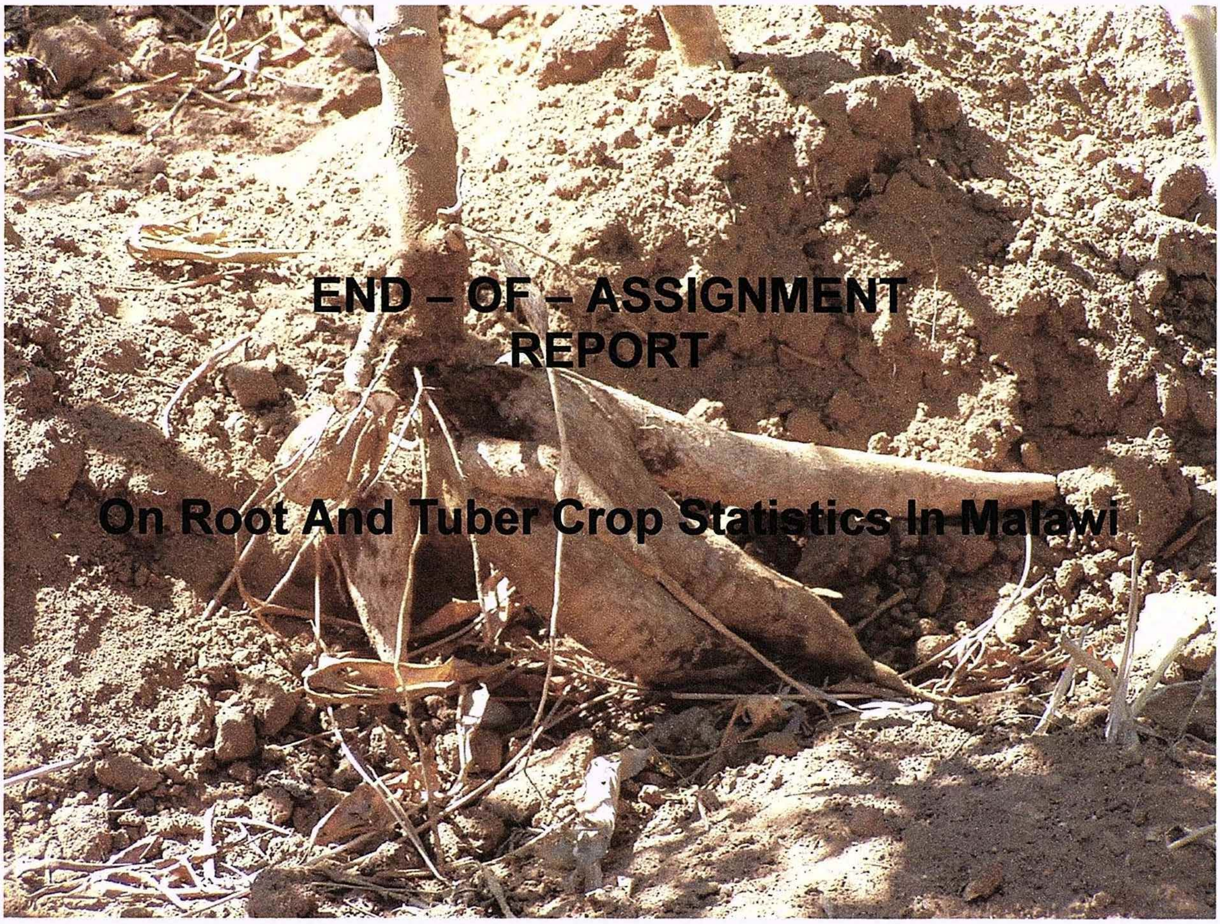
FOOD AND AGRICULTURAL ORGANIZATION OF THE UNITED NATIONS (FAO)

PROJECT GCP/MLW/019/UK
Preparatory Support to Agricultural Statistics and Food Security Information Systems



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July 2004

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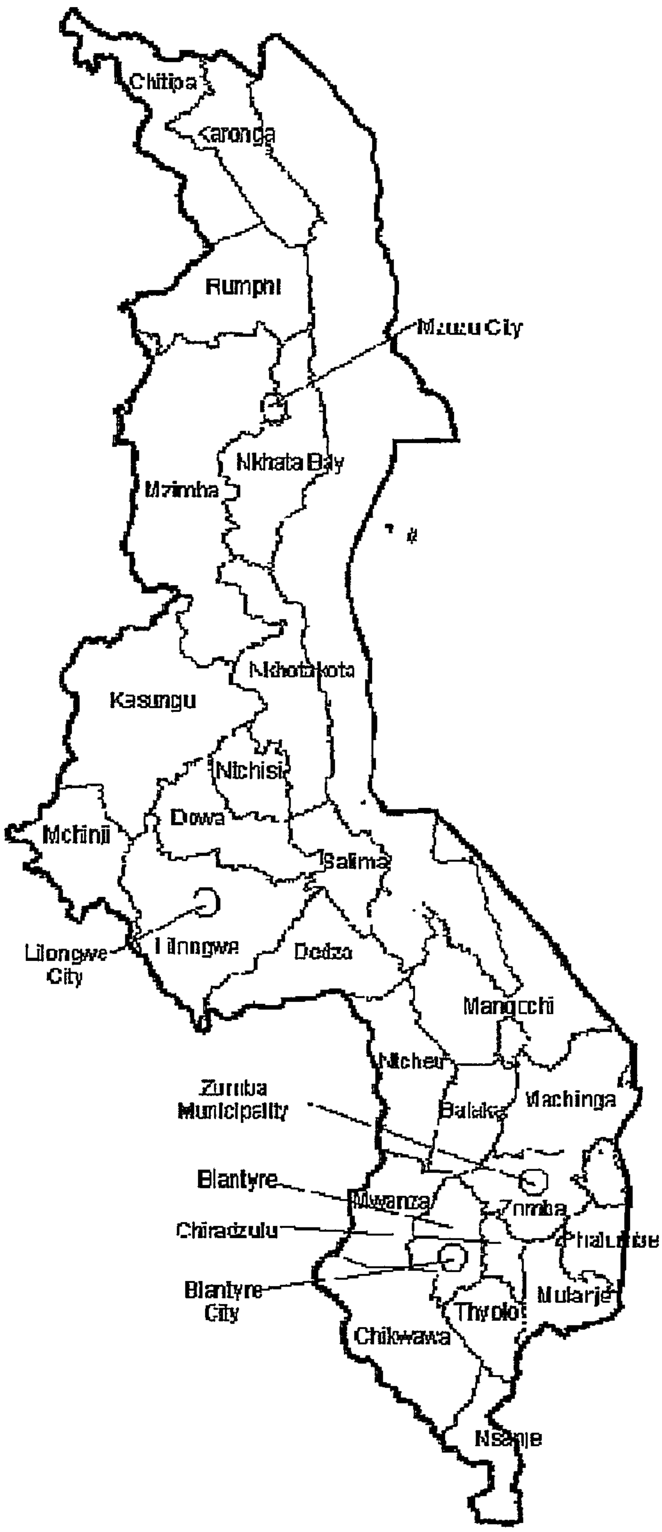
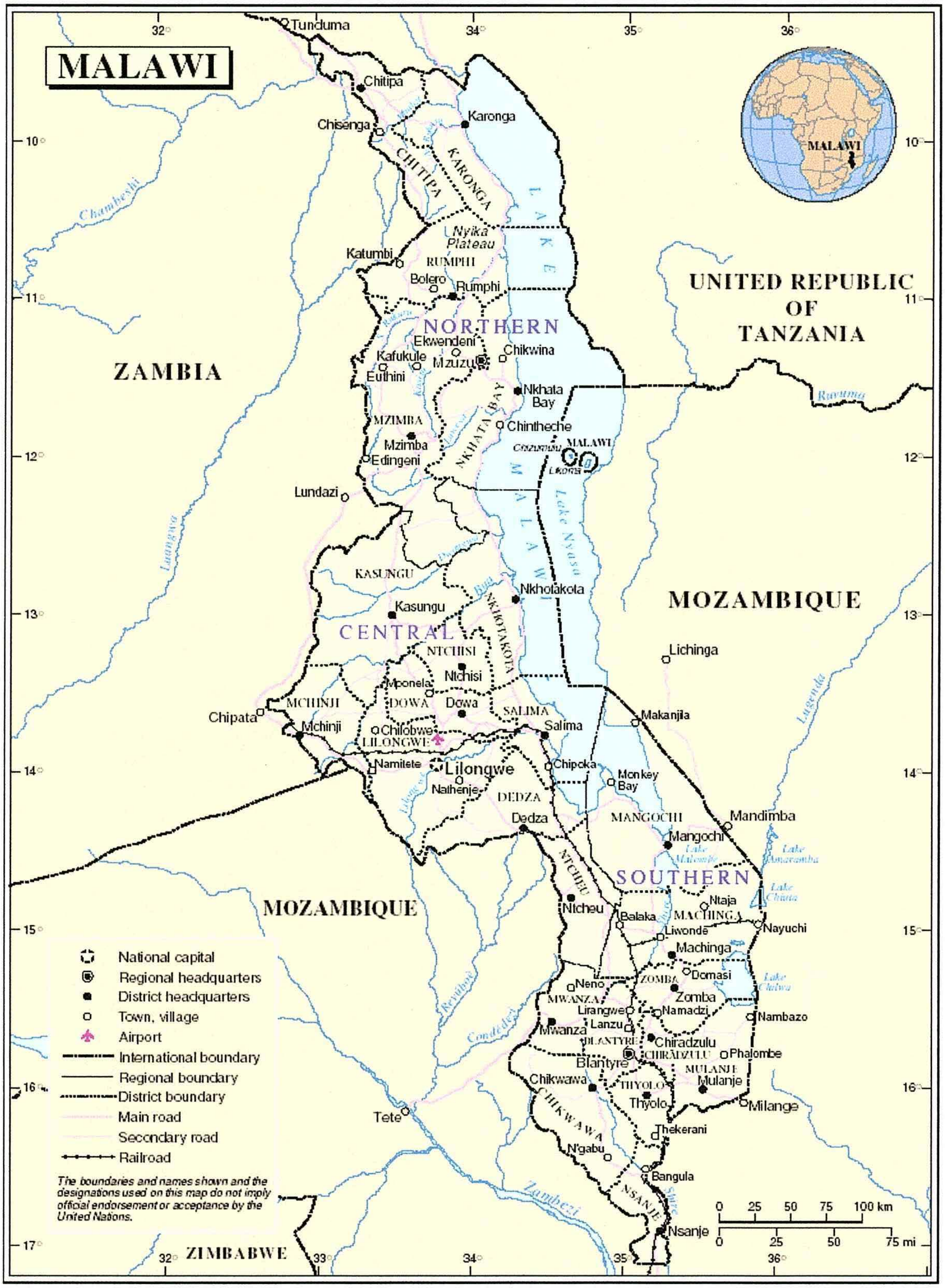
List of Abbreviations used in this report

ADD	Agricultural Development Division
AEDC	Agric Extension Development Coordinator
AEDO	Agric Extension Dev. Officer (formerly FA)
AGRESS	Agricultural Gender Roles Ext. Support Services
AHH	Action Against Hunger-Malawi (NGO)
CIRAD	Centre de Coop. Int'l en Recherche Agronomique pour le Développement
DADO	District Agricultural Development Officer (DADO)
DEPD	Dept. of Economic Planning and Development, formerly NEC
DFID	Dept. for Int'l Development (British Int'l Development Agency)
EA	Enumeration Area
EPA	Extension Planning Area
EU	European Union
FA	Field Assistant
FAO	Food and Agriculture Organisation of the United Nations
FEWSNET	Famine Early Warning System Network
GoM	Government of Malawi
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (German Technical Co-operation Agency)
IITA	International Institute of Tropical Agriculture (Ibadan)
MoAI&FS	Ministry of Agriculture, Irrigation and Food Security
NAC	National Agricultural Census
NEC	National Economic Council (see DEPD)
NGO	Non-Governmental Organisation
NSO	National Statistical Office
NSSA	National Sample Survey of Agriculture
PNAC	Pilot National Agricultural Census
RDP	Rural Development Project
SARRNET	Southern African Root Crops Research Network
USAID	United States Agency for International Development
TA	Traditional Authority
VAC	Malawi Vulnerability Assessment Committee



Administrative boundaries of Malawi



Map No. 3858 Rev. 3 UNITED NATIONS
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Cartographic Section

INTRODUCTION

1 BACKGROUND

1.1 OVERVIEW OF THE COUNTRY AND AGRICULTURAL SECTOR

Malawi is a landlocked country with 118,480 km2 (98,480 km2 land and 24,400 km2 water). It is located between 9°30 and 17° N in latitude and 33° and 36° E in longitude. Most of the areas are highlands located more than 1000 m above the sea level while Lake Malawi has an altitude of 473 m asl. The population was estimated at about 11 million people at the end of 2003. The population is growing at more than 3% per annum and the country has one of the highest population densities in Africa, with 96 inhabitants per square kilometres of land surface and 176 inhabitants per square kilometres of arable land.

Agriculture is the backbone of Malawi's economy, which accounts for 36% of the GDP. The agricultural sector is extremely climate dependant and has a narrow base with maize for food and tobacco for cash being the predominant smallholder crops (ECFSU, 1999). The majority of the population live a subsistence existence, and an estimated 85% rely on agricultural output, either directly or indirectly, for their livelihood. Agricultural output generates over 90% of export earnings and tobacco alone for approximately 50%, followed by tea and sugar. Tobacco is grown throughout the country, whereas sugar and tea production is found mostly in the South (GCP/MLW/019/UK – project document, 2003).

The main staple food crops grown by smallholder farmers is maize (by nearly 100%), current production is estimated at 1.723 million tonnes on more than 1.5 million hectares for the 2003/2004 season. Although maize is considered the main staple in the country cassava remains the staple food for 30 % of households, especially in the lakeshore districts; for instance Nkhotakota and Nkhata Bay. Sweet potato (grown by 38 % of farmers) can be considered as the third food crop in the country. Last crop estimates for 2004 give 2.5 millions MT of fresh roots on 156,000 ha for cassava and more than 1.5 millions MT on 150,000 ha for sweet potato (NSO 2004 R2 estimates). Then comes rice grown by nearly 15 % of smallholders. Other staple food crops – sorghum, millet and bananas – are specific to the far north (Chitipa) and south (Mulanje, Thyolo, Mwanza, Chikwawa and Nsanje). Irish potatoes also highly localised; are grown by less than 2% of farmers nationally. The other main food crops are vegetables and legume grains (Levy S. and C. Barahona, 2002).

1.2 MISSION BACKGROUND

The present mission, was undertaken within the framework of the project "GCP/MLW/O19/UK 'Preparatory Support to Agricultural Statistics and Food Security Information Systems in Malawi" implemented by the Food and Agriculture Organization (FAO) in collaboration with Malawi Government and with financial assistance from DFID.

