to have long time lags between data uptake and evaluation. For example the above cited IFPRI study was published in 2006 but based on data from between 1994 and 2000, whereas the present study is based on data between 2004 and 2006, and results were published in 2006 and 2007. This is a cycle of 1-2 years and hence a reduction of the time lag by 70-90 percent compared to the IFPRI study. However, such an approach requires both methodological validation and validation of results, which is done constantly throughout this paper.

LITERATURE REVIEW

Food security in the literature

Definition of concepts

The definition of food security as an operational concept has, over time, ranged from an emphasis on self-sufficiency to coping with vulnerability and risk in food and nutrition access (IFPRI, 2004). Due to the intricate technical and policy issues involved, as many as 200 definitions have been used in published writings (FAO, 2003). For example, at the 1974 World Food Summit, food security was defined as "availability at all times of adequate world food supplies of basic foodstuff to sustain a steady expansion of food consumption and to offset fluctuations in production and prices". This definition was then revised to incorporate concerns of food safety, nutritional balance as well as social and cultural food preferences. These concerns were reflected in the 1996 World Food Summit definition of food security as "physical and economic access by all people at all times to enough nutritionally adequate and safe food of their preference, for an active and healthy life". In essence, the salient features of food security are *food availability* and *accessibility*. Food availability refers to the supply of food (Ramakrishna and Demeke, 2002) whereas accessibility refers to the ability to obtain the necessary food either through own production or purchase from the market (Bahiigwa, 2002). Following the above definition of food security, households will be food insecure if they do not have adequate physical and economic access to food. 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. However, other institutions have made recommendations for different social settings. Food insecurity can be chronic or transitory (Baro, 2002). Chronic food insecurity refers to a continuously inadequate diet caused by the inability to acquire food (Saad, 1999). On the other hand, transitory food insecurity refers to short-term household inability to access enough food (FAO and WFP, 2005). Transitory food insecurity can be further divided into two sub-categories namely cyclical and temporary. Cyclical food insecurity is where there is a regular pattern of food insecurity, for example in periods before harvest. Temporary food insecurity is a result of short-term shocks such as droughts, floods or conflict.

Approaches to studying food security

Food security can be measured at the national, household and individual level. Measuring food security at the national level entails determining the amount of food available in the country and the extent to which it provides the recommended minimum calorie intake per person per day (Safiliou-Rothschild, 2001). Using the national food balance sheets, which contain statistics on agricultural and industrial production and trade, changes in stocks, agricultural and industrial usage within a country, information is obtained on supply and availability of foods. Total energy available for consumption is obtained by adding total energy produced, energy imported and change in stock minus energy exported, energy wasted and energy used for other than human consumption (Habicht, *et al.,* 2004). One of the factors underpinning the use of this approach is the plethora of national-level data sets on food availability. Food balance sheets data have contributed substantially to policy analysis and are crucial to determining where food insecurity is most prevalent, monitoring food security trends over time and predicting future food insecurity (Jacobs and Sumner, 2002). Availability of food at national level is a necessary condition for achieving food security but it is not sufficient. This has given prominence to food security assessments at household level. These are usually in the form of food expenditure surveys, which are used to capture issues of accessibility to food hence enabling more accurate identification of food insecure households, social groups and regions. In addition, food expenditure data have formed the basis of much work on consumption and savings behaviour, living standards and inequality (Naeem *et al.,* 2005). Data collected include household composition, total household expenditure as a proxy for income and consumption of major food products. In most cases, data are collected on expenditures, not amounts of food purchased. Quantities of food consumed are then derived from these expenditures based on actual prices at the time of acquisition. Using food composition tables, amount of calories, protein and other nutrients are computed. Food expenditure surveys are prone to errors such as sampling errors despite all precautions that may be taken at all stages of the survey (Auger *et al.,* 2005). This approach is relatively easy but its major drawback is its inability to capture intra-household distribution of food.

Many commentators on food security have concurred that its occurrence at the household level does not guarantee that at individual level. In order to understand intra-household food distribution, special dietary surveys have been employed. Generally, data collected include total food consumption of the family during a given period, age and sex distribution of the family, occupations of wage earners and number of meals taken out by family members and those consumed within the household by visitors (Quenouille, 1950). The major limitation of special dietary surveys, however, is that they are very costly.

The approaches discussed thus far are largely quantitative. However, qualitative approaches based on households' perception of their food security status are now widely applied. This is done subjectively by assessing not only aspects of availability, access and utilization but also about how household members feel. For example, the U.S Department of Agriculture uses the food sufficiency question and the household food security scale to measure food security (Keenan *et al., op cit*). The food sufficiency question is stated as: "Which of the following statements best describes the food eaten in your household?" (i) Enough of the kinds of food we want to eat (ii) Enough but not always the kind of food we want to eat (iii) Sometimes not enough to eat or (iv) Often not enough to eat. On the other hand, the food security scale measures the level of severity of food insecurity and hunger by classifying households into one of four food security status categories. (1) Food secure – household with no or minimal evidence of food insecurity; (2) Food insecure without hunger – household with concerns and adjustments to food management (e.g. reduced dietary quality) but little or no reported reduction in the quantity of food intake by household members; (3) Food insecure with hunger – households in which adults have reduced food intake to the extent that they have experienced hunger; (4) Food insecure with severe hunger – households in which children have reduced food intake and adults report going whole days with no food owing to a lack of resources. The major advantage of qualitative approaches is the ease with which they can be implemented.

Determinants of calorie intake: Empirical evidence

A number of studies have been done on the determinants of household calorie intake. Using a quantile regression approach, Sinha (2005) estimated a calorie intake function for rural India with household income as one of the predictors. The study revealed that the calorie income elasticity for households of very low nutritional status was 0.51 for the period 1993-94, which was significantly less the elasticity of 0.59 for households with high nutritional status. Gibson and Rozelle (2000) used the parametric, non-parametric and semi-parametric techniques in a quantile regression framework to estimate the income elasticity of calorie demand in urban Papua New Guinea. Results of the non-parametric method showed that the calorie elasticity for the poorest one-quarter of the population was 0.60. It then fell to 0.30 for the richest one-quarter of the population. Using parametric and semi-parametric estimation to control for the influence of other exogenous variables on calorie intake did not substantially reduce the size of the elasticities. What is discernible from the results of Sinha (2005) and

Gibson and Rozelle (2000) is that, firstly, an increase in household income leads to an increase in calorie intake irrespective of the nutritional/poverty status of households. Secondly the magnitude of this response depends on the nutritional/poverty status of households. However, whereas results from rural India show that elasticities increase with increase in nutritional status, those of urban Papua New Guinea indicate that elasticities decrease with poverty status.

More extant empirical evidence from Aromolaran (2004) shows that per capita expenditure elasticity of calorie intake for low income households of rural south-western Nigeria was 0.03. A study by Aubert and Abdulai (2003) found the per capita expenditure elasticity of calorie demand in Dar es Salaam and Mbeya regions of Tanzania to be 0.32. Further, the effect of education level of household head was negative whereas that of age of household head was positive. These results were consistent with those obtained by Jamal (2003) for urban Pakistan. Dawson (2002) used time series data to estimate a vector autoregressive model (VAR) of economic demand for calories in Pakistan. The income elasticity of calorie demand was 0.19 and was statistically significant. Due to the importance of the calorie income demand elasticity in policy formulation, researchers concur that it is imperative to study the parameter in the context of changing economic conditions. One such attempt was by Skoufias (2002) who investigated the sensitivity of the parameter to price changes for the case of Indonesia. The empirical analysis found that the income elasticity of demand for total calories in both rural and urban areas was higher in the crisis year of 1999 compared to its level in 1996. The study also found non-linearities in the calorie-income relationship, with poorer households having a higher elasticity than richer households.

Conclusions from the literature review

From the above literature review, the following conclusions for the implementation of the study can be drawn:

- The demographic level of food security will include the national level and the household level. On national level, assessment can easily be made from secondary statistics like FAO etc., whereas at household level, primary survey data will be used. Due to its scope and limitations in time, the food security assessment cannot cover intra-household distribution and equity of food security.
- The overall indicator of food security on household level will be accessibility of food either through own production or through external acquisition (purchase, gifts, aid). The indicator will be quantified as an aggregate of actual intake of calories by the household, and food security will be assessed on the basis of balancing the actual intake with the calorie requirements of the given households.
- Variables/determinants affecting the above discussed calorie intake will be the socio-demographic characteristics of households, the endowment of resources to produce own food, the biotic and abiotic factors affecting food production and the available off-farm income to purchase food from the market.

An inventory of East African food security analysis and information systems

Fewsnet

Fewsnet is a global famine early warning system with several target countries in Eastern Africa (www.fews.net). Of the C3P target countries, it covers Uganda, Tanzania, Rwanda, and Kenya. Its approach to assess food security is similar to the one envisaged in this study, applying food intake as an indicator and describing food consumption as a multitude of variables, amongst them harvests, income, market prices and demographic factors. In addition to descriptive reports, categorized in several warning categories (emergencies,

warnings, watches, no alert), FEWSNET provides GIS on biotic and abiotic factors affecting food security, as well as overall reports on market developments in the region.
Fewsnet can be an important source of information to use in the C3P food security assessment, as well as an important tool to cross check own findings. However, the C3P food security system should be more to the point (using a single indicator), and more detailed.

Ratin

Ratin is a regional trade intelligence network (www.ratin.net) which mainly focuses on commodity prices and trade flows, and not on food security issues. It is, however a valuable source of market information and especially import prices for maize, the major food security crop in the C3P region.

Kace

The Kenya Agricultural Commodity Exchange (www.kacekenya.com) is a private enterprise which facilitates the exchange of market information and commodity trade between traders, farmers and processors. It can be a valuable source of market information and agricultural analyses, however, it is a private business that charges for information and requires membership subscriptions.

FAMIS

The Food and Agricultural Market Information System, FAMIS, initiated by COMESA and currently being designed by IITA/FOODNET aims at providing a broad range of relevant information on both a private and public basis. This information will contain market information and trade floors, but also information on food security, food safety as well as plant and animal health. It is also aiming at providing a GIS on food security and related data. Thus, FAMIS can be a valuable source of information, yet it also depends on national MIS, and consequently on institutions like the C3P GIS. It should also be noted that of the C3P target countries, Tanzania is not a COMESA member.

METHODOLOGY

Surveys and samples

Surveys were conducted in six countries of east and central Africa namely Uganda, Kenya, Tanzania, Burundi, Rwanda and DR Congo between July 2006 and July 2007. Study areas in each country were selected based on the incidence of CMD and/or BXW. Districts/provinces surveyed in the different countries are listed in Table 1.

Table 1: Countries and districts surveyed

Country	Sample size	Districts/provinces surveyed[1]
Uganda	1,076	Mbale; Kamuli; Kayunga; Mpigi; Masaka; Rakai; Bushenyi; Mbarara; Kabarole; Kyenjojo, Tororo, Iganga, Pallisa, Kumi, Soroti, Mukono, Luwero, Masindi, Apac, Lira, Nebbi, Arua
Kenya	262	Bay; Teso; Kuria; Siaya; Rachuonyo; Homa Bay, Busia
Tanzania	320	Bukoba; Muleba; Ngara; Geita; Sengerema; Ukerewe; Tarime; Mwanza; Bunda; Musoma
Burundi	331	Cankuzo; Makamba; Muramvya; Muyinga; Kayanza; Bururi; Kirundo; Cibitoke; Rutana; Karuzi; Ngozi; Gitega; and Mwaro
Rwanda	402	Western; Eastern; North; South; Kigali city
DRC	480	Kivu; North Kivu; Katanga; Maniema
Total	**2,871**	

[1]Including districts included as databases in previous surveys used in the food security assessment in Uganda

Sampling and sample size

In all countries, the study employed probability sampling procedures, specifically the systematic random sampling method. The minimum sample size per country was guided by the following formula:

$$n = \frac{N}{(1 + N (e)^2)}$$

where n = sample size of survey area, N = population size of survey area, and e = desired level of precision. We assumed a 95% confidence level and maximum degree of variability of 50% (0.5). Our desired level of precision was 10%. Thus, the resulting sample size for Uganda, Kenya, Tanzania, Burundi, Rwanda and DR Congo was 1076, 262, 320, 331, 402 and 480, respectively, hence an overall sample size of 2,871 respondents.

Descriptive analysis

Data and data analysis

Primary cross-sectional data were collected through interviews using a structured questionnaire[1] (see appendix). The survey obtained quantitative and qualitative data on several variables relevant to computation of different food security indicators. These included types of foods and food groups produced and consumed and their quantities, household incomes and expenditures, respondent's perception of their food security status, months of the year in which households are food insecure, and food insecurity coping mechanisms. Since the studies also sought to investigate the relationship between the crop diseases, i.e. CMD and BXW and household food security, data were also collected on households' experience with the diseases and the effect that they have had on households' food security status. Other data collected included households' GPS coordinates, socioeconomic and demographic variables such as household size and composition by age and sex, education level of household head, land holding, labour availability, availability of and accessibility to seed/planting materials, and constraints to crop production, all of which are thought to influence household food security.

The data analytical framework used aims at measuring household food security, investigating the factors that influence it and modeling the likely impact of losses due to CMD/BXW on food security. Due to the complex and multi-dimensional nature of the concept of food security, these studies used a combination of indicators, which are broadly categorized into quantitative and qualitative indicators. These include calorie availability from own-production, calorie intake from own-production, and household dietary diversity as quantitative indicators, and households' perception of their food security status as a qualitative indicator. Calorie availability and consumption were obtained by converting quantities of foods produced and consumed in different seasons of the year into their kilocalorie equivalents using food composition tables for use in Africa by Wu Leung (1968). Average per capita daily calorie availability and intake were then compared with the FAO/WHO recommended intake of 2,100 kcal per day. Percentage contribution of bananas and cassava to calorie intake was also calculated by dividing the calories consumed of either crop by total calorie intake. Whereas calorie intake simply shows the intake of a single nutrient, household dietary diversity – the number of individual foods or food groups consumed by a household over a given period – reflects the quality of a household's diet. A list of twelve food groups including cereals, roots and tubers, vegetables, fruits, meat, eggs,

[1] Questionnaire used in Burundi, Rwanda and DR Congo was translated into French. Attached questionnaire is for Kenya survey.

fishes, pulses, milk, oils and fats, sugar and miscellaneous (coffee, tea etc) was drawn. Respondents were then asked to indicate what food groups members of their households had consumed in the previous 24 hours but only if the previous 24 hours had been a normal day. Households' dietary diversity score variable was calculated by adding up the number of food groups consumed. The value of this variable ranges from 0 – 12. The fourth indicator – household's perception of their food security status – was based on the food sufficiency question, which required respondents to indicate whether (i) they had enough of the foods they wanted to eat or (ii) they had enough but not always the kind of food they wanted to eat or (iii) they sometimes did not have enough food to eat or (iv) they always did not have enough food to eat.

Algebraic models

Introduction and model selection

Algebraic models are commonly used to analyse and forecast economic relationships. There are two types of algebraic models: Algebraic programming models (algebraic models in a narrow sense) and econometric models. Algebraic programs are algorithms to solve arithmetic problems, like production optimization models, trade models or general computed equilibrium models (linear and nonlinear programs). Such models are normative, i.e. they depend on assumptions on economic behaviour. Parameters of these models are either based on econometric analyses or calibration processes that are based on benchmark data. In particular calibration processes are often criticized for being too normative – up to being accused of tautological processes ("rubbish in – rubbish out" argument). Further critics are the limited capability for scaling up between economic levels (farm models to market models), due to their restrictions of exchanging endogenous variables, and their strict limitation to functional forms based on economic theory. Advantages of programming models are their capability for introduction of new technologies.

Econometric models are the various forms of statistical estimation of function coefficients, they are analysis models rather than forecast models, with their biggest limitation being the inability to introduce new variables, and hence the need to forecast changes through changing existing variable values – which then often compromises validity and representativity of the forecast. Econometric models have clear advantages over algebraic programs in integrating non-monetized variables (like social characteristics) and are less strict in terms of normative assumptions, although the model specification has to comply with economic theory. Their disadvantages lie in the extensive data requirements for reasons of validity and degrees of freedom in terms of model specification.

For this study, we decided to use econometric models due to their capability of capturing both monetized (household income proxies like expenditures) and non-monetized variables like social household characteristics, and the degrees of flexibility they offer in terms of functional forms and the integration of variables of different economic scales.

Model specification

The basic calorie demand function is based on the theory of utility maximization, which postulates that a household maximizes its utility, which is a combination of food and non-food items, subject to income and time constraints. It is assumed that there is income pooling in the household but that the preferences of household members are uniform. In this common preference model, the household utility function is defined as:

$$U = f(FD, NFD, L, Z, e) \text{ .... } (1)$$

where *FD* is food consumed, *NFD* is non-food items, *L* is leisure, *Z* is a vector of household socio-demographic characteristics and *e* is the error term. Quantity of food consumed (*FD*) determines the food security status of the household, which is indicated by the level of calorie intake. Maximization of equation (1) subject to the usual income constraint leads to a reduced-form calorie demand function expressed as:

$$C_i = \alpha + \beta\, Y_i + \Gamma Z_i + e_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(2)}$$

where *C* is daily per capita calorie intake, *I* is per capita monthly income and *Z* a vector of controls. We assume that prices are constant in a cross-sectional sample hence a calorie Engel demand function. However, as income rises, households may switch to higher valued foods but not necessarily with higher calorie content Among poor households, calorie intake may increase with income but at a high enough income level, the income elasticity will decline to zero or even negative. This implies that nonlinearities exist in the calorie demand function. Therefore we include quadratic terms in income to reflect a concave relationship between calorie intake and income.

Household demographic factors are important determinants of per capita calorie intake. In addition, we include losses in cassava output experienced by farmers due to *Cassava Mosaic Disease (CMD)*. Controlling for these factors, the empirical model used in this analysis for household ***i*** is specified as:

$$\begin{aligned} CALORIE_i &= \alpha + \beta_1 EXP_i + \beta_2 EXP_i^{\,2} + \beta_3 EDUCHEAD_i + \beta_4 AGEHEAD_i + \beta_5 HHSIZE_i \\ &+ \beta_6 CASSLOSS_i + \beta_7 SEXHEAD_i + \beta_8 FARMLAB_i + \beta_9 LANDOWN_i + e_i \ldots\ldots\ldots\ldots \text{(3)} \end{aligned}$$

where *CALORIE* is per capita daily calorie intake in kilocalories from own production; α the intercept; *EXP*, per capita monthly expenditure in country's respective currency, EXP^2 , *EXP* squared; *EDUCHEAD*, education level of household head in years spent in school excluding years repeating a class; *AGEHEAD*, age of household head in years, *HHSIZE*, number of household members; *CASSLOSS*, loss in cassava production in kilograms due to CMD; *SEXHEAD*, sex of household head where 1 if male, 0 female; *FARMLAB*, number of household members constituting farm labour; *LANDOWN*, land owned by household in hectares; and *e*, error term assumed normally distributed. The above model was estimated only for those households affected by CMD. Determining the appropriate functional form is a matter of judgment and empirical fit. The functional forms of the estimated Engel calorie demand models were double-log quadratic for Uganda, Kenya and Rwanda, log-lin quadratic for Tanzania and DR Congo, and lin-log quadratic for Burundi. Thus the total elasticity of demand for calories with respect to the variable with a quadratic term (in this case, per capita monthly expenditure, as a proxy for income) in the double-log quadratic model is calculated as $\beta_1 + 2^{B_2} EXP$. On the other hand, the total effect of a change in income on calorie intake in log-lin quadratic is computed as $(\beta_1 + 2\beta_2 EXP)\ CALORIE$. Since β_2 is consistently negative for all regression specifications, the income elasticity of demand for calories declines smoothly with higher incomes.

For the double-log specification, the coefficients of the other variables (those without the quadratic term) are the elasticities and are constant. However, for the log-lin specification, the coefficients measure the <u>relative</u> change in per capita daily calorie intake due to an <u>absolute</u> change in the respective exogenous variables, whereas for the lin-log, they measure the <u>absolute</u> change in per capita daily calorie intake due to a <u>relative</u> change in the respective exogenous variables. Hence the calorie intake elasticities of the log-lin and lin-log models are computed as $\beta(X)$, and $\beta\ (1/Y)$, respectively, where *X* is the exogenous variable and *Y* is the endogenous variable. Elasticities of log-lin and lin-log models are variable depending on the value taken by *X* or *Y* or both. But where no *X* and *Y* values are specified, these elasticities are measured at the mean values of these variables.

Annex 11 summarizes the statistics by country, of the variables used the regression models. Two things should be noted: The caloric intakes are intakes from own production at farms that have been affected by the disease, and they are significantly lower than the ones for the overall samples, which shows the severity of the impact of CMD on agricultural production. The impact of banana bacterial wilt could not be modelled in the same way as the CMD impact, as the number of observations from households affected by BXW was too small to allow for sufficient degrees of freedom in the model specification, as in Uganda . We can nonetheless use the CMD effects as a proxy for overall crop disease effects on nutrition, in particular when looking at the social variables in the model.

Annex 12 and 13 give a total overview of the regression models results, whereas the respective country results are displayed and briefly discussed in the country sections.

Overall model outcomes

Calorie-Expenditure (Income) Elasticities

Although we assess caloric intake from own production, we expect a positive impact of cash income on subsistence production, which is based on the Ricardian theory of comparative advantages. When farms have access to markets, both out-and input or factor markets, they can improve their production for both own and marketing purposes according to their comparative advantages. They can specialise their subsistence production, mitigate production risks on markets and thus reach a higher level of productivity than they would reach under autarchy. Access to markets provides inputs (like fertilizers, planting material etc.), that further increase production efficiency.

As expected *a priori*, income coefficients in all the six countries were positive and statistically significant while those of its quadratic term were negative and significant. Converting average per capita monthly expenditures to their US Dollar equivalents, the total calorie-income elasticities for DR Congo, Tanzania, Burundi, Uganda, Kenya and Rwanda calculated at the means of the data are 0.02, 0.03, 5.1, 24.8, 54.7, and 76.7, respectively. Given the on-going debate in the food security literature over the response of food insecure populations to higher incomes, these results corroborate earlier empirical evidence that calorie-income elasticities are substantially greater than zero in low-income countries where calorie intake levels are considerably low, as is the case for the six countries in this study. This means that where functioning markets (notabene: input, output and factor markets) are in place, like in Uganda, Rwanda and in Kenya, the possibility of utilising comparative advantages are tremendous, whereas respective elasticities are lower in countries where such markets are not really in place (DRC, Tanzania, Burundi). This yields and important conclusion for the work of C3P as well: Helping farmers with germplasm through market-like voucher systems will have a positive impact on food security.

Yield loss elasticities

In all the six countries, losses in cassava production due to CMD were found to significantly reduce calorie intake. A one percent increase in cassava losses, *ceteris paribus*, leads to a reduction in calorie intake by 54.4, 0.007, 0.03, 0.02, 0.03, and 9.87 percent in DR Congo, Burundi, Rwanda, Uganda, Kenya and Tanzania, respectively. Note that whereas the elasticities for Rwanda, Uganda and Kenya are constant, i.e. do not change with change in levels of either calorie intake or cassava losses or both, those of DR Congo, Burundi and Tanzania are variable depending on the level of these two factors. Households in DR Congo, Burundi and Tanzania have lost on average 777.1, 14.5 and 1,646.6kg of cassava, respectively, which are lower than the losses reported in other countries. However, the implication of their variable elasticities is that unlike in Rwanda, Uganda and Kenya, every additional unit loss in cassava output due to CMD will lead to a higher reduction in calorie intake than that caused by the previous unit loss. This means that households in the Rwanda, Uganda and DRC can cope better with distress situations caused by crop disease losses than the other countries.

These results therefore suggest that interventions aimed at mitigating the impact of CMD should focus more on DR Congo, Burundi and Tanzania than the other countries in which the C3P project is being implemented.

COUNTRY REPORTS

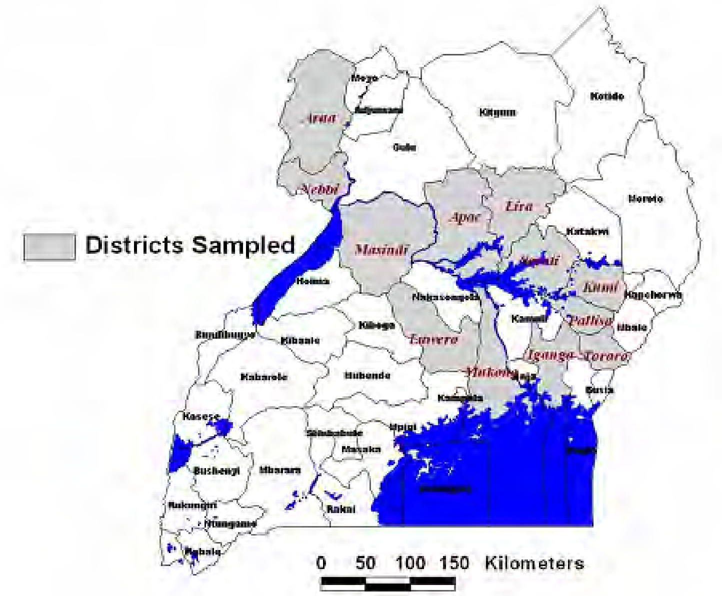
Uganda

Food security in the major cassava growing regions of Uganda

The region

Figure 2 shows the 12 Ugandan main cassava growing districts in which the first survey was undertaken in 2004.

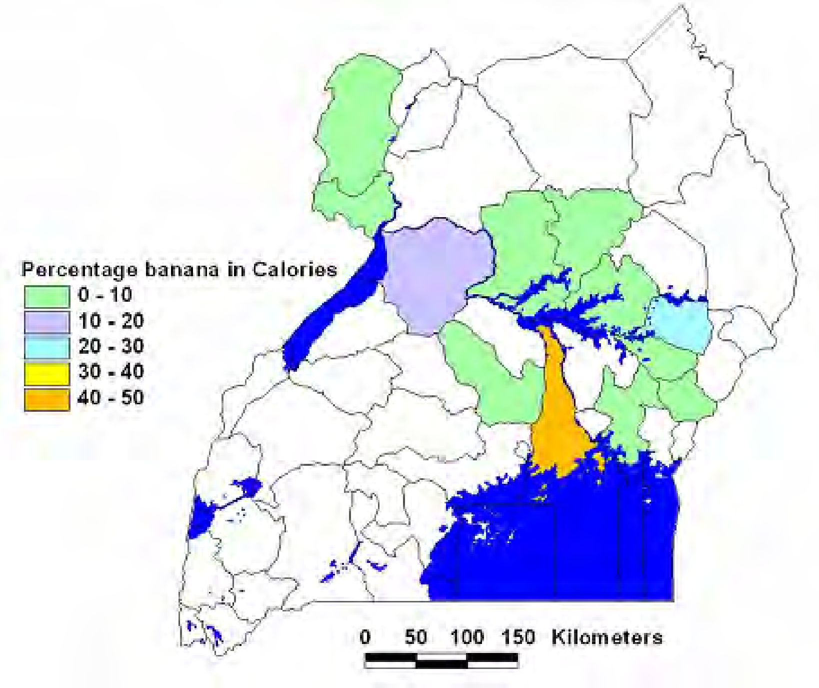
Figure 2: Map of districts surveyed in the cassava region of Uganda



The role of banana and cassava in the region’s food security

Bananas play a minor role in the household’s diet in most of the districts, except for Mukono, where cooking banana accounts for half of the daily calorie intake from own production. Further away, bananas cover only between one and twenty percent of the caloric intake (Figure 3). For overall Uganda, bananas provide 20 % of the daily caloric intake (FAO 2004). The low calorie intake in Mukono is probably related to the outbreak of Banana Xanthomonas Wilt in Uganda, since this district is heavily dependent on bananas for calories. This disease was first recorded in Mukono district and has up to now had a devastating effect on banana production.

