REGIONAL EARLY WARNING SYSTEM
FOR
FOOD SECURITY

Selected Technical Papers
on
Methodology of Food
Crop Forecasting
in
SADC

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PREFACE

The following technical papers were presented and discussed at a joint SADC-FAO Technical Workshop on Methodology for Food Crop Production Forecasting held on 10 and 11 April 2000 in Harare, Zimbabwe. The workshop was mostly attended by statisticians working in the SADC Member States' National Early Warning Units.

The report of this joint SADC-FAO Workshop was unfortunately not published. Hence the FANR Directorate decided, after several years, to publish several papers from the workshop dealing with crop forecasting methodologies being used in SADC Member States. The aim of producing these is to facilitate the sharing of best practices among Member States and preserving the methodologies which have been in use in the region. The document has been edited for publication by Mr. Bentry Patrice Chaura, Senior Programme Officer - Food Security, SADC Secretariat, FANR Directorate.

The printing and translation of this document into French and Portuguese have been made possible through financial support from the Belgian Development Cooperation through their Office in Pretoria, South Africa. The SADC Secretariat greatly appreciates this support.

Director,
SADC Food, Agriculture and Natural Resources Directorate
October 2009

SUMMARY OF DISCUSSIONS AND RECOMMENDATIONS FROM THE JOINT SADC/FAO WORKSHOP ON METHODOLOGY OF FOOD CROP PRODUCTION FORECASTING

1. Institutional Organisation

It was noted that the institutional set up for crop forecasting vary from country to another within the region. In some countries there is an obvious duplication of effort as two or more institutions collect the same type of data. There is need for integration in such cases in order to avoid duplication and reduce costs to the country.

In particular CSOs and NEWUs should coordinate their crop forecasting activities in order to avoid unnecessary duplications.

2. Methodology

In most countries, crop forecasting has been limited to cereals and other major crops. Few countries are currently considering or have extended crop forecasting to minor agricultural commodities. However, experts expressed the need to develop new methods of forecasting crop production to include minor crops. There is a growing need to develop and use forecast methods that are not only cost-effective but also sustainable given the general financial difficulties countries in the region are facing.

FAO was urged to help regional governments develop methodologies that can used to forecast minor crops. FAO and SADC were also requested to facilitate the introduction of suitable methodology for estimating cassava and other root crops. The meeting suggested the formation of a small group of national and international consultants to develop a suitable method of cassava production forecasting.

3. Field Operations

The central statistical offices, in most countries, do not have structures at sub-national levels to conduct objective methods of crop estimate/forecast. The countries, therefore, rely on extension workers to do crop forecast, report on crop damages due to natural causes and others. Unfortunately in most cases there is lack of coordination between the CSO and Extension services to properly conduct the surveys.

Experts, therefore, recommended the need for a proper coordination and supervision of crop forecasting surveys between CSOs and Extension units. Adequate resources are needed to properly conduct surveys including proper supervision of field activities.

4. Dissemination

The meeting noted that the results of crop forecasts were only being circulated to a limited audience: generally confined to the senior officers of the government ministries. In some countries, the release of forecast data is delayed because of the bureaucratic clearances required before statistical agencies could release them to a wider audience. In the process the utility of the forecasts are being greatly reduced.

SADC countries are urged to release forecast data and information to as wider audience as possible, in good time. Where NEWU are facing these delays, SADC should try to help through their contacts with senior officials. In order to increase circulation of the data and information, crop forecasts should be published in newspapers and where possible should also be installed on the Internet.

5. Need For Constant Review Of User Data Requirements

The meeting discussed the various implications for the NEWS/Crop forecasting systems of the changing needs of the users resulting from various factors such as market liberalisations, emphasis on household level food security, decentralisation of decision making to District or Provisional levels etc.

The meeting urged NEWUs/crop forecasting systems to continuously assess the changing data needs of the users and this should be reflected in their work. Assessments of users needs could be done through User/Producer workshops and User/Producer committees. It was recommended that NEWUs and CSOs should sensitise data users as to the importance of the various data and information they publish.

SADC was asked to take a leading role in facilitating country reviews of data requirements. The meeting also emphasised the need to sensitise politicians and ministers on the importance of NEWU.

6. Technical Co-operations

The meeting also reviewed requirements for external assistance in areas such as crop forecasting methodologies, capacity and institutional building among others. It was noted that previous FAO/SADC technical cooperation had done a lot in these areas but most countries still need assistance aimed mostly at consolidating crop forecasting methods which are already in place.

FAO was urged to provide technical assistance in these areas as there is still quite a lot to be done to help develop capacity in the SADC countries. At the same time SADC Governments are urged to develop capacity in their ministries to adequately provide resources for the surveys.