The principal government institutions involved in this project are Ministry of Agriculture, Irrigation and Food Security (MoAI&FS), Ministry of Economic Planning and Development (MEPD) and National Statistical Office (NSO).

The overall development objective of the project is to achieve sustainable food security for the people of Malawi in addressing concerns of both chronic and temporary food insecurity. The immediate objectives are as follows: (GoM- 2003 -project document)

- Establish a functional and institutionally viable framework for the medium-term development of integrated agricultural and food security information in Malawi
- Provide practical and immediate response to the current and near-term food security situation in Malawi

2 TERMS OF REFERENCE OF THE MISSION

The objectives of this mission were to assist the project for the improvement of the agricultural statistics and information systems in the field of root and tuber crops. Indeed because of their specification it is difficult to apply current methodologies for production estimation on these crops. Consequently, root and tuber crop production estimates are generally perceived as inaccurate.

The consultant on root crop statistics has been hired for a first 3 week period. Due to shifts in the initial timing of the mission it was agreed between the CTA and the consultant at the beginning of the study that the mission will focus more precisely on the following items of the terms of reference:

- review the current method of estimation of root crop production in Malawi;
- review all methodologies tested locally so far on root crop statistics and evaluate their performance;
- describe all stages of the cassava processing (from fresh root up to flour);
- prepare a suitable methodology for the estimation of the yield and production of cassava and sweet potatoes;
- study and propose conversion coefficient for the estimation of cassava yields (from fresh cassava root to cassava flour);
- initiate a field pilot survey for the estimation of cassava and sweet potatoes production;
- prepare an end-of-assignment report describing the activities undertaken, findings, conclusions and recommendations.

A second one-month assignment is planned to review and monitor the implementation of the recommendations made during the first mission. The detailed terms of reference of the two assignments are given in annex 1.

3 MISSION DURATION

The mission was initially planed to take place before the implementation of the pilot census which occurred in May 2004. It was finally decided to postpone it after the elections. The mission was effectively carried out between 10^{th} of June to 2^{nd} of July 2004.

4 ACKNOWLEDGEMENTS

During his stay in Malawi, the mission met various Senior Officials to whom he expresses his sincere acknowledgement, and more specifically to:

- Dr Louise L. Setshwaelo, FAO Representative in Malawi
- Mr. Thierry Antoine, Chief Technical Advisor of the Project
- Mr. C. Machinjili, Commissioner, National Statistical Office (NSO)
- Mrs. M. Kanyuka, Deputy Commissioner, National Statistical Office (NSO).
- Mr. L. Mpando, Chief of Agricultural Statistics Division, NSO and National Deputy Coordinator of the project
- Mr. F. Ngopya, FAO Statistician/SAFR, Harare.

The consultant (P. Vernier) wishes also to express his gratitude to the following persons and institutions, who has provided him very useful documents and sources of information for this report:

- Mr. Moses Kachale, Economist secondee to the project; MEPD
- Mr. Richmond Chinula, Statistician, secondee to the project, NSO
- Mr. Charles Rethman, Save the Children (UK)
- Mr. Evance Chapasuka, FEWS-NET
- Ms Blariaux Dominique FAO/Emergency Coordination Unit
- Ms Christa Roth, GTZ
- Dr Nzola M. Mahungu, SARRNET

Special thanks to Mr. Daisi. Kachingwe Phiri, Economist of MoAI&FS seconded to the project, who accompanied me during the field trip and assisted me in editing the present report.

The list of persons that were visited during the mission is attached herewith as **annex 3.**

5 DUTY STATION & PLACES VISITED

The project being based in Lilongwe, the mission spent most of its time in the project's office at the FAO site. However, the mission spent some time outside Lilongwe:

- 09 – 11 June 2004 trip to Mzuzu, Nkhotakota and Salima. The purpose of this trip was to meet with staff of Ministry of Agriculture and NSO at ADD, RDP and EPA level for technical discussions on the methodology root crop yield estimation/statistics.
- 15-16 June trip to Mulanje RDP, visit to the GTZ project on food security and meeting with RDP crop officer. Visit to some farmers' field.
- 29-30 June in Zomba, together with the project CTA for discussions with the NSO Agricultural Statistics Division and Deputy Commissioner.
- 1 July: Visit to Sarrnet at Chitedze Research Station
- 2 July, debriefing meeting at the FAO project with the following participants

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6 MISSION ACTIVITIES

6.1 STUDY OF THE EXISTING MATERIALS

The list of the reviewed documents made available to the mission by the Project Chief Technical Adviser is given in Annex 3.

6.2 OVERVIEW OF THE SITUATION OF ROOT CROPS IN MALAWI

The methodology for crop estimation in general will depend on crop pattern and cropping system characteristics. Thus we will give hereby some of the characteristics of these productions in order to better define the most appropriate methods to design root crop estimation scheme.

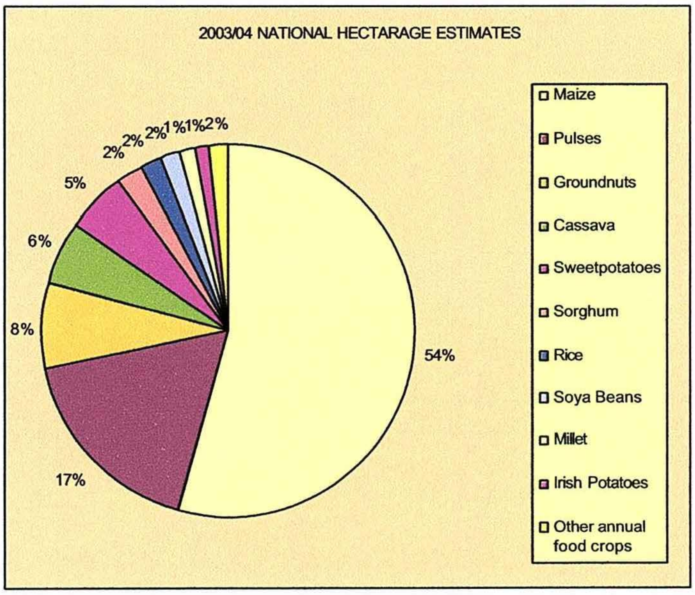
According to the last figures of crop estimation[1], the two most important root crops grown in Malawi in term of land occupation (Table 1) are cassava and sweet potato with approximately 150 000 ha which is far from Irish potato area, estimated to cover about 33,000 ha. Cassava comes in fourth position after maize, the major staple food in the country, pulses and groundnuts.

Table 1 : National hectarage estimates

Crops	Hectare
Maize	1 537 651
Pulses	493 085
Groundnuts	218 028
Cassava	156 645
Sweet potatoes	149 478
Sorghum	63 459
Rice	51 016
Soya Beans	49 714
Millet	37 368
Irish potatoes	33 066
Other annual food crops	46 081

source MOAI&FS/NSO : 2003/04 estimation R2

In term of relative area occupation maize represents 54 % of the land dedicated to annual food crop production (without taking into account perennial food crops such as orchards, tea & coffee plantation nor non food crops such as cotton). Cassava (8%) and sweet potato (6%) come after pulses (17%) while potato represents only 1%.



Graph 1 : relative area covered by crop on the total of annual food crop

1 National Crop Estimates 2004 (second round), NSO

According to the same production estimates (Table 2) cassava is the first national production with an amount of more than 2.5 millions metric tons (MT) of fresh tubers in front of maize (1.731 millions MT), sweet potato (1.5 millions MT). Irish potato output (430,000 MT) is even greater than the production of pulses (about 286,000). Nevertheless these figure based on gross weight production are not very appropriate to compare products as different as grains (cereals and legumes) and root and tubers. Indeed the former have a high moisture content (between 60% to 80%) when the latter are dry stuff with generally less 15% of water content.

Hence the best manner to compare nutritive potential among foodstuff is to express the production in term of energy content. In Malawi with regards to the status of maize as "The Food", official statistics generally convert the production of the different products in "maize equivalent" which is the quantity of maize corn which contains the same amount of energy (in Kilocalories or kilo joules[2]) as the given amount of this product.

The conversion calculation is given by the formula

$$\text{Maize equivalent of Y tonnes of Crop 1} = Y \times \frac{\text{energy content of 1 kg of Crop1}}{\text{energy content of 1 kg of maize}}$$

Table 2: National estimate of crop production 2003/2004 (2nd round)

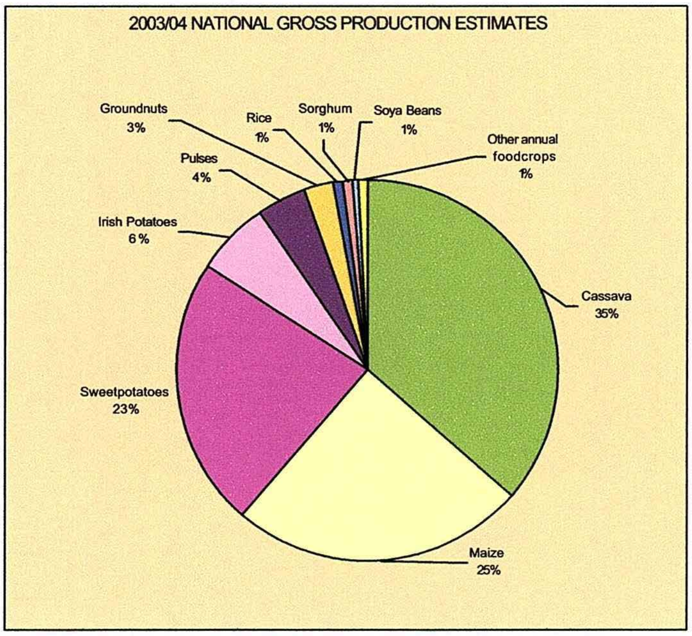
Crops	Production	Post harvest losses & seed	available output	energy of raw product	Maize equivalent
	MT(a)	% of prod (b)	MT	Kcal/kg (c)	MT
Cassava	2 501 298	30	1 750 908	1380 ~~3180~~	700 363
Maize	1 731 925	16	1 454 817	3450	1 454 817
Sweet potatoes	1 575 022	15	1 338 769	1090	422 973
Irish Potatoes	430 601	25	322 951	800	74 887
Pulses	286 635	10	257 971	3200	239 278
Groundnuts	173 027	10	155 725	4000	180 550
Rice	66 336	8	61 029	3330	58 907
Sorghum	41 944	13	36 491	3430	36 279
Soya Beans	41 079	10	36 971	4070	43 615
Other annual food crops	50 105				

source: (a) MOAI&FS/NSO : 2003/04 estimation 2nd round ; (b) Sandifolo (2003); (c) CTA

<u>NB</u>: In several documents on Malawi's crop estimation and food security issues we have noticed wrong figures used to make these conversions from fresh tuber production. Indeed several authors have taken 3180 Kcal as energy content of cassava root when the actual rate is around 1350-1450 Kcal per kg of fresh tuber (CTA; Bradley and Holloway, 1988; FAO, 1991). Indeed we should keep in mind that fresh tubers have moisture content between 65-85 % according to the root crop species taken into account. Thus it is logical that one kg of fresh tuber brings much less energy than the same quantity of cereal grains of which water content varies generally between 10-15 %. This mistake has led the authors to overestimate the energy content of cassava by nearly a factor of 2.2.

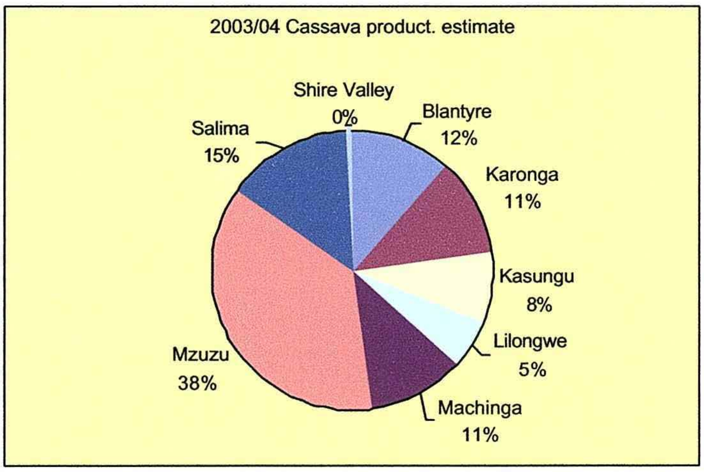
[2] 1 Kcal = 1,000 calories = 4.18 Kjoules

In terms of relative gross production (table 2) cassava comes first with 35 % of annual food crops, followed by maize (25 %) and sweet potato (23 %). But as we have stressed above, comparisons between food crops based on gross weight are rather meaningless. Thus we prefer to use the so-called maize equivalent once post-harvest losses and seed requirements have been deducted. According to this conversion the total cassava production can be estimated at 700 thousand tonnes of maize equivalent, sweet potato 422 thousand tonnes and Irish potato nearly 75 thousand, than can be compared with 1.7 million tons of maize. This means –that root crop as a whole represent 70 % of maize in term of food supply. Even if the figures of crop estimation are questionable - the importance of root crops in Malawi's food security cannot be ignored.

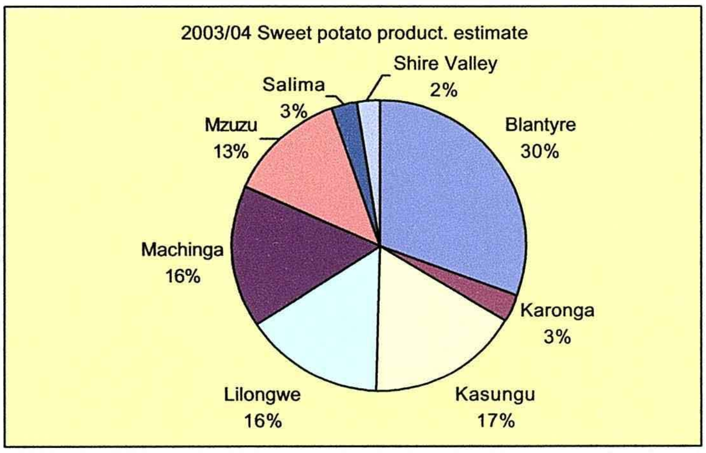


Graph 2 : relative production of annual food crop

With regards to geographical repartition the most important producing places for cassava can be found in Mzuzu, Karonga and Salima ADD's territories, especially along the lakeshore districts of Nkhotakota, Nkhata bay, Rumphi and Karonga.
Sweet potato is mostly found in Blantyre, Lilongwe and Machinga ADD's area.