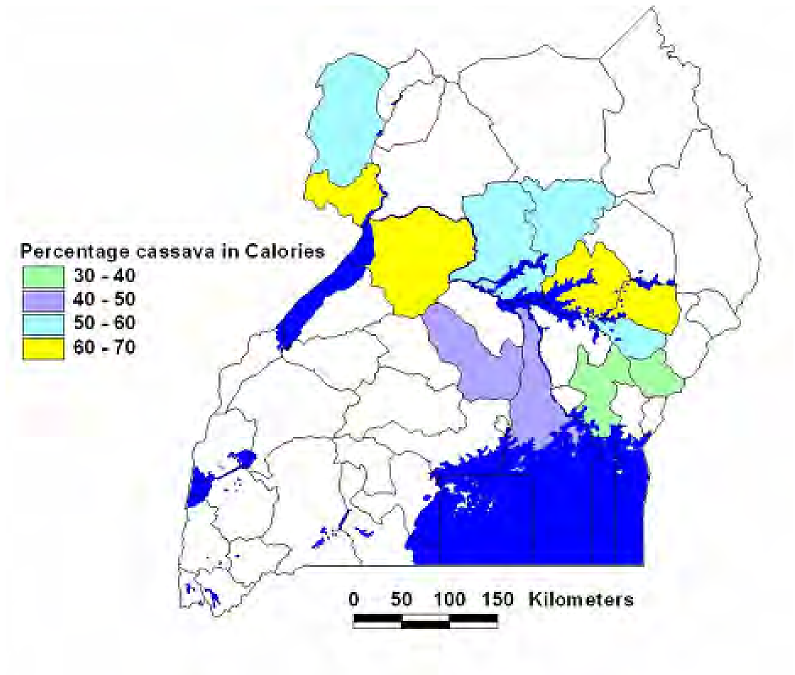
Figure 3: Map of contribution of bananas to caloric intake in the cassava regions of Uganda



Source: Own data

Cassava plays a major role in the household's caloric intake in the region. For the whole of Uganda, cassava provides around 13 percent of the daily caloric intake. In the twelve districts assessed here, it provides from 25 to almost 70 percent of the total calorie intake (Figure 4). This indicates the importance of cassava in this particular region. In the mid nineties, the region was struck by Cassava Mosaic Disease. Since then, NARO and its regional partners, IITA and EARRNET, have made efforts to counter the disease by introducing CMD-resistant varieties to these districts. Adoption rates of up to 90 percent of farmers have successfully controlled the disease.

Figure 4: Map of contribution of cassava to caloric intake in the cassava regions of Uganda

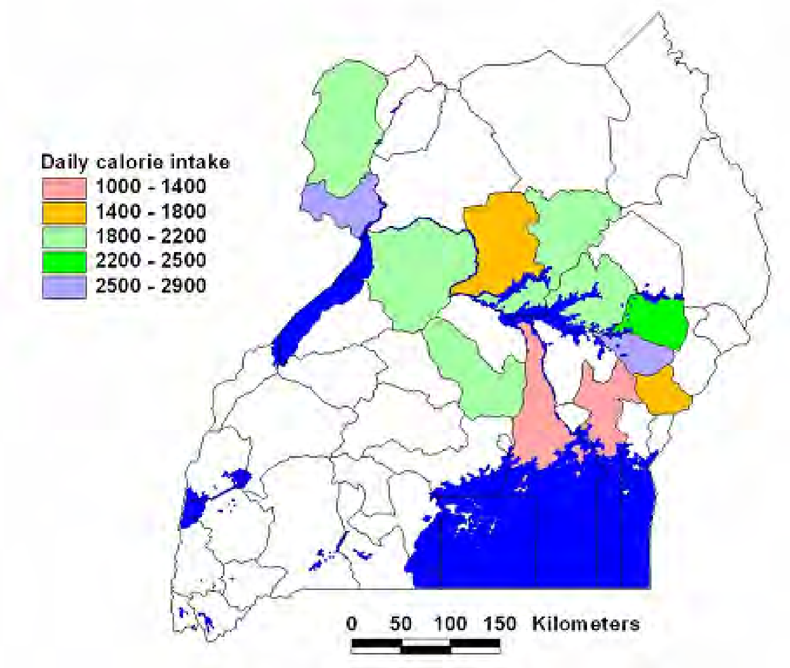


Source: Own data

Food security I: Daily calorie intake from subsistence production

This indicator comprises the actual intake from own production, not including the calories from crops that were sold on the market. Across the region, the intake ranges from 1,000 kcal/caput/day (in Mukono district) to 2,900 kcal/caput/day in Nebbi district. The average is around 2000 kcal, which corresponds with the Ugandan average calorie intake from vegetal crops of around 2270 kcal/caput/per day (Figure 5).

Figure 5: Map of calorie intake from own production in the cassava regions of Uganda



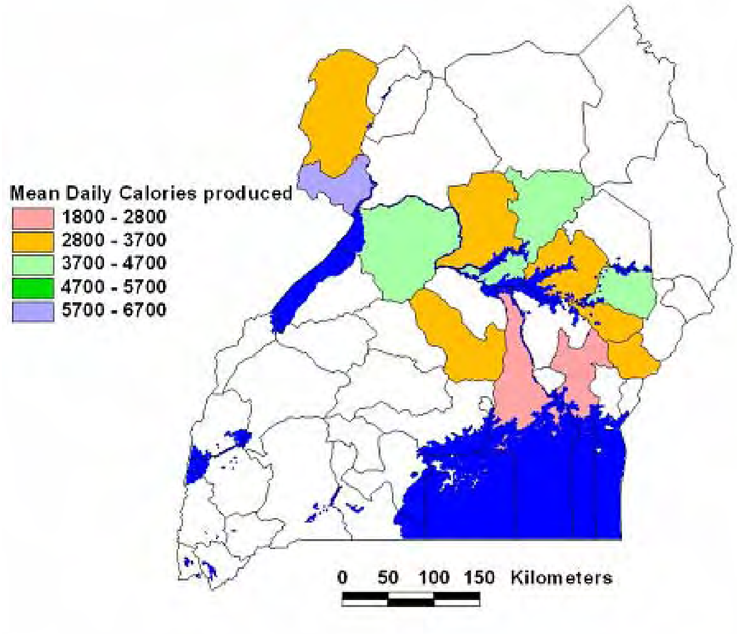
Source: Own data.

Food security II: Daily calorie capacity from total crop production

The daily calorie potential comprises the overall production of edible vegetal crops in terms of kcal. This figure includes the calories produced and self-consumed, as well as the calories that could be potentially obtained from crops that are presently grown but sold on the market. This is particularly relevant for times of shortages in production, as households then tend to cut down on sales to market in favour of own consumption of the produce.

This calorie production ranges from about 1,800 (Mukono) to 6,700 kcal per capita per day Figure 6.

Figure 6: Map of daily calorie intake capacity in the cassava regions of Uganda

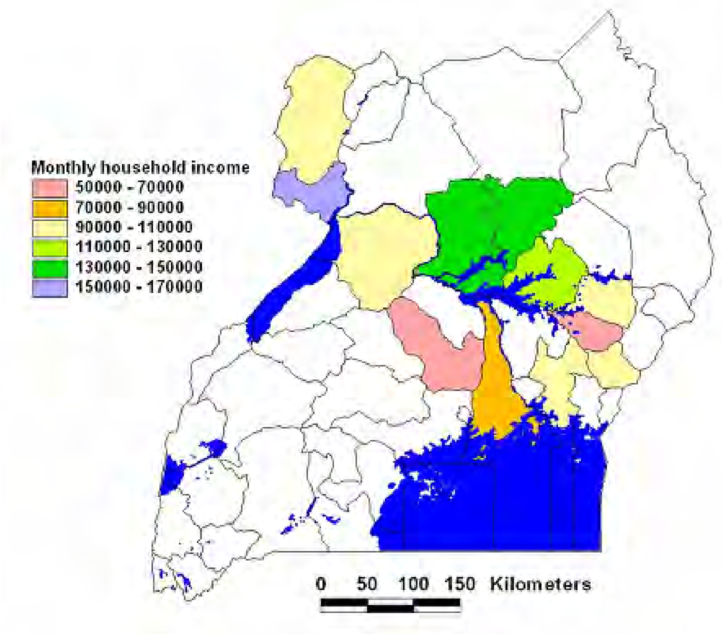


Source: Own data

Food security III: Cash income

Off-farm income provides additional access to food through purchases from markets. The monthly off-farm income ranges from 54,000 Ugandan Shillings per household (an equivalent of about 29 US $) in Luwero district to about 170,000 Ugandan Shillings (92 US $) in Nebbi district. The distribution is depicted in Figure 7.

Figure 7: Map of monthly cash income per household in Ugandan cassava regions

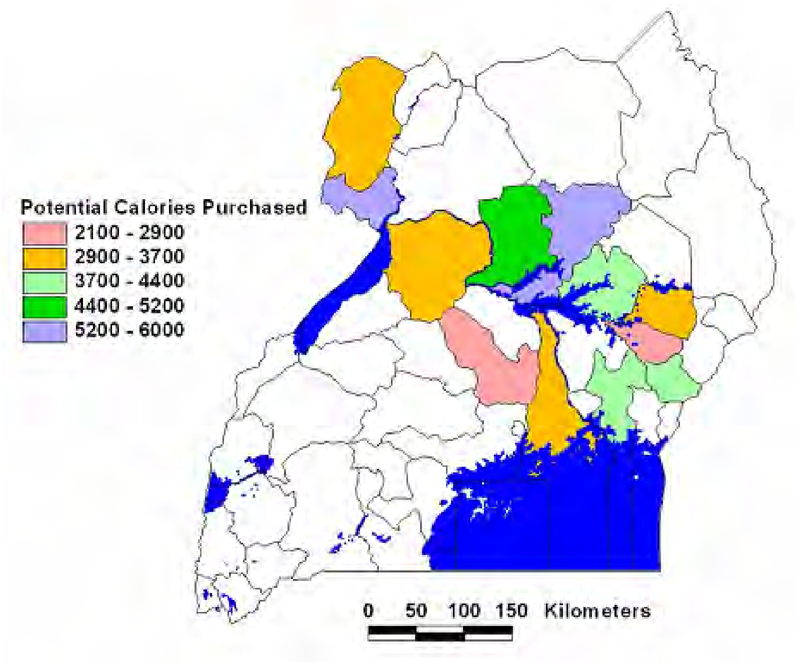


Source: Own data.

How does this translate into food security? For example, households that earn 100,000 Ugandan Shillings per month could purchase 200 kg maize (at an assumed price of 500 Shillings/kg). This would translate into 662,000 kcal per month, 22,000 kcal per day or, at a household size of eight people, supply about 2,800 kcal per caput per day for this household.

This means that the capacity of the household in terms of calorie intake would be more than doubled in most of the cases. However, the money is usually only allocated to food in times of crisis, as it is needed for other expenditures than food in normal situations.
Figure 8 shows that households in all the districts have sufficient money to cater for their food needs, and so they would even be able to counter threats from production losses. The off-farm income capacity ranges from 2100 kcal/cap/day to almost 6,000 kcal/cap/day.

Figure 8: Map of calorie intake capacity from cash income in Ugandan cassava regions



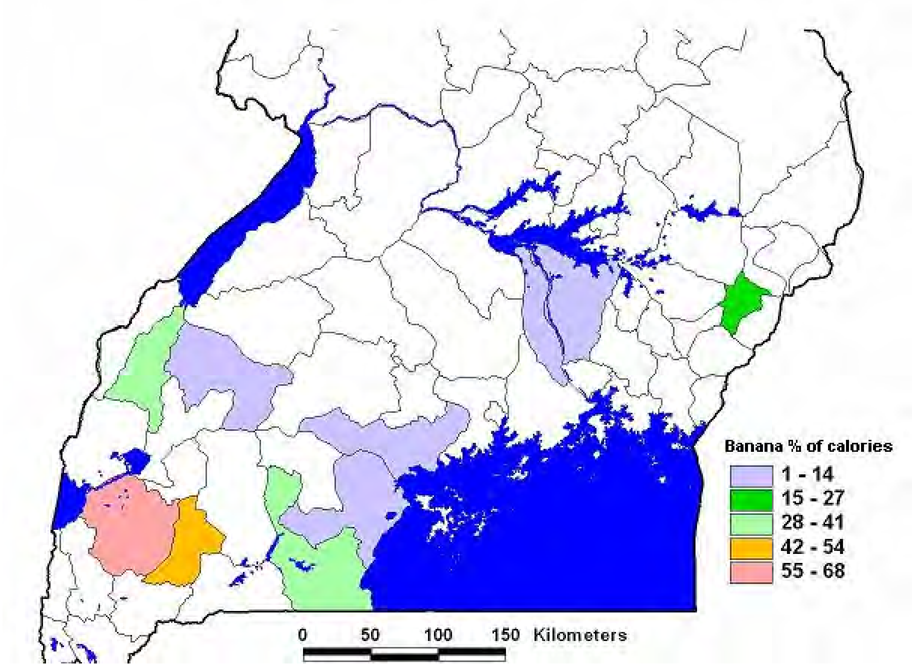
Source: Own data, FOODNET/MIS

Food security in Central and Western Uganda

The role of banana and cassava in the region's food security

The region covered in this survey is ten districts in Central and Western Uganda: Mbale, Kamuli, Kayunga, Mpigi, Masaka Rakai, Bushenyi, Mbarara, Kabarole and Kyenjojo.
Bananas play a major role in Western Uganda, particularly in Mbarara and Bushenyi with diet shares between 54 and 69 percent. The rest of the region has a diet share of bananas between only 1 and 29 percent of the diet. Considering that in Uganda as a whole, bananas constitute about 20 percent of the caloric intake, we can see that in many of the Western and Central districts, bananas play a more important role than in the rest of Uganda. Figure 9 shows the significance of bananas in the survey region's diets.

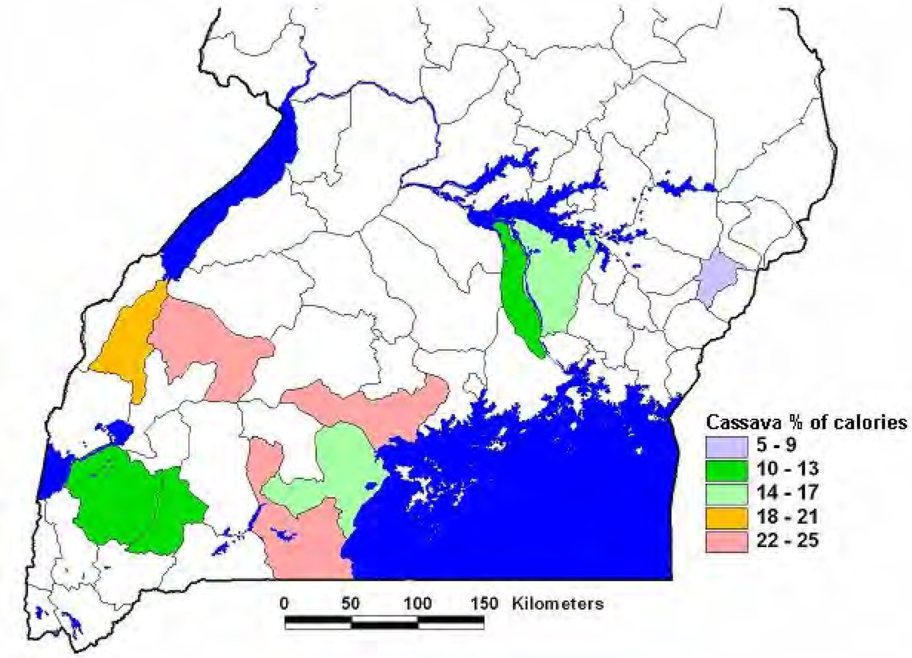
Figure 9: Map of the bananas' caloric intake contribution in Central/Western Uganda



Source: Own data

The role of cassava in this region's diets is less significant than for the rest of the Uganda (Abele et al. 2006). It ranges from 5 to 25 percent (Figure 10), whereas in the major cassava growing regions, it can reach 70 percent. However, the overall average of cassava shares in the diets match the value for the whole of Uganda, which is about 13 percent.

Figure 10: Map of cassava's caloric intake contribution in Central/Western Uganda

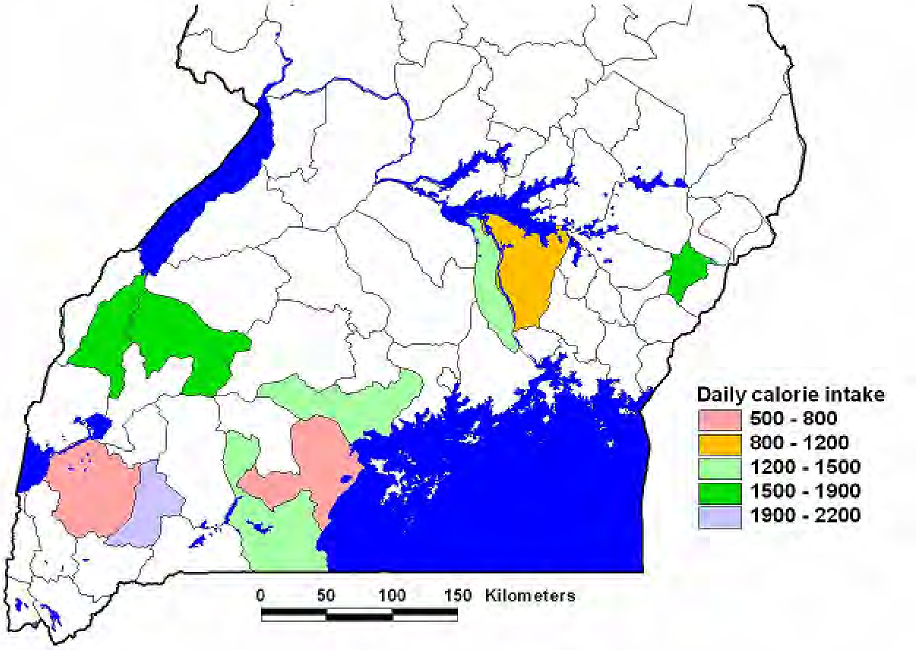


Source: Own data

Food security I: Daily calorie intake from subsistence production

Daily calorie intake from subsistence production ranges from only about 460 kcal per capita in Bushenyi to more than 2,200 in Mbarara. This means that most of the households in this region cannot or do not cover their energetic food needs from own production but have to get food from the market (Figure 11).

Figure 11: Map of own production's share in calorie intake in Central/Western Uganda

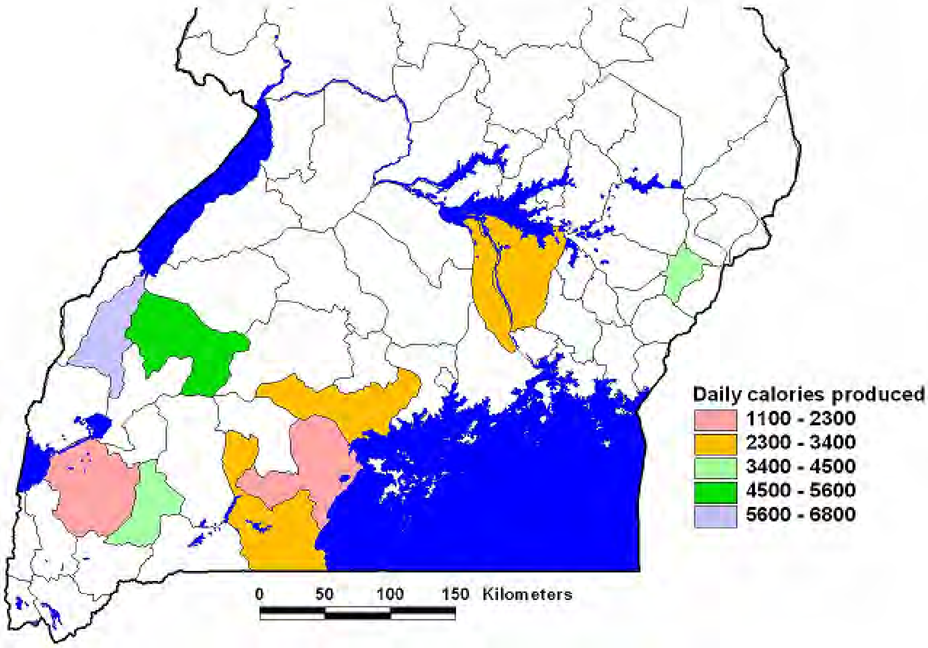


Source: Own data.

Food security II: Daily calorie capacity from total crop production

The availability of calories from total crop production ranges from about 1,100 (again, Bushenyi) to more than 6,700 kcal per capita per day in Kabarole. The distribution is depicted in Figure 12.

Figure 12: Map of daily calorie intake capacity in Central and Western Uganda

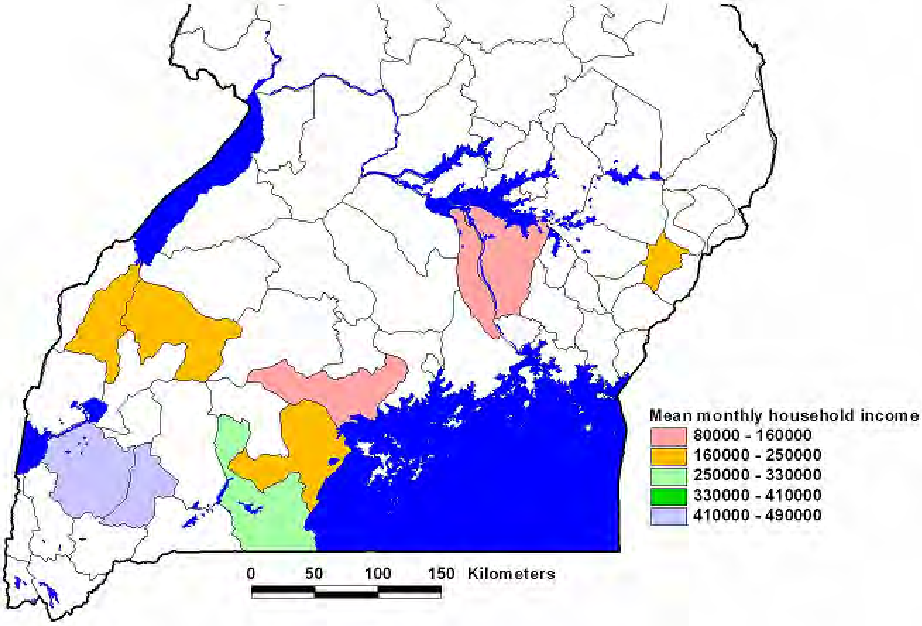


Source: Own data

Food security III: Cash income

Off-farm income provides an additional access to food through purchases from markets. This figure ranges from 80,000 Ushs to almost 500,000 Ushs. The distribution is depicted in Figure 13.

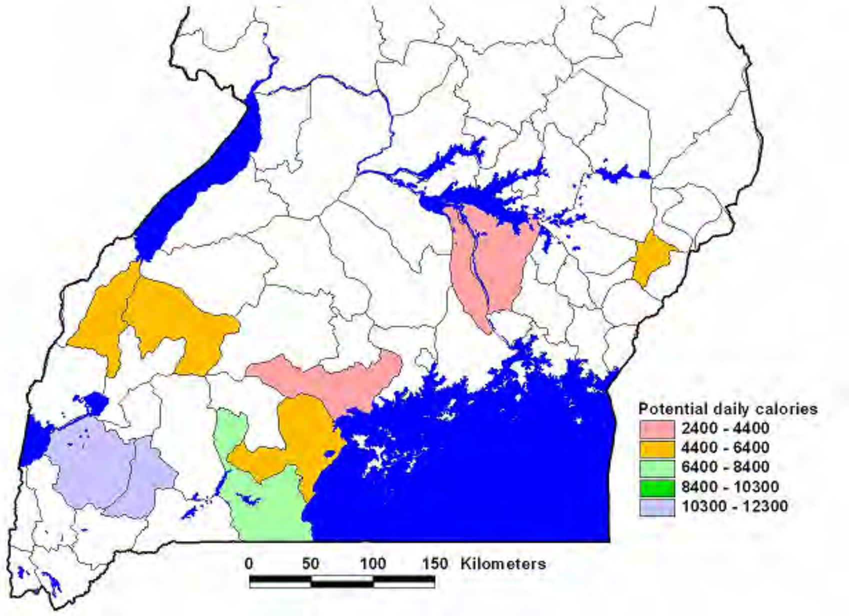
Figure 13: Map of cash income in Central and Western Uganda



Source: Own data.

How does this translate into food security? For example, households that earn 100,000 Ugandan Shillings per month could purchase 200 kg maize (at an assumed price of 500 Shillings/kg). This would translate into 662,000 kcal per month, and thus 2,200 kcal per day. In the survey region, households can obtain from about 2,400 up to 12,000 kcal per capita per day from their off-farm income sources, which could contribute a decisive part to their diets and eventually their food security (Figure 14).

Figure 14: Map of calorie capacity from cash income in Central and Western Uganda



Source: Own data, FOODNET/MIS

Household dietary diversity in Central and Western Uganda

Household dietary diversity – the number of individual foods or food groups consumed by a household over a given period – reflects the quality of a household's diet in terms of different food groups and is therefore a valuable extension to the mere caloric intake figures discussed above. We used 12 food groups to determine the HDD, as discussed earlier in this report.

Results are presented in Table 2 below. It can be seen that all households are below the maximum mark of twelve, with the lowest values in (relatively urban) Mbarara

Table 2: Household dietary diversity in Central and Western Uganda

District	Av. HDDS (scale 0-12)
Mbale	7.6
Kamuli	6.9
Kayunga	5.8
Mpigi	6.6
Masaka	6.6
Rakai	5.6
Bushenyi	6.6
Mbarara	4.9
Kabarole	6.1
Kyenjojo	6.1

Source: Survey

Food security as perceived by households

To obtain a picture of the own perception of households in terms of their food security, we asked the households whether they have always enough and the desired type of food to eat, whether they have enough but not the desired food to eat, or whether they have either sometimes or always not enough to eat. The results are depicted in Table 3. The figures show that households in Central and Western Uganda are in their majority food secure, however, there are some some districts where food insecurity seems to be permanent for some households (Rakai, Kayunga). In all districts, between 5 and 33 percent of the households are temporarily food insecure.

Table 3: Food security as perceived by the households in Central and Western Uganda

District	Enough of the kinds of food desired	Enough but not always the kinds of food desired	Sometimes not enough to eat	Always not enough to eat	Food secure overall	Food insecure (temporal + permanent)
Mbale	34.7	45.8	15.3	4.2	80.6	19.4
Kamuli	18.9	62.2	14.9	4.1	81.1	18.9
Kayunga	10.7	57.1	21.4	10.7	67.9	32.1
Mpigi	22.5	50.0	25.0	2.5	72.5	27.5
Masaka	14.3	50.6	29.9	5.2	64.9	35.1
Rakai	14.3	31.0	33.3	21.4	45.2	54.8
Bushenyi	43.7	33.8	21.1	1.4	77.5	22.5
Mbarara	45.6	30.1	16.5	7.8	75.7	24.3
Kabarole	15.0	67.5	12.5	5.0	82.5	17.5
Kyenjojo	25.7	62.9	5.7	5.7	88.6	11.4

Figures are percentages of total number of households.
Source: Own data

Conclusions

Households in the 12 main cassava growing districts in Uganda are food secure. They have in general, with a few exceptions, enough food from own production to sustain their food needs. In any case, they have enough capacity to cater for their food needs either through own production or through purchases from off-farm income.