Workshop Papers

I. OVERVIEW OF PREVIOUS ACTIVITIES ON CROP FORECASTING IN SADC COUNTRIES

By
B. P. Chaura, SADC, REWU[1]

1.1 INTRODUCTION

The SADC regional Early Warning System for food security (REWS) became operational in mid-1987 after a formal request for a feasibility study made to FAO in 1981 by the Government of Zimbabwe on behalf of SADC. The System is currently comprised of the Regional Early Warning Unit (REWU) based at SADC Food, Agriculture and Natural Resources Development Unit (FANRDU) in Harare, Zimbabwe and National Early Warning Units (NEWUs) in all but two SADC countries. The Democratic Republic of Congo and the Seychelles have not yet established their units.

One of the main aim of the system is to provide timely and reliable information on the supply and demand for food, in particular cereals, to SADC Governments, donors and any interested individuals or institutions. Given the large fluctuations in food production in the region, mostly due to weather patterns, the information is thought to be of critical importance to Governments as well as donors in ensuring a steady flow of food supplies from surplus to deficit areas. The data is also used by each country to help decide whether or not to import or export food based on whether the analysis shows a deficit or surplus respectively.

In order to accomplish these tasks the system collects, compile, analyse data and disseminate information at both national as well as regional levels. For the system to be of any use for planning in food security matters, the information being disseminated has to be adequate, which means it has to be relevant, reliable and timely among other attributes. However, this information can only be reliable if the data from which the information is generated/derived from is itself adequate.

One of the most important data on the supply side of the food security equation is that on annual domestic crop production. All SADC countries using different methods collect crop production data.

1.2 CROP FORECASTING/ESTIMATING METHODS USED IN SADC COUNTRIES

Crop forecasting/estimating methods used in SADC countries may be grouped into four main categories as shown in Table 1.

[1] Currently Senior Programme Officer – Food Security, SADC FANR Directorate

Table 1: Methods of Crop Forecasting/Estimation being used in SADC Countries

COUNTRY	CROP FORECASGS (Statistical)	CROP ESTIMATES (Statistical)	AGROMET YIELD MODELS	CROP REPORTS AND/OR FIELD VISITS
Angola	-	-	-	+
Botswana	-	-	+?	+
Lesotho	+	+	+?	+
Malawi	+	+	+?	+
Mauritius	-	+	?	+
Mozambique	-	-	-	+
Namibia	-	-	-	+
South Africa	-	-		+
Swaziland	-*	+	+?	+
Tanzania	-	-	+	+
Zambia	+	+		+
Zimbabwe	+?	+?		+

Key:
- a method not used
-* Some plan to use a method
+ method being used
+? Not known/or used with questionable results

1.3 HOW ADEQUATE ARE DATA OBTAINED THROUGH THESE METHODS?

Among the four listed categories of crop forecasting/estimation, crop reports/field visits, agro-met yield models and statistical crop forecasts surveys are normally used to provide timely crop production forecasts for early warning purposes. Data from Crop Estimates, which are obtained through surveys conducted after harvests, are in most countries available quite late for early warning purposes.

The following are among the various important characteristics of a reliable crop forecasting/estimating method:

- It should be possible to independently verify the basic data obtained using the method. Such a method should, therefore, be objective and not based on subjective judgement or opinion of the person collecting the data;
- It should use a sound statistical methodology so that the accuracy of the estimate can also be estimated.

Using the two characteristics, it is clear that most SADC countries do not have reliable methods of crop forecasting/estimation. REWU has always recommended the use of statistical methods for crop forecasting in all SADC countries.

1.4 DATA FROM STATISTICAL SURVEYS

The two sub-sets of data obtained from statistical surveys are crop areas and yields. Statistical surveys normally provide reliable crop yield data when crops are in advanced stage of maturity (in most SADC countries this means in March/April) while reasonable data on areas can be obtained as early as late January. It is for this reason that yield data from agro-met models or extension crop reports is usually used in conjunction with area data from statistical crop surveys during the early stages of crop production forecasting. Once the crops are in advanced stages, however, statistical crop forecasting methods should be used to collect data on both sets of data.

In countries where both crop forecasting and crop estimating surveys are conducted, data from crop forecasts should be replaced by crop estimates data as soon as the later become available. This is because data from statistical crop estimates in normally more accurate than data from forecasting methods. The final crop estimates are also used to check on the accuracy of crop forecasting methods which, as pointed above, are used because they are more timely and reasonable reliable for early warning purposes.