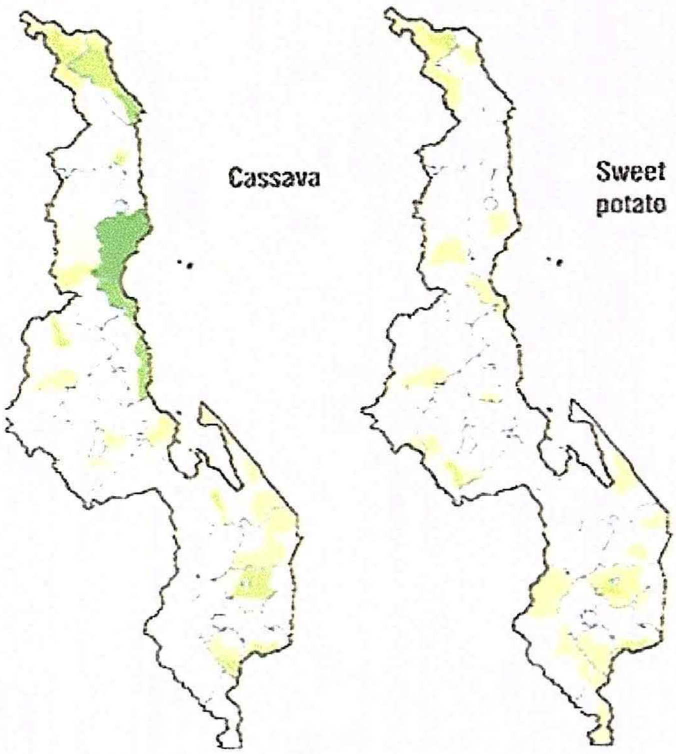


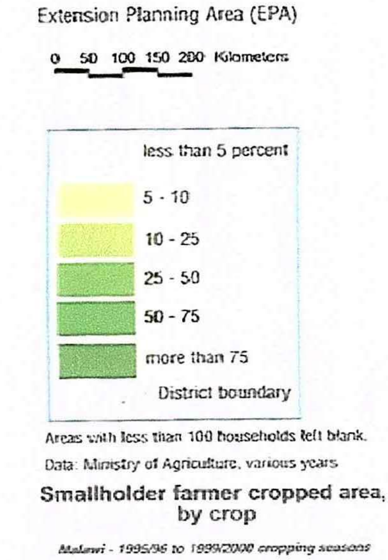
Graph 3: cassava and sweet potato production according to location



However, administrative zones are not the most appropriate to localize growing areas.

The situation of main producing zones can be better appreciated on the following map.



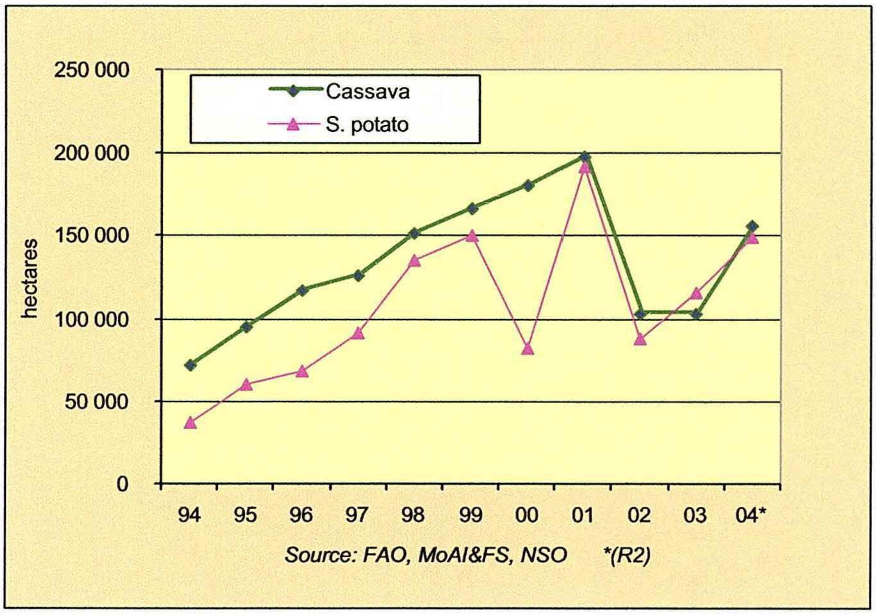


from Malawi an Atlas of social statistics, NSO – IFPRI

6.2.1 Historical background of root crop production

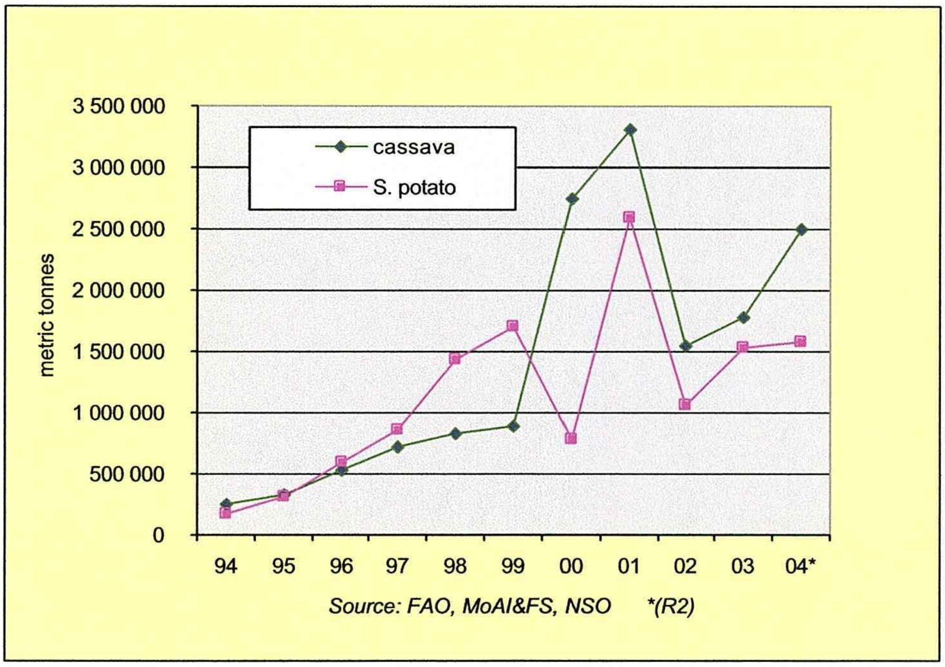
Data on cropped land, production and yield evolution from 1994 to 2004 are shown by graphs 6 to 9. All data refer to the total production at national level including summer and winter seasons and smallholders as well as estate outputs. As there are very important differences according to data source gathered during the mission we have based our analysis on cassava until the year 2003 on the FAOSTAT data that can be considered as the official figures. Sweet potato's data are surprisingly not available on the FAO web site. Figures for this crop originate directly from MoAI&FS. With regards to year 2004 data have just been released by NSO and are related to the second round estimates.

These data raise a lot of questions as these evolutions are sometimes very brusque and not very explainable. Indeed it is very unlikely that area planted in sweet potato with regard to the previous year could have increased by 63 % in 1995 and decreased by 45% in 2000 and by 54 % in 2002. In the same way the fall by 48 % of cassava area in 2002 is suspicious.



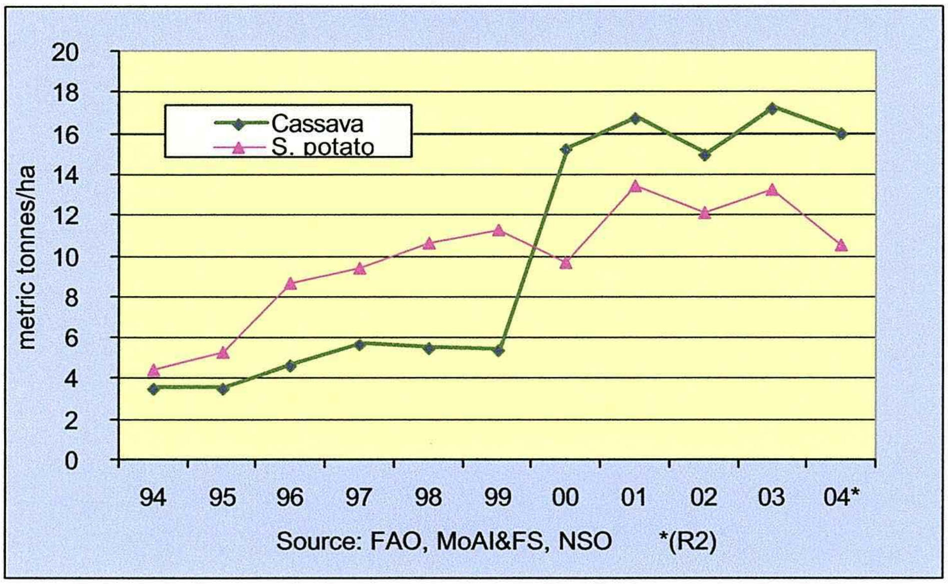
Graph 4: Cassava and sweet potato hectareage trend from 1994 to 2004

Production figures (Graph 5) show the same variations. Cassava production dramatically increased in 2002 (+208 %). According to MoAI&FS's official this is due to the change in the output calculation from dry matter basis to raw product. Nevertheless this shift is not explicitly mentioned in any of the documents made available to the mission.



Graph 5: Cassava and sweet potato production trend from 1994 to 2004

As production estimate are only combination of area and yield estimation the analysis should better concentrate on yield evolution.

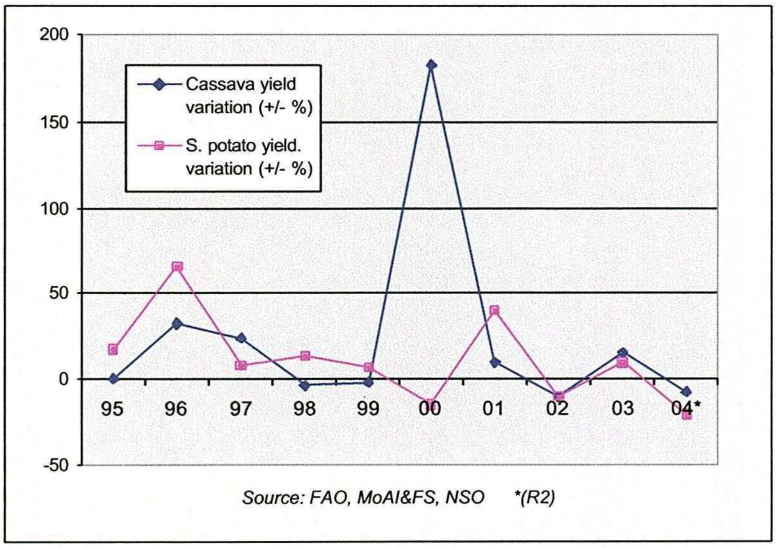


Graph 6: cassava and sweet potato yield trend from 1994 to 2004

The jump in cassava yield in year 2000 (see graph n°6) can be explained by the new calculation method (from 5.39 to 15.25 t/ha). Indeed water content of cassava fresh roots is in the range of 65 % and fresh/dry weight ratio is about 2.8-2.9.

Nevertheless, it is very unlikely that cassava yield could have reached an average of 16 tonnes per hectare since 2000 whilst in most of the cassava growing countries, this crop generally get less than 10 t/ha. More realistically Fisher and Mvula (2003) estimate the overall yield in Malawi at 6.6 tonnes/ha.

MoAI&FS did not mention any change in sweet potato yield calculation method. The graph 6 shows a nearly continuous increase from 5 t/ha in 1994-95 to an average of 13 tonnes in 2001-2003. Even if the jump is less important than with cassava this growth can also be questionable.



Graph 7: cassava and sweet potato yield variation compared to previous year from 1995 to 2004

The analysis of graph 7 also raises some questions. Without taking into account the year 2000, which interferes with methodological changes, the raise of cassava and sweet potato yield is extremely surprising.

6.2.2 Agricultural calendar

Shrestha and Mahungu (1993) have carried out in 1992 a survey on 395 farmers in 5 RDPs among the major cassava growing areas and recorded the range of planting and harvesting periods -. As usual in cassava cultivation worldwide planting and overall harvesting stretch over a long period of time and in most regions all year round. Indeed cassava is biologically a perennial crop and can be maintained in cultivation for several years even if practically growers leave it no longer than 2 years. The age of the plants at harvest also can vary a lot between 6 and 24 months as shown in Table 3.

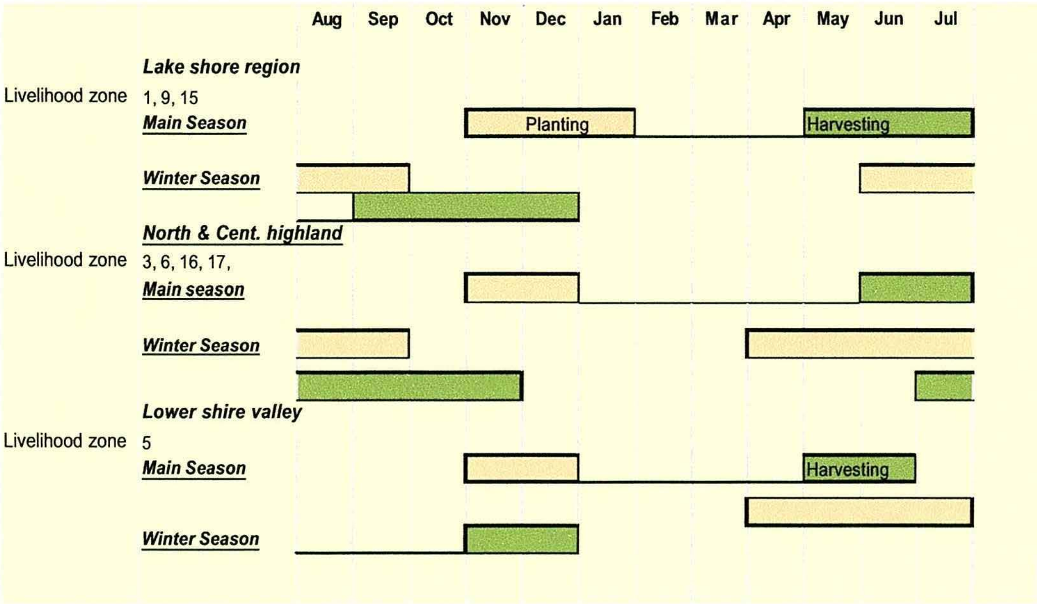
Interviews with farmers and NSO/MoAI&FS staff carried out during our field trips confirm the situation. However as we have been told for example in Mulanje there are generally peak periods for harvest in wintertime when the dry weather is more favourable to the drying of Makaka (sun dried chip). In other areas such as Nkhata bay harvests decrease in December-January when overcast sky does not -favour drying of roots for processing into flour.

Table 3 Cassava planting and harvesting period and average at harvest according to Shrestha and Mahungu (1993).