However, it is also clear that cassava constitutes a major share of household's diets in many districts, so that a severe loss of cassava could still negatively affect household's diets, and in particular their wealth.
It is therefore important to maintain the cassava productivity, in order to make sure that these households can maintain their diets and their livelihoods.
Households in Central and Western Uganda are in their majority food secure, as only a small minority is permanently food insecure. Although they cover only a small part of their food requirements from own production, they have enough production and off-farm income capacity to cater for their food needs.
Yet as bananas cover a large part of the diet, it is clear that banana production losses negatively affect food security, however, without really threatening the overall food security in this region.

Household vulnerability to crop diseases in Uganda

Households in Uganda can cope well with crop diseases such as CMD and probably also BXW. The elasticity of the disease effect on calorie intake is significantly low, which means that one percent of CMD loss only accounts for 0.02 loss in calorie intake. However, social characteristics show that male-headed households have a larger caloric intake per capita, as well as smaller families, whereas variables on age and education are insignificant. This means that for targeting, large female headed households as well as land-poor farmers have to be selected (Table 4).

Table 4: Determinants of caloric intake in CMD affected households in Uganda

Variable	Coefficient	t-value	p-value
EXP	5.36 (2.54)	2.10	0.036
EXP^2	-0.24 (0.12)	-1.97	0.050
EDUCHEAD	-0.004 (0.007)	-0.61	0.541
AGEHEAD	-0.006 (0.01)	-0.41	0.679
HHSIZE	-0.79 (0.52)	-1.53	0.127
CASSLOSS	-0.02 (0.007)	-3.63	0.000
SEXHEAD	0.02 (0.008)	2.78	0.006
FARMLAB	0.003 (0.009)	0.39	0.697
LANDOWN	0.05 (0.01)	4.81	0.000
CONSTANT	-23.15 (12.93)	-1.79	0.074

No. of observations = 361, Prob > F = 0.000, R-squared = 0.157 Adj R-squared = 0.136
Root MSE = 4.858 Figures in parentheses are standard errors.

Source: Own calculations

Kenya

Overview

In 2003, Kenyans had an average daily calorie intake per person of 1876.16 kcal. Of this amount, 87 % come from vegetal products, whereas 13 percent come from animal products (FAO 2006).

The figures below indicate that Western Kenya has a better food supply than overall Kenya, which is not surprising as the region is both in terms of climate and soil fertility better off than many other parts of Kenya (Table 5).

Table 5: Food consumption for overall Kenya and the respective districts

	Overall Kenya	Average Western Kenya
Calories from vegetal products	1,876.16	n.a.
Of which from alcoholic beverages	17.94	n.a.
Calories from vegetal products excl. alc.	1,858.22	2,756
Calories from animal products	278.61	n.a.
Daily calorie intake	2,154.77	n.a.
Percentage calories from vegetals excl. alc. covered in survey	n.a.	147
Percentage calories from total excl. alc. covered in survey	n.a.	

Source: FAO 2006, own data

The region

The region covered in the first dataset covers six districts of Western Kenya, namely Busia, Kuria, Homa Bay, Rachuonyo, Siaya and Teso (Figure 15).

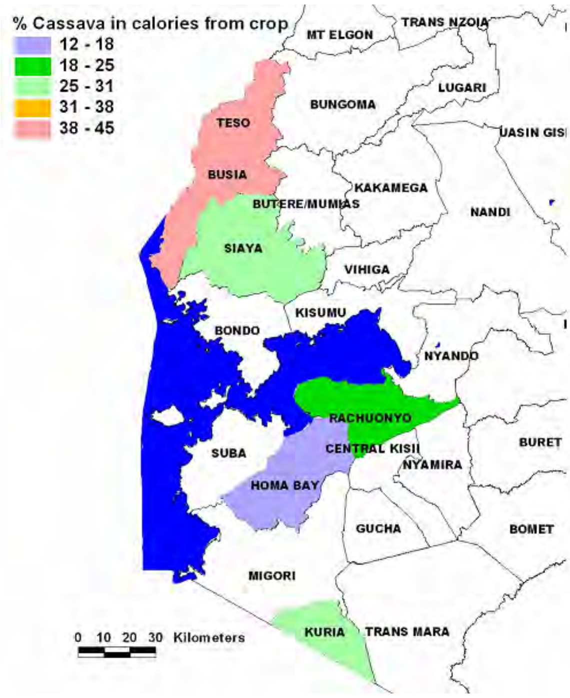
Figure 15: Map of districts covered in the first dataset of Western Kenya

Source: GIS.

The role of cassava and maize in the region's food security

In Kenya as a whole, cassava plays a minor role in the population's diet, with only 1.7 percent of the daily calorie intake coming from cassava across the whole of Kenya. In the surveyed region, however, cassava is one of the major staple food crops, accounting for between 12 and 45 percent of the daily per capita calorie intake (Figure 16). There is a North-South gradient, with cassava being most important in the North and of less importance in the South of Western Kenya.

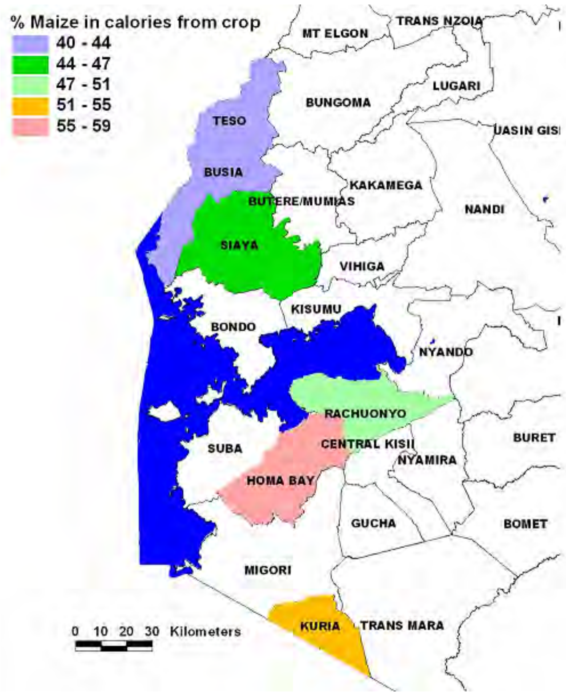
Figure 16: Map of contribution of cassava to caloric intake in Western Kenya



Source: Own data

Bananas do not play a role in the household's diet in Western Kenya. The major staple crop for this region is definitely maize, which accounts for between 40 and 60 percent of the overall caloric intake (Figure 17). For the whole of Kenya, bananas provide three percent of the daily caloric intake (FAO 2004), whereas maize constitutes 36 percent of the daily calorie intake of the average Kenyan. The importance of maize seems to be the inverse of the cassava importance, as in the South, where cassava is less important, maize is more important, and vice versa in the North.

Figure 17: Map of contribution of maize to caloric intake in Western Kenya



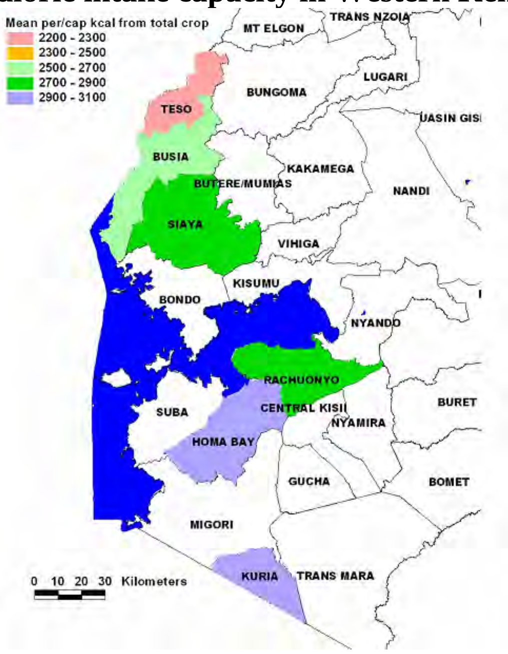
Source: Own data

Food security I: Daily calorie capacity from total crop production

The daily calorie potential comprises the overall production of edible vegetal crops in terms of kcal. This figure includes the calories produced and self-consumed, as well as the calories that could be potentially obtained from crops that are presently grown but sold on the market. This is particularly relevant in times of shortages in production, as households then tend to cut down on marketed sales in favour of own consumption of the produce.

This calorie production ranges from about 2,100 kcal to 3,100 kcal per capita per day (Figure 18). There is a clear North-South gradient, with the lowest capacity in the North (Teso). This indicates that the relation between cassava and calorie intake is negative, probably due to frequent problems with cassava diseases, like CMD.

Figure 18: Map of daily calorie intake capacity in Western Kenya

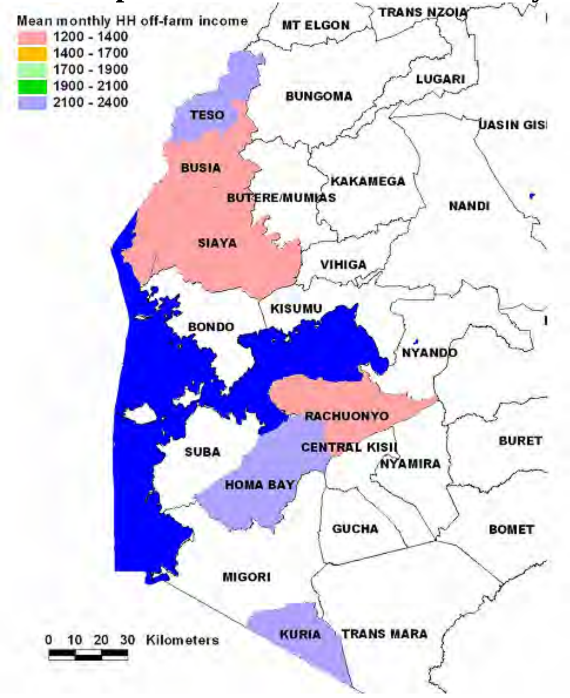


Source: Own data

Food security II: Cash income

Off-farm income provides an additional access to food through purchases from markets. The monthly off-farm income ranges from 1,200 Kenyan Shillings per household (an equivalent of about 17 US $) to about 2,400 Kenyan Shillings (34 US $). The distribution is depicted in Figure 19.

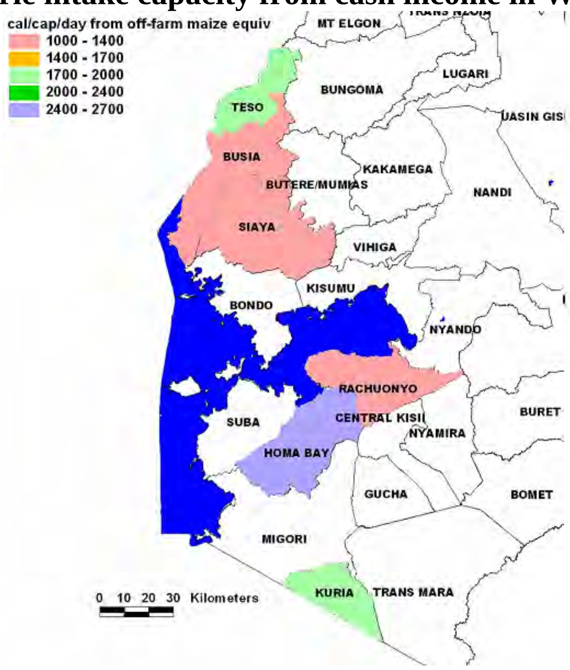
Figure 19: Map of cash income per household in Western Kenya



Source: Own data.

This off-farm household income would translate into a per capita calorie intake potential between 1,000 and 2,700 kcal per day. Figure 20 shows the respective distribution across districts.

Figure 20: Map of calorie intake capacity from cash income in Western Kenya



Source: Own data

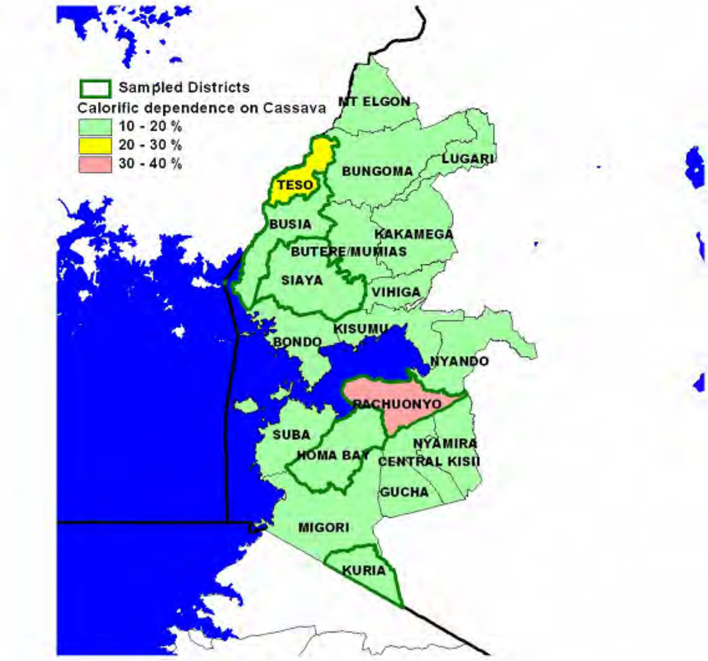
Findings from the update survey

In 2006, a survey was conducted in Western Kenya to update the data from the previous survey, which had been a survey on adoption of CMD-resistant varieties in the region and conducted in 2004. In contrast to the first survey, the update survey was designed like the other food security surveys and therefore more compatible with the rest of the data.

Dependence on banana and cassava in Western Kenya

The dependence on cassava as a food crop ranges from 10 to 40 percent in the region, with Teso and Rachuonyo being the most dependent areas. This is a slight difference from the first survey, as there, Busia was also heavily dependent on cassava, and the cassava dependence seems to have declined in the meantime. Rachuonyo seems to have experienced a slight increase in cassava dependence, whereas the other areas stay in the same relationships.

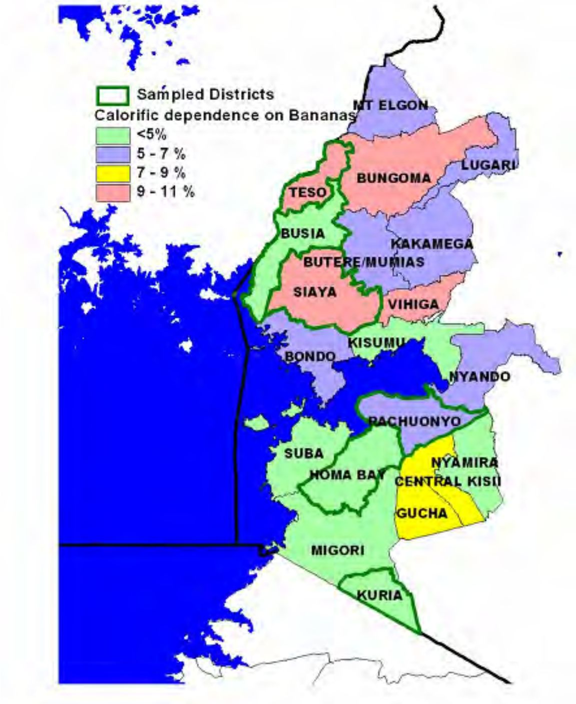
Figure 21: Calorific dependence on cassava in Western Kenya



Source: Own data

As in the previous survey, the role of bananas in Western Kenya's peoples' diets is significantly low, with most of the areas' values lower than 10 percent. Areas of slightly higher proportions of bananas in dietary intake are in the West of the region, with declining values to the Southeast (Figure 22)

Figure 22: Calorific dependence on bananas in Western Kenya

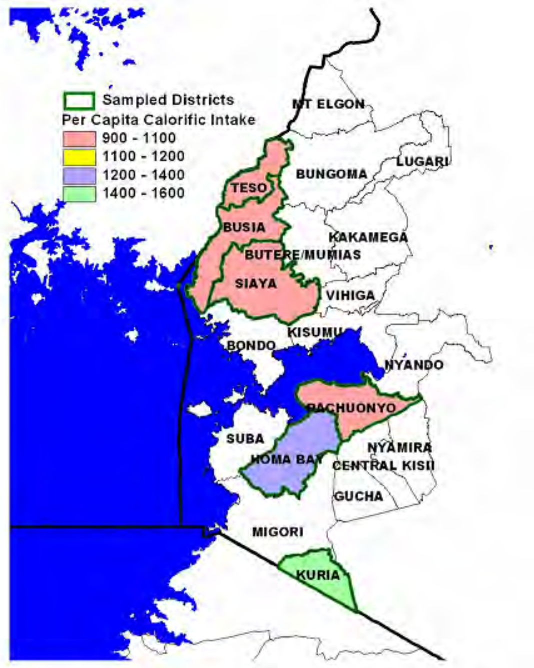


Source: Own data

Daily calorie intake from subsistence production

The range of daily calorie intake from subsistence production is between 900 and 1600 kcal per capita per day. Unfortunately, data on the same characteristics were not obtained from the first survey.

Figure 23: Daily calorie intake from own production

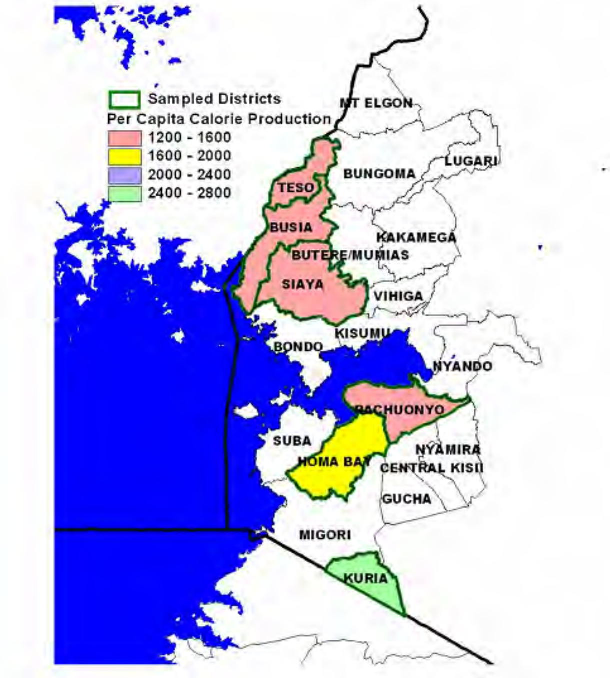


Source: Own data.

Total calorie production per capita has the same range as in the initial survey, with a slightly lower tendency. Geographical patterns are by and large the same as in 2004, with the more

Northwestern regions having the lowest calorie production and the more South-Eastwards regions having slightly higher potentials (Figure 24).

Figure 24: Potential calories from overall production

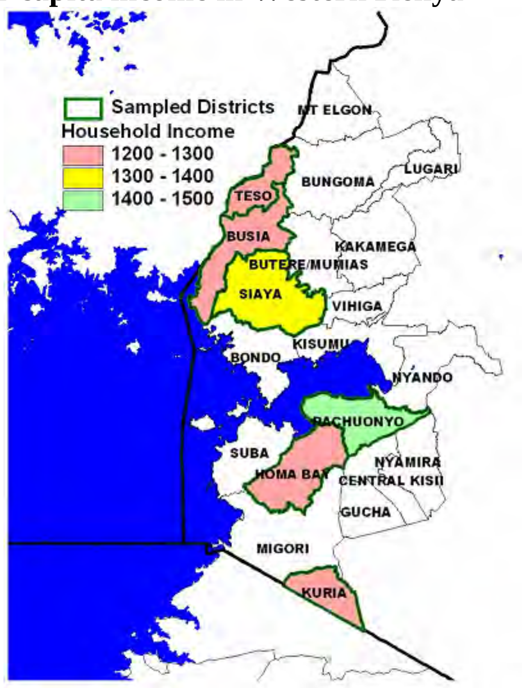


Source: Own data.

Household per capita income

Household cash income per capita is significantly higher than in the first survey, with a slight change in structure. The Northwest is still the part with the lower income, with a slight increase to the south. It has to be noted that the present figures are closer to the figures found in official statistics (see e.g. CIA 2007), which is probably due to the more accurate capturing of cash income in the second survey (Figure 24).

Figure 25: Household per capita income in Western Kenya

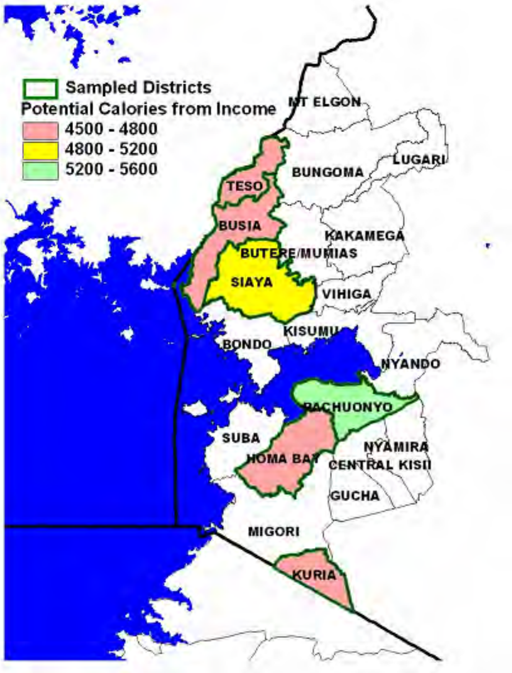


Source: Own data

Potential calories per capita from cash income

Figure 26 shows the respective computations for the potential of calories per capita (maize equivalent) for Western Kenya. All of the districts are therefore potentially food secure, as they can, when necessary, cover their food requirements from cash income.

Figure 26 Potential calories from cash income

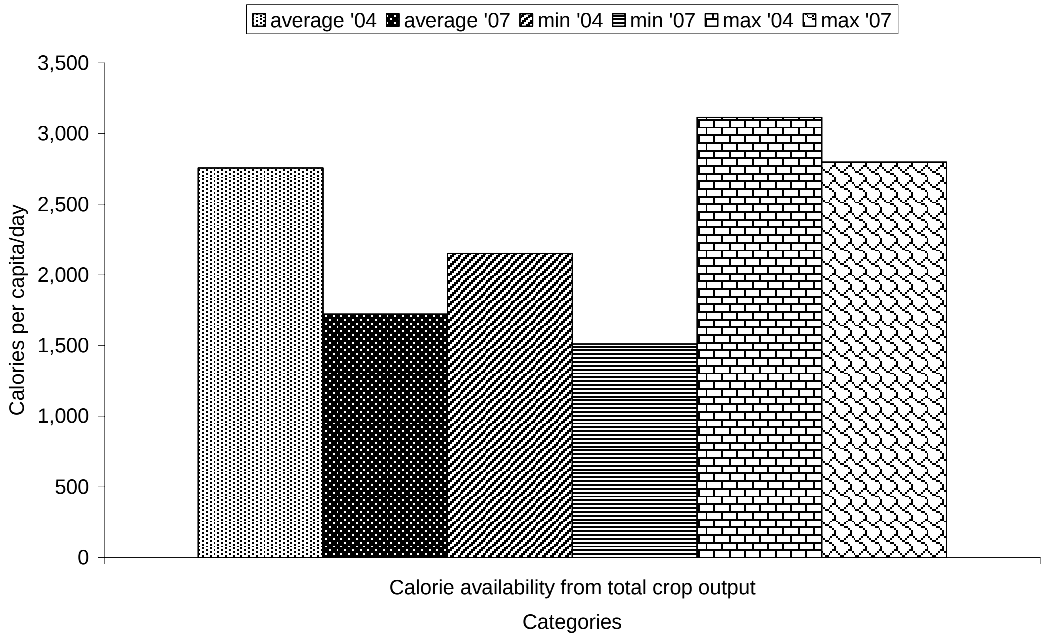


Source: Own data

A reference to the 2004 survey results

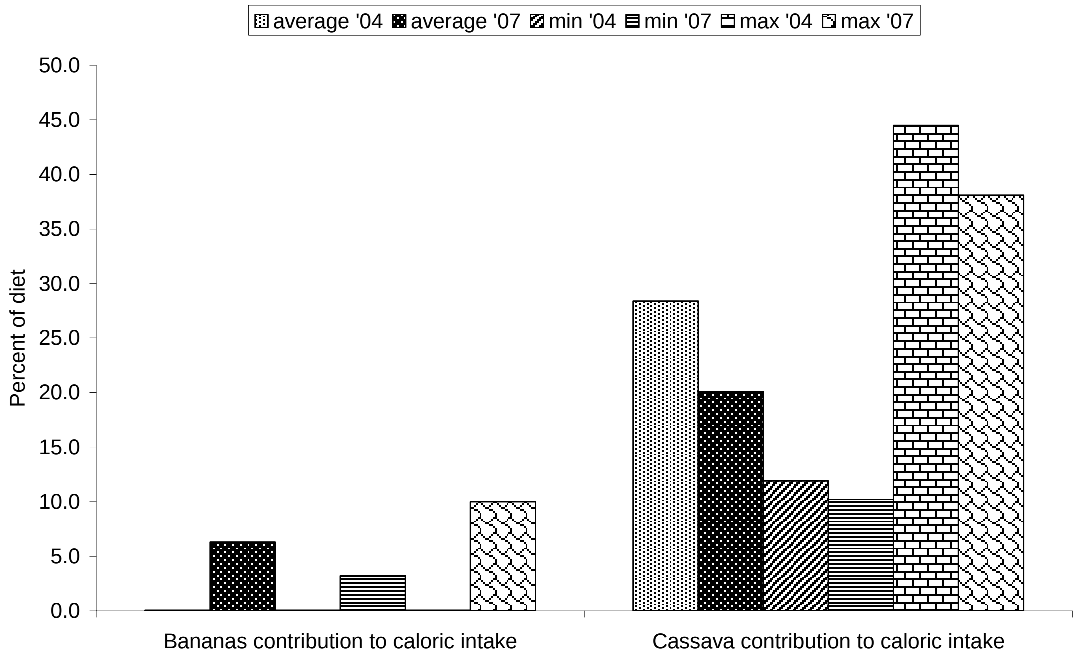
Figure 27 and Figure 28 show a brief comparison of the major results in 2004 and 2007. There are differences, as shown in the figure, which are not only in the values but as discussed also in the regional distribution. Although the overall outcomes are the same, it can be speculated that the results may not only be due to temporal changes (which they may well be), but also due to differences in survey tools and evaluation methodologies. As will be shown below, the differences in the two Tanzanian surveys are much smaller and can be attributed to residual survey errors, which emphasizes the assumption that the use of uniform survey tools is crucial.

Figure 27: Caloric intake parameters as surveyed 2004 and 2007 in Western Kenya



Source: Own data

Figure 28: Importance of banana and cassava in 2004 and 2007 in Western Kenya



Source: Own data

Household dietary diversity in Western Kenya

The below Table 6 shows the household dietary diversity in Western Kenya. The diet there is relatively diverse, with an index varying between 7.2 and 7.7, which has the region rank among the highest in the six investigated countries.

Table 6: Household dietary diversity in Western Kenya

District	Av. HDDS (scale 0-12)
Kuria	7.7
Homa bay	7.2
Teso	7.5
Busia	7.6
Rachuonyo	7.4
Siaya	7.5

Source: Own data.

Food security as perceived by the households in Western Kenya

Table 7 shows the food security status as perceived by the households in Western Kenya. The majority of households seem to be food secure, however, a large proportion of the households across all districts is at least temporarily insecure.