1.5 REVIEW OF SADC REWU ACTIVITIES IN FOOD CROP FORECASTING

Since its establishment, REWU has carried out a number of activities aimed at helping SADC member States in the area of crop forecasting. Some of these activities include the following:

- ♦ Mostly through the FAO/SADC project GCPS/RAF/270/DEN, REWU provided financial as well as technical assistance to most SADC countries. Survey equipment, computers and vehicles were bought for most NEWUs. In some countries, FAO provided statisticians to help NEWU develop crop-forecasting methods.

- ♦ During the Project phase, two main documents on crop surveys were produced and distributed to member States. The documents are Crop Survey, Vol. 1: Design, Data Collection and Processing by B. Goel and Crop Surveys, Vol.2: Interpretation and Reporting by B. Kiregyera. These two documents were produced based on training workshop organised in Windhoek, Namibia in 1993. The documents were aimed at helping REWU and NEWU staff in their crop forecasting training programmes as well as acting as easy references for staff in the system.

- ♦ REWU has and continues to provide annual training in methods of crop forecasting for NEWU and in some cases National Statistical staff. Subjects in the past training programmes have included:

  - general concepts in surveys;
  - basic sampling procedures;
  - Planning and designing of crop surveys;
  - Field data collection;
  - Crop survey data analysis;
  - Preparation of survey reports etc.

  The training programmes normally involve both theory and practical exercises.

- ♦ Backstopping missions are usually undertaken to individual countries that require help in particular area such as survey analysis etc. The Unit has also been involved in crop assessment missions, both those organised by FAO as well as those organised by individual member States.

1.6 PROBLEMS

As indicated above, most SADC countries do not use statistical methods of crop forecasting. Even in countries referred to as having adopted statistical methods in the table above, the actual methods adopted are semi-statistical as they combine elements of both objective and subjective methods. Current indications are that most countries are even finding it difficult to carry out these semi-statistical surveys. Some of the problems NEWUs and CSOs are encountering include the following:

- General reduced financial resources to government institutions responsible for crop forecasting. This has led to difficulties in acquiring survey equipment, fuel for transport etc. REWU is no longer able to help countries financially as was the case in the past;
- Non-availability or reduced staff levels of both survey enumerators as well as supervisors;
- Previously trained personnel have left for greener pastures outside the civil services leaving shortages of trained statistical staff in most NEWUs and CSOs.

1.7 SUGGESTIONS FOR THE FUTURE

Financial problems facing SADC countries are unlikely to go away in the near future while at the same time, timely and reliable crop forecasting data continue to be required for planning purposes. Suggestions for a way forward may include:

- ➢ Re-devising crop forecasting/ estimating methods which are not only reasonably reliable but also less costly. This, in most countries, needs deployment of crop forecasting consultants. But the question is who will pay for this?
- ➢ Re-training of office as well as field staff in the new adopted methods of crop forecasting.

Several suggestions for improving crop forecasting in the SADC region should be explored including how SADC and FAO can help countries in this field.

II. ZAMBIA METHODOLOGY FOR FOOD CROP PRODUCTION FORECASTING

Prepared by

Masiye Nawiko

1. BACKGROUND AND OBJECTIVES OF CROP FORECASTING

A. Background

The National Early Warning System (NEWS) for food security was started in Zambia in 1982 to provide advance information to government on crop conditions; crop forecasts on production/yield, sales and national food security situation throughout the year.

Before 1982, the crop-forecast system could not adequately predict food shortfalls, and import arrangements were hurriedly made whenever there was need to import grain. NEWS was started with technical assistance from FAO with funding from the government of the Royal Netherlands. It started as Crop Forecasting and Early Warning System (CFEWS) in the Ministry of Agriculture and Water Development (MAWD).

In Zambia, the crop forecasting survey used to be conducted by Central Statistical Office (CSO) and the Ministry of Agriculture, Food and Fisheries (MAFF) independently using two different methodologies. CSO used to conduct the survey on a sample basis while MAFF used to do a complete enumeration and the results from the two surveys were not similar. In 1993 these two surveys were integrated into one survey with a view of generating more accurate data in a cost-effective manner.

B. Objectives

The main purpose of crop forecasting is to produce advance information on food crop production and food supply in the country. It is on the basis of this information that the Government of Zambia (GRZ) is able to plan for agricultural development and execution of food supply management policies and programmes. Given the information from this survey, the GRZ can plan well ahead for the necessary logistics such as in the event of deficit for the importation of cereal requirements. This information is also used by the donor community and NGO's in provision of emergency relief programmes as a result of natural disasters such as droughts, floods etc.

2. SCOPE AND COVERAGE (COMMODITY AND SPATIAL COVERAGE)

The Crop Forecasting exercise is conducted through out the country and has attempted to cover all crops grown by all farmers. However, some localised crops have sometimes been missed out of this survey. Crop forecasting monitoring used to restrict concentrate itself to cereal crops. Cash crop production such as cotton, tobacco, wheat and paprika were not covered by the crop forecasting exercise.