RDP surveyed	Average hectareage in cassava 91/90-92/91	Planting	Harvest	Crop age at harvest
Karonga	4377	Nov-May	Year-round	7-24
Nkhata Bay	11689	Year round	Year-round	6-20
Nkhota kota	4687	Nov-June	Year-round	7-20
Salima	225	Nov-Mar	Aug-march	9-20
Zomba	6200	Sept-Jan	Sept-Oct	10-14
Shire Highlands	5800	Year-round	July-Oct	7-18
Thiwi/Lifidzi	2055	Nov-March	Oct-March	6-13
Rumphi/N	2699	Dec-June	Year-round	9-36
Mulanje	1325	Year round	Year-round	6-12
Area covered by the study	61671			
% of national area in cassava at that time	63			

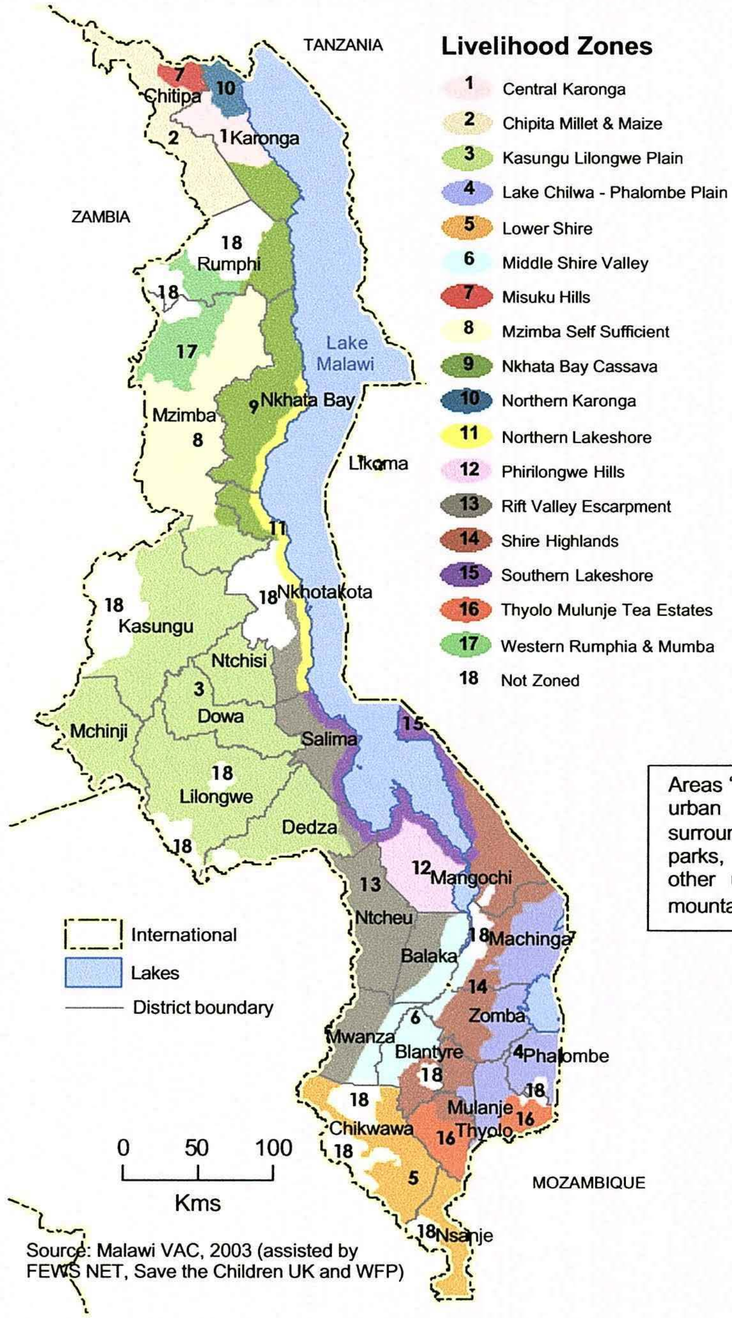
The situation of sweet potato is different. The cropping cycle lasts between 3 to 6 month and tubers in a particular plot are generally pulled out all together once they have ripened. Nevertheless as planting periods stretch over several months so do harvest periods. In addition farmers often grow sweet potato twice a year, during rainy season (main season) and in winter time in lowland area. Figure 8 below allows the visualization of three groups of agro-ecological zones and the average seasonal calendar of crops, according to livelihood profiles defined by MVAC. The relevant livelihoods zones can be geographically located by using the 'national livelihood zone map' (Figure 9).

Figure 8: sweet potato cultivation calendar according to livelihood zone (source MVAC[3])



[3] The Malawi Vulnerability Assessment Committee (MVAC) is a consortium committee of government, NGO and UN agencies that is chaired by the Ministry of Economic Planning and Development (formerly the National Economic Council). MVAC members contributing to the livelihood rezoning and baseline assessments included: the Ministry of Economic Planning and Development, the Ministry of Agriculture, Irrigation and Food Security, the Department of Local Government, the National Statistics Office, the Ministry of Health and Population, Save the Children (UK), World Vision International, FEWS NET, FAO and WFP.

Figure 9: **National Livelihood Zone Map**



Areas 'Not Zoned' include major urban areas, Likoma and its surrounding Islands, national parks, nature reserves and other uninhabited areas (e.g. mountains).

6.3 REVIEW OF ROOT CROPS ESTIMATION METHODOLOGY

6.3.1 Review the current method of estimation of root crop production

Estimation of agricultural production in Malawi is conducted by the NSO, which took over agricultural statistics in 2003/2004 formerly under the responsibility of the MoAIFS. Basically the methodology has not changed much with the shift of the lead institution.

Nationally crop estimates are implemented through the National Agricultural Production Survey, which is carried annually on a sample, and National Agricultural Census (NAC) or National Sample Survey of Agriculture (NSSA) which are conducted on a comprehensive basis approximately every ten years, the next one is expected to be launched in 2005.

6.3.2 Organisation and methodology of crop estimations

The organisational and sampling scheme used in the crop estimation survey either by MoAI&FS or NSO is detailed in table 3. All ADD, RDP/district, EPA and EA were and are still involved in the survey process nationally.

When MoAI&FS was in charge of annual crop estimation, a survey was carried out annually using a stratified two-stage systematic sampling method. EPAs in each RDP constituted the strata and the block was the Primary Sampling Unit (PSU).

In the first step of sampling 25% of the blocks in each EPA were selected randomly (2 out of 8). In the second step all agricultural households (AH) or farm families were listed. From the list, 15 households per block were identified using systematic random sampling.

For production estimation 3 plots from 3 different AH were selected at random for each crop. Yield estimate was made on 10m x 10 m sub-plot in each selected crop.

Since NSO took over agricultural statistics the methodology remained basically the same except for the following:

- Only 1 block selected per section (instead of 2 previously)
- 10 farmers selected per selected block (instead of 15).
- YSP are now 5m x 5m. (before 10m x 10m)

The organization chart for crop estimation under MoAI&FS and NSO administration is given in Table 5. According to this chart sample size at each level of aggregation is given in Table 4.

Table 4: Number of surveyed households and YSP per crop at each aggregation level according to NSO sampling method

	Average area in food crop (ha)	Surveyed household	YSP per crop
National	2,800,000	20,000	6,000
ADD (8)	350,000	2,500	750
RDP (33)	85,000	606	182
EPA (187)	15,000	107	32

With reference to the statistical laws outlined in annex 4, and if we assume a coefficient of variation (CV) of 50 % on yield, it means that with a sample size of 32 units at EPA level the maximum accuracy of the figures is 20 % which can be acceptable for crop estimate. If the CV would be 100 %, which is the real situation, the same accuracy would require a size four times that of the sample.

Hence, it would be highly recommended to verify that the expected precision can be achieved with the current sample size considering the CV actually obtained in crop estimation. Presently, it can be assumed that for many crops a 20% precision is only obtained at RDP level.

Table 5: Organisation and Sampling Scheme for National Agriculture Statistics Survey (NSSA)

Organisational structure	**(Number) and head**	**Annual Sampling scheme for NASS – sampling rate (till 2003)**		**NASS – sampling rate (since 2003/2004)**	
MOAI&FS **Planning division**			**NSO** **Agricultural Div.**		
ADD	(8) Project Manager (PM)		ADD (8)	comprehensive	
District/RDP (Rural Develop. Project)	(31) Distric Agri. Dev. Officer (DADO/ ex. PJO)		District (28) but 33 RDP	comprehensive	33 Supervisors
EPA (extension Rural area)	(166) Agric Extension Devt Coordinator (AEDC)	1rst level of data aggregation FA in charge of survey	EPA (187)	comprehensive	Enumerator (actually 306) but 360 planned
Section/EA	(2250) AEDO/ ex. Field Assistant (FA)	Two-stage sampling (block/household)	Sections/ (around 2000) Enumeration Area (EA)	comprehensive	Two-stage sampling (block/household)Each section covers 6 blocks in average
Blocks	(8 per section)	2 blocks selected per section. (4,500 selected blocks nationally)	1st stage of the sampling	1/ 6 (about 2,000 blocks selected nationally)	1 block selected per section
Household		15 farming households per selected blocks (about 65,000 fh selected)	2nd stage of the sampling	10/x (about 20,000 fh selected)	10 farming households per selected blocks
Crop estimation		3 plots per block for each major crop		3/10 (about 6,000 plots selected per crop nationally)	3 plots per block for each major crop

The annual crop estimate survey is conducted in four distinct phases: (source NSO Crop estimate methodology)

First Round: (October-December)

This round of the survey will be carried out at planting time and will involve an assessment of percentage change (+ or -) to planted areas and production compared to the previous year. NSO will base 2003/04 forecasts on Ministry of Agriculture and Irrigation 2002/03 third round estimates because it assumes the estimates will be better due to intensified supervision by Ministry of Agriculture and Irrigation staff and NSO staff.

The first forecasts will deal with both major and minor crops and will be based on actual planted area and not farmer's intentions. However, in cases where the major crops have not been planted (e.g. rice) the forecasts will be based on farmer's intention.

A listing will be taken crop by crop from all households growing minor crops in the blocks. And actual area measurement will be conducted to determine area of production and this will be translated into total production.
These forecasts will be presented early February.

Second Round: (January -March)

These forecasts will also involve major and minor crops. The major crop forecasts will be based on the 10 selected households. The forecasts will involve getting farmers expectation of production. It will also be based on the same scoring pattern used by Ministry of Agriculture and Irrigation in terms of rainfall, crop stand, etc.

Third Round: (April - May) Report in June

This round is implemented by weighing the actual harvest. Both major and minor crop yields will be weighed.

6.3.3 Measuring crop area

Area of all fields or plots including gardens from each selected household are supposed to be measured regardless of whether or not they are planted at the time of area measurement. So far the pacing method has been used for area measurement.

Since plots are often of irregular shapes, enumerators have first to make an approximation of squares or rectangles. Then, the length and width of each individual rectangles or squares are measured in paces. Previously, enumerators would have calibrated their own pace interval using a measuring tape or rule.

During-the 2004 Pilot National Agricultural Census, area measurement was done using triangulation method with tape, compass and pole. The method is detailed in the Pilot

National Agricultural Census field manual. This way of measurement could be adopted for the forthcoming crop estimations.

More comments on crop area measurement method:

The current pacing method is too inaccurate and should be replaced by triangulation as tested during the pilot census. However, it should be noted that even though this method is much more accurate, it is also more labour demanding and need to be implemented with a lot of care and consciousness. Thus, the utilization of **GPS (Global Positioning System) device with area measurement feature** should be really considered by NSO. Area measurement is simple and fast with GPS. Operators have just to walk around the perimeter to be measured, press a button, and read the area. Even with first price apparatus, which costs between US $ 200-300[4], it is possible to get acceptable accuracy in surface area measurements.

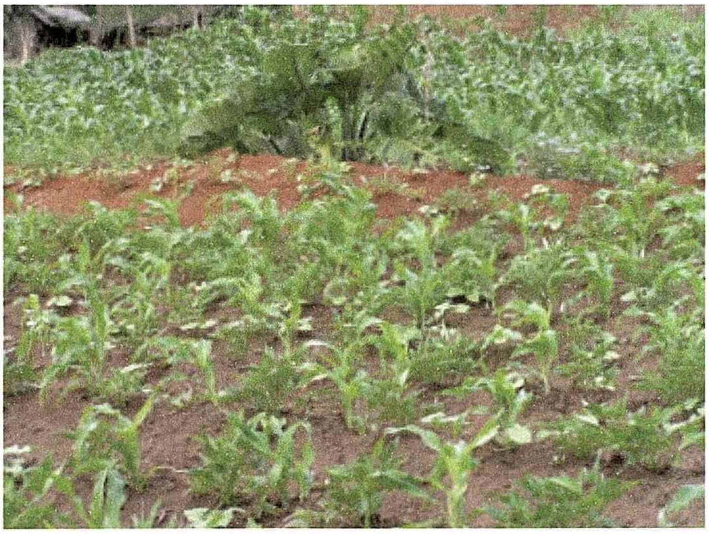
For example a comparative study carried out by Cirad in Vanuatu, South Pacific, showed a very high correlation rate ($r^2 = 0.95$) between GPS and triangulation method in spite of a majority of very small (S< 1000 sq m) and irregular in shape plots (Morelli, 2003).

As the productivity of area measurement is much greater with GPS a sole GPS unit can manage with much more cropping area assessment than an operator using triangulation with compass, poles and tape. We estimate that a GPS unit for each supervisor should be enough to cope with measuring work.

6.3.4 The case of mixed cropping

Area assessment methodology of mixed crop plots is not very detailed and precise in the documents (general field manual, questionnaires) published by NSO. Actually enumerators are asked to score only the type of mixture (pure stand, main crop, secondary crop, scattered) regardless of its actual proportion in the plot.

Many stakeholders involved in agricultural statistics and food security issues expressed concern that in the case of crop mixture the current system leads to overestimation of the growing area because each crop is scored as having covered the whole plot area.



Maize-sweet potato mixed crop in Mulanje

[4] E.g. : See annexe 5 for discussion on GPS specifications and costs

Proposal for improvement

In mixed-cropping plots the actual proportion of surface covered by each crop should be evaluated more precisely. This does not require complicated and time-consuming method. A visual scoring of the area covered by each crop using a predefined scale is widely sufficient. The questionnaire n°5 of the pilot census (PNAC) could be modified as shown below in the frame ***3.1 What crops are grown on this mixed cropping plot this cropping season?***:

The scale is designed as to balance overestimation of minor crops and underestimation of major crops in the mixture.

Cropping patterns can of course be more complicated and crops are sometimes rather relay crops than mixed crops. In some cases, the juxtaposition of different species does not last throughout the full season but only few months. For example maize can be sown in November and remains as a sole crop until January or February when the cassava is interplanted. Then the maize is removed in April or May and the cassava is a sole crop until its harvest some months later (Fisher and Mvula, 2003).