Table 7: Food security as perceived by the households in Western Kenya

District	Enough of the kinds of food desired (%)	Enough but not always the kinds of food desired (%)	Sometimes not enough to eat (%)	Always not enough to eat (%)	Food secure overall (%)	Food insecure (temporal + permanent)
Kuria	33.3	26.2	38.1	2.4	59.5	40.5
Homa bay	25.6	23.3	39.5	11.6	48.8	51.2
Teso	32.6	23.3	39.5	4.7	55.8	44.2
Busia	31.8	31.8	25.0	11.4	63.6	36.4
Rachuonyo	14.3	28.6	35.7	21.4	42.9	57.1
Siaya	22.7	22.7	43.2	11.4	45.5	54.5

Source: Own data

Conclusions

Households in Western Kenya are food secure, however, they are not in a situation of abundance, like for example the households in Central and Eastern Uganda. They are heavily dependent on cassava and on maize, so that a loss of either crop or both crops at the same time would bring them into distress. The recent examples of droughts destroying the maize harvest and CMD destroying cassava harvests give a good example of this. A disease of cassava, like the CMD pandemic of the mid-nineties that basically destroyed half of the crop would leave the households totally vulnerable to maize losses, which have become more frequent in recent years due to drought.

Household vulnerability to crop diseases in Western Kenya

Households in Western Kenya seem to be slightly more vulnerable to crop diseases than in Uganda, yet the vulnerability is still low, with an elasticity of 0.03. Of the social characteristics, only education of the household head seems to be significant, yet also at a very low level. This makes targeting of social strata difficult, with the only possibility to target labour constrained households, as the availability of farm labour significantly affects caloric intake from subsistence (Table 8).

Table 8: Determinants of caloric intake in CMD affected households in Western Kenya

Variable	Coefficient	t-value	p-value
EXP	49.40	1.79	0.076
	(27.57)		
EXP^2	-3.76	-1.86	0.065
	(2.01)		
EDUCHEAD	0.07	1.85	0.067
	(0.04)		
AGEHEAD	3.22	0.87	0.388
	(3.72)		
HHSIZE	-0.73	-0.23	0.819
	(3.19)		
CASSLOSS	-0.03	-1.73	0.085
	(0.02)		
SEXHEAD	2.57	0.54	0.592
	(4.78)		
FARMLAB	1.04	7.83	0.000
	(0.13)		
CONSTANT	-171.05	-1.77	0.080
	(96.91)		

No.of observations=125, Prob>F=0.000, R-squared=0.390,
AdjR-squared=0.348, RootMSE=12.422 Figures in parentheses are standard errors.

Source: Own calculations

Tanzania

Overview: Food security and food sources in Tanzania

In 2003, Tanzanians had an average daily calorie intake per person of 1,959 kcal. Of this amount, 90 % came from vegetal products, 4 % came from alcoholic beverages, whereas only 6 percent came from animal products (FAO 2006). Hence, crop production and the calories obtained from crops give a good indicator of food security in Tanzania (Table 9), as the surveyed region is at 103 percent of the caloric intake from vegetal crops in overall Tanzania, as well as at 96 percent of the overall caloric intake.

Table 9: Food consumption for overall Tanzania and the respective districts

	Overall Tanzania	Average Northern Tz
Calories from total vegetal products	1,832	n.a.
Of which from alcoholic beverages	61	n.a.
Calories from vegetal products excl. alc.	1,771	1,832
Calories from animal products	127	n.a.
Daily calorie intake	1,959	n.a.
Percentage calories from vegetals excl. alc. covered in survey	n.a.	103
Percentage calories from total excl. alc. covered in survey	n.a.	96

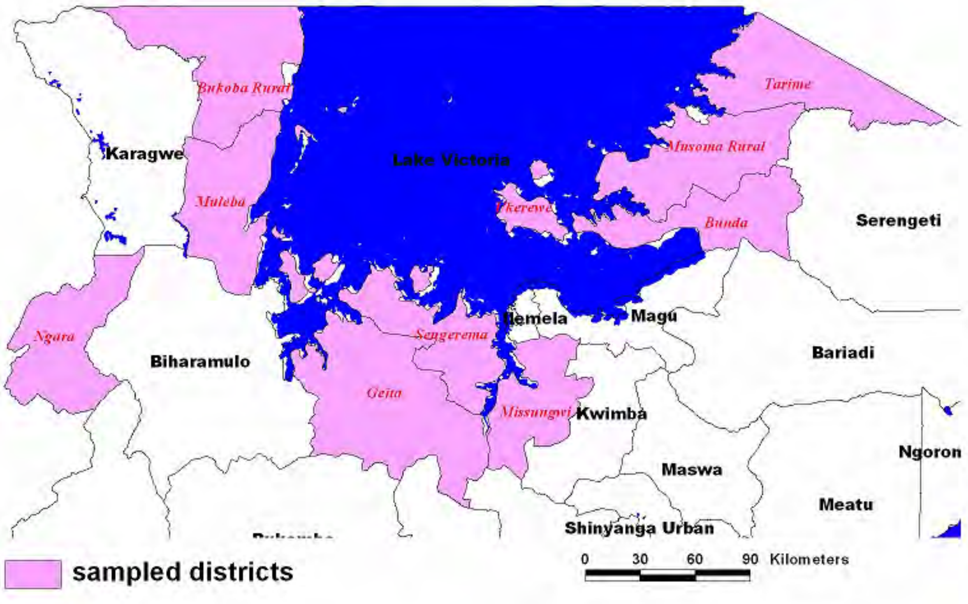
Source: FAO 2006, own data

Findings from the 2005 survey

The region

The region covered in the first food security survey (2005) contains 10 Tanzanian districts in Northern Tanzania around Lake Victoria (Figure 29).

Figure 29: Map of districts covered in the first Tanzania food security survey

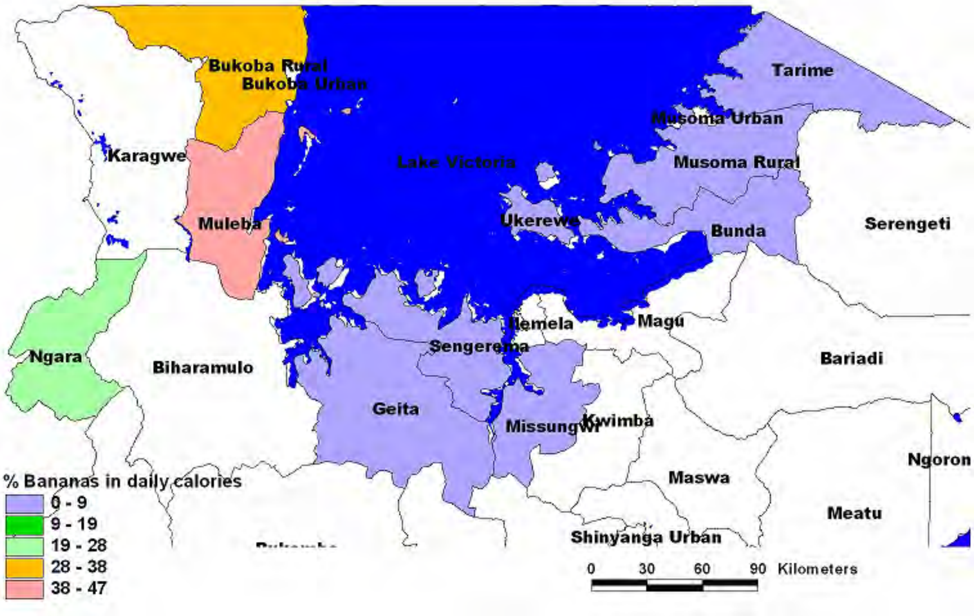


Source: GIS.

The role of banana and cassava in the region's food security

Bananas play a minor role in the household's diet in most of the districts, except for the Western part of the region, in Bukoba, Mulewa, and Ngara, where cooking bananas account for between 20 and 40 percent of the calorie intake. (Figure 30). For Tanzania as a whole, bananas provide only about 1.7 percent of the daily caloric intake (FAO 2004).

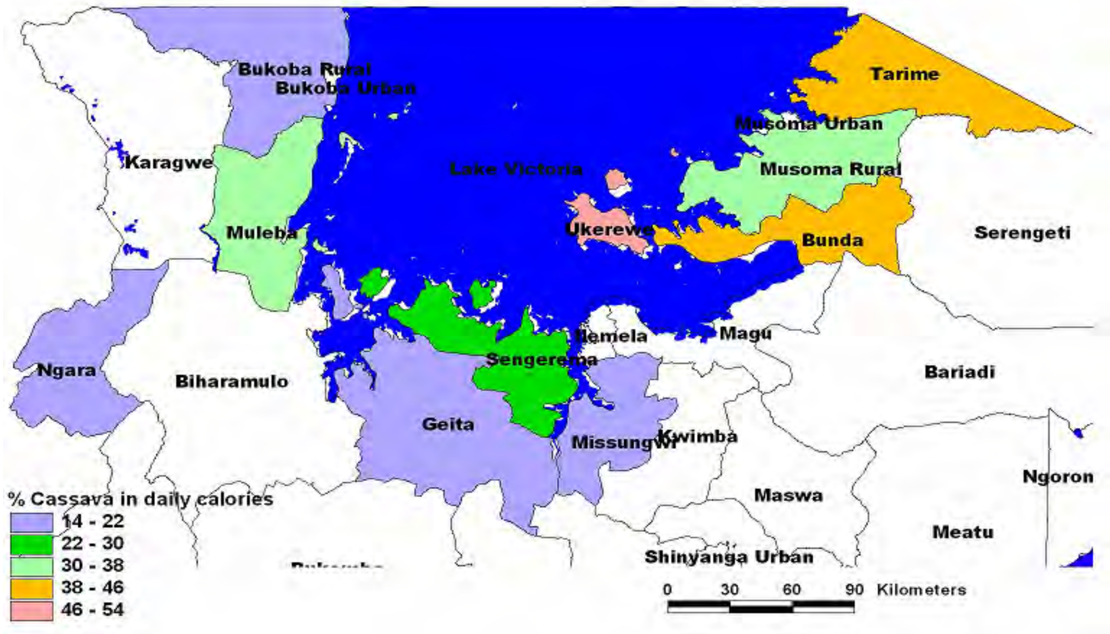
Figure 30: Map of contribution of bananas to caloric intake in Northern Tanzania



Source: Own data

Cassava plays a major role in the household's caloric intake in the region. For the whole of Tanzania, cassava provides around 15 percent of the daily caloric intake. In the ten districts assessed here, it provides between 15 and 54 percent of the total calorie intake (Figure 31).

Figure 31: Map of contribution of cassava to caloric intake in Northern Tanzania



Source: Own data

It is quite clear that in contrast to Uganda, where food consumption is dominated by cassava and banana, in Tanzania, and in particular in this area, food production and consumption patterns are much more diverse. Table 10 gives an overview of the major food crops consumed in the region. Apart from cassava, maize is the most important food crop, with even more households consuming maize than cassava. Sweet potato is the third most important crop, followed by beans. Bananas are the least important crop among the major staples.

Table 10: Food consumption patterns in Tanzania

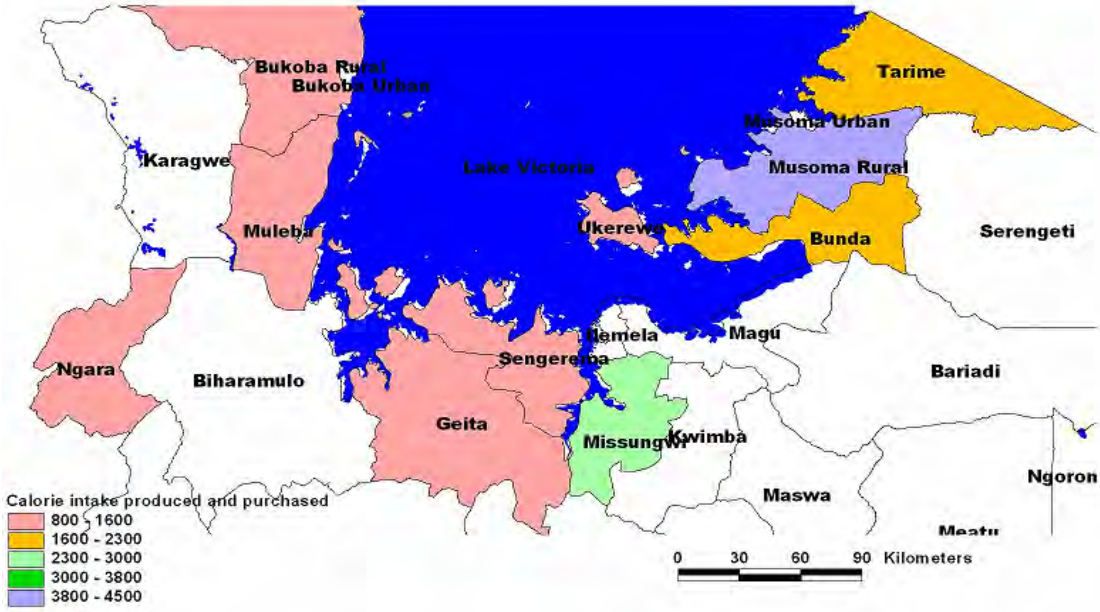
Crop	Percentage of households consuming the crop
Cassava	84
Banana	26
Maize	87
Beans	30
Sweet potato	61

Source: Own data

Food security I: Daily calorie intake from subsistence production and purchases

This indicator comprises the actual intake from own production, not including the calories from crops that were sold on the market, as well as the intake from food purchases. The average is around 1,860 kcal/caput/day, which is well below the recommended level of 2,100 kcal per day. The range is from 800 kcal per day in Ngara (West) to 4,200 kcal per day in Musoma. These sometimes severe food shortages are exacerbated by events such as droughts and diseases like CMD and banana bacterial wilt (Figure 32).

Figure 32: Map of calorie intake from own production and food purchases in Tanzania



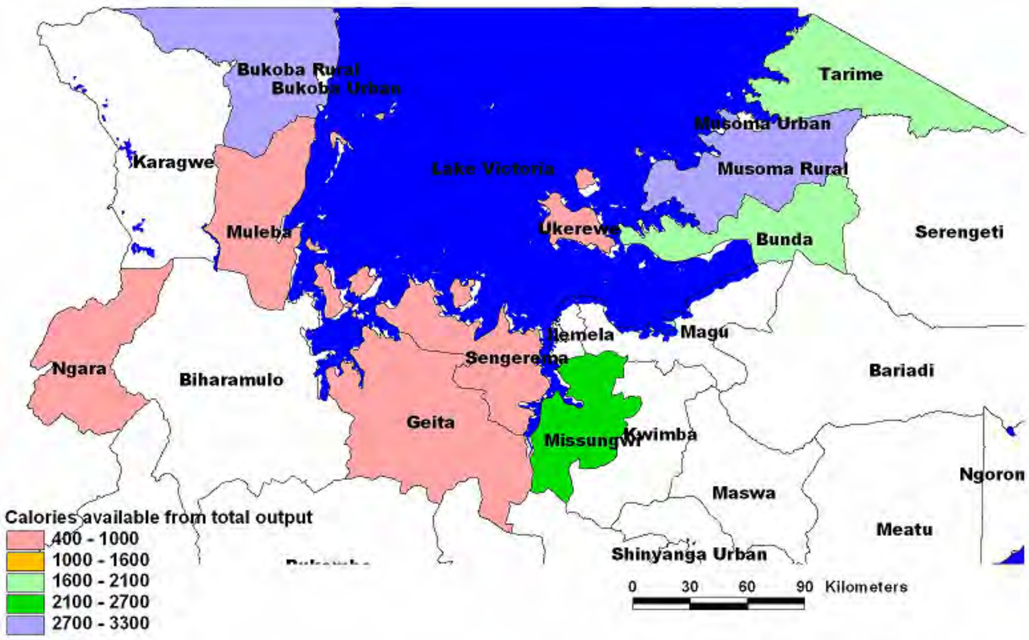
Source: Own data.

Food security II: Daily calorie capacity from total crop production

The daily calorie potential comprises the overall production of edible vegetal crops in terms of kcal. This figure includes the calories produced and self-consumed, as well as the calories that could be potentially obtained from crops that are presently grown but sold on the market. This is particularly relevant for times of shortages in production, as households then tend to cut down on marketed sales in favour of own consumption of the produce.

Contrary to the status of Uganda, the amount of calories obtained from own production is lower than the actually consumed amount (Figure 33). This means that the region's household suffer from food shortages and have to purchase food. The daily intake capacity from own production averages at about 1572 kcal per capita per day and ranges from 600 to 3,200 kcal.

Figure 33: Map of daily calorie intake capacity in Northern Tanzania

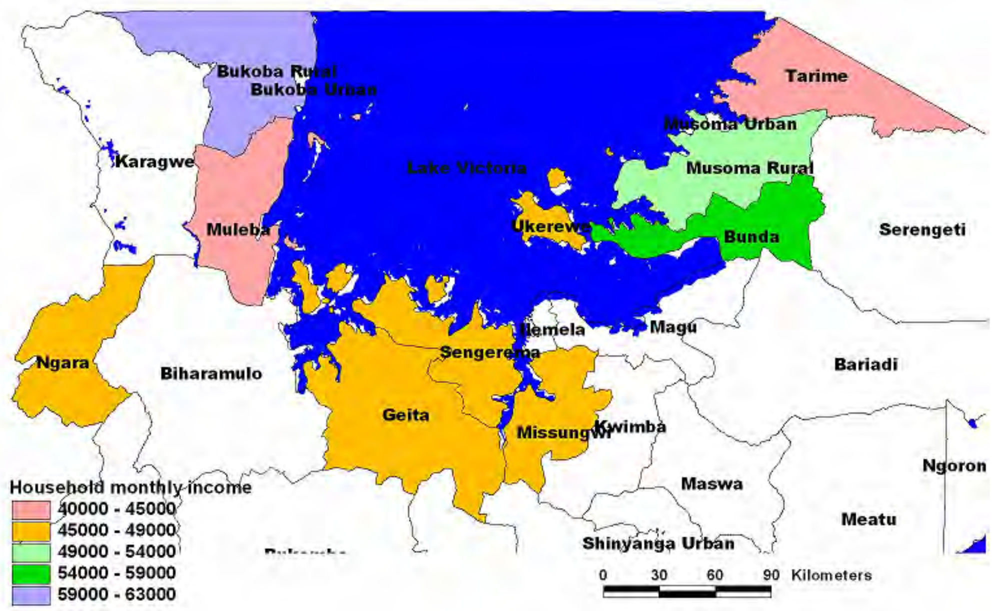


Source: Own data

Food security III: Cash income

Off-farm income provides an additional access to food through purchases from markets. The monthly off-farm income ranges from 39,000 Tanzanian Shillings per household (an equivalent of about 30 US $) in to about 63,000 Tanzanian Shillings (50 US $). The distribution is depicted in Figure 34.

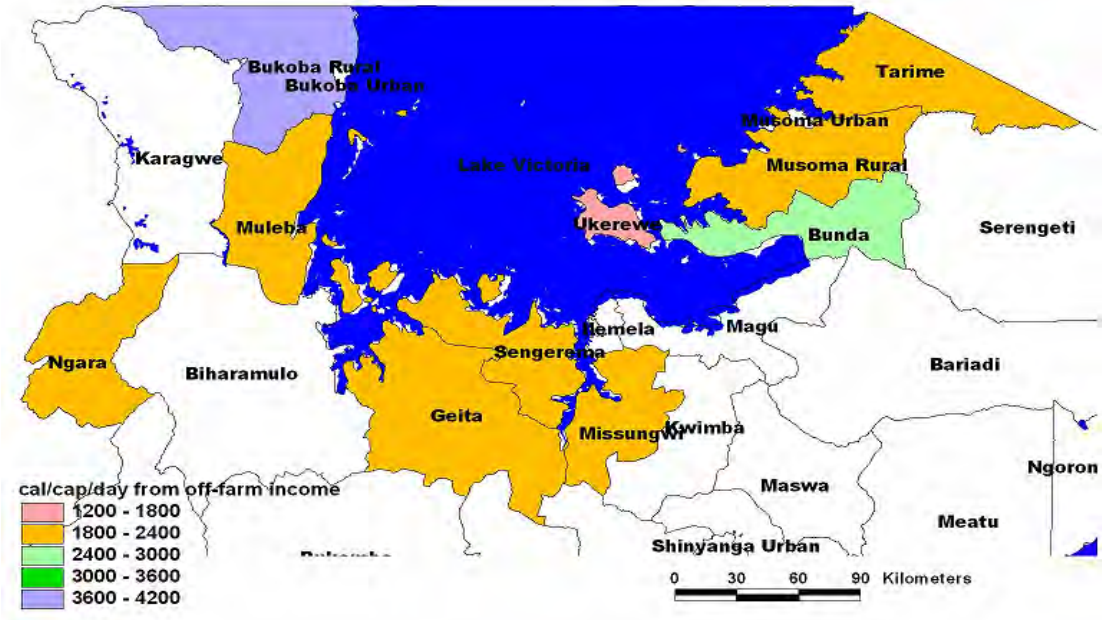
Figure 34: Map of cash income per household in Northern Tanzania



Source: Own data.

How does this translate into food security? If we transform the household income in maize equivalents by dividing the income by the price per kg of maize and transform the available maize quantity from cash income into calories, we get the calorie intake capacity from off-farm income. Figure 35 shows that households in Northern Tanzania do not always have sufficient off-farm income to cater for their food needs in times of crises. The off-farm income capacity ranges from 1,250 kcal/cap/day to almost 4,300 kcal/cap/day.

Figure 35: Map of calorie intake capacity from cash income in Northern Tanzania



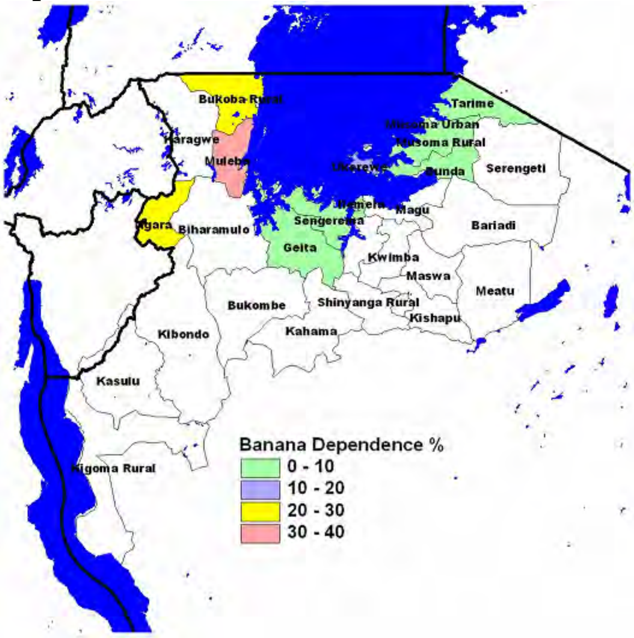
Source: Own data, FEWSNET

Findings from the 2007 survey

The role of banana and cassava in the region's food security

Bananas play a minor role in the household's diet in most of the districts, except for the Western part of the region, in Bukoba, Mulewa, and Ngara, where cooking bananas account for between 20 and 40 percent of the calorie intake. (Figure 36).

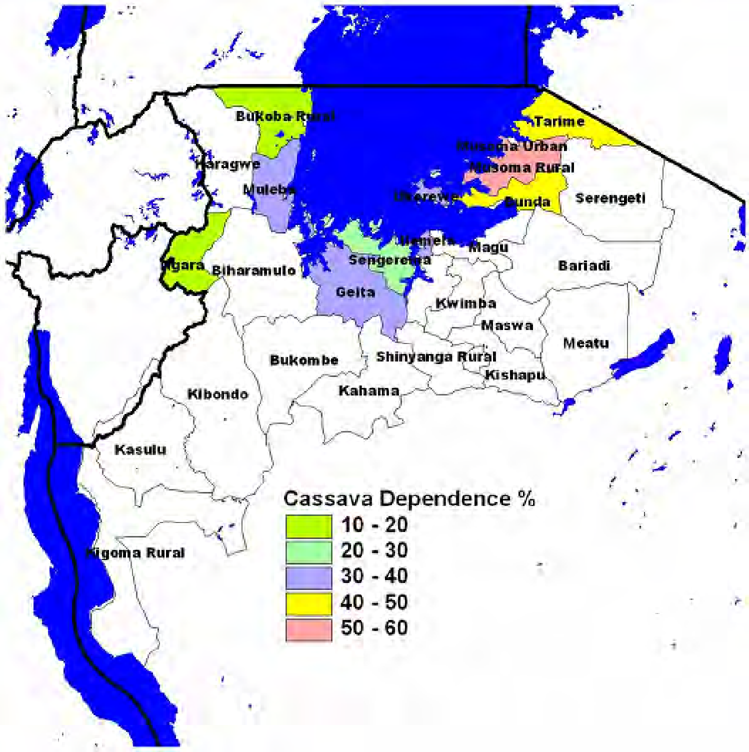
Figure 36: Updated map of contribution of bananas to caloric intake in Tanzania



Source: Own data

Cassava plays a major role for the household's caloric intake in the region. For the whole of Tanzania, cassava provides around 15 percent to the daily caloric intake. In the ten districts assessed here, it provides between 15 to 54 percent of the total calorie intake, with the highest amount in the Eastern part of the lake zone, with 40-60 percent and the lowest amount in the Western part, where bananas are more important than in the Eastern part. (Figure 37).

Figure 37: Updated map of contribution of cassava to caloric intake in Tanzania

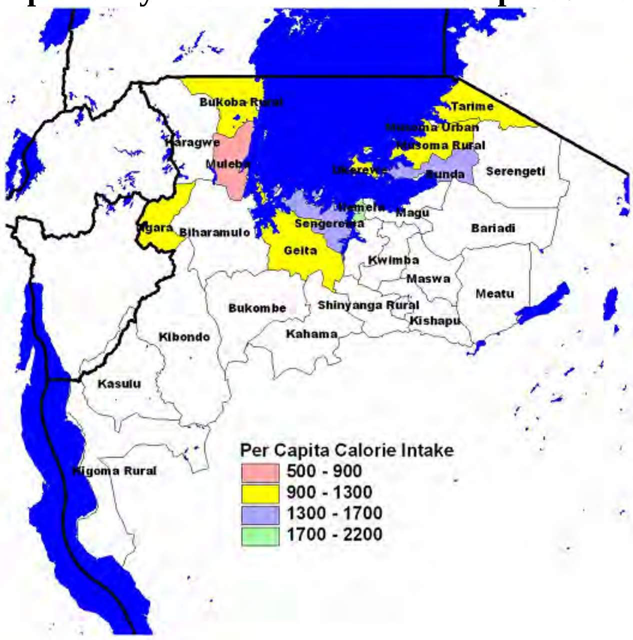


Source: Own data

Food security I: Daily calorie intake from subsistence production

This indicator comprises the actual intake from own production, not including the calories from crops that were sold on the market. The average is around 1,200 kcal/caput/day, which is well below the recommended level of 2,100 kcal per day. The range is from 900 kcal per day in Ngara (West) and Ukerewe (East) to 2,100 kcal per day in the Mwanza area (Figure 38).

Figure 38: Updated map of daily calorie intake from own production in Tanzania

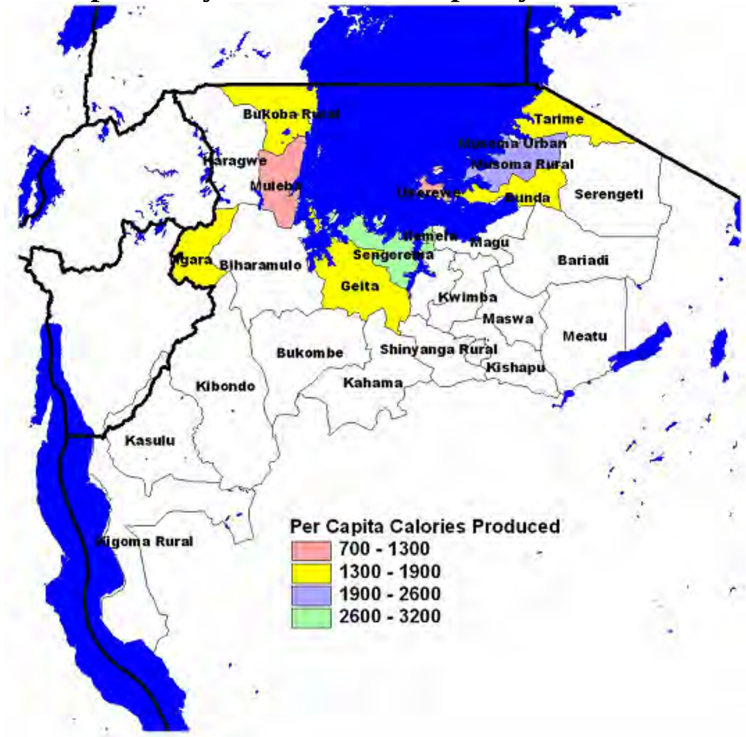


Source: Own data.

Food security II: Daily calorie Capacity from total crop production

The caloric production ranges from 700 kcal/cap/day in the West to 3,200 in Sengerema and Mwanza. The situation seems to be better in the Eastern area, with the exception of Ukerewe (Figure 39).

Figure 39: Updated map of daily calorie intake capacity in Tanzania

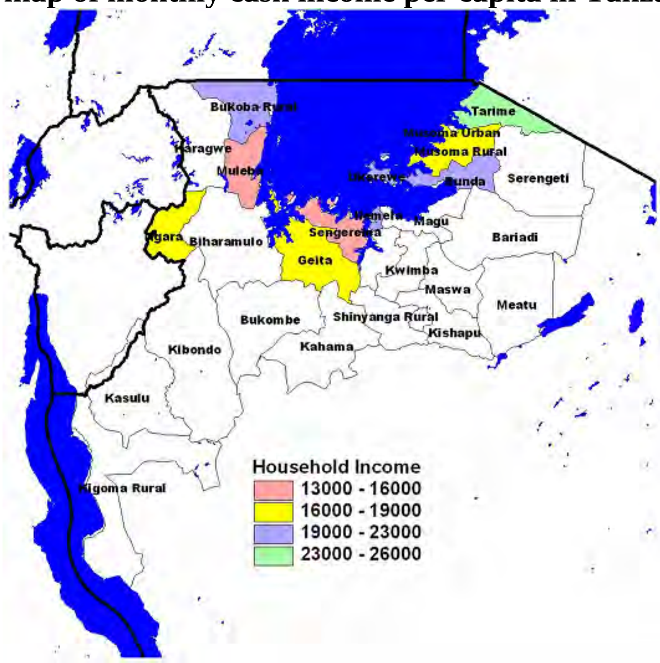


Source: Own data

Food security III: cash income

Monthly cash income per household ranges from 13,000 Tanzanian Shillings to 26,000 TzSh, with the highest income again on the Eastern side of the lake (Figure 40).

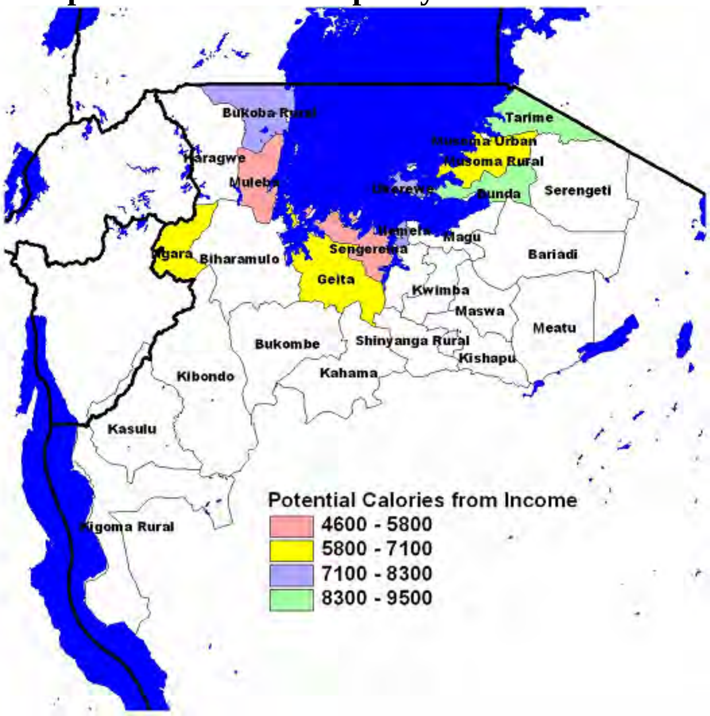
Figure 40: Updated map of monthly cash income per capita in Tanzania



Source: Own data.

If we transform the household income in maize equivalents by dividing the income by the price per kg of maize and transform the available maize quantity from cash income into calories, we get the calorie intake capacity from off-farm income. Figure 41 shows that households in Northern Tanzania seem to have sufficient capacity from their cash income to get calories beyond their own production. This also shows the importance of market access and off-farm income for food security.

Figure 41: Updated map of calorie intake capacity from off-farm income in Tanzania



Source: Own data

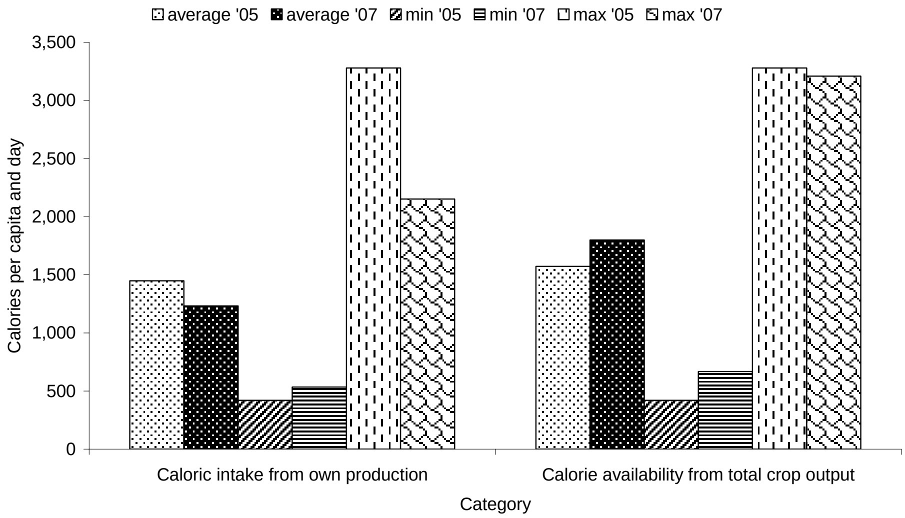
Food security in Northern Tanzania around Lake Victoria shows a quite diverse picture. While most of the households do not seem to be capable to cover their food requirements from own production, they seem to have enough cash income to cover their food needs.

A reference to the 2005 survey results

A comparison with the survey results in 2005, which were depicted in the food security brief no.3, shows that there is a remarkable congruence in particular in terms of the structure of food production, and in particular the relevance of bananas and cassava for food intake. Regional patterns are, as shown above, largely the same. Figure 42 below shows a summary of the two caloric intake parameters of the two surveys. The small differences could be due to changes over time, but might also be within the error envelope of surveys of this type. The survey findings on banana and cassava importance are depicted in Figure 43.

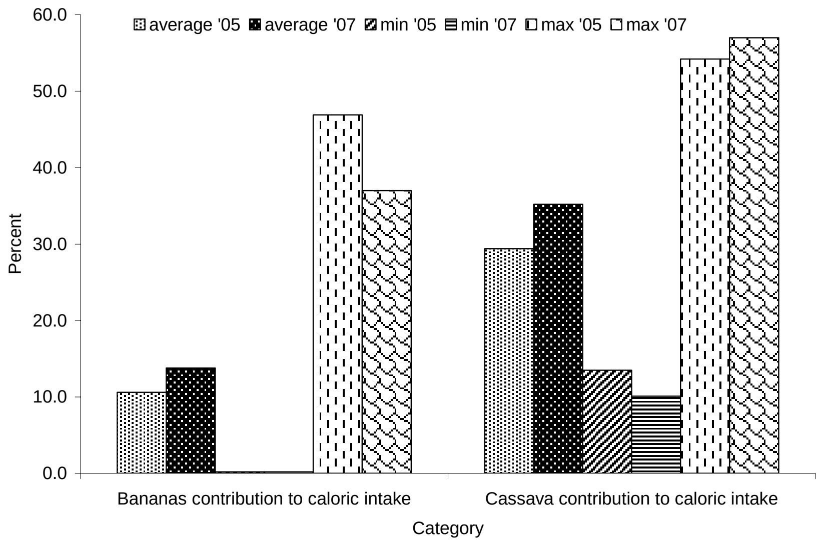
The only parameter that significantly differs across the two surveys is the monthly household cash income (note: not including subsistence crop production), which averages at around 50,000 Tzshs in the 2005 survey and 214,000 Tzshs in the 2007 survey. In general, statistics give a diverse picture. The regional data from the Tanzanian Bureau of Statistics suggest that for 2002, the cash flow per capita in the Northwest (Mara, Kagera, Mwanza and Kigoma) is between 7,000 and 9,000 Tshs per capita and month (NATIONAL BUREAU OF STATISTICS TANZANIA, 2007), which extrapolated by the income growth rate, would translate into 10,500 Tzshs for 2005 and 11,200 Tzshs in 2007. Thus, the 2005 survey results (6,500 Tzshs) seem to be more realistic if we assume that the survey was done in rural small scale farmers' households which are at the lower end of income distribution. However, the results show that probably only an increase in sample size can further sharpen the picture, which should be taken into account in follow up surveys.

Figure 42: Caloric intake parameters as surveyed 2005 and 2007 in Tanzania



Source: Own calculations

Figure 43: Importance of banana and cassava as surveyed 2005 and 2007 in Tanzania



Source: Own data

Household dietary diversity in Northern Tanzania

Household dietary diversity is lower than in Uganda, with values averaging between 4.9 and 6.6, as depicted in Table 11.

Table 11: Household dietary diversity in Tanzania

District	Av. HDDS (scale 0-12)
Gieta	6.0
Sengerema	6.3
Muleba	6.0
Ngara	6.6
Ukerewe	5.3
Bukoba	6.3
Bunda	4.9
Mwanza	6.0
Tarime	5.4
Musoma rural	4.9

Source: Survey data

Food security as perceived by the households in Tanzania

Households in the survey region are not always food secure, in fact, the share of food insecure households reaches a majority in half of the districts, with only between 40 and 70 percent of the households being permanently food secure (Table 12).

Table 12: Food security as perceived by the households in Tanzania

District	Enough of the kinds of food desired (%)	Enough but not always the kinds of food desired (%)	Sometimes not enough to eat (%)	Always not enough to eat (%)	Food secure overall (%)	Food insecure (temporal + permanent)
Gieta	34.4	31.2	34.4	0.0	65.6	34.4
Sengerema	43.8	28.1	28.1	0.0	71.9	28.1
Muleba	15.6	28.1	37.5	18.8	43.8	56.3
Ngara	34.4	40.6	15.6	9.4	75.0	25.0
Ukerewe	21.9	25.0	40.6	12.5	46.9	53.1
Bukoba	37.5	31.3	18.8	12.5	68.8	31.3
Bunda	25.8	16.1	51.6	6.5	41.9	58.1
Mwanza	21.9	18.8	46.9	12.5	40.6	59.4
Tarime	23.3	23.3	43.3	10.0	46.7	53.3
Musoma rural	28.1	37.5	31.3	3.1	65.6	34.4

Source: Survey data

Conclusions

Households in Northern Tanzania around Lake Victoria can definitely not be regarded as stably food secure. Although they may have sufficient access to food in good harvest years, they are quite vulnerable in years of drought or high disease pressure. In some cases, they do not have enough own production potential to cover their food needs. While most of the households do not seem to be capable of covering their food requirements from own production, the majority seem to have enough cash income to cover their food needs, although some may have difficulties there as well.

The fact that in most of the regions cassava, which is prone to CMD and CBSD and maize, which is prone to drought, are major food crops increases the vulnerability. The regions where bananas play a large role in food consumption are not well off in terms of calorie intake either.

So it is clear that interventions have to be made in terms of increasing cassava productivity by offsetting the diseases, as well as by countering BXW in some regions. However, interventions will also have to consider other crops, in particular maize, beans, and sweet potatoes, which are major food crops in the region.

Household vulnerability to crop diseases in Northern Tanzania

Households in Northwestern Tanzania are, as discussed above more vulnerable to crop diseases than in Uganda and Kenya. The elasticity of CMD on calorie intake from own production is almost 10, which means that one percent loss in cassava production (and potentially any other crop disease) leads to a ten percent loss of food from subsistence production. Of the social characteristics, only the availability of family labour is significant, which again yields only the possibility to target labour constraint households, as the availability for farm labour significantly affects caloric intake from subsistence (Table 13).

Table 13: Determinants of caloric intake in CMD affected households in Tanzania

Variable	Coefficient	t-value	p-value
EXP	2.47E-05	2.13	0.035
	(1.16E-05)		
EXP^2	-2.42E-11	-1.95	0.053
	(1.24E-11)		
EDUCHEAD	-0.01	-1.03	0.304
	(0.01)		
AGEHEAD	-0.01	-0.96	0.340
	(0.01)		
HHSIZE			
CASSLOSS	-0.006	-1.65	0.100
	(0.003)		
SEXHEAD	-0.09	-0.24	0.809
	(0.39)		
FARMLAB	0.02	2.90	0.004
	(0.008)		
LANDOWN	-0.003	-0.14	0.887
	(0.02)		
CONSTANT	6.47	8.25	0.000
	(0.78)		

No.of observations=134, Prob>F=0.069, R-squared=0.107, AdjR-squared=0.050
RootMSE=2.037 Figures in parentheses are standard errors

Source: Own calculations

Rwanda

Introduction

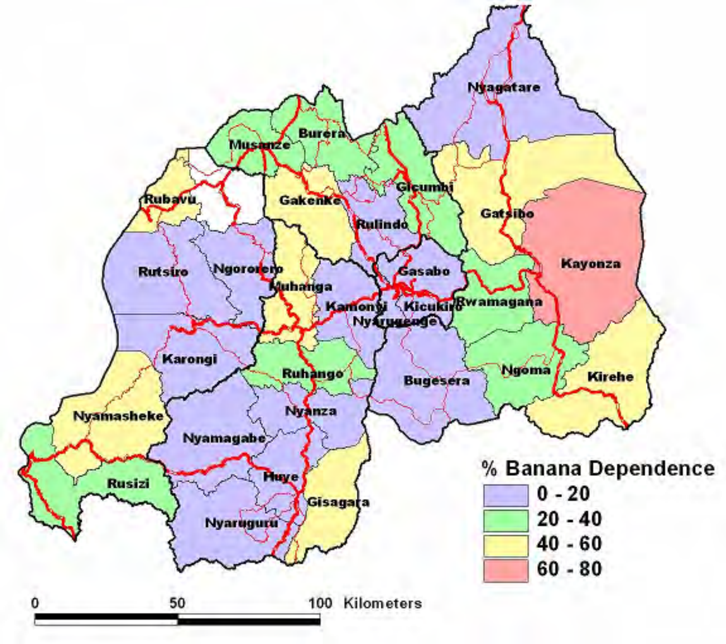
In contrast to the other three countries assessed in the Food Security Briefs 1-4 (Abele et al. 2006), Rwanda is definitely on the edge of food insecurity. FAO (2007) reports an average per capita calorie intake in the years from 2002-2004 of around 2,100, which is just the minimum of intake for humans, and certainly does not allow any downward variation or distributional biases without jeopardizing food security.

Rwanda has a series of issues to be considered when considering the origin of these food security problems. High population density, small farms and a hilly landscape which makes agriculture prone to erosion and hence low soil fertility are the major contributors to the problems. Recently, diseases like banana bacterial wilt and cassava mosaic disease, but also abiotic stresses like droughts, have further contributed to the instability of food security.

The role of banana and cassava in the region's food security

Bananas and cassava play an important role in Rwanda's diets. Together, they make up more than 90 percent of the diets in some areas. Bananas contribute from 12 to almost 80 percent of the diet, depending on the district (Figure 44). The highest banana dependence is found in the East, near Lake Victoria in Tanzania, whereas the lowest diet share is in the central corridor.

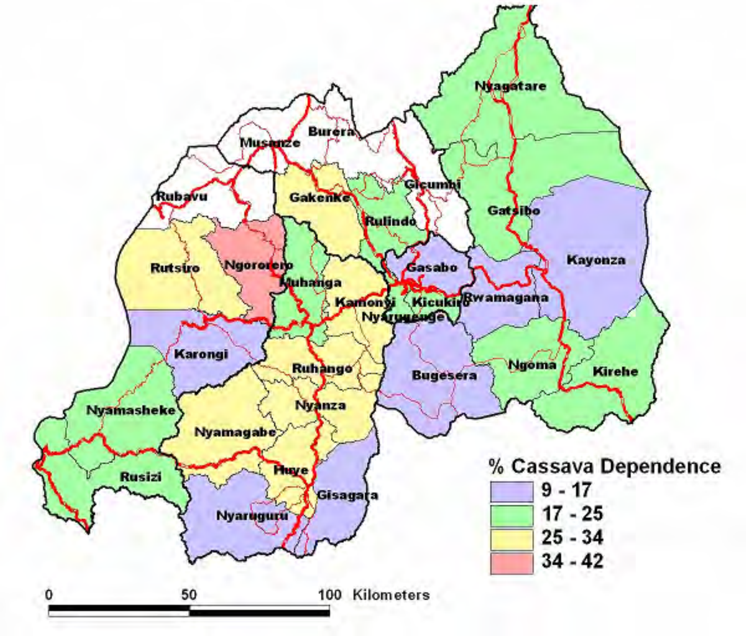
Figure 44: Map of contribution of bananas to daily calorie intake in Rwanda



Source: Own data.

The cassava dependency range is from twelve to 42 percent (Figure 45). It is highest in a kind of corridor running through the middle of Rwanda and lower in the West and East. It thus appears that bananas and cassava are substituting for each other in Rwanda.

Figure 45: Map of contribution of cassava to daily calorie intake in Rwanda

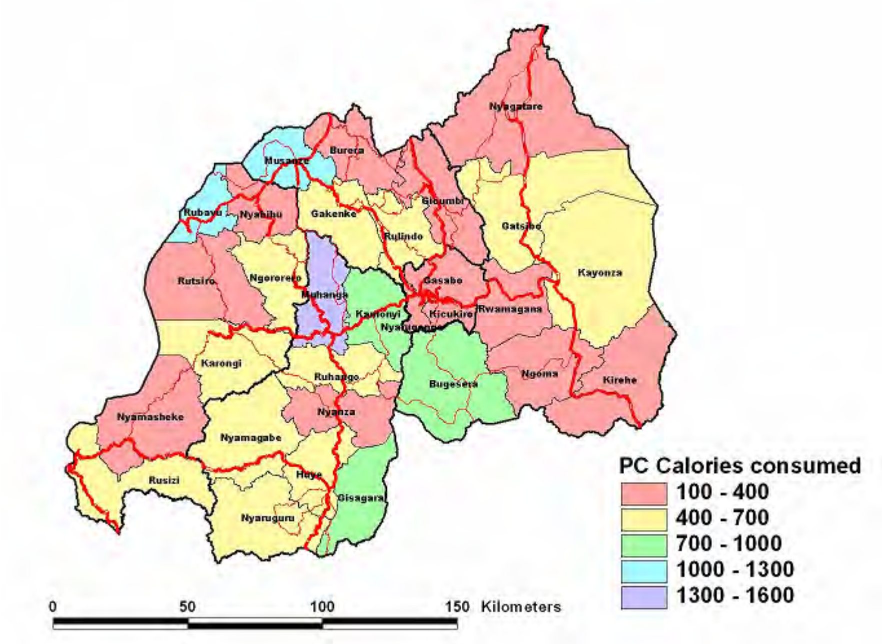


Source: Own data.

Food security I: Daily calorie intake from subsistence production

Daily calorie intake from subsistence production is seriously low. The variation per district ranges from 128 to 1,600 calories per capita per day from own production. This means that most of the households have to cover their food requirements from the market. There is – again – a kind of corridor of relatively high calorie intake from own production in the middle of Rwanda, whereas the more remote areas seem to struggle with their agricultural subsistence production (Figure 46).

Figure 46: Map of daily calorie intake from subsistence production in Rwanda

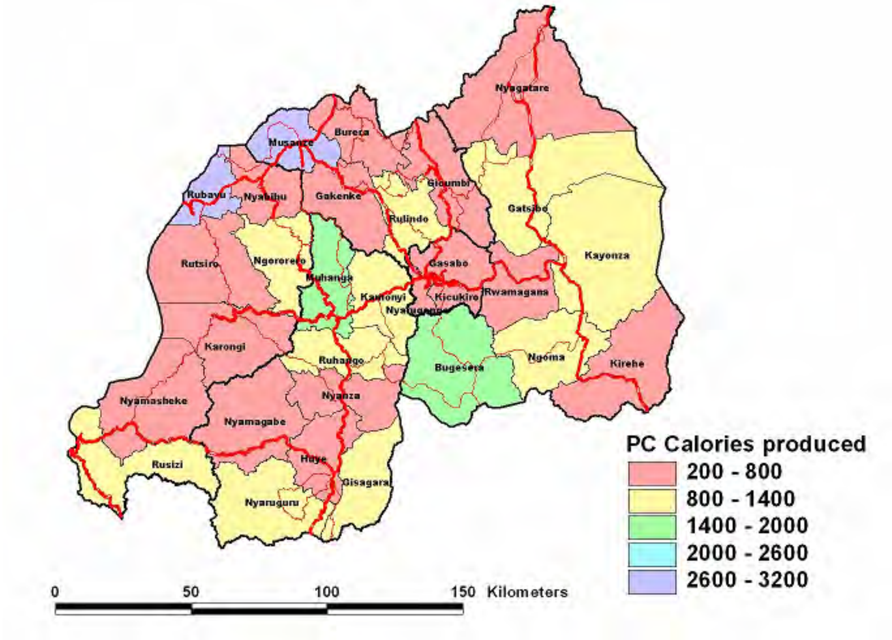


Source: Own data.

Food security II: Daily calorie capacity from total crop production

The daily calorie potential from total crop production ranges from 200 to 2,800 kcal per capita per day (Figure 47). This again implies that the majority of Rwandan households are not in a position to cover their food needs from own agricultural production. The geographical distribution matches with the intake from subsistence production.

Figure 47: Map of daily calorie capacity from total crop production in Rwanda

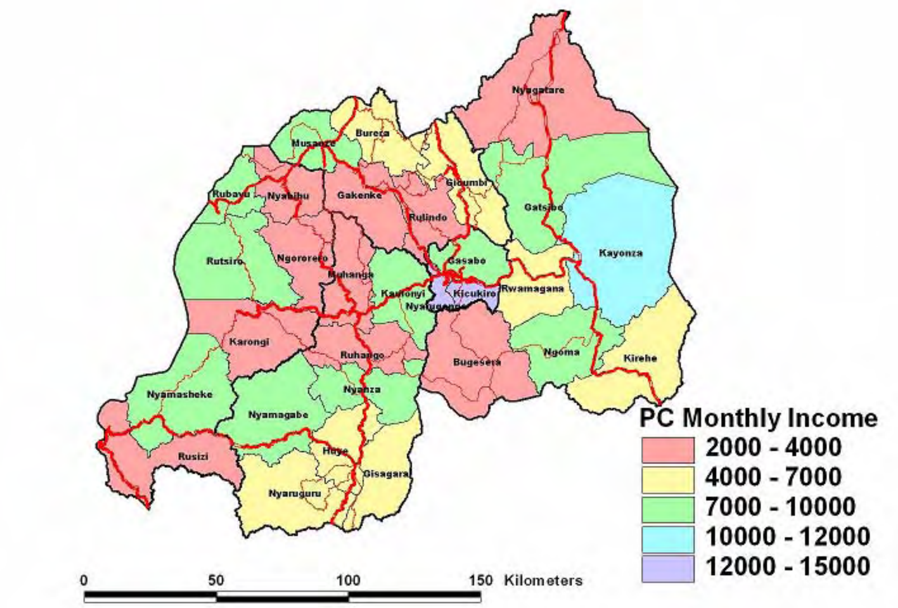


Source: Own data.

Food security III: Off-farm income

Official sources (CIA 2007) report a per capita income of about 60 US cents per day. The survey found a range from 0.3 to 1.2 US $ per capita per day (the latter in Kigali). Of this amount, between 40 and 80 percent are available for food expenditures. Figure 48 shows the spatial distribution of available cash per capita and month (in Rwandese Francs, exchange rate FRw/US $ = 550). Income is expectedly highest in the Kigali area with no clear pattern otherwise across the country.

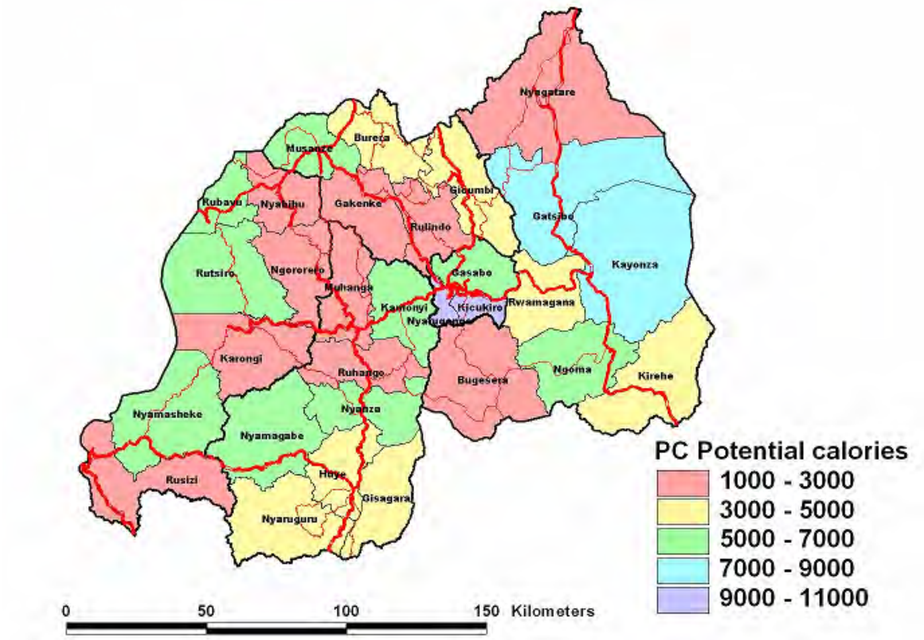
Figure 48: Map of per capita monthly income available for food purchases in Rwanda



Source: Own data.

This translates in a potential daily per capita intake from cash income through maize as depicted in Figure 49. The range is from 1,000 kcal per capita per month to 11,000 kcal per capita per month, following the same patterns as the per capita income.

Figure 49: Map of per capita daily calorie potential from income in Rwanda



Source: Own data.

Conclusions

The above data clearly show that Rwandan households, although in total food sufficient, live at the edge of food security. They are clearly susceptible to yield losses and price fluctuations. This implies that improved production technologies, including disease resistant varieties of banana and cassava, can significantly improve food security in Rwanda.

Household dietary diversity in Rwanda

Household dietary diversity is much lower than in Uganda, and even lower than in Tanzania. Table 14 shows that it ranges from 3.2 to a maximum of 6.3, with lowest average values in the North and highest in Kigali and the East. Figures by district are depicted in Annex 7.

Table 14: Household dietary diversity in Rwanda

Province	Av. HDDS (scale 0-12)
Average Western	4.5
Average Eastern	5.2
Average North	4.1
Average South	4.4
Average Kigali	5.3

Source: Survey data

Food security as perceived by the households in Rwanda

Households in Rwanda are in their majority food insecure as per their own perception. Except for the East, every province is at least temporarily food insecure, with large portions (up to 30 percent). The situation by province is depicted in Table 15, whereas the figures per district are depicted in Annex 7.