3.1 What crops are grown on this mixed cropping plot this cropping season?

S = area of the whole plot

Crop code	covered Area score (P)	Area covered by the score = P x S

Estimate of the plot area covered by this crop	Scoring scale
1/10 or less	0.1
1/4	0.2
1/3	0.3
1/2	0.5
2/3	0.6
3/4 or more	0.7

Where this situation prevails, scoring of crop proportion has to be done when the probability to meet all crops juxtaposed is the highest according to local habits. Generally speaking this takes place in the first quarter of the year, which is the period when the second round of crop estimate occurs.

A pilot assessment on a sample of mixed cropping plots could be launched rapidly by using this method even if winter time is not the most appropriated period to carry out this exercise according to what has been pointed out just above. Figures will be compared afterwards with an actual counting of the different species in sub-plots in order to check the accuracy and the relevance of the scoring scale.

6.3.5 Estimation of root crop production

In the current method implemented by NSO, crop estimation is done at two stages. It does not differ between crop species and root crop estimations follow the general methodology.

Estimated production is computed at PSU level (EA/section) by multiplying the calculated crop area of the EA by the average yield for that crop.

During the first round (October-December), enumerators made a subjective assessment with regards to crop appearance, weather condition, in relation to crop situation at the same period of the previous season. The assessment is made for the whole block and not for individual selected households.

In the third round (April-May) crop–cuttings are carried out by enumerators. As stated above 3 plots for each major crop from 3 different households are selected in each block.

6.3.6 Yield estimation

In the selected parcels a square of 5m x 5m or Yield sub-plot (YSP) is laid randomly by using random number table to determine the location within the main plot.

Cassava

The enumerator then records the number of cassava plants in the YSP. Then he uproots ONLY the plants located at the 4 corners of the YSP and weighs the roots. Yield of the plot is obtained by the formula:

$$Y = 400 \times \frac{P \times W}{P'}$$

Where

Y = yield of the plot in kg per ha
P = number of plants in YSP
P' = number of plants uprooted
W = weight in kg of uprooted fresh (raw) roots

Sweet potato and other tubers

The methodology is the same except that as these crops are generally planted in ridges the enumerator has to count the number of ridges in YSP and then uproot and weigh the tubers of a single ridge.

So far, yield estimations lie on actual weights of a very limited numbers of plants in YSP, often only 4 stands in cassava field and about 15-20 in sweet potato. In addition in the case of cassava fields as YSP location have to be chosen by enumerators at random, the probability that they land in place where farmers would not have harvested by their own because plants were too small to be pulled out is quite high. The current method is not appropriate at all for cassava and seems to have been designed rather to minimize quarrel with farmer when crop-cuttings are undertaken than to get acceptable precision.

Comments and propositions

Concerning cassava, as the crop is mostly harvested all the year round and not at a specific physiological stage, our proposition is to change completely the method. **Estimations should be based on production estimate after harvest. Output in fresh or processed form should be monitored not in the field but at household level with periodical recording using local units on declarative basis over the full harvesting period,** generally the whole year. As we have checked during our field trip in several regions of Malawi farmers always use the same kind of containers (bags, baskets) to transport cassava roots from the field to their farm or to store dried chips (makaka) or flour (in basket, plastic drums..) once processing is completed. Enumerators can easily calibrate these units and convert them into kg.

This methodology has been tested in other countries with success and a good level of precision such as in DR of Congo, a very large cassava producer (Tollens, 2003 see communication in annex 7; Goossens et al, 1994). These studies have shown that crop-cutting based methods lead to overestimate yields by 15 to 40 % with greater variance in measurement due to heterogeneity in sampling. They have also demonstrated that farmers are very capable to estimate precisely their own production even if they can sometimes be reluctant in communicating their data. Other advantages of the post-harvest estimation method are:

- Less travel time and cost for enumerator.
- Better accuracy of the actual availability of food products as recording occurs much downstream in the food supply especially if measurement is done on processed products (flour).
- Possibility to produce estimates at any time of the year once the first full year round has been completed.

The methodology will be described more in detail further in the report.

The case of sweet potato is a little bit different. In a particular garden plants are harvested when tubers are ripe and crop-cutting based estimation are acceptable. Nevertheless the actual area taken into account in the current method is very small (1 single 5m long ridge, roughly 5 sq meters x 3 samples) for a whole block. Thus, if the NSO wishes to keep using crop-cuttings the full YSP area should be weighted and in preference its size enlarged up to 10m x 10m. Indeed too small samples increase the probability of augmenting the statistic weight of unrepresentative area.

However there would be a big advantage to adopt on sweet potato the method proposed on cassava. This is also valid for Irish potato.

6.4 CASSAVA PROCESSING (FROM FRESH ROOT TO FLOUR)

Raw cassava roots have poor shelf-life and post-harvest deterioration is complete in few days when stored in fresh form. For that reason processing is more crucial than in any of the other root-crops. (Westby, 2002). In addition bitter varieties with high cyanogen (cyanogenic glucosides) content need to have this poisonous component removed before consumption. In the lake shore zones bitter varieties are predominant. Cosca survey carried out in Sub Saharan Africa from Cote d'Ivoire to Tanzania pointed out that 45% of cassava meal is prepared from flour, 38 % from other processed forms (fermented, granulated..) and only 17 % from fresh roots (NRI, 1992). MoAI&FS officers met during our field trip in the Nkhotakota RDP estimate that 80% of cassava harvested is bitter while 20 % is sweet. The situation seems different in the Southern Region where sweet material is mostly grown.

In Malawi according to Kalenga (1994) two methods are commonly used by rural household in cassava processing (see Figure 10)

1. Simple sun drying of peeled roots is called **makaka.** After pounding or milling, the flour is known as **ntandaza**. Only sweet cultivars can be processed that way.

2. Peeled roots are soaked into water pond for 2-7 days depending on weather conditions. They are -then cleaved /split into small pieces for spreading on draining racks or mats before being sun dried for 2 to 7 days depending on weather conditions. The dried product is turned into flour by pounding or milling and sieving. This flour is known as **kondowole.** Bitter cassava is generally processed in that way in order to eliminate cyanogens through the soaking process.

Table 6: Conversion rate at different stage of cassava processing starting from 100 kg of fresh cassava roots in kg[4].

Fresh root	**100 kg**
Peeled roots	75-85
Soaked peeled roots	80-87
Dried chips (makaka)	25-36
Flour	22-35
1 kg of flour give	3.2 kg of nsima

The most common conversion rates used on cassava are recalled in table 5 starting from fresh and unpeeled roots. In addition it has been measured that 1 kg of flour allows to produce in average 3.2 kg (3 – 3,9) of nsima (hard porridge or dough) the most popular way to prepare food in Malawi.

[4] sources: *Kalenga Saka, 1994 ; Sandifolo, 2003 ; Wheatley, 1995*

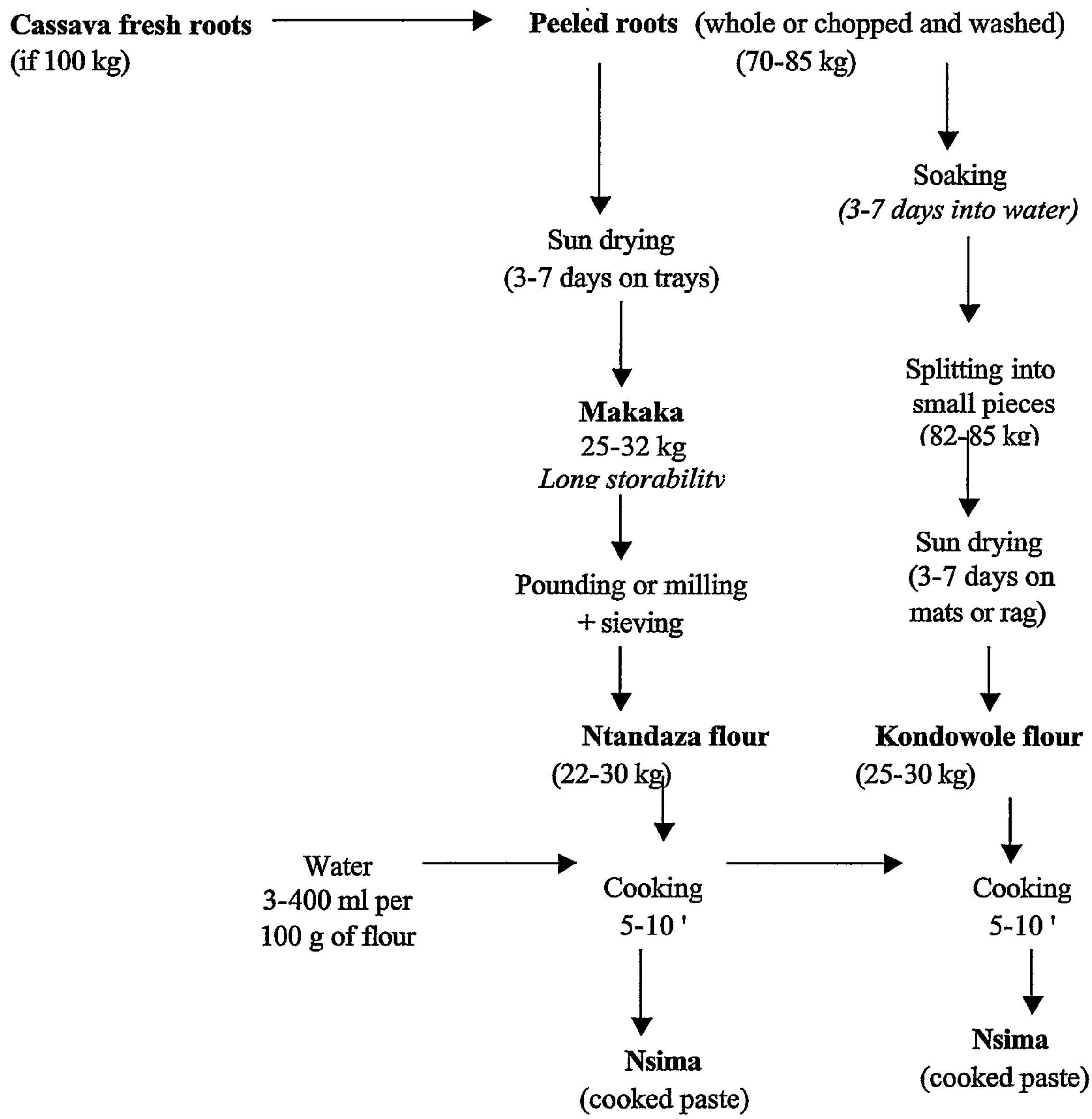
Comment and proposition:

Actual conversion rates depend on local varieties' features and processing habits and their range are too wide to retain average figures nationally. Thus it will be relevant to calibrate these figures according to local conditions. This could easily be done by enumerators/supervisors in a participatory manner with farmers starting from a known quantity of raw roots (fresh and unpeeled) and then measuring the final amount of processed product obtained at the end of the processing exercise.

Our proposition is to calculate locally, in the areas selected for the pilot test, the conversion (or extraction) rates into flour. The winter season is a peak period for cassava processing and seems very convenient to carry out this measurement.

NB: To get true figures it is important to weigh raw cassava roots as soon as possible (less than 24 hours) after harvesting due to the fact that they get dehydrated very rapidly.

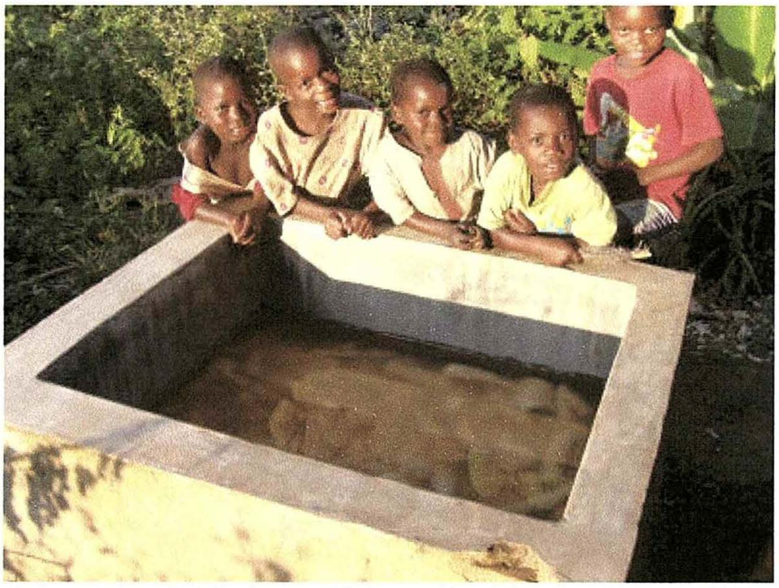
Figure 8: traditional cassava processing processes in Malawi



Sweet potato processing

Sweet potatoes are not traditionally processed in Malawi. Nevertheless some development projects are fighting to disseminate processing techniques of these tubers in order to increase food security by reducing post-harvest losses. Flour is easily obtained from sweet potato tubers by grating and sun drying. Flour extraction rates are recorded to range between 15 to 31 % depending on varieties (Roth C. and Messinger C., 2004).

Soaking of cassava roots (bitter varieties)



Drying of cassava root after soaking

6.5 NEW METHOD FOR ESTIMATION OF CASSAVA AND SWEET POTATO

6.5.1 Description of the new methodology

We propose that for root crop estimate, within the annual surveys of Agriculture as well as the forthcoming national agricultural census, should be based on direct output estimation on a declarative basis at household level instead of the current crop cutting based method.

The production estimation should be carried out during the whole harvesting season by periodic recording of production in local units and based on farmers' statement.

Farmers should be asked to make a record of the number of units (sacks, bags, basket, basin ...) they have harvested during the previous period. When enumerators then visit the farmers he/she just asks how many units of each kind (basins, bag...) have been harvested since his/her last visit. This is a quick method to assess production in a wide area.

The recording period should be defined according to local cultivation calendar in each zone. On cassava, with regards to what has been seen above, monitoring should last in most cases throughout the year. On sweet potato the period can be reduced to 2 or 3 months for each cropping season.

Recording should be done initially on a weekly basis by enumerators in each surveyed household (10 in each selected block). Once farmers get accustomed enumerators' visits can be spaced out every 2 or 4 weeks.

The measurement of the production will be obtained by counting the number of local units of fresh or processed product. When counting is done on processed form (makaka, flour) fresh equivalent will then be calculated using conversion factors previously defined.

At the beginning of the survey the enumerators will have to calibrate in each farm the most common containers used to carry or to store cassava (sweet potato). It is important to make this exercise in each farm because actual weights depend on local habit such as variety, processing technique. Records can be done in full unit or portions of them (1/2, ¼...).

The whole production has to be recorded for all kind of uses (self consumption, sale, ...) including estimation of piecemeal harvesting if any.

To be successful, the method should be carried out in a participatory way and the farmer's co-operation should be gained. Farmers (male and female) involved in the process will need some minimal training from NSO staff in the collection system (purpose, importance, need for reliability), and get some incentive which can be for example the gift of a standard basin or a plastic drum.

A questionnaire for the estimation of cassava production has been proposed (see template in annex 6).