Table 15: Food security as perceived by the households in Rwanda

Province	Enough of	Enough but	Sometimes	Always not	Food secure	Food

	the kinds of food desired (%)	not always the kinds of food desired (%)	not enough to eat (%)	enough to eat (%)	overall (%)	insecure (temporal + permanent)
East	20.2	44.0	28.6	7.1	64.2	35.7
West	12.5	31.7	35.6	20.2	44.2	55.8
North	16.0	26.7	26.7	30.7	42.7	57.4
South	9.0	38.0	29.0	24.0	47.0	53.0
Kigali	7.9	42.1	44.7	5.3	50.0	50.0

Source; Survey data.

Household vulnerability to crop diseases in Rwanda

Households in Rwanda are, as discussed above, not too vulnerable to crop diseases, with a similar elasticity as in Uganda and Kenya of 0.03. Of the social characteristics, only the age of the household head as a positive effect on caloric intake and therefore the capability to cope with such crises. Therefore, households led by younger people may be targeted in Rwanda (Table 16).

Table 16: Determinants of caloric intake in CMD affected households in Rwanda

Variable	Coefficient	t-value	p-value
EXP	1.10	11.31	0.000
	(0.09)		
EXP^2	-0.08	-2.25	0.025
	(0.03)		
EDUCHEAD	0.003	0.16	0.874
	(0.02)		
AGEHEAD	0.07	2.38	0.018
	(0.03)		
HHSIZE			
CASSLOSS	-0.03	-2.35	0.020
	(0.01)		
SEXHEAD			
FARMLAB	-0.05	-0.59	0.559
	(0.09)		
LANDOWN	0.004	0.13	0.894
	(0.034)		
CONSTANT	-0.76	-0.26	0.791
	(2.90)		

No.of observations=229, Prob>F=0.000, R-squared=0.509, AdjR-squared=0.494
RootMSE=10.773. Figures in parentheses are standard errors.

Source: Own calculations

Burundi

Introduction

In comparison with the four countries assessed in the Food Security Briefs 1-5 (Abele et al., various issues), Burundi is definitely food insecure. FAO (2007) reports an average per capita calorie intake in the years from 2002-2004 of around 1,700, which is below the minimum of intake for healthy humans.

Burundi has a series of issues to be considered when discussing the origin of these food security problems. High population density, small farms and a hilly landscape which makes agriculture prone to erosion and hence low soil fertility are supposedly the major contributors to the problems. The political instability of recent years has also decreased food security significantly. Recently, diseases like banana bacterial wilt and cassava mosaic disease, but also abiotic stresses like droughts have further contributed to the instability of food security.

Table 17 lists the provinces surveyed in Burundi. Almost the entire country has been surveyed, except for a few militarily insecure regions, and Bujumbura.

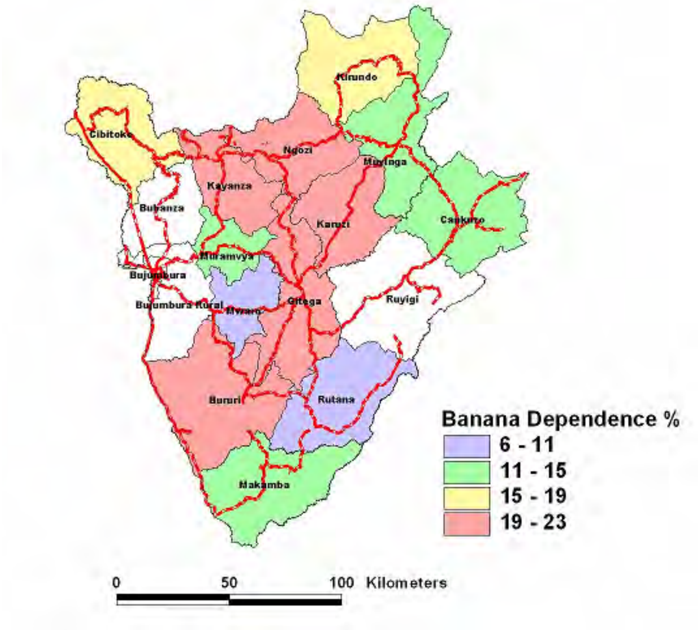
Table 17: Provinces surveyed in Burundi

Province
Cankuzo
Muyinga
Kirundo
Ngozi
Kayanza
Karuzi
Gitega
Cibitoke
Bururi
Makamba
Rutana
Mwaro
Muramvya

The role of banana and cassava in the region's food security

Bananas and cassava play an important role in Burundi's diets. Together, they make up almost 60 percent of the diets in some provinces. Bananas contribute from as little as 6 percent to as much as 23 percent of the diet (Figure 50). There seems to be a banana corridor going through the heart of Burundi.

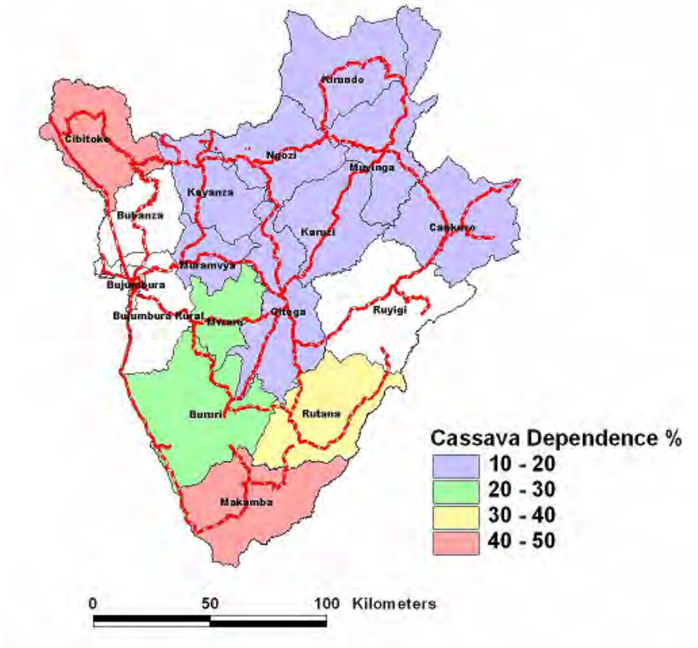
Figure 50: Map of the share of banana in daily calorie intake in Burundi



Source: Own data

Cassava contributes between 12 and 47 percent of the diets. This clearly shows that cassava is the most important food crop in Burundi (Figure 51). The highest importance of cassava in the diets is found in the South and the Northwest.

Figure 51: Map of the share of cassava in daily calorie intake in Burundi

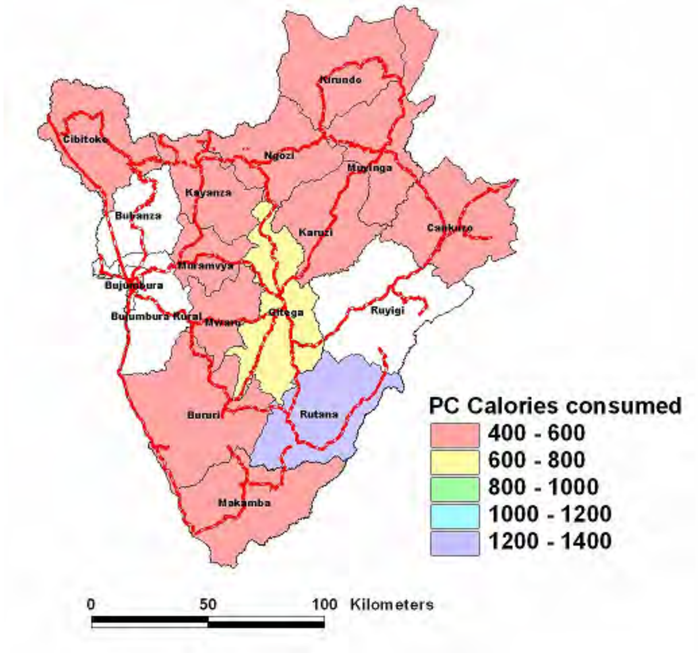


Source: Own data.

Food security I: Daily calorie intake from subsistence production

Daily calorie intake from subsistence production is significantly low, however, higher than in Rwanda. It ranges from 390 kcal per day in Muramvya to about 1,400 kcal per capita per day in Rutana (Figure 52). This means that most of the households are covering their food requirements from the market.

Figure 52: Map of the calorie intake from own production in Burundi

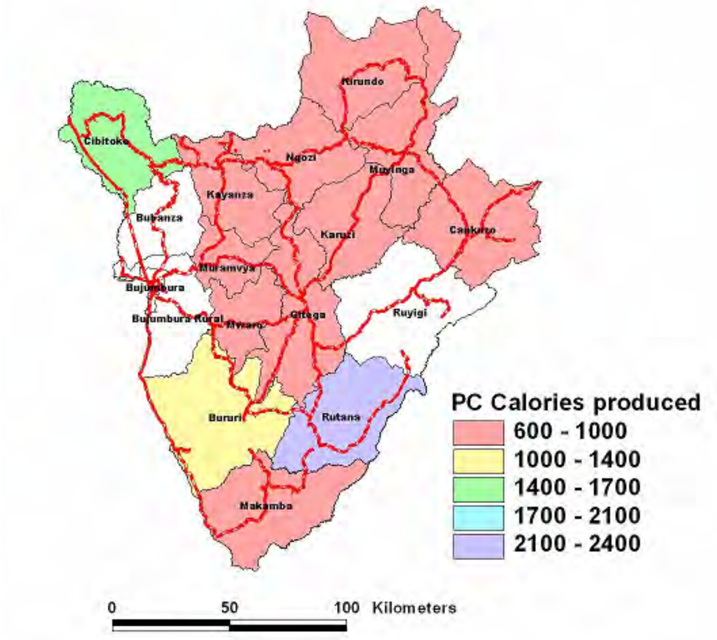


Source: Own data.

Food security II: Daily calorie capacity from total crop production

The daily calorie potential from total crop production ranges from 650 to little more than 2,600 calories per capita per day (Figure 53). This again implies that most of the households in Burundi are not in a position to cover their food needs from agriculture.

Figure 53: Map of the calorie capacity from own production in Burundi



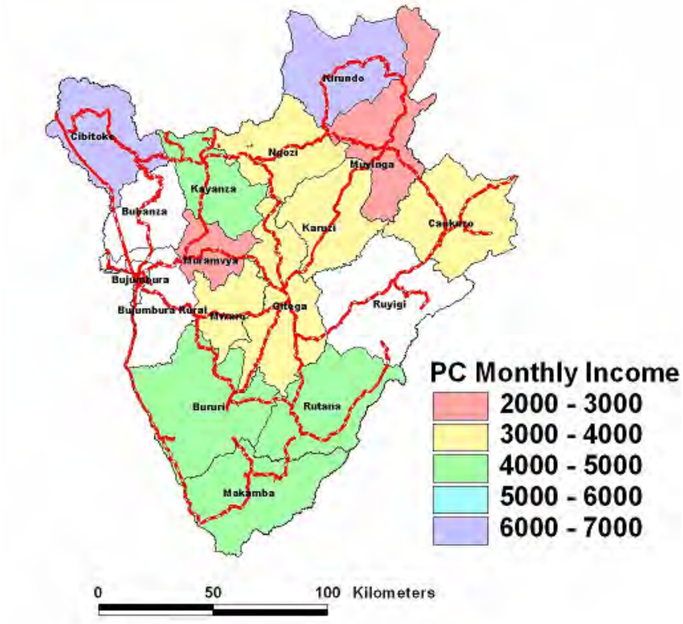
Source: Own data.

Food security III: Cash income

Figure 54 shows the monthly off-farm income per capita per household. It ranges from 1,880 to 6,500 FrBu.

From this value, we can deduce the maize equivalent of the household per capita per day by computing the monthly maize equivalent as the units of maize to be purchased at given prices. From there, we can determine the daily amount of calories that can be obtained from off-farm income.

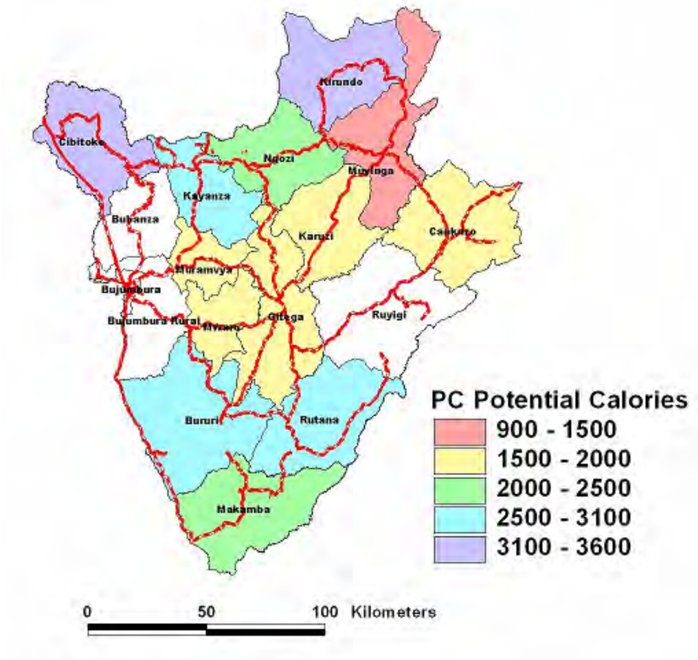
Figure 54: Map of per capita cash income per month in Burundi



Source: Own data.

The above figures translate in potential calorie values per capita per day as depicted in Figure 55. In this "best of all worlds" scenario, where we assume that potentially all of the cash income of a household could go into food purchases, and that the "best bet" calorie crop, maize, is available at stable prices, we can see that some provinces' households still do not have enough food, whereas most of the others live at the very edge of food security.

Figure 55: Map of potential per capita calorie purchases from cash income in Burundi



Source: Own data

Conclusions

The above data clearly show that households in Burundi are food insecure. They are clearly susceptible to yield losses, as they have not enough potential for own food production even in "normal" times" as well as price and income fluctuations, as they are heavily dependent on the food market for their calorie supply. This implies that improved production technologies, including disease resistant varieties of banana and cassava, can significantly improve food security in Burundi, in particular as cassava plays a major role in the Burundi diet, and so does, although to a lesser extent, banana.

Household dietary diversity in Burundi

Household dietary diversity in Burundi is the lowest so far discussed, slightly lower than that of Rwanda. Table 18 depicts the distribution across districts.

Table 18: Household dietary diversity in Burundi

Province	Av. HDDS (scale 0-12)
Cankuzo	4.0
Muyinga	4.8
Kirundo	3.6
Ngozi	3.6
Kayanza	4.3
Karuzi	4.2
Gitega	4.3
Cibitoke	5.6
Bururi	5.1
Makamba	5.0
Rutana	3.8
Mwaro	4.2
Muramvya	4.4

Source: Survey data

Food security as perceived by the households in Burundi

Table 19 shows the household food security as per the households' own perception. The vast majority (up to 96 percent) of the households is either temporarily or permanently food insecure. Up to 67 percent are food are permanently food insecure, and only between four (!) and thirty-seven percent of households can be seen as overall food secure, depending on the districts.

Table 19: Food security as perceived by the households in Burundi

Province	Enough of the kinds of food desired (%)	Enough but not always the kinds of food desired (%)	Sometimes not enough to eat (%)	Always not enough to eat (%)	Food secure overall (%)	Food insecure (temporal + permanent)
Cankuzo	6.7	26.7	43.3	23.3	33.4	66.6
Muyinga	4.3	0.0	60.9	34.8	4.3	95.7
Kirundo	3.7	18.5	40.7	37.0	22.2	77.7
Ngozi	3.6	17.9	32.1	46.4	21.5	78.5
Kayanza	8.3	12.5	33.3	45.8	20.8	79.1
Karuzi	4.2	16.7	12.5	66.7	20.9	79.2
Gitega	11.1	11.1	25.9	51.9	22.2	77.8
Cibitoke	0.0	29.6	14.8	55.6	29.6	70.4
Bururi	16.7	4.2	12.5	66.7	20.9	79.2
Makamba	15.0	20.0	25.0	40.0	35.0	65.0
Rutana	12.0	12.0	36.0	40.0	24.0	76.0
Mwaro	4.3	17.4	56.5	21.7	21.7	78.2
Muramvya	7.4	3.7	63.0	25.9	11.1	88.9

Source: Survey data

Household vulnerability to crop diseases in Burundi

Households in Burundi are, as discussed above, much more vulnerable than the three "better off" countries, although they have a lower elasticity than the former three, but the functional form implies that the losses in caloric intake increase both in relative and absolute terms as harvest losses increase. In contrast to the other countries assessed, there are huge differences in terms of the relationship of social characteristics and caloric intake. Households with a higher educated and older household head are better off in terms of caloric intake, and the same holds for male headed, smaller households and households with large land endowment. These characteristics give a lot of indicators for targeting, as large, female headed households, with younger household heads and little land endowment can be targeted (Table 20).

Table 20: Determinants of caloric intake in CMD affected households in Burundi

Variable	Coefficient	t-value	p-value
EXP	3547.01 (824.74)	4.30	0.000
EXP^2	-214.70 (49.70)	-4.32	0.000
EDUCHEAD	2.67 (1.01)	2.63	0.010
AGEHEAD	485.78 (118.19)	4.11	0.000
HHSIZE	-833.07 (165.01)	-5.05	0.000
CASSLOSS	-4.77 (2.32)	-2.06	0.042
SEXHEAD	697.73 (177.30)	3.94	0.000
FARMLAB	0.17 (2.75)	0.06	0.950
LANDOWN	24.30 (19.35)	1.26	0.212
CONSTANT	-15741.73 (3300.58)	-4.77	0.000

No.of observations=124, Prob>F=0.000, R-squared=0.374, AdjR-squared=0.325
RootMSE=391.2 Figures in parentheses are standard errors.

Source: Own calculations

Democratic Republic of Congo

Introduction

The food security survey in the DRC was done in mid-2006, mainly due to the ongoing political unrest before that time, and due to long-term logistic preparations. The survey was done in four provinces of Eastern DRC, namely South Kivu, North Kivu, Maniema and Katanga, and twelve geographical sub-units (territories/territoires) were surveyed. Table 21 depicts the regional scope of the survey.

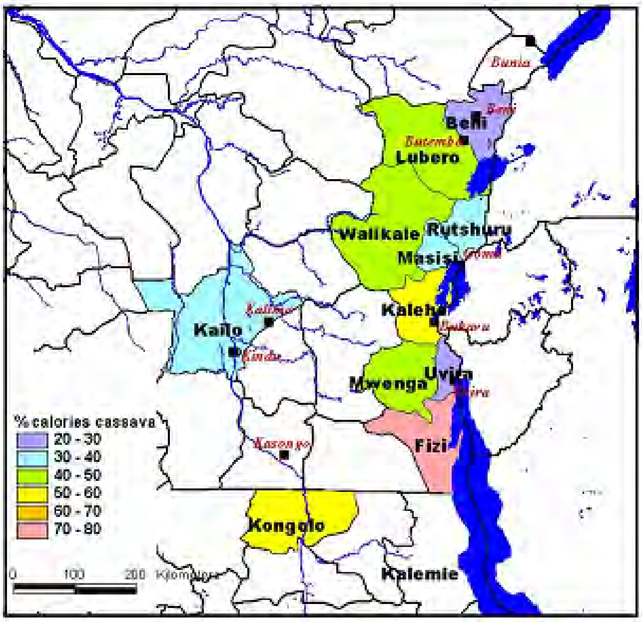
Table 21: Surveyed territories by province

Province	Territory
South Kivu	Walungu
	Kalehe
	Fizi
	Uvira
	Mwenga
	Kabare
North Kivu	Masisi
	Rutshuru
	Beni
	Lubero
Maniema	Kailo
Katanga	Kongolo

The role of bananas and cassava in the region's food security

Cassava plays a major role in people's diets, with a minimum level of 20 percent (in Beni), and a maximum close to 80 percent (Fizi), as shown in Figure 56.

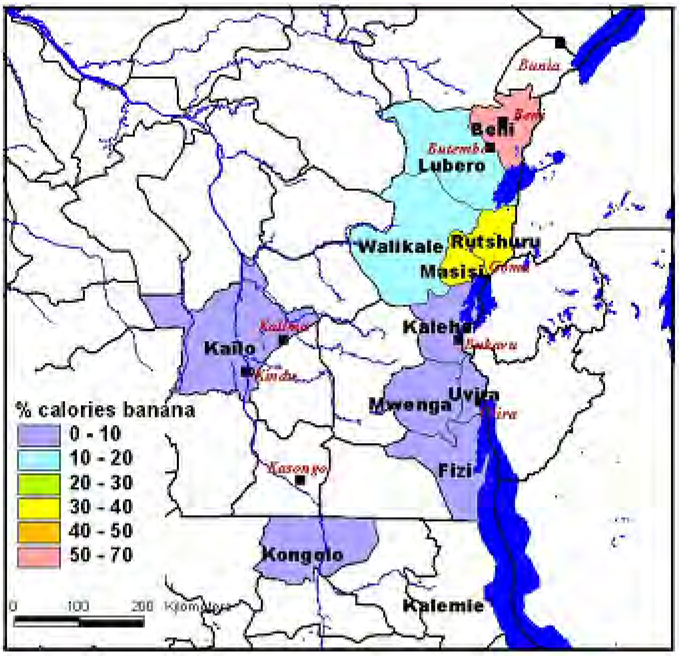
Figure 56: Map of the role of cassava in Eastern DRC's people's diets



Source: Own data

The role bananas are play in the food supply of the region is also important, although on average lower than that of cassava. The highest values for bananas are found in the East of the region, with a sharp decline further West and Southwest (Figure 57).

Figure 57: Map of the role of bananas in the dietary intake of Eastern Congo

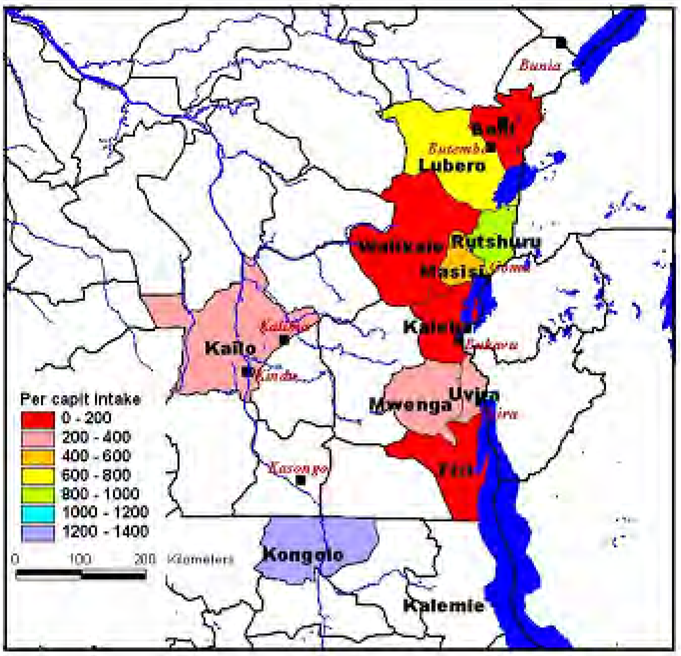


Source: Own data

Caloric intake from subsistence production

The caloric intake from subsistence production is extremely low, and probably the worst of all the regions assessed in this study (Figure 58). In most regions, it is below 800 kcal per capita per day, with only one region going above 1,000 kcal per capita per day.

Figure 58: Map of caloric intake from subsistence production in Eastern DRC

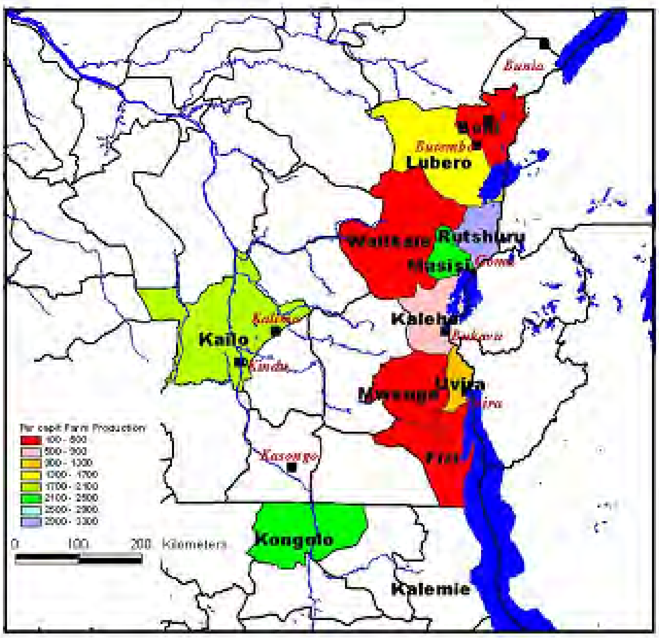


Source: Own data

Caloric intake capacity from overall agricultural production

The overall potential to obtain calories from total production is slightly higher in some of the districts and only marginally higher in others. Figure 59 shows that the Northeastern region is similarly badly off as in the subsistence intake, which shows that there is hardly any marketable surplus and most if not all of the food goes into own consumption. Exemptions are at the border to Uganda and to the South, were people stated to produce significantly more than they consume from their own production.

Figure 59: Caloric intake capacity from overall agricultural production

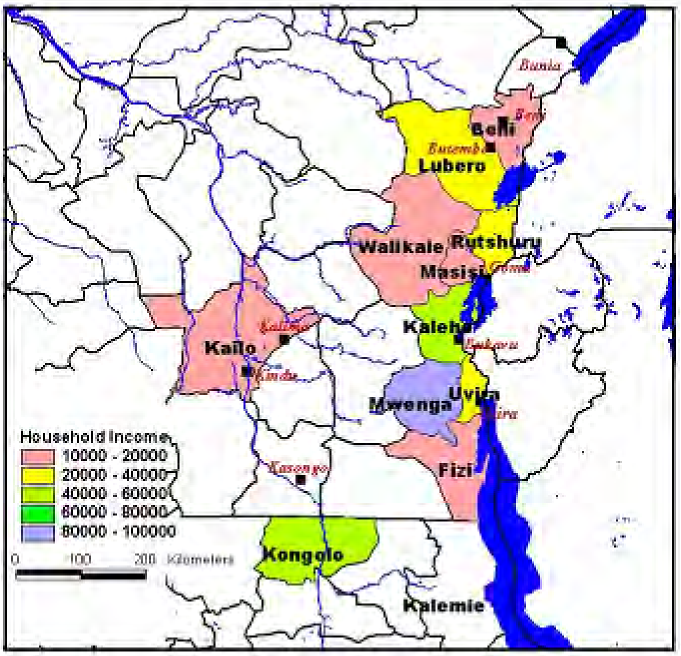


Source: Own data

Household cash income

Household cash income ranges from 10,000 to 100,000 Congolese Francs, with a slight North-South gradient, being higher in the southern regions than in the North (Figure 60).

Figure 60: Map of monthly household cash income in Eastern DRC

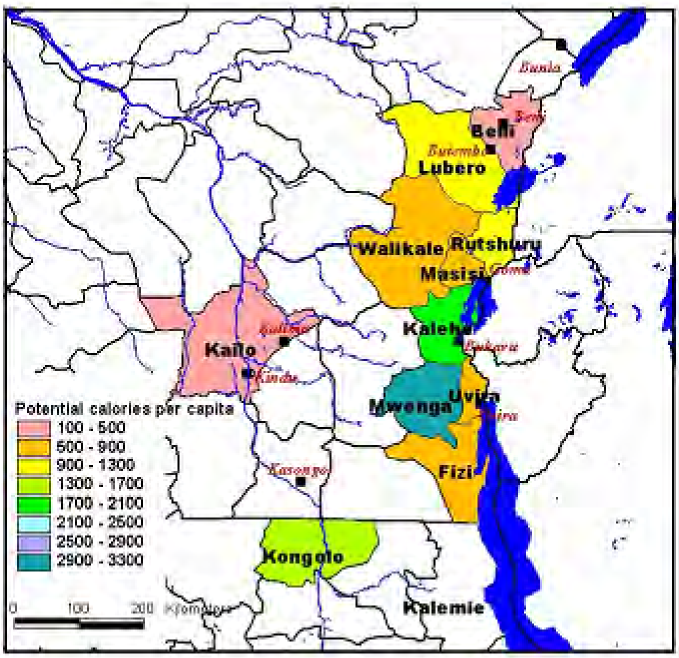


Source: Own data

Caloric purchase capacity from household cash income

The caloric purchase capacity follows the same patterns as the cash income distribution. It is notable that some of the districts, namely Walungu, Fizi and Beni, are not able to get sufficient food from crops and cash income together (Figure 61).

Figure 61: Map of maize calorie equivalent of cash income in Eastern DRC



Source: Own data

Household dietary diversity in Eastern DRC

The household dietary diversity in Eastern DRC is low, probably lower than in Kenya, Uganda and Tanzania, however, it is not as low as expected from the above findings, as it is only slightly lower than in Burundi or Rwanda (Table 22).

Table 22: Household dietary diversity in Eastern DRC

Province	Av. HDDS (scale 0-12)
Walungu	4.0
Kalehe	5.3
Fizi	5.7
Uvira	4.7
Mwenga	2.5
Kabare	5.3
Masisi	4.9
Rutshuru	5.3
Beni	5.0
Lubero	6.1
Kailo	3.9
Kongolo	4.2

Source: Survey data

Food security as perceived by the households in Eastern DRC

From the Table 23 below, we see that the majority of households in Eastern DRC are food insecure, either temporarily or permanently.

Table 23: Food security as perceived by the households in Eastern DRC

Territory	Enough of the kinds of food desired (%)	Enough but not always the kinds of food desired (%)	Sometimes not enough to eat (%)	Always not enough to eat (%)	Food secure overall (%)	Food insecure (temporal + permanent)
Walungu	0.0	35.0	55.0	10.0	35.0	65.0
Kalehe	30.0	17.5	35.0	17.5	47.5	52.5
Fizi	12.5	0.0	20.0	67.5	12.5	87.5
Uvira	17.5	20.0	30.0	32.5	37.5	62.5
Mwenga	2.5	10.0	10.0	77.5	12.5	87.5
Kabare	15.0	50.0	17.5	17.5	65.0	35.0
Masisi	15.0	62.5	17.5	5.0	77.5	22.5
Rutshuru	15.0	55.0	25.0	5.0	70.0	30.0
Beni	2.6	69.2	28.2	0.0	71.8	28.2
Lubero	50.0	22.5	27.5	0.0	72.5	27.5
Kailo	15.0	62.5	15.0	7.5	77.5	22.5
Kongolo	0.0	82.8	6.9	10.3	82.8	17.2

Source: Own data

Conclusions

Households in Eastern DRC are definitely food insecure, and even more serious, they depend heavily on starchy staples like bananas and cassava. On average, more than 67 % of their caloric intake comes from these two crops, with a specific focus on cassava. This makes Eastern DRC a priority target for any food security measure, including the dissemination of disease resistant cassava varieties.

Household vulnerability to crop diseases in Eastern DRC

As stated above, DRC has a high priority for measures to counter crop diseases, due to their high losses from CMD, and their relatively high elasticity of calorie losses. DRC has, like Burundi, significant differences in the impact of social characteristics on food security. Households headed by people with higher education, higher age and of female gender have a better calorie intake from subsistence production. Especially the gender variable might be surprising, as in the other countries, if significant, male headed households are better off. However, as DRC households are heavily depending on their subsistence production due to the low level of cash income, it has to be recommended to target male headed households to improve food security (Table 24).

Table 24: Determinants of caloric intake in CMD affected households in Eastern DRC

Variable	Coefficient	t-value	p-value
EXP	0.000053	2.69	0.008
	(0.00002)		
EXP^2	-3.65E-11	-2.32	0.021
	(1.57E-11)		
EDUCHEAD	0.65	17.80	0.000
	(0.03)		
AGEHEAD	0.19	14.60	0.000
	(0.01)		
HHSIZE	0.08	0.88	0.381
	(0.09)		
CASSLOSS	-0.07	-1.66	0.098
	(0.04)		
SEXHEAD	-3.15	-3.17	0.002
	(0.99)		
FARMLAB			
LANDOWN			
CONSTANT	-7.36	-6.09	0.000
	(1.20)		

No.of observations=296, Prob>F=0.000
R-squared=0.752
AdjR-squared=0.746
RootMSE=0.737 Figures in parentheses are standard errors.

Source: Own calculations

SUMMARY AND CONCLUSION

Recommendations for targeting

The algorithm for targeting countries and social groups is as follows: Both the GIS-maps and the econometric results suggest the countries where interventions to counter crop diseases should have high priority. The most vulnerable areas are definitely in eastern DRC, due to low food production and income, as well as a high elasticity of crop disease impact on caloric intake. In Tanzania, also the effect of crop diseases on subsistence production is significantly high, and in Burundi, with increasing disease pressure, the impact will increase both in relative and absolute terms. As these countries have not yet lost so much of their cassava to CMD, and probably also have not suffered high bacterial wilt losses, there is room for preventive measures.

Uganda, Rwanda and Kenya have lesser probable impacts from crop diseases, at least in marginal and elasticity terms. It should be noted that in particular in Uganda and Kenya, crop diseases have had a large impact in the past decade, in particular CMD, and in Uganda also BXW in some districts. However, in these countries, households seem to have been able to cope with these diseases, be it through the numerous mitigation measures by NARS, IITA and other stakeholders (Abele et al. 2007, Abele et al. 2005), or be it through their high potential for other crops and income sources. The upcoming CBSD threat, however, newly jeopardise to food security.

The way that social groups are affected also differs across countries. In particular in the less food secure countries, social characteristics play a high role in food security, while in the more food secure countries, this seems to be a lesser issue.

Table 25 depicts the decision making matrix for targeting between and within countries as per social strata. Note that the final determination of disease incidences and severity (both CMD and BXW) has to be made by the respective disciplines.

The table also shows the effect of different preferences/objectives from stakeholders. In an unweighted ranking like the one done in the table below, Rwanda, Burundi and DRC would come out as high priorities. However, they have up to now a low disease impact in terms of cassava losses per household, so that this would maybe be rather a food aid case for immediate relief of food insecurity than longer term germplasm distribution. However, the potential threat in these countries is very high, as DRC shows a high elasticity of food security to crop diseases, and the functional form for Burundi implies an increasing threat. Tanzania, on the other hand, seems to be food secure, but has a high calorie-crop disease elasticity, which indicates a high potential threat and calls for preventive measures as well. Kenya seems to be able to cope well with crop diseases (at least with a single disease incident like CMD), but has a weaker food security status than Uganda, and a high CMD incidence. Uganda is stable in terms of food security, seems to be coping well with all kinds of disease situations, but has a high CMD incidence, which might call for a continuous effort to mitigate the disease.

Table 25: Decision matrix for targeting

Indicator	**Quantification and ranking**	**Kenya**	**Uganda**	**Tanzania**	**Rwanda**	**Burundi**	**DRC**
CMD severity	Losses from CMD (av. Kg)	2,234	3,881	1,647	407	15	777
	Rank	2	1	3	4	6	4
Food production	Calories produced	1,772	3,500	1,799	1,022	1,053	1,247
	Rank	4	5	6	1	2	3
Food purchasing power	Maize cal equiv. from cash	4,870	5,044	2,240 (7,078)	4,918	2,254	1,131
	Rank	4	6	3	5	2	1
Food security	% of households food secure	53	74	56	50	22	55
	Rank	3	6	5	2	1	4
Impact of crop diseases	Disease vulnerability (calorie intake elasticity of disease loss)	0.03	0.02	9.8	0.03	0.007	54.4
	Rank	3	4	2	3	6	1
Rank summary	**Targeting priority[2]**	**3.5**	**5.25**	**4**	**2.75**	**2.75**	**2.25**
Specific social target groups		Low education headed hh, labour constraint hh	Land poor, large households	Labour constraint hh	Low age headed hh	Low education headed, low age headed, large hh size, female headed hh	Low age headed, low education headed, male headed

[1]Rank implies subject to food insecurity
[2] Highest figure implies lowest priority

REFERENCES

Abele, S., Twine, E., Ntawuruhunga, P., Baguma, Y., Kanobe, C. and A. BUa (2007): Development and dissemination of improved cassava varieties in Uganda: Analysis of adoption rates, variety attributes and speed of adoption. Contributed paper for the conference of the African Association of Agricultural Economists in Accra, Ghana, 20-22 August 2007.

Abele, S., Twine, E. and C. Legg (2007): Food security in Burundi. C3P Food Security Brief No.6. Ibadan, Nigeria (IITA). http://c3project.iita.org/

Abele, S., Twine, E. and C. Legg (2007): Food security in Central and Western Uganda. C3P Food Security Brief No.4. Ibadan, Nigeria (IITA). http://c3project.iita.org/

Abele, S., Twine, E. and C. Legg (2007): Food security in Rwanda. C3P Food Security Brief No.5. Ibadan, Nigeria (IITA). http://c3project.iita.org/

Abele, S., Twine, E. and C. legg (2006): Food security in the major cassava growing regions of Uganda. C3P Food Security Brief No. 1, Ibadan (IITA). http://c3project.iita.org/

Abele, S., Twine, E. and C. legg (2006): Food security in Western Kenya. C3P Food Security Brief No. 2, Ibadan (IITA). http://c3project.iita.org/

Abele, S., Twine, E. and C. legg (2006): Food security in the Lake Victoria Bassin of Northern Tanzania. C3P Food Security Brief No. 3, Ibadan (IITA). http://c3project.iita.org/

Abele, S. and E. E. Twine 2006. Household food security in Tanzania: An econometric analysis of calorie intake in the Lake Victoria Bassin. Internal IITA research report, Kampala (IITA).

Abele, S., Twine, E., I. Ndyetabula and J. Legg. (In press). “Household Food Security in Tanzania: An Econometric Analysis of Calorie Intake in the Lake Victoria Basin”. Eastern Africa Journal of Rural Development 21(2): 57-68

Abele, S., Ntawuruhunga, P., Odendo, M., Obiero, H., Twine, E. and J. Odenya 2005. Effectiveness of breeding and disseminating CMD-resistant cassava varieties in Western Kenya, in: Tenywa, J.S., Adipala, E., Nampala, P., Tusiime, G., Okori, G. and W. Kyamuhangire (Eds.): African Crop Science Conference Proceedings, 7/1, Kampala (Makerere University), pp.233-238.

Aromolaran, A.B. 2004. “Intra-household Redistribution of Income and Calorie Consumption in Southwestern Nigeria,” *Center Discussion Paper* # 890, Economic Growth Center, Yale University

Aubert, D and A. Abdulai. 2003. *Demand for Human Nutrients in Dar es Saalam and Mbeya Regions of Tanzania*. ZIL, ILRI and IFPRI Research Report

Auger, S., K. Khan, S. Nadon and J. Tremblay. 2005. “2001 Food Expenditure Survey Data Quality Indicators,” Household Expenditure Research Paper Series, Canada

Bahiigwa, B.A.G. 2002. “Rural Household Food Security in Uganda: An Empirical Analysis,” *Eastern Africa Journal of Rural Development* 18(1): 8-22

Baro, M. 2002. “Food Insecurity and Livelihood Systems in Northwest Haiti,” *Journal of Political Ecology* 9:1-33

Brooke, A.., Kendrick, D., Meeraus, A. and E.R. Rosenthal 1988. GAMS; A user’s guide. South San Francisco, California, USA.

CIA (2007): The world factbook. www.cia.gov/cia/publications/factbook/geos/rw.html

Dawson, P.J and R. Tiffin. 1998. “Estimating the Demand for Calories in India,” *American Journal of Agricultural Economics* 80: 474-481

Dawson, P.J. 2002. “Nutrition in Pakistan: Estimating the Economic Demand for Calories,” *Pakistan Journal of Nutrition* 1(1): 64-66

FAO 2007: Statistical databases.

FAO and WFP. 2005. *Crop and Food Supply Assessment Mission to Lesotho: A Special Report*. Rome, Italy

FAO. 2003. *Trade Reforms and Food Security: Conceptualizing the Linkages*. Rome, Italy

FOODNET/MIS (2006): Price data. IITA/FOODNET

FEWSNET. www.fews.net

Food Security Analysis Unit (2006): Integrated Food Security and Humanitarian Phase Classifi cation: Technical Manual Version I.

Gibson, J and S. Rozelle. 2000. "How Elastic is Calorie Demand? Parametric, Nonparametric and Semi Parametric Results for Urban Papua New Guinea," *Working Paper* # 00-022 Department of Agricultural and Resource Economics, University of California Davis

Habicht, J., G. Pelto, E. Frongillo and D. Rose. 2004. "Conceptualization and Instrumentation of Food Insecurity," Paper Presented at the National Academy of Sciences Workshop, 14-16 July, 2004, USA

IFPRI. 2004. "Development Strategies and Food and Nutrition Security in Africa: An Assessment," *2020 Discussion Paper* # 38, Washington USA

Jacobs, K and D.A. Sumner. 2002. "The Food Balance Sheets of the Food and Agriculture Organization: A Review of Potential Ways to Broaden the Appropriate Uses of the Data," www.faostat.fao.org/abcdq/docs/FBS_Review.pdf

Jamal, H. 2003. *Price and Income Effects of Urban Under-nutrition*. Research Report # 51, Social Policy and Development Center, Karachi, Pakistan

Keenan, D.P., C. Olson, J.C. Hersey and S.M. Parmer. 2001. "Measures of Food Insecurity/Security," *Journal of Nutrition Education* 33(1): 49-58

Naeem, A., M. Brzozowski and T.F. Crossley. 2005. *Measurement Errors in Recall Food Expenditure Data*. QSEP Research Report # 396 McMaster University

National Bureau of Statistics Tanzania (2007): Key Statistics by Regions of the United Republic of Tanzania, www.nbo.gs.tz

Quenouille, M.H. 1950. "An Application of Least Squares to Family Diet Surveys," *Econometrica* 18 (1): 27-44

Ramakrisha, G and A. Demeke. 2002. "An Empirical Analysis of Food Insecurity in Ethiopia: The Case of North Wello," *African Development*, 27 (1&2):127-143

Safiliou-Rothschild, C. 2001. "Food Security and Poverty: Definitions and Measurement Issues," *Dialogue Working Paper* # 4. Colombo, Sri Lanka: Dialogue Secretariat

Smith, L.C., Alderman, H., Aduayom, D. (2006): Food insecurity in Sub-Saharan Africa. New estimates from household expenditure surveys. IFPRI Research Report 146. Washington, D.C. (IFPRI)

Sinha, K. 2005. "Household Characteristics and Calorie Intake in Rural India: A quantile Regression Approach," *ASARC Working Papers* 2005-02, Australian National University, Australia South Asia Research Center

Skoufia, E. 2002. "The Sensitivity of Calorie-Income Demand Elasticity to Price Changes: Evidence from Indonesia," *FCND Discussion Paper* # 141, IFPRI Washington USA

Wu Leung, W.T. 1968. Food Composition Tables for Use in Africa. FAO, Rome, Italy and US Department of Health, Education and Welfare, Bethesda, MD, USA

ANNEXES

ANNEX 1: FOOD SECURITY DATA KENYA (FIRST SURVEY)

District	Mean per capita kilocalories (kcal) available from total crop output	Average monthly off-farm household income (KSh)	Mean contribution of cassava to available calories from crop output (%)	Mean contribution of maize to available calories from crop output (%)	Mean contribution of cassava to available calories from crop output (%)
Busia	2,661.2	1,187.5	44.5	39.9	44.5
Homa Bay	3,114.1	2,375.0	11.9	58.7	11.9
Kuria	2,996.8	2,375.0	25.9	52.0	25.9
Rachuonyo	2,856.2	1,187.5	22.7	50.6	22.7
Siaya	2,759.0	1,187.5	25.9	45.7	25.9
Teso	2,150.7	2,375.0	39.6	40.5	39.6
All districts	**2,756.3**	**1,781.3**	**28.4**	**47.9**	**28.4**

ANNEX 2: FOOD SECURITY DATA KENYA (UPDATE SURVEY)

District	Av household size	Av per capita daily calorie intake from crop output consumed (kcal)	Av per capita daily calorie availability from total crop output (kcal)	Av per capita monthly income (KSh)	Bananas' contrib. to cal. (%)	Cassava's contribution to cal (%)	Av. HDDS (scale 0-12)
Kuria	6.0	1600.3	2798.4	1,219.6	3.2	16.3	7.7
Homa bay	6.3	1264.6	1886.9	1,274.2	4.5	10.2	7.2
Teso	7.7	1074.2	1535.6	1,212.2	9.6	25.2	7.5
Busia	7.7	1105.1	1378.4	1,301.1	5.2	19.8	7.6
Rachuonyo	6.9	871.3	1224.2	1,521.2	5.5	38.1	7.4
Siaya	6.6	1076.6	1511.1	1,416.8	10.0	10.9	7.5

District	Enough of the kinds of food desired (%)	Enough but not always the kinds of food desired (%)	Sometimes not enough to eat (%)	Always not enough to eat (%)	Food secure overall (%)	Food insecure temporal + permanent (%)
Kuria	33.3	26.2	38.1	2.4	59.5	40.5
Homa bay	25.6	23.3	39.5	11.6	48.8	51.2
Teso	32.6	23.3	39.5	4.7	55.8	44.2
Busia	31.8	31.8	25.0	11.4	63.6	36.4
Rachuonyo	14.3	28.6	35.7	21.4	42.9	57.1
Siaya	22.7	22.7	43.2	11.4	45.5	54.5

ANNEX 3: FOOD SECURITY DATA UGANDA (CASSAVA GROWING REGIONS)

District	Mean daily calorie intake (kcal) from proportion consumed	Mean daily calorie intake (kcal) from total crop output	Average monthly off-farm household income (USh)	Mean contribution of cassava to total calorie intake (%)	Mean contribution of bananas to total calorie intake (%)	Family sizes (head p. hh)
Tororo	1,745.2	2,893.2	113,400.0	32.3	4.1	10.0
Iganga	1,441.1	2,196.9	108,000.0	26.2	12.1	11.1
Pallisa	2,680.7	3,713.9	72,000.0	56	0.38	11.6
Kumi	2,315.5	3,770.3	101,250.0	66.8	30.4	11.3
Soroti	1,940.7	3,740.5	126,000.0	69	7.46	11.1
Mukono	1,036.4	1,780.7	88,363.6	53.2	46.7	9.8
Luwero	2,067.5	3,301.9	54,000.0	50.3	7.7	7.2
Masindi	1,860.7	4,514.1	108,000.0	69.4	20.2	10.0
Apac	1,820.8	3,540.6	135,000.0	61.5	3.3	10.4
Lira	2,233.0	4,625.9	144,000.0	61.9	0.0	9.6
Nebbi	2,919.3	6,663.0	169,714.2	68.8	13	10.3
Arua	1,853.2	2,968.2	101,250.0	60	0.0	8.6

ANNEX 4: FOOD SECURITY DATA UGANDA (WESTERN AND CENTRAL)

District	Av household size	Av per capita daily calorie intake from crop output consumed	Av per capita daily calorie availability from total crop output	Av per capita monthly expenditure (USh)	Mean contribution of bananas to total calorie intake (%)	Mean contribution of cassava to total calorie intake (%)	Av. HDDS (scale 0-12)
Mbale	9.38	1,670.7	3,688.9	22,379.4	18.9	5.3	7.6
Kamuli	8.24	1,230.9	3,306.9	15,647.4	1.2	16.0	6.9
Kayunga	7.33	1,269.9	3,200.5	11,961.1	6.4	11.2	5.8
Mpigi	7.51	1,265.9	2,482.9	11,125.0	12.6	22.8	6.6
Masaka	8.06	767.4	1,699.2	22,770.1	8.9	14.7	6.6
Rakai	8.45	1,357.4	2,631.7	35,588.8	28.0	23.0	5.6
Bushenyi	7.28	465.8	1,143.9	67,238.7	68.4	10.1	6.6
Mbarara	7.24	2,228.8	3,786.3	61,474.0	54.3	11.2	4.9
Kabarole	8.5	1,731.3	6,753.7	25,713.7	29.7	18.4	6.1
Kyenjojo	7.37	1,704.6	5,314.6	23,393.8	14.0	24.9	6.1

ANNEX 4: FOOD SECURITY DATA UGANDA (WESTERN AND CENTRAL), CTD.

District	Enough of the kinds of food desired (%)	Enough but not always the kinds of food desired (%)	Sometimes not enough to eat (%)	Always not enough to eat (%)	Food secure overall (%)	Food insecure (temporal + permanent)
Mbale	34.7	45.8	15.3	4.2	80.6	19.4
Kamuli	18.9	62.2	14.9	4.1	81.1	18.9
Kayunga	10.7	57.1	21.4	10.7	67.9	32.1
Mpigi	22.5	50.0	25.0	2.5	72.5	27.5
Masaka	14.3	50.6	29.9	5.2	64.9	35.1
Rakai	14.3	31.0	33.3	21.4	45.2	54.8
Bushenyi	43.7	33.8	21.1	1.4	77.5	22.5
Mbarara	45.6	30.1	16.5	7.8	75.7	24.3
Kabarole	15.0	67.5	12.5	5.0	82.5	17.5
Kyenjojo	25.7	62.9	5.7	5.7	88.6	11.4

ANNEX 5: FOOD SECURITY DATA TANZANIA (FIRST SURVEY)

District	Mean daily calorie intake (kcal) own produced and purchased	Mean kilocalories (kcal) available from total crop output	Average monthly household income (TSh)	Mean contribution of cassava to total calorie intake (%)	Mean contribution of bananas to total calorie intake (%)	Family sizes (head p. hh)
Muleba	1,408.7	958.0	41,905.2	37.9	46.9	8
Bukoba	1,526.7	2,769.9	63,496.7	15.70	35.3	5.5
Ngara	828.6	802.1	49,434.5	13.5	23.5	8.5
Musoma	4,503.2	3,279.5	52,970.3	36.1	0.0	10.4
Bunda	2,144.7	1,819.5	57,750.9	38.5	0.0	7.4
Tarime	2,001.5	1,743.9	39,839.7	39.1	0.0	6.9
Sengerema	1,350.2	421.8	48,407.7	29.0	0.0	8.3
Geita	1,370.8	966.0	46,697.3	14.5	0.0	8.4
Ukerewe	1,056.7	600.1	45,877.5	54.2	0.0	13.5
Misungwi	2,447.4	2,366.9	46,891.4	15.8	0.0	7.7

ANNEX 6: FOOD SECURITY DATA TANZANIA (UPDATE SURVEY)

District	Av household size	Av per capita daily calorie intake from crop output consumed (kcal)	Av per capita daily calorie availability from total crop output (kcal)	Av per capita monthly income (TSh)	Mean contribution of bananas to total calorie intake (%)	Mean contribution of cassava to total calorie intake (%)	Av. HDDS (scale 0-12)
Gieta	7.5	1,121.2	1,374.0	19,091.7	0.0	40.5	6.0
Sengerema	7.8	1,601.0	3,209.6	12,554.3	0.0	28.8	6.3
Muleba	5.6	534.2	668.2	15,844.2	37.0	37.0	6.0
Ngara	6.0	962.1	1,743.9	18,933.8	29.9	11.9	6.6
Ukerewe	8.7	964.1	1,093.5	20,552.2	23.7	38.3	5.3
Bukoba	5.1	1,074.6	1,621.8	9,624.0	32.6	10.1	6.3
Bunda	8.6	1,442.0	1,587.5	22,783.1	0.0	45.2	4.9
Mwanza	7.4	2,151.3	3,083.9	20,547.3	0.2	35.7	6.0
Tarime	8.3	1,280.9	1,657.2	25,897.3	14.6	47.5	5.4
Musoma rural	10.9	1,195.0	1,954.9	16,641.4	0.0	57.0	4.9

ANNEX 6: FOOD SECURITY DATA TANZANIA (UPDATE SURVEY), CTD.

District	Enough of the kinds of food desired (%)	Enough but not always the kinds of food desired (%)	Sometimes not enough to eat (%)	Always not enough to eat (%)	Food secure overall (%)	Food insecure (temporal + permanent)
Gieta	34.4	31.2	34.4	0.0	65.6	34.4
Sengerema	43.8	28.1	28.1	0.0	71.9	28.1
Muleba	15.6	28.1	37.5	18.8	43.8	56.3
Ngara	34.4	40.6	15.6	9.4	75.0	25.0
Ukerewe	21.9	25.0	40.6	12.5	46.9	53.1
Bukoba	37.5	31.3	18.8	12.5	68.8	31.3
Bunda	25.8	16.1	51.6	6.5	41.9	58.1
Mwanza	21.9	18.8	46.9	12.5	40.6	59.4
Tarime	23.3	23.3	43.3	10.0	46.7	53.3
Musoma rural	28.1	37.5	31.3	3.1	65.6	34.4

ANNEX 7: FOOD SECURITY DATA RWANDA

Province	District	Av household size	Av per capita daily calorie intake from crop output consumed(kcal)	Av per capita daily calorie availability from total crop output(kcal)	Av per capita monthly income (FRw)	Mean contribution of bananas to total calorie intake (%)	Mean contribution of cassava to total calorie intake (%)	Av. HDDS (scale 0-12)
Western	Karongi	5.2	474	790.0	6,091.0	15.7	12.4	5.8
	Rutsiro	4.6	128.8	211.1	11,612.0	24.5	31.5	4.3
	Rubavu	4.7	1,172.3	2,785.3	13,585.6	60.8	unknown	4.2
	Nyabihu	5.4	364.2	646.9	6,937.0	unknown	unknown	4.3
	Ngororero	4.2	683.9	916.2	5,294.3	12.4	42.0	4.1
	Rusizi	5.2	530.1	894.0	4,204.9	35.0	23.4	4.7
	Nyamasheke	5.56	434.0	712.2	10,796.6	46.2	24.8	4.9
Eastern	Nyagatare	7.31	356.2	585.3	8,755.1	5.6	21.8	4.3
	Gatsibo	5.17	585.4	1,323.5	14,616.3	49.1	22.9	6.3
	Kayonza	9	557.4	1,303.2	14,107.1	79.2	14.8	5.3
	Rwamagana	6	443.4	751.7	7,512.9	31.6	10.6	4.5
	Bugesera	5.58	897.7	1,791.0	4,775.6	4.9	15.7	4.8
	Kirehe	7.08	403.4	789.6	9,234.8	50.0	18.7	5.5
	Ngoma	4.83	403.2	884.6	12,547.1	44.5	22.0	5.3
North	Rulindo	6.42	596.3	1,276.9	6,173.9	18.4	21.9	3.6
	Gakenke	4.25	526.0	816.8	4,781.6	46.0	25.6	3.3
	Musanze	5.06	1,290.3	3,185.2	10,559.7	41.4	unknown	5.4
	Burera	5.38	408.4	659.1	7,506.4	31.4	unknown	4.3
	Gicumbi	5.44	397.9	595.8	9,175.7	37.0	unknown	3.9

ANNEX 7: FOOD SECURITY DATA RWANDA (CTD.)