Comments:

The advantage of this method is generally a greater accuracy and reliability as the estimations are based on actual harvested products and not on yield estimates computed from small crop cutting not necessarily representative of whole garden potential.

As estimations of production are made more downstream along the food chain, especially when based on processed products, the figures are closer to the real available quantities fir consumption. Therefore rates of post harvest losses used to work out available production, as indicated in table 2 for maize equivalent calculation, should be reduced accordingly.

Apart from being less time and resources consuming the method also allows the generation of production estimations at any time of the year once the first full year recording has been completed. Yield estimation will then be obtained by division of estimated production by cultivated area measured at the beginning of the cropping season.

An important issue raised by some interlocutors met during the mission is related to crop forecasting. Indeed NSO should provide to the GoM and others stakeholders and donors at the beginning of the cropping season estimations of the production for the coming year. So far forecasts are based on cultivated area estimation collected during the first round of annual crop survey and yield expectations based on farmers' and extension services statements.

Expected yield are generally based on the previous year's yield modulated by variations in production environment such as introduction of new variety, variation in intensification techniques (use of fertilization, irrigation...) and climatic conditions. Taking into account all these factors the expected yield will be expressed relatively to the previous yield. *For example 2003/2004 cassava yield is expected to reach 120 % of the 2002/2003 one.*

The new method basically does not change anything to production forecasts year. These will continue to be based on yield estimates of the previous year. The only difference is the way yield estimates are obtained with the new method.

6.5.2 Implementation of a pilot test

The new methodology to estimate crop production is not difficult to implement. Nevertheless there is a need to test it in real conditions in order to assess practical problems than can arise from implementing such a methodology and the level of understanding and acceptance by NSO staff and farmers involved in the process.

For that purpose the project and the NSO agreed to implement a pilot survey to test the new methodology. The test will be carried out as soon as possible from August 2004 onward for an initial period of 2 months and in two limited cassava producing areas. The NSO proposed to implement the test in 2 zones:

1. Nkhotakota RDP: area where cassava is the staple food, harvested and processed throughout the year.
2. Zomba RDP: where cassava is a secondary food crop and also a commercial crop partially processed into makaka.

According to the availability of staff and material resources several sections will be selected in each of the two RDPs. The staff involved in the PNAC will take charge of the pilot test. The test will be carried out in the same selected households (10 per selected blocks) within the blocks selected than the ones selected during PNAC. The followings activities will be carried out:

- In each selected household, calibration of local units (containers) used to carry or store cassava and sweet potato products.
- In each EA, calibrate extraction rate of processed products (basically makaka or cassava flour).
- In each selected household, record on a weekly basis of the production in fresh, or in processed form if any, of all cassava and sweet potato harvested within the household's gardens.
- Primary data (production per household) will be used to calculate coefficient of variation in order to determine required sample sizes.

All production including crop sales and household consumption (snacks as well as staple food) should be taken into account.

In order to avoid a double recording production should be recorded only in one single form: fresh or processed. Unprocessed roots will be counted only in fresh weight. The ones that are processed will be recorded in processed form and then converted into fresh tuber basis using reverse extraction rate.

For example, if an extraction rate of 25 % has been determined on Kondowole and if 60 kg of flour has been recorded in one particular household, this would be equivalent to: (60/0.25) = 240 kg of fresh cassava roots.

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

The current method for root crop production estimations implemented by NSO and previously by MoAI&FS is mainly based on crop cuttings for yield estimation and pacing method for area estimation. The sample size is particularly small.

This method seems to be very inaccurate, especially for cassava. It is not appropriate for a crop which is harvested throughout the year and not at a particular physiological stage of the plant.

7.2 RECOMMENDATIONS

At the end of this first visit, the mission makes the following recommendations for root crop estimations:

- Root crop estimations should be calculated from the farmers' recall of their production throughout the actual harvesting season.

- At the beginning, enumerators should record declared production periodically on a weekly basis. Once the process will be a routine, production could be recorded over a longer period of time (for instance at a monthly basis).

- Farmers should be asked to record the whole production harvested from all household's gardens (whatever the person in charge of the garden is: family head, other men and women, minors) and this including piecemeal harvesting and consumption in snack.

- On cassava, recordings should be done all the year round whilst on sweet potato they can be limited on the actual harvesting time in summer as well as winter season.

- Production estimations will be captured at farm level by counting the number of local containers (basins, baskets, bags...) of fresh roots or processed product. If recorded on a processed product basis, quantities will be converted into fresh form equivalent using extraction rates.

- Pacing method should be abandoned and area calculation done as soon as possible by using GPS units.

- Extraction rates from fresh roots to processed form (flour, dry chips..) should be calibrated locally in each EPA during the pilot test.

- In the same way the main containers used by farmers to carry or to store root crop stuff should be calibrated in each farm at the beginning of the pilot test.

- The method should be implemented on a participatory way and farmers should get some training for that purpose. The provision of incentives in kind (e.g. plastic drum or basin) could be envisaged.

- Root crop estimations based on this new methodology should be incorporated in the general sampling scheme used for crop estimation nationally. As this method is less time and resource consuming than the crop cutting based one, root crops estimation can be carried out in each selected household within the survey's sample (10 households in each selected block within each section).

- The pilot test should be carried out during at least 2 months starting from August 2004 in order to check the feasibility of the whole process (understanding of the new methodology by field staff and selected farmers, logistics). The test will take place in 2 EPA from 2 different RDP (Nkhotakota and Zomba) if possible in the households already selected for the purpose of the PNAC.

- A the end of the pilot test a second mission will be necessary in order to:
    - Assess the reliability of data
    - Adjustment of the methodology taking the local conditions into consideration
    - Calculate the variability of the measures and the required sampling size.

* * * * *

Bags of sweet potato roots for shipping

8 REFERENCES

APRU –(Agricultural Policy research Unit, Bunda College of Agriculture- (2000) National pilot crop production survey – 2000, crop production, food situation & farmgate prices. Final report. MOAI&FS 42 p + annexes.

Akoroda M.O. (1999) Study of the contribution of cassava and sweet potato to the total food availability in Malawi, USAID Lilongwe, 59 p.

Benson Todd, with James Kaphuka, Shelton Kanyanda and Richmond Chinula. (2002) An Atlas of social statistics, by National Statistical Office, Zomba, Malawi and International Food Policy Research Institute, Washington, DC, 106p.

(ECFSU) European Commission Food Security Unit - Malawi (1999) The food security programme of the European commission and the Non governmental organization.
Strategy document – Malawi1999.
http://europa.eu.int/comm/europeaid/projects/resal/Download/report/mission/mlwmoz/0101stmlwngo.pdf

Fisher N. and Mvula G. (2003) Cassava in Malawi, Findings of a reconnaissance survey. Action against Hunger, 8p.

Goossens, F., B. Minten, E. Tollens (1994) Nourrir Kinshasa: L'approvisionnement local d'une métropole africaine (How to feed Kinshasa: local supply of an African metropolis), L'Harmattan, Paris, 397 p.

Kalenga Saka J. D. (1994) Cassava Flour in Malawi: Processing, Quality, and Uses. In proceeding of the Int'l meeting in Cassava flour and Starch. (Eds) Dufour D., O' Brien GM., Rupert Best, CIRAD-CIAT, 289-296.

Levy S. and C. Barahona, (2002) 2001-02 Targeted Inputs Programme (TIP). Main Report of the Evaluation Programme, MoAI&FS - Univ of Reading/Calibre consultants Reading (UK), 44p available at http://www.personal.rdg.ac.uk/~snsbarah/TIP2/Main%20Report%202001-02.pdf

Morelli C. (2003) Évaluation des performances agronomiques des jardins mélanésiens (assessment of agronomic performance of Melanesian gardens); CIRAD-ENSAR, 90p.

(NRI) Natural Resources Institute (1992) Cosca Phase I, processing component. Cosca, Working Paper n°7, IITA, Ibadan, Nigeria.

Roth C. and C. Messinger; (2004) Substituting maize – How cassava and sweet potato can close the food gap in Mulanje. To be published in Roots newsletter SARRNET-IITA (in press)

Rubey L., (2003) Malawi's Food Crisis: Causes and Solutions, personal note May 2003, USAID (Malawi), 4p.

Sandifolo V. S.(2003) Estimation of crop losses due to Different causes in Root and tuber crops: the Case of Malawi, In the Proceedings of the Expert Consultation on Root crop statistics, FAO 2003 (eds), Harare, Zimbabwe, 3-6/12/2002. 9p

Tango International Inc , (2003) Malawi Baseline Survey (Draft from 21 July 2003) 63p

Tollens E. (2003). Estimation of production of cassava in Bandundu (1987-1988) and Bas Congo (1988-1989) regions by an intensive yearlong, weekly visit, production and marketing survey, on a large sample, as compared to official R.D. Congo statistics"
In the Proceedings of the Expert Consultation on Root crop statistics, FAO 2003 (eds), Harare, Zimbabwe, 3-6/12/2002. 16p

VAC, (Malawi National Vulnerability Assessment Committee), (2003) Malawi baseline Livelihood profiles May/June, 54p (Draft)

Westby A. (2002) Cassava Utilization, storage and small scale processing. In CAB Int'l 2002, cassava Biology, production and Utilization. Eds RJ Hillocks, JM. Tresh and AC. Belloti, chap 33: 281-300.

Wheatley C., Scott G., Best R. and Wiersema S. (1995) Adding value to root and tuber crops: A manual on product development, CIAT publication n°27,166p.

ANNEXES

1.1 ANNEX 1: TERMS OF REFERENCE.

PROJECT GCP/MLW/019/UK
'Preparatory Support to Agricultural Statistics and
Food Security Information Systems in Malawi'

TERMS OF REFERENCE OF THE INTERNATIONAL CONSULTANT IN ROOT CROP STATISTICS

The project *GCP/MLW/O19/UK 'Preparatory Support to Agricultural Statistics and Food Security Information Systems in Malawi'* is implemented by the Food and Agriculture Organization (FAO) in collaboration with Malawi Government and with financial assistance from DFID. The principal government institutions that will be involved are Ministry of Agriculture, Irrigation and Food Security (MoAI&FS), Ministry of Economic Planning and Development (MEPD) and National Statistical Office (NSO). Each of these three institutions has seconded one counterpart to the project.

The overall development objective of the project is to achieve sustainable food security for the people of Malawi in addressing concerns of both chronic and temporary food insecurity. The immediate objectives are as follows:

- Establish a functional and institutionally viable framework for the medium-term development of integrated agricultural and food security information in Malawi
- Provide practical and immediate response to the current and near-term food security situation in Malawi

The International Consultant in Root Crop Statistics will work under the general supervision of the FAO Representative in Malawi, the technical supervision of the Chief Surveys and Statistical Development Service of FAO Statistics Division, Rome and the technical guidance of the FAO Statistician, FAO Sub-Regional Office for Southern and Eastern Africa (SAFR), Harare, and the day-to-day direction of the CTA. More specifically, the International Consultant will carry out the following tasks:

- **First mission (four weeks)**

1. review the current method of estimation of root crop production in Malawi;
2. assist in the analysis of the results for the current cropping season;
3. review all methodologies tested locally so far on root crop statistics and evaluate their performance;
4. describe all stages of the cassava processing (from fresh root up to flour)
5. prepare a suitable methodology for the estimation of the yield and production of cassava and sweet potatoes;
6. study and propose conversion coefficient for the estimation of cassava yields (from fresh cassava root to cassava flour);
7. train the field staff in the use of the new methodology;
8. initiate a field pilot survey for the estimation of cassava and sweet potatoes production;

9. prepare a specific contribution to the Report of the Formulation Mission (long-term project document to operationalise the updated Framework for the Development of Agricultural Statistics and Food Security Information in Malawi);
10. prepare an end-of-assignment report describing the activities undertaken, findings, conclusions and recommendations.

1.1.1 Second mission (four weeks)

- review the progress made since the last mission;
- follow-up of the field survey;
- prepare the survey report describing main findings, conclusion and recommendations;
- prepare a contribution to the Final Report of the Project;
- perform other duties as required;
- prepare an end-of-assignment report describing the activities undertaken, findings, conclusions and recommendations.

Qualifications and experience: University degree in Statistics or in agronomy with specialisation in agricultural statistics. At least seven years experience in the organisation and conduct of agricultural surveys, preferably in sub- Saharan African countries. Experience in the collection and analysis of root crop statistics. Willingness and ability to use word processing and spreadsheet software. Ability to communicate and write effectively in English.

Duration: two months, two assignments

Location: Lilongwe with in-country travel, as required.

1.2 ANNEX 2: LIST OF PERSONS MET

FAO

Dr Louise L. Setshwaelo, FAO Representative in Malawi
Mr. Thierry Antoine, Chief Technical Advisor of the Project
Mr. F. Ngopya, FAO Statistician/SAFR, Harare
Dr Mark L. Mc Guire, FAO Food systems economist/SAFR, Harare
Mr. Richmond Chinula, NSO, Secondee to the project
Mr. Moses Kachale, MEPD, Secondee to the project
Mr. Daisi. Kachingwe Phiri, Ministry of Agriculture, Secondee to the project
Ms Blariaux Dominique, FAO/Emergency Coordinator

MINISTRY OF AGRICULTURE, IRRIGATION AND FOOD SECURITY

Ms Mphatso Janet Nyekanyeka, Principal Economist, Planning div., Lilongwe

NATIONAL STATISTICAL OFFICE (NSO)

Mrs. M. Kanyuka, Deputy Commissioner, National Statistical Office (NSO).
Mr. L. Mpando, Chief of Agricultural Statistics Division, National Statistical Office NSO
Mr M. J. T. Khwepeya, Agricultural Statistics Division NSO

DEPT. FOR INTERNATIONAL DEVELOPMENT (DFID)

Dr Harry Potter, Livelihoods Adviser

PEOPLE MET DURING FIELD TRIP.

Mzuzu ADD
Mrs Moyo, Chief -Crops -Officer

Mpamba EPA - underMzuzu ADD-

Mr Kasenjere, B.S. Mtambo, AEDC, MOAI&FS
D. Mkandawire, NSO supervisor
+ several farmers

Chintheche EPA, under Khata Bay RDP, Mzuzu ADD

Mr H- Horea, Horticulture officer, MOAI&FS
Ms J. Mtawali, AGRESS Officer, MOAI&FS
+ several farmers of Chikwina village (close to Mazala Trading Centre)

Linga EPA, Nkhotakota RDP, Salima ADD
M.C. Khofi, NSO supervisor
J.B N'Khoma, AEDC, MOAI&FS
+ farmers from Khufi village, Kasamba West section.

Salima RDP, Salima ADD

M. Bota , NSO supervisor
+ farmers in Village of Makombe (about 50 km from Salima on the road to Lilongwe)

At Mulanje,

Mr Precious USSI, -RDP Crops Officer
+ farmers of Ntonya village

At Zomba, RDP (30/06)

Mr F. F-Y MATUMULA, Supervisor 6Balaka RDP, Machinga ADD
Mr. G. L. Jimu, Crop estimate Supervisor, Zomba RDP
+ farmers of Chilambe village, EPA Nsondole)

OTHER INSTITUTIONS

Save the Children - UK/ MVAC, Lilongwe

Charles Rethman, Food Security Advisor

GTZ, Integrated Food Security Programme Mulanje

Ms Christa Roth, Advisor for Food Processing and Household Energy
Dr Christopher Messinger, Food Security Advisor

SARRNET (Southern African Root Crops Research Network)

Dr Nzola M. Mahungu, Sarrnet co-ordinator Chitedje Research Station

1.3 ANNEX 3 : LIST OF DOCUMENTS REGARDING AGRICULTURAL STATISTICS AND FOOD SECURITY ISSUE SIN MALAWI MADE AVAILABLE TO THE MISSION BY THE PROJECT.

GoM

Government of Malawi (2003) Project Document: Preparatory Support to Agricultural Statistics and Food Security Information Systems in Malawi, GCP/MLW/019/UK, 37p

NSO (National Statistical Office)

- Crop estimates methodology, 5p
- **Pilot National Agricultural census:**
  - Enumerators' General Field Manual , 35p
  - Supervisors' Manual, 12p
  - Questionnaire n°1: Community variables
  - Questionnaire n°2: Listing of all household in the EA
  - Questionnaire n°3: Composition and Characteristics of the household
  - Questionnaire n°4: Land survey
  - Questionnaire n°6: Crop-cutting questionnaire
  - Questionnaire n°7: Food Security

FAO - PROJECT GCP/MLW/019/UK Agricultural Statistics and Food Information System

Ngopya François, FAO Statistician: Assessment of the situation of agricultural statistical data collection, processing and dissemination in Malawi, February 2003.

EBONGUÉ Abel, International consultant in agricultural census: Mission Report to Malawi, May 2004
Rojas, O. : End-Of-Assignment Report of O. by Consultant in Crop Forecasting and Food-Supply Demand, May 2004 + Technical Note Vegetation Index as Crop Yield Indicator in Malawi + Technical Note No.2 FAO Crop Specific Water Balance (CSWB) model for estimating crop yield in Malawi

1.4 ANNEX 4: STATISTICAL CONSIDERATIONS

At some moment it will be convenient to check that the sample size chosen allows to reach the expected precision for the assessment of the measured variable.

We would just remember that for a given level of precision sample size is proportional to the variable's coefficient of variation according to the formula :

$$n = \frac{Z^2\alpha_{/2} * Cv^2}{d^2}$$

d is the acceptable margin of error or degree of precision of measurement (± d in %) that relates to the amount of deviation from the estimate one is willing to accept.

Cv is the coefficient of variation (in %)

Z is a vahe associated with a desired confidence level. The confidence level is the probability that the true value falls between the specified range (± d).

$Z_{\alpha/2}$= the standard normal score from statistical tables (Student Table), based on a specified significance level, α. . The significance level, corresponds to the confidence level (i.e., the confidence level = 100 (1- α)%). For example, if the confidence level is 90%, α is 0.10. Likewise if the confidence level is 95%, α is 0.05. For a 90% confidence level, Z =1.645. For α 95% confidence level, Z = 1.96.

For example if we state a margin of error of 10 % with a level of confidence of 95% and if the coefficient of variation of the variable is 50%

$$n = \frac{1.96^2 * 0.5^2}{0.1^2} = 96$$

The sample size should be at least 96 in order to reach the required precision. Still with a margin of error of 10 % we can calculate the sample size according to different coefficient of variation and significance level α.

CV	α = 0.05	α = 0.10
50 %	96	68
100 %	384	270

If a margin of error of 20% would be accepted these figures would have to be divides by 4

The formula can be applied only if the sample is chosen within an unstratified population. As the smallest sampling level in the current procedure implemented by NSO for annual crop estimation is the block, calculation of sample size should rhetorically be done at this level.

Actually the survey utilized a three-stage random sampling methodology. District (formerly RDP) constitute the first strata, section the second level and enumeration area, previously block (8 EA per section), is the Primary Sampling Unit (PSU) within where households to be surveyed are randomly selected. It seems difficult to reach the desired sample size within such small units and even at section level. Thus, if the cropping patterns are not too diverse it can be acceptable to calculate sample size for crop estimation at he first strata level (district).

Nota bene:

If the size of the population is less than 20 times the calculated sample size (n) using the initial formula, a finite correction factor should be used to reduce the estimate for the minimum number of samples required, as shown in the following equation:

$$n_1 = \frac{n}{1+\frac{n}{N}} \quad \text{where,}$$

n_1= adjusted estimate of the minimum number of samples required.
N= number of units in the population being sampled.

For example is the first calculated sample size was 100 for a total population of 500 units, the recalculated size will be:

$$n_1 = \frac{100}{1+\frac{100}{500}} = 83.3 \approx 83$$

In the case of multivariable recording within the same unit formula to determine sample size for the whole sample is:

$$n = \sqrt[n]{\sum_{1}^{n} n_i}$$

Where

n = estimate of the minimum number of samples required for the multivariable sample
n $_i$,= estimate of the minimum sample size calculated for each variable according to its specific variability.

References

Environment Protection Agency (EPA), (2003) Generic Guide to Statistical Aspects of Developing an Environmental, Results Program, April 2003, 97p.

Snedecor, G. W. and Cochran, W. G. 1989. Statistical Methods, Eighth Edition. Iowa State University Press. Ames, Iowa.

1.5 ANNEX 5 : BRIEF DISCUSSION REGARDING GPS IN AGRICULTURE

Precision Agriculture: Global Positioning System (GPS)

Cost vs. accuracy

The accuracy attainable with GPS depends partly on how much you are willing to spend, ranging from approximately $100 to $100,000. A low-cost GPS receiver (from $100 to $500) may be sufficiently accurate providing a RMS horizontal accuracy within 15 meters for many crop applications, including sampling area.

For examples of low cost units recommended units for agricultural use see www.garmin.com and www.magellangps.com for examples of GPS. For comparisons between GPS models used in agriculture see the following publications available on the Web:

http://www.fse.missouri.edu/mpac/pubs/wq0452.pdf

http://www.wkarc.org/Research/ARCH/PrecisionAg/DGPS_web.pdf

1.1 ANNEX 6: QUESTIONNAIRE : ESTIMATION OF CROP PRODUCTION (TEMPLATE)

ADD	RDP	EA	Village/block	Household	crop	Area cultivated in cassava by the household (Ha)
					cassava	

Week	Large Bag of fresh root	Medium bag of fresh root	Basin of fresh root	Drum of fresh root	Basket of fresh root	Basket of flour	Drum of flour	Total
Gross weight								
Conversion factor	1	1	1	1	1	To be determined	To be determined	
Equivalent in kg of fresh tubers								
1.								Sum of line
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								
11.								
12.								
13.								
14.								
15.								

1.2 ANNEX 7 : REPORT ON A FIELD EXPERIENCE (PR TOLLENS)

Communication presented at the FAO Expert Consultation on Root Crop Statistics
(Harare, Zimbabwe, 3-6 December 2002)

"Estimation of production of cassava in Bandundu (1987-1988) and Bas Congo (1988-1989) regions by an intensive yearlong, weekly visit, production and marketing survey, on a large sample, as compared to official R.D. Congo statistics"

by

Prof. Eric TOLLENS
Catholic University of Leuven (K.U.Leuven)
Dep. of Agricultural and Environmental Economics
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Summary

Over the period 1987-1989, K.U.Leuven, in collaboration with the Ministry of Agriculture, Rural Extension and Community Development in R.D. Congo, conducted large, in-depth surveys on agricultural production and marketing in Bandundu and Bas Congo provinces, as part of a larger study on food marketing for Kinshasa markets. The production surveys covered 3 products in Bandundu (cassava, maize, and groundnuts) and 7 in Bas Congo (the previous three plus cassava leaves, beans, plantains and rice). They were held over a full year, with weekly recordings of production in physical units (basins) on specially designed survey forms, on a large sample (1305 households in Bandundu, 1040 in Bas Congo). All physical units were converted to weights and the results were aggregated to cover the whole population.

The results thus obtained were compared with official production data. For Bandundu, the measured production of cassava was 37.6% higher than official data; in Bas Congo, it was 72.2% higher. Production was also much higher for all other crops, except plantains. For various reasons, particularly civil unrest in the 1990's, the official statistics, and in particular the methodology used, were not changed or adapted to take account of our findings.

Another aspect concerns a rapid and reliable methodology for estimation of agricultural production, which was tried out for several months. The method is based on once monthly recordings, by the field enumerator, of the number of basins harvested by a farmer. The results obtained compare very favourably with the results obtained by weekly recording by the village enumerators. This method holds a lot of potential for improving cassava production statistics and is cheap and reliable. It is based on the farmer's recall of the number of units (basins) harvested over a month.

Finally, the variances for all variables recorded in the surveys were calculated. Under certain assumptions, and for a given K (confidence level) and D (maximum difference between measured value and real value), this allows a precise calculation of the required sample size. At 95% confidence level and 10% maximum error, the sample size for bitter cassava production in Bandundu is 103 households, and 240 in Bas Congo. For cassava, maize and groundnuts, the three main staple crops, and the income from the sale of the main cash crop, cassava, the required sample size for Bandundu is between 200 and 300.

It is concluded that actual food production in R.D. Congo is thus likely to be higher than official statistics indicate. The food situation would then appear better than official statistics indicate, although clearly still far from acceptable. Household budget food consumption data over the 1975-2000 period nevertheless also show a very poor nutritional situation, one of the worst in the world. But maybe also the household budget survey data are underestimated. In any case, the situation is alarming and better production statistics are an imperative for agricultural and food policy, for aid programs and for an improvement in the food insecurity situation.

1. Introduction

As part of a large study on the marketing of food products for Kinshasa markets, extensive production and marketing surveys were conducted in Bandundu region in 1987-1988 and in Bas Congo region in 1988-1989, R.D. Congo. The study was financed by the Belgian Agency for Development Cooperation (AGCD), with co-financing for the surveys by USAID-Kinshasa. They were conducted by the Catholic University of Leuven (K.U.Leuven) under the direction of Prof. E. Tollens, with Frans Goossens and Bart Minten as researchers, and local support and collaboration of D.M.P.C.C. (the Direction of Markets, Prices and Campaign Credit) of the Ministry of Agriculture and SPCSA (Permanent System for the Collection of Agricultural Statistics) of the same Ministry. Surveys were also conducted in Kinshasa markets. The results were published in 29 (blue) working papers and 19 (yellow) statistical papers, and summarised in the book: "Nourrir Kinshasa: L'Approvisionnement local d'une métropole africaine", F. Goossens, B. Minten and E. Tollens, l'Harmattan, Paris, 1994, 397 P. More specifically for cassava, E. Tollens (1992) presented the results of the study at a workshop in Feldafing, Germany and Dr. F. Goossens published a book based on his doctoral thesis with title: "Cassava Production and Marketing in Zaire" Frans Goossens, Leuven University Press, 1996, 178 p.. A standard publication and reference on cassava production in R.D. Congo (Bandundu province in particular) remains Dr. L. Fresco's book, based on her doctoral thesis. Since the general belief was that official production figures, particularly for cassava, were notoriously unreliable[5], an effort was made to record production, sales and purchases over a full year at the household level by statistically reliable methods. In this way, a comparison could be made with the official data, but such a comparison was never published in order not to embarrass the authorities. The comparison follows hereafter.

First of all, the survey methodology is presented, followed by a comparison of the production results with the official data. This is followed by a discussion on the methodology used to collect production and marketing data, including a quick and light method which was tried out. Finally, results are presented on the variances of principal farm characteristics in Bandundu region with implications for sample sizes and survey methods.

2. Cassava survey methodology

It should be noted that our survey methodology is based on that of the 1984 "Enquête Nationale Agricole" of Rwanda. Several studies (Sukhatme, 1954; Casley, Kumar, 1982; Poate, Casley, 1985; Verma, Marchant, Scott, 1988) have shown that our method was better than the physical recording of yields and production by crop cuts in a square in a field. Crop cuts usually overestimate production by 15 to 40% and show a large variance because of sampling and measurement errors. The same studies also indicated that farmers can be relied on to estimate their own economic production.

The surveys started in October, at the beginning of the rainy season in Bandundu and Bas Congo. To measure production, sales, purchases, prices and market conditions of the main food staples, a survey on a sample of 1305 households in Bandundu and 1040 households in Bas-Congo was organised. Five households per village were visited on a weekly basis by a field enumerator who lived in the village. In total, in Bandundu, 261 field

[5] According to Davies and Lipton who in 1986 did an in depth study in Zaire in preparation for a national food strategy, financed by the European Commission, ..."the FAO Food Balance Sheet for Zaire is useless because it is based on official output data" (Davis and Lipton, 1986).

enumerators were employed, 60 enumerators, 18 supervisors and 5 head-supervisors. For Bas Congo, there were 208 field enumerators, 38 enumerators, 11 supervisors and 3 head-supervisors. The enumerators had a bicycle, the supervisors and head-supervisors a motorbike. In Bandundu, the survey included cassava, maize and groundnuts. In Bas-Zaire, also bananas, cassava leaves, beans and rice were included. Production, sales and purchases were measured in local harvest units. For cassava, and most other crops, the main unit used was the basin. Basins are ubiquitous in all households, and are in particular used to transport cassava roots from the field to the dwelling on the head of women. To entice participation in the survey and in order to standardise the measuring unit, a new dark blue colour basin was given to all participating households. A particular survey form was designed (see Annex 1) for the easy recording of the harvest and of all transactions. Instead of recording numbers, the field enumerators only had to indicate (mark with shade) the number of units or half-units harvested. Sometimes, the production survey form remained with the farmers. For the transaction form, the field enumerator had to visit each farmer once a week to make a record of all transactions. Visits were always on the same day in the week in the evening, to make sure that the farmer's wife was present as she usually harvests most of the crops. For each transaction, receipts and major parameters such as participants, sales unit, product form, transport, place and distance were registered. Results were extrapolated towards the total farm population of the region. Also purchases of these products, which are generally neglected, were registered. The survey was combined with a one-visit survey on general farm characteristics, such as hectarage, land use, storage behaviour, etc.. In Bas-Congo, an additional survey on household characteristics was organized. The survey villages were regularly visited by a supervisor and by the project team. All forms were checked carefully. All enumerators participated in a week long training session. They were all relatively well paid, on a monthly basis, with money rewards for good performance. Rather generous payments were made possible by a USAID-Kinshasa grant in local currency, using project counterpart funds.

The survey sampling plan was that of the Permanent System for the Collection of Agricultural Statistics (SPCSA) elaborated by an FAO-expert, Mr. SIMAIKA (SIMAIKA, 1986). Our data was regularly checked and controlled. A team of 9 persons in the head office assured data control and data entry.