Province	District	Av household size	Av per capita daily calorie intake from crop output consumed(kcal)	Av per capita daily calorie availability from total crop output(kcal)	Av per capita monthly income (FRw)	Mean contribution of bananas to total calorie intake (%)	Mean contribution of cassava to total calorie intake (%)	Av. HDDS (scale 0-12)
South	Nyanza	6.33	225.0	291.3	10,649.8	21.5	34.4	5.6
	Gisagara	6.08	868.0	1,158.4	7,131.0	46.7	8.5	3.3
	Nyaruguru	5.83	625.6	932.3	8,455.5	20.0	11.0	5.6
	Huye	4	451.9	634.0	6,139.5	7.7	32.3	3.8
	Nyamagabe	5.75	459.2	662.1	9,236.0	15.3	30.5	3.2
	Ruhango	6.17	652.4	1,130.8	6,672.4	36.4	30.0	5.0
	Muhanga	5.94	1,631.5	2,030.9	5,544.1	52.2	18.0	5.0
	Kamonyi	7.58	787.1	1,213.5	10,636.2	19.7	28.3	3.9
Kigali city	Nyarugenge	4.83	155.5	319.3	16,742.8	14.0	24.8	4.4
	Gasabo	4.94	335.0	812.7	13,418.8	19.6	14.0	5.8
	Kicukiro	5.1	282.7	542.8	19,311.2	13.6	20.6	5.7

ANNEX 7: FOOD SECURITY DATA RWANDA (CTD.)

Province	District	Enough of the kinds of food desired (%)	Enough but not always the kinds of food desired (%)	Sometimes not enough to eat (%)	Always not enough to eat (%)	Food secure overall (%)	Food insecure (temporal + permanent)
Western	Karongi	33.3	41.7	16.7	8.3	75.0	25.0
	Rutsiro	0.0	8.3	41.7	50.0	8.3	91.7
	Rubavu	25.0	18.8	25.0	31.3	43.8	56.3
	Nyabihu	0.0	56.3	31.3	12.5	56.3	43.8
	Ngororero	6.3	25.0	50.0	18.8	31.3	68.8
	Rusizi	6.3	43.8	37.5	12.5	50.1	50.0
	Nyamasheke	18.8	25.0	56.3	0.0	43.8	56.3
Eastern	Nyagatare	25.0	43.8	18.8	12.5	68.8	31.3
	Gatsibo	16.7	41.7	25.0	16.7	58.4	41.7
	Kayonza	0.0	87.5	12.5	0.0	87.5	12.5
	Rwamagana	25.0	25.0	41.7	8.3	50.0	50.0
	Bugesera	0.0	33.3	58.3	0.0	33.3	58.3
	Kirehe	50.0	41.7	8.3	0.0	91.7	8.3
	Ngoma	16.7	50.0	33.3	0.0	66.7	33.3
North	Rulindo	25.0	16.7	16.7	41.7	41.7	58.4
	Gakenke	6.3	25.0	12.5	56.3	31.3	68.8
	Musanze	33.3	26.7	20.0	20.0	60.0	40.0
	Burera	6.3	43.8	37.5	12.5	50.1	50.0
	Gicumbi	12.5	18.8	43.8	25.0	31.3	68.8

ANNEX 7: FOOD SECURITY DATA RWANDA (CTD.)

Province	District	Enough of the kinds of food desired (%)	Enough but not always the kinds of food desired (%)	Sometimes not enough to eat (%)	Always not enough to eat (%)	Food secure overall (%)	Food insecure (temporal + permanent)
South	Nyanza	25.0	33.3	25.0	16.7	58.3	41.7
	Gisagara	8.3	16.7	25.0	50.0	25.0	75.0
	Nyaruguru	16.7	66.7	16.7	0.0	83.4	16.7
	Huye	0.0	8.3	58.3	33.3	8.3	91.6
	Nyamagabe	0.0	0.0	41.7	58.3	0.0	100.0
	Ruhango	8.3	75.0	16.7	0.0	83.3	16.7
	Muhanga	6.3	37.5	31.3	25.0	43.8	56.3
	Kamonyi	8.3	66.7	16.7	8.3	75.0	25.0
Kigali city	Nyarugenge	0.0	33.3	58.3	8.3	33.3	66.6
	Gasabo	0.0	50.0	43.8	6.3	50.0	50.1
	Kicukiro	30.0	40.0	30.0	0.0	70.0	30.0

ANNEX 8: FOOD SECURITY DATA BURUNDI

Province	Av household size	Av per capita daily calorie intake from crop output consumed (kcal)	Av per capita daily calorie availability from total crop output (kcal)	Av per capita monthly income (FBu)	Mean contribution of bananas to total calorie intake (%)	Mean contribution of cassava to total calorie intake (%)	Av. HDDS (scale 0-12)
Cankuzo	5.7	519.8	921.1	3,529.5	13.2	23.2	4.0
Muyinga	5.6	546.8	881.7	1,885.4	12.6	22.6	4.8
Kirundo	6.3	546.9	973.0	7,174.7	18.2	20.2	3.6
Ngozi	5.3	481.3	703.7	4,324.6	20.3	22.4	3.6
Kayanza	5.8	511.2	868.7	5,391.1	21.0	19.0	4.3
Karuzi	6.0	496.6	874.6	3,702.0	22.0	23.0	4.2
Gitega	6.2	662.0	933.6	3,545.2	23.3	12.0	4.3
Cibitoke	7.2	647.5	1,524.6	6,557.0	17.3	54.0	5.6
Bururi	6.3	598.0	1,089.4	5,221.0	20.7	33.4	5.1
Makamba	11.6	510.3	912.1	4,977.0	12.0	47.4	5.0
Rutana	6.4	1,411.8	2,437.2	5,353.5	6.4	42.2	3.8
Mwaro	8.9	576.2	927.3	3,595.0	7.5	26	4.2
Muramvya	7.0	389.2	645.6	3,185.0	12.3	13.2	4.4

ANNEX 8: FOOD SECURITY DATA BURUNDI, CTD.

Province	Enough of the kinds of food desired (%)	Enough but not always the kinds of food desired (%)	Sometimes not enough to eat (%)	Always not enough to eat (%)	Food secure overall (%)	Food insecure (temporal + permanent)
Cankuzo	6.7	26.7	43.3	23.3	33.4	66.6
Muyinga	4.3	0.0	60.9	34.8	4.3	95.7
Kirundo	3.7	18.5	40.7	37.0	22.2	77.7
Ngozi	3.6	17.9	32.1	46.4	21.5	78.5
Kayanza	8.3	12.5	33.3	45.8	20.8	79.1
Karuzi	4.2	16.7	12.5	66.7	20.9	79.2
Gitega	11.1	11.1	25.9	51.9	22.2	77.8
Cibitoke	0.0	29.6	14.8	55.6	29.6	70.4
Bururi	16.7	4.2	12.5	66.7	20.9	79.2
Makamba	15.0	20.0	25.0	40.0	35.0	65.0
Rutana	12.0	12.0	36.0	40.0	24.0	76.0
Mwaro	4.3	17.4	56.5	21.7	21.7	78.2
Muramvya	7.4	3.7	63.0	25.9	11.1	88.9

ANNEX 9: FOOD SECURITY DATA DRC

Province	Territory	Av household size	Av per capita daily calorie intake from crop output consumed (kcal)	Av per capita daily calorie availability from total crop output (kcal)	Av per capita monthly income (TSh)	Mean contribution of bananas to total calorie intake (%)	Mean contribution of cassava to total calorie intake (%)	Av. HDDS (scale 0-12)
South Kivu	Walungu	9.2	118.7	188.4	22,729.2	17.7	51.6	4.0
	Kalehe	8.3	244.8	639.8	56,335.3	11.1	57.0	5.3
	Fizi	9.3	242.7	463.2	21,260.1	14.0	78.6	5.7
	Uvira	8.6	405.5	1,289.5	28,398.0	3.1	25.6	4.7
	Mwenga	7.9	260.6	416.5	95,854.2	7.7	45.1	2.5
	Kabare	7.1	162.4	370.7	36,574.8	15.0	39.6	5.3
North Kivu	Masisi	8.4	579.1	2,159.4	23,364.2	36.1	43.3	4.9
	Rutshuru	7.3	1,039.9	3,276.3	27,235.4	37.8	39.0	5.3
	Beni	7.8	37.9	122.5	7,072.1	65.3	23.7	5.0
	Lubero	8.0	836.2	1,490.9	30,039.7	21.7	50.2	6.1
Maniema	Kailo	12.1	416.4	2,103.3	6,155.9	11.7	42.9	3.9
Katanga	Kongolo	11.7	1,436.0	2,454.1	62,452.3	8.7	61.8	4.2

ANNEX 9: FOOD SECURITY DATA DRC, CTD.

Province	Territory	Enough of the kinds of food desired (%)	Enough but not always the kinds of food desired (%)	Sometimes not enough to eat (%)	Always not enough to eat (%)	Food secure overall (%)	Food insecure (temporal + permanent)
South Kivu	Walungu	0.0	35.0	55.0	10.0	35.0	65.0
	Kalehe	30.0	17.5	35.0	17.5	47.5	52.5
	Fizi	12.5	0.0	20.0	67.5	12.5	87.5
	Uvira	17.5	20.0	30.0	32.5	37.5	62.5
	Mwenga	2.5	10.0	10.0	77.5	12.5	87.5
	Kabare	15.0	50.0	17.5	17.5	65.0	35.0
North Kivu	Masisi	15.0	62.5	17.5	5.0	77.5	22.5
	Rutshuru	15.0	55.0	25.0	5.0	70.0	30.0
	Beni	2.6	69.2	28.2	0.0	71.8	28.2
	Lubero	50.0	22.5	27.5	0.0	72.5	27.5
Maniema	Kailo	15.0	62.5	15.0	7.5	77.5	22.5
Katanga	Kongolo	0.0	82.8	6.9	10.3	82.8	17.2

ANNEX 10: FOOD SECURITY QUESTIONNAIRE

CROP CRISIS CONTROL PROJECT (C3P): A REGIONAL RESPONSE TO CMD AND BXW IN EASTERN AND CENTRAL AFRICA

HOUSEHOLD FOOD SECURITY SURVEY 2007

International Institute of Tropical Agriculture
Catholic Relief Services

Section 1: Identification of household and study area

1.1 (a) Province-------------------- (b) District--------------------- (c) Division--------------------

(d) Location------------------------- (e) Sub-location -------------------- (f) Village --------------

1.2 GPS coordinates of residence: (a) Latitude -------------------------- (b) Longitude---------------

(c) Elevation (m.a.s.l.): --------------------------------

1.3 Name of interviewer ---

1.4 Date of interview (day/month/year) --- (IDATE)

Section 2: Household characteristics

A "household" includes all members of a common decision making unit (usually within one residence) that are sharing income and other resources. Include workers or servants as members of the household only if resident at least six months in the household.

Variable		**Codes/measure**
A.2.1 Name of Household head		
A.2.2 Sex of Household head		*1=Female, 2=Male*
A.2.3 Education level of household head		*Number of years in school excluding those in repeated classes*
A.2.4 Age of Household head		*Years*
A.2.5 Name of respondent		
A.2.6 Sex of the respondent		*1=Female, 2=Male*
A.2.7 Relationship to household head		*1=head; 2=spouse, 3=father, 4=mother, 5=son, 6=daughter, 7=other (specify)*
A.2.8 Household size		

A 2.9 Household composition by age and sex

Age category (years)	**Males**	**Females**
<1		
1 – 6		

7 – 13		
14 – 19		
20 – 59		
>59		

B. Land holding

Conversion: 1 ha = 10,000m^2 = 2.471 acres

B.1.1 Total land owned (acres)	
B.1.2 Total land rented in, sharecropped in, or borrowed (acres)	
B.1.3 Total land rented out, sharecropped out, or lent out (acres)	
B.1.4 Total land under cultivation (acres)	

Section 3: Crop production, consumption and marketed surplus

A. Output of crop enterprises and cropping systems

Crop grown	**Cropping system***	**Total acreage under crop**	**Average quantity per season (long rains) (kg/other units)**	**Average quantity per season (short rains) (kg/other units)**

** **Cropping system**: 1=Pure stand (monocropping), 2=Two crop intercropping, 3=More than two crop mixed cropping, 4=other (specify)*

B. Home consumption and marketed surplus: For all crops grown (Section 3A),

B.1 What proportion of output is consumed and marketed after the long rains (period of relatively sufficient food availability)?

Crop	**Share marketed (%)**	**Share consumed at home (%)**	**Share given to others for consumption (%)**	**Share used to plant next season (%)**

B.2 What proportion of output is consumed and marketed after the short rains (period of relatively insufficient food availability)?

Crop	**Share marketed (%)**	**Share consumed at home (%)**	**Share given to others for consumption (%)**	**Share used to plant next season (%)**

C. Seed security: For all crops grown (Section 3A),
C.1 Where do you usually get your seed/planting material from?

Crop	**Sources of seed/planting material***	**Percentage of seed/planting material obtained from source**
Crop 1:		
Crop 2:		
Crop 3:		
Crop 4:		

Crop 5:		
Crop 6:		
Crop 7:		
Crop 8:		
Crop 9:		

**1 = Own production; 2 = Neighbors as gift; 3 = Purchase from market; 4 = Purchase from neighbors; 5 = NGO's (free-of-charge); 6 = Government (free-of-charge); 7 = Purchase from Government; 8 = Purchase from NGOs; 99 = others*

C.2. Where did you get the seed/planting material for the last season from?

Crop	**Sources of seed/planting material***	**Percentage of seed/planting material obtained from source**

Crop 1:		
Crop 2:		
Crop 3:		
Crop 4:		
Crop 5:		
Crop 6:		
Crop 7:		
Crop 8:		

Crop 9:		

**1 = Own production; 2 = Neighbors as gift; 3 = Purchase from market; 4 = Purchase from neighbors; 5 = NGO's (free-of-charge); 6 = Government (free-of-charge); 7= Purchase from Government; 8 = Purchase from NGOs; 99 = others*

Section 4: Household labor availability

4.1 How many household members work on farm full time? --------------------------------

4.2 How many household members work on farm part-time? --------------------------------

4.3 How many household members work off farm full-time? --------------------------------

4.4 Does the household hire any labor services paid for in cash or kind? ------(1 = yes, 0 = no)

4.5 Does the household hire any animal services? ------------------------------- (1 = yes, 0 = no)

4.6 Does the household hire tractor services? ------------------------------- (1 = yes, 0 = no)

Section 5: CMD, CBSD, BXW, other diseases and production constraints/risks

5.1.1 Have you experienced a disease called Cassava Mosaic Disease? (*Describe the symptoms to respondent*) ------------ (1 = yes; 0 = no)

5.1.2 Have you experienced a disease called Cassava Brown Streak Disease? (*Describe the symptoms to respondent*) ------------ (1 = yes; 0 = no)

5.1.3 Have you experienced a disease called Banana Bacterial Wilt? (*Describe the symptoms to respondent*) ------------ (1 = yes; 0 = no)

If yes to any or all of the above questions, ask 5.2 - 5.7

5.2 Year first experienced disease, effect of disease on crop production and food security, source(s) of information about disease.

Disease	**Year 1st experienced**	**Loss in crop production before intervention (%)**	**Reduction in food consumption due to disease* (%)**	**Source(s) of information****
CMD				

CBSD				
BXW				

**0 = no reduction at all (0%); 1 = minimal (0-20%); 2 = moderate (21-50%); 3 = high (51-70%); 4 = very high (71-100%)*
***1 = extension worker; 2 = researchers; 3 = fellow farmers; 4 = radio; 5 = Television; 6 = newspapers; 7 = NGO/CBO; 99 = other*

5.3 For each of the diseases above, what solutions have you put in place?

Disease	**Solutions**
CMD	
CBSD	
BXW	

5.4 Have you shifted from consumption of cassava to other crop(s) as a result of the disease? ------------------------------- (1 = yes, 0 = no). If yes,
5.5 What crop(s) do you eat in place of cassava? --
5.6 Have you shifted from consumption of banana to other crop(s) as a result of the disease? ------------------------------- (1 = yes, 0 = no). If yes,
5.7 What crop(s) do you eat in place of banana? --
5.8 For each of the crops (Cassava and Banana), list 5 other important production constraints/risks

Crop	**Constraint/risk**	**Rank***
Cassava		
Banana		

**1-5 where 1 = most important……5 = least important*

Section 6: Household income and expenditure

6.1 List the 3 major sources of income for the household over the last 5 years

Income source	
Primary source	
Secondary source	
Tertiary source	

** 1 = Production and sale of crops; 2 = Sale of own-produced planting/seed material; 3 = Production and sale of livestock & livestock products; 4 = Service providers (operating boda boda, bar, hotel, photography etc); 5 = Beer brewing; 6 = Brick making/masonry/stone quarrying; 7 = Carpentry/lumbering; 8 = Crafts and arts; 9 = Shop selling mainly industrial products; 10 = Trading in agricultural commodities (crop and livestock) other than own-produced; 11 = Agricultural input trading; 12 = Salary employment by local or central government; 13 = Salary employment by NGOs or CBOs; 14 = Salary employment by private companies; 15 = Casual laborer (labor export); 16 = Pension earners; 17 = Remittance income (from relatives, friends, rental income, donations, gifts); 18 = Mining;19 = Sale of firewood; 20 =Sale of Charcoal; 21 = Fishing; 22 = Fish mongering; 99 = Others (specify)*

6.2 How much do you earn per month from each of the sources above?

Income source	**Average earnings per month (KSh)**
Primary source	
Secondary source	
Tertiary source	

6.3 What other income-generating opportunities exist for your household but have not yet been exploited and why?

Unexploited income-generating opportunities*	**Reason(s)**

** use codes for 6.1 above*

6.4 Household consumption expenditures

Purchased Products		Frequency purchased	Period 1=daily 2=weekly 3=monthly 4=Yearly	Average quantity purchased (kg/unit)	Price per unit (kg/unit)	Purchased products/contribution made		Frequency purchased	Period 1=daily 2=weekly 3=monthly 4=Yearly	Average quantity purchased (kg/unit)	Price per unit (kg/unit)
Staples											
Maize grain	1					Salt	26				
Maize flour	2					Cooking oil/ghee	27				
Millet	3					Coffee	28				
Sorghum	4					Tea	29				
Wheat flour	5					Beer	30				
Rice	6					Soda	31				
Cassava (Fresh)	7					Local brew	32				
Cassava (Processed)	8					Tobacco/Cigarettes	33				
Sweet Potato	9					Others	34				
Irish Potato	10										
Matooke	11					Non Food items					
Other staples (any)	12					School fees	35				
Non Staples						Text books, pens etc	36				
Pork	13					Medical care	37				
Chicken	14					Transport	38				
Beef	15					Clothing	39				
Mutton	16					Cooking/lighting fuel	40				
Goat	17					Rent	41				
Fish	18					Others	42				
Dairy products	19					Contributions					
Beans	20					Saving schemes	43				
G. nuts	21					Remittances to relatives	44				
Cow peas	22					Church/Mosque	45				
Vegetable (any)	23					Credit repayments	46				
Fruits (any)	24					Mutual support groups	47				
Non Fresh Food items											
Sugar	25										

Section 7: Household food security status

7.1. What is the major source of food for the household? (*Tick only one*)

Source	
Own production	
Market purchase	
Inter-household transfers	
Relatives	
Exchange of labor for food	
Lending land in exchange for food	

7.2 What are your major food security crops grown and why?

Major food security crop	**Reason(s)**

7.3 Household dietary diversity: *Use the previous 24 hours as the reference period. First determine whether the previous 24-hour period was "usual" or "normal" for the household. If it was a feast or funeral or if over half of the household members were absent, skip this question. Include only food groups consumed by household members in the home or prepared in the home for consumption by household members outside the home.*

What types of foods did you or anyone else in your household eat yesterday during the day and at night?

Food group	**Coding category***
Cereals (e.g. foods made from millet, maize, sorghum, rice, wheat)	
Roots and tubers (e.g. potatoes, yams, cassava)	
Vegetables	
Fruits (including bananas)	
Meat (e.g. beef, goat, poultry, wild game)	
Eggs	
Fish	
Pulses, legumes, nuts (e.g. beans, peas, ground nuts)	
Milk and milk products	
Oil/fats	
Sugar/honey	
Miscellaneous (e.g. coffee, tea)	

**1 = if anyone in the household ate the food in question; 0 = otherwise*

7.4 Which of the following statements best describes the food eaten in your household? (*Tick only one*)

(i) Enough of the kinds of food we want to eat -------------------------------
(ii) Enough but not always the kind of food we want to eat -------------------------------
(iii) Sometimes not enough to eat -------------------------------
(iv) Often not enough to eat -------------------------------

7.5 If (ii)-(iv) above,

(a) Give reasons why

(b) During periods of food insecurity, by how much does consumption of crops indicated in 7.2 above fall?

Major food security crop	**Reduction in consumption ***

**0 = no reduction at all (0%); 1 = minimal (0-20%); 2 = moderate (21-50%); 3 = high (51-70%); 4 = very high (71-100%)*

(c) How do you cope with food shortages?

(d) Which month(s) of the year are you most food insecure and why?

Month of food insecurity	**Reason(s)**

(e) How best can the problem of food insecurity in your household be solved?

END

THANK YOU

ENUMERATOR'S COMMENTS

ANNEX 11: DEFINITION AND SUMMARY STATISTICS BY COUNTRY, OF VARIABLES USED IN THE ANALYSIS

Variable	Definition	Uganda	Kenya	Tanzania	Burundi	Rwanda	DR Congo
CALORIE	Per capita daily calorie intake (kilocalories)	1,349.5 (3,298.6)	1,300.9 (1,393.8)	1,261.4 (1,392.7)	609.0 (1,054.1)	588.5 (788.2)	442.3 (739.4)
EXP	Per capita monthly expenditure in local currency	40,214.7 (USh) (127,835.7)	1,302.8 (KSh) (842.2)	19,173.5 (TSh) (20,354.6)	18,874.4(FBu) (185,069.5)	43,782.4(FRw) (373,994.6)	34,837.3 (FC) (98,979.7)
EDUCHEAD	Education level of household head (number of years in school)	7.5 (5.2)	7.1 (4.0)	5.9 (2.8)	3.1 (3.0)	4.8 (4.73	6.2 (4.35)
AGEHEAD	Age of household head (years)	47.0 (15.1)	48.6 (16.0)	49.9 (15.4)	44.0 (12.4)	44.9 (13.1)	45.1 (12.8)
HHSIZE	Number of household members	7.9 (3.9)	6.9 (2.9)	7.5 (4.1)	6.7 (6.2)	5.6 (2.3)	8.7 (3.9)
CASSLOSS	Loss in cassava output due to CMD (Kg)	3,881.6 (14,568.2)	2,233.5 (5,482.8)	1,646.6 (6,098.8)	14.5 (36.5)	406.8 (961.4)	777.1 (1,559.6)
FARMLAB	Number of household members constituting farm labour	5.1 (3.0)	3.9 (2.4)	4.1 (2.4)	4.2 (2.0)	2.9 (1.7)	4.1 (2.4)
LANDOWN	Total land owned by household (ha)	3.4 (20.1)	2.2 (6.3)	2.2 (3.1)	3.5 (33.7)	0.8 (1.7)	5.9 (27.5)
SEXHEAD	Sex of household head; 1 if male, 0 otherwise						

Figures in parentheses are standard deviations

Annex 12: Determinants of calorie intake in Uganda, Kenya and Tanzania

Variable	Uganda			Kenya			Tanzania		
	Coefficient	**t-value**	**p-value**	**Coefficient**	**t-value**	**p-value**	**Coefficient**	**t-value**	**p-value**
EXP	5.36	2.10	0.036	49.40	1.79	0.076	2.47E-05	2.13	0.035
	(2.54)			(27.57)			(1.16E-05)		
EXP^2	-0.24	-1.97	0.050	-3.76	-1.86	0.065	-2.42E-11	-1.95	0.053
	(0.12)			(2.01)			(1.24E-11)		
EDUCHEAD	-0.004	-0.61	0.541	0.07	1.85	0.067	-0.01	-1.03	0.304
	(0.007)			(0.04)			(0.01)		
AGEHEAD	-0.006	-0.41	0.679	3.22	0.87	0.388	-0.01	-0.96	0.340
	(0.01)			(3.72)			(0.01)		
HHSIZE	-0.79	-1.53	0.127	-0.73	-0.23	0.819			
	(0.52)			(3.19)					
CASSLOSS	-0.02	-3.63	0.000	-0.03	-1.73	0.085	-0.006	-1.65	0.100
	(0.007)			(0.02)			(0.003)		
SEXHEAD	0.02	2.78	0.006	2.57	0.54	0.592	-0.09	-0.24	0.809
	(0.008)			(4.78)			(0.39)		
FARMLAB	0.003	0.39	0.697	1.04	7.83	0.000	0.02	2.90	0.004
	(0.009)			(0.13)			(0.008)		
LANDOWN	0.05	4.81	0.000				-0.003	-0.14	0.887
	(0.01)						(0.02)		
CONSTANT	-23.15	-1.79	0.074	-171.05	-1.77	0.080	6.47	8.25	0.000
	(12.93)			(96.91)			(0.78)		
	No. of observations = 361			No. of observations = 125			No. of observations = 134		
	Prob > F = 0.000			Prob > F = 0.000			Prob > F = 0.069		
	R-squared = 0.157			R-squared = 0.390			R-squared = 0.107		
	Adj R-squared = 0.136			Adj R-squared = 0.348			Adj R-squared = 0.050		
	Root MSE = 4.858			Root MSE = 12.422			Root MSE = 2.037		

Figures in parenthesis are standard errors. Dependent variable is natural log of per capita daily calorie intake from own-production.

ANNEX 13: DETERMINANTS OF CALORIE INTAKE IN BURUNDI, RWANDA AND DR CONGO

	Burundi			Rwanda			DR Congo		
Variable	**Coefficient**	**t-value**	**p-value**	**Coefficient**	**t-value**	**p-value**	**Coefficient**	**t-value**	**p-value**
EXP	3547.01	4.30	0.000	1.10	11.31	0.000	0.000053	2.69	0.008
	(824.74)			(0.09)			(0.00002)		
EXP^2	-214.70	-4.32	0.000	-0.08	-2.25	0.025	-3.65E-11	-2.32	0.021
	(49.70)			(0.03)			(1.57E-11)		
EDUCHEAD	2.67	2.63	0.010	0.003	0.16	0.874	0.65	17.80	0.000
	(1.01)			(0.02)			(0.03)		
AGEHEAD	485.78	4.11	0.000	0.07	2.38	0.018	0.19	14.60	0.000
	(118.19)			(0.03)			(0.01)		
HHSIZE	-833.07	-5.05	0.000				0.08	0.88	0.381
	(165.01)						(0.09)		
CASSLOSS	-4.77	-2.06	0.042	-0.03	-2.35	0.020	-0.07	-1.66	0.098
	(2.32)			(0.01)			(0.04)		
SEXHEAD	697.73	3.94	0.000				-3.15	-3.17	0.002
	(177.30)						(0.99)		
FARMLAB	0.17	0.06	0.950	-0.05	-0.59	0.559			
	(2.75)			(0.09)					
LANDOWN	24.30	1.26	0.212	0.004	0.13	0.894			
	(19.35)			(0.034)					
CONSTANT	-15741.73	-4.77	0.000	-0.76	-0.26	0.791	-7.36	-6.09	0.000
	(3300.58)			(2.90)			(1.20)		
	No. of observations = 124			No. of observations = 229			No. of observations = 296		
	Prob > F = 0.000			Prob > F = 0.000			Prob > F = 0.000		
	R-squared = 0.374			R-squared = 0.509			R-squared = 0.752		
	Adj R-squared = 0.325			Adj R-squared = 0.494			Adj R-squared = 0.746		
	Root MSE = 391.2			Root MSE = 10.773			Root MSE = 0.737		

Figures in parenthesis are standard errors. Dependent variable is per capita daily calorie intake from own-production for Burundi and natural log of per capita daily calorie intake from own production for Rwanda and DR Congo.