We conducted a special survey in each province to standardize the weight of a basin ("enquête calibrage"). The results are summarized in table 1. The coefficient of variation varies between 13% end 34% for Bandundu and Bas Congo, which is relatively small but it proves the necessity of standardisation. In addition, we used the following conversion factors, based on our own surveys and research by L. Fresco. One kg of fresh cassava roots results in:

0.759 kg fermented cassava
0.494 kg cassava paste ("kimpuka")
0.559 kg chikwangue
0.390 kg cossettes (source: L. Fresco)
0.270 kg flour (source: L. Fresco)

Surveys on the distribution sector covered 1000 food retailers in markets and 300 semi-wholesale stores. For the survey on river transporters, 208 survey forms were completed; for the survey on road transporters, 500 transporters were interviewed in one-third of the 55 parking places in the city where the trucks arrive; 1405 questionnaires were completed for the par-colis traders, of which 1000 in truck parking places and 405 in ports.

Three sources of price statistics are available in Zaire: Institut de Recherches Economiques et Sociales of the Université de Kinshasa (IRES), which publishes monthly retail prices since 1960, the Institut National de la Statistique (INS) and the DMPCC (Ministry of Agriculture) which collected and published prices since 1984. The DMPCC collected prices at the retail and semi-wholesale level (arrival in Kinshasa), which makes it possible to study retail margins. DMPCC price collection was organized by the K.U.Leuven research team. Farm gate prices were collected by the K.U.Leuven team during one year in the Bandundu and Bas-Zaire regions.

Data on consumption come from secondary sources. Main sources on consumption are the data collected under the direction of J. Houyoux: a one year's study in 1969 on 1471 households (1/100 of households), the second on 1367 households (1/200 of households in 1975), the third in 1986 on 205 households (1/2000 of households). Subsequent surveys took place in 1990, 1995 and 2000.

Official population statistics were provided by the Institut National de la Statistique (INS). These statistics are extrapolations based on the provisional data of the 1984 census. The value of the census statistics is not known.

Table 1: Standardisation of measuring unit for cassava (basin) for Bas Congo

	number of observations	weight (kg)	standard deviation	coefficient of variation
cassava:				
fermented	608	19.56	2.71	13.88
fresh roots	100	18.79	3.84	20.48

Source: Marketing surveys

N.B.: The basin used in Bas Congo was not exactly the same as the one used in Bandundu because the manufacturer could not supply exactly the same unit.

3. Comparison of the survey data with official statistics

As the focus is on cassava, we will only present the results for cassava. The source of official statistics is the "Annuaire des Statistiques Agricoles 1986-1989, Kinshasa, 1990.

Table 2: Production of cassava (fresh root equivalent) in Bandundu (Oct. 1987 - Sept. 1988) and Bas Congo (Oct. 1988 - Sept. 1989), marketing project and official statistics, in ton

	marketing project	official data	% difference
Bandundu	3.975.634	2.890.000	+ 37.6
Bas Congo	1.498.300	870.000	+ 72.2

Source: Marketing surveys

The surveys always recorded a higher production than the official statistics. This also holds for maize and groundnuts in Bandundu and Bas Congo and also for rice and beans in

Bas Congo (see Annex 2). Only for plantains, where the recording unit was bunches, surpassed the official statistics our production data with 59.5%.

We cannot really explain why generally the survey data always indicates higher production than the official statistics. We basically used the same sampling plan, but we had a weekly recording of production in local units while official data are based on a one-yearly recording of the harvest for all crops together. We submit that once yearly recording in metric weights grossly underestimates real, effective production. This seems to be true for roots and tubes, but also for cereals, beans and groundnuts (see tables in Annex 2). At the time of our surveys, the SPCSA was trying to improve its collection methodology, with support of FAO and USAID, but in a vast country like R.D. Congo, and with so many different crops and animal production, it is a daunting task. Undoubtedly our results would have led to improvements in the collection methodology, but the civil unrest in 1991, with widespread looting, made most official donor organisations leave the country. Widespread looting was repeated in January 1993, and it is only in 1997, when J.D. Kabilo became president, that most donors resumed their aid programs.

It is to be noted that R.D. Congo is one of the worst countries of the world in terms of the state of food insecurity. According to FAO's (2001) State of Food Insecurity in the World, the largest increases in the proportion of undernourished 1990-92 to 1997-99 is the R.D. Congo with +29%, i.e. with 17 million more undernourished people, 22% of the total increases in the world. R.D. Congo has thus contributed the most to the rise in food insecurity in the world over the 1990-92 to 1997-99 period. According to the 2002 FAO report on Food Insecurity in the World, R.D. Congo is the worst country in the world in the 1998-2000 period in terms of undernourished people: about 75%. But it is also the country with the highest per capita cassava consumption in the world, according to our data. But we would submit, based on the foregoing, that food production statistics in Congo are underestimated, and that in reality the food security situation is probably better, although still grossly inadequate.

4. Proposal for a rapid and reliable cassava production survey based on farmer's recall

As a side-exercise to the production surveys, at the near end of the year-long survey in Bandundu, we asked for several months that farmers make a record of the number of basins that they have harvested. When the field enumerator then visits the farmer monthly, he/she just asks how many basins are harvested since his/her last visit. This is a quick method to assess production in a wide area. We assessed that the statistical reliability of such a system is quite good, but unfortunately we did not fully prepare the data for publication. But is was clear that this was a relatively cheap and reliable method of recording cassava production. Many farmers noted the number of basins harvested on the wall of their house or on a piece of wood.

For the system to work, the farmer's confidence needs to be gained, he/she needs some minimal training in the collection system (purpose, importance, need for reliability), and an incentive. The first incentive can be the giving of a standard basin, but other small incentives need to be provided later on a regular basis. We even found that some farmers (women farmers) got quite skilled in the exercise, were proud to announce their production and were probably totally reliable. Because we could not manage our Bandundu and Bas Congo surveys at the same time, and since our main focus was agricultural marketing for the

Kinshasa market, we eventually discontinued the exercise, but were convinced that it was the route to follow in the future.

5. Variances of principal farm characteristics in the Bandundu region and implications for sample sizes and survey methods[6]

This part of our work was performed on the suggestion of, and with the support of Dr. Suha Satana, USAID-technical advisor to the Studies and Planning Service (SEP) of the Ministry of Agriculture.

Our sampling plan included 1305 households in Bandundu and 1040 in Bas Congo. When the total population is large compared to the number of persons in the sampling plan, the variance and the statistical reliability of the survey results is a function only of the absolute number of households in the sample and not the sampling fraction. The sample size depends on the variance of the measured variables and the required precision or reliability of the results.

The required precision or reliability requires two factors, D and K. D represents the largest acceptable difference between the estimated value and the true value. K is the confidence level which allows to make statistical statements about the probability that the true value falls between the specified range (± D). The general formula is:

$$n = \frac{K^2 V^2}{D^2}$$

This formula can only be applied if the sampling procedure consists of one step only. The sampling design used in our survey had 4 stages and in principle, this formula thus cannot be applied. But for reasons of simplicity, it is applied nevertheless. Thus, the real variance will be at least equal or greater than the calculated ones (table 3). As the households in the population are all fairly similar, the error made cannot be too large.

Table 3 presents the sampling size for combinations of K and D. For K, a normal distribution of the variables is assumed and 95% corresponds to K=1,96; 90% corresponds to K=1,645. The error margin D is fixed at 10%. With K and D fixed, the sample size is only a function of the variance of the variables considered. The variances were calculated from the survey data.

It is to be noted that for bitter cassava, by far the largest cassava type in Bandundu and Bas Congo, the minimum sample size for production is 103 households, quite small (we used 1305). For Bas Congo, the figure is 240 (we used 1040). It is to be remarked that K and D are fixed arbitrarily, but at a reasonable level, and in line with common practice of statisticians.

If we consider that for the Bandundu survey production data for 4 crops (bitter cassava, sweet cassava, maize, groundnuts) and farm income data for 3 crops (cassava, maize, groundnuts) need to be statistically reliable at K=1,96 and D=0,10, and if we accept a geometric estimation, and assuming that all variables are equally important, the overall sample size is 821. This figure is the result of the 7th root of the product of the 7 sample sizes needed for each of the 7 variables. In Bas Congo with 14 variables, we arrived at 1389 sample size.

[6] The full report is available in publication 18 in the blue series of working papers, project "Commercialisation des produits agricoles", AGCD-K.U.Leuven and USAID-Chemonics, Kinshasa, June 1990.

However, if for Bandundu we consider only statistical reliability at 95% and a maximum error margin of 10% for the production of the three main food crops cassava, maize and groundnuts, and for the income from sales of the main cash crop, cassava, the required sample size is between 200 and 300. This is because the variance of the indicated variables is small. It is to be noted that Bandundu has about the size of France!

One of the advantages of the intensive, in-depth survey work is thus that it has produced variances for all the variables considered, and that these are indispensable to calculate the statistically required sample sizes. In their absence, an arbitrary a-priori probability distribution of the variables needs to be assumed.

Tabel 3: The calculation of minimum sample sizes needed for given K (95%) and D (error margin: 10%) values for Bandundu and Bas Congo for production and farm income (from sales) data for the three main crops grown (cassava, maize, groundnuts)

	coefficient of variation		required sample size K=1,96	
	Bandundu	Bas Congo	Bandundu	Bas Congo
Production				
- bitter cassava	0.517	0.790	103	240
- sweet cassava	2.132	1.061	1747	433
- maize	1.199	1.360	553	711
- groundnuts	1.188	1.192	542	501
Income				
- cassava	1.255	1.171	605	526
- maize	2.654	2.797	2707	3006
- groundnuts	2.730	2.871	2862	3167

Source: "Nourrir Kinshasa", F. Goossens, B. Minten and E. Tollens, L'Harmattan, Paris, 1994, p. 81

6. Conclusions

Our survey in the R.D. Congo carried out from 1987 to 1991 in the framework of the food marketing study for Kinshasa yielded important knowledge, not only on the marketing side but also in terms of agricultural production in the two major supply provinces of Kinshasa, Bandundu and Bas Congo. Cassava is by far the most important food staple. We submit that agricultural production statistics in Congo are seriously underestimated. This is also plausible because the FAO food balance sheet for Congo shows a continuing deterioration, to the extent that Congo contributes for 22% of the increase in under nutrition in the world between 1990-92 and 1997-99. Particularly the production data for cassava, a root crop with continuous harvest during the year, are probably well below actual production levels. However, the surveys also showed a serious underestimation of the production in the official statistics for all crops, except plantains.

Nevertheless, other sources of data on cassava, particularly per capita consumption data for Kinshasa based on household surveys conducted in 1975, 1986, 1990, 1995 and 2000 also show a continuous decline in cassava consumption, from 176,7 kg in 1975 to 145,3 kg in 2000 (Annex 3). Even in 2000, cassava consumption amounted to 49% in weight of all products consumed, including beer and soft drinks, and 31,7% of calories and 9,1% of protein (Guy-Bernard Nkwembe Unsital, 2002) in the diet. But is it possible to live and function with only 1.368 calories/person/day and 39,5 g protein/person/day? We personally doubt it and we would not be surprised if, again, cassava consumption is grossly underestimated in household surveys.

It is regrettable that the findings have not been used to improve the statistical situation, but the culprit is the civil disorders in 1991, the departure of most bilateral donors in 1991 until their return in 1997, and the unstable political situation in the 1990s.

I am grateful to FAO for the opportunity given to present our findings and to be able to contribute to the immense task of producing better root crop statistics in Africa. I am convinced that with more reliable statistics on root crops, the food situation and food outlook will not appear as bleak as it appears from official publications, although it will no doubt remain far from adequate.

References

CASLEY, J.D. and K. KUMAR, The Collection, Analysis and Use of Monitoring and Evaluation Data, The Johns Hopkins University Press, Baltimore, 1982, 20 p..

DAVIES, S and M. LIPTON, "A New Start: Preconditions for a Food Strategy in Zaire", Report of Food Strategy Team's Mission to Zaire, (January 18th to March 18th, 1985), 1985, 198 p..

Division des Statistiques Agricoles, République du Zaïre, Annuaire de Statistiques Agricoles, 1986-1989, Ministère de l'Agriculture, Animation Rurale et Développement Communautaire, Service d'Etudes et Planification, Projet PNUD/FAO-ZAI/88/004 et Projet USAID-0119, Kinshasa, juin 1990.

FAO, The State of Food Insecurity in the World, 2001 and 2002, Rome.

FRESCO, L., Cassava in Shifting Cultivation, A Systems Approach to Agricultural Technology Development in Africa, Royal Tropical Institute, Amsterdam, 1986, 240 p..

GOOSSENS, F., B. MINTEN and E. TOLLENS, Nourrir Kinshasa: L'approvisionnement local d'une métropole africaine, L'Harmattan, Paris, 1994, 397 p..

GOOSSENS, Frans, Cassava Production and Marketing in Zaire, Leuven University Press, Leuven, 1996, 178 p..

KANKONDE, Mukadi and Eric Tollens, ed., Sécurité alimentaire au Congo-Kinshasa, Production, Consommation et Survie, L'Harmattan, Paris, 2001, 478 p..

NKWEMBE Unistal Guy-Bernard, Evolution de la consommation alimentaire au Congo-Kinshasa pendant la période de transition: Essai d'une analyse pour une sécurité alimentaire durable, Mémoire du Diplôme d'études spécialisées en Economie Rurale, Louvain-la-Neuve, septembre 2002, 79 p..

POATE, C.D. and J.D. CASLEY, Estimating crop Production in Development Projects, Methods and their Limitations, The World Bank, Washington, D.C., June 1985, 34 p..

SHAPIRO, David and Eric TOLLENS, The Agricultural Development of Zaire, Avebury, Aldershot, 1992, 201 p..

SIMAIKA, J.B., Rapport de mission sur les enquêtes statistiques du projet ZAI/88/008-Système Permanent de Collecte des Statistiques Agricoles, Kinshasa, mai 1986.

SOLAGRAL - Réseau Stratégies Alimentaires, Economie des Racines et Tubercules, Analyse dans les pays d'Afrique de l'Ouest et du Centre (CMA/AOC), Ministère de la Coopération, Paris, octobre 1995.

SUKHATME, P.V., Sampling Theory of Surveys with Applications, Iowa State College Press, 1954.

TOLLENS, E., Cassava Marketing in Zaire, An Analysis of its Structure, Conduct and Performance, in Traditional marketing systems: proceedings of an international workshop, ed. Georg Bokeloh, Norma Lange, Stefan Schad, Feldafing, July 6th to 8th, 1992, pp. 113-127.

VERMA, V., T. MARCHANT, and C. SCOTT, Evaluation of crop-cut methods and farmer report for estimating crop production, Longacre Agricultural Development Centre, Limited, London, January 1988, 73 p..