Before conducting the survey, the crop growing season is monitored through assessing:

- Agro-meteorological factors influencing crop production

- Crop conditions

- Availability of agricultural inputs

A household listing frame is normally established in the areas to be enumerated before the Crop Forecasting survey is conducted. The Listing Book, which is used in construction the household list frame, solicits information on the following:

- Village/locality name,
- Name of head of household,
- Sex of head of household;
- Number of members of household;
- Area under crops during the season;
- Involvement in rearing livestock; and,
- Involvement in rearing poultry.

The variables listed above are useful for identification purposes in part, and for generating data on demographic characteristics of the rural small and medium scale-farming households.

Based on the household listing frame a sample of 20 households is drawn. Using personal interviews with the sampled households, crop forecast data are collected on the following variables:

- Type of crop(s) grown by the household;
- Area planted to each crop;
- Expected production of each crop;
- Expected sales of each crop produced; and,
- Quantities of chemical fertilizers applied to the crop(s).

Information recorded in the crop-forecast questionnaire is based on the responses provided by the head of the household or a qualified respondent on behalf of the other members of the household.

3. INSTITUTIONAL ORGANISATION/STRUCTURE

The Crop Forecasting exercise is co-ordinated by the Early Warning and Database Management Unit of the Ministry of Agriculture, Food and Fisheries. The planning and execution of the survey is carried out by the Agricultural and Environmental Division of Central Statistical Office in conjunction with the Early Warning and Database Management Unit of the Ministry of Agriculture, Food and Fisheries. As input into the crop Forecasting survey, the Department of Meteorology (DOM) provides agro-meteorological data from the field.

4. METHODOLOGY FOR CROP FORECASTING

The crop forecasting methodology being used in Zambia is that of sample surveys of rural households. Zambia is divided into 9 provinces and 72 districts. For the purpose of conducting sample surveys, the Central Statistical Office had divided each district into several Census Supervisory Areas (CSAs) and each CSA into several Standard Enumeration Areas (SEAs).

Initially, during the period 1982 to 1985 the sample design used for crop forecasting was one of a rotating simple random sample selected without replacement (SRSWOR) of Primary Sampling Units (PSUs). These Primary Sampling Units are the standard enumeration areas (SEAs) made up of between 60 and 100 households on average, or 300 to 500 population. They are demarcated using identifiable physical features as boundaries. Selection of sample households during the initial period was also carried out without replacement. Both stages of selection employed predetermined sampling rates of 20 percent for the Primary Sampling Units and 10 percent for the households.

The reason for adopting such a sample design, i.e., rotating sample, for the PSUs was to conduct a Census of Agriculture over a period of five (5) years in order to cover the whole country in that period. However, the short comings of such a scheme, for example, lack of longitudinal comparison in a given geographical area, in this case the primary sampling unit, led to the scheme being discarded in the 19985/86 agricultural season.

During the 1985/86 agricultural season, a Master Sample Frame was then set up just using data from the 1980 Census of Population and Housing. From the 1980 Census data, the number of households in each rural Census Supervisory Area was extracted for each district. Using probability proportional to size (PPS) selection procedure (with the number of households as a measure of size), a 20 percent sample of rural Census Supervisory Areas was selected from each district. It was ensured that at least two Census Supervisory Areas were selected from each district in order to facilitate computation of standard errors and hence coefficients of variation (CVs).

At the second stage of selection, again using probability proportional size based on the number of households in each standard enumeration area (SEA), one SEA from each sample CSA was selected. Overall, this sample design generated a Master Sample of 376 CSAs/SEAs out of 1,910 rural CSAs. Thus, a 19.7 percent sampling rate was achieved at the first stage of selection.

For the present day annual agricultural surveys the sample design has remained that which was initiated in the 1985/86 agricultural season. The only differences being the total number of CSAs/SEAs which was increased to 407, and the number sample households which was reduced from 25 households per sample CSA/SEA in 1985/86 to 20 households currently.

Household Selection

A household listing exercise is carried out in each sampled Standard Enumeration Area before the households to be canvassed are selected. During the listing exercise a stratification of the households in the Sampled Standard Enumeration Area is done based on the following criteria:-

Stratum A: A household should have land under crops not exceeding 5.0 hectares and should not be raising exotic livestock or hybrid poultry.

Stratum B: A household should have land under crops measuring 5.0 hectares or more but less than 20.0 hectares. For those raising livestock, they have to have some dairy cows not exceeding 20 in number, less than 50 beef cattle, less than 6,000 broilers raised per annum, less than 1,000 layers raised per annum, produce parent stock for poultry, or raise less than 10 sow units.

Stratum C: All agricultural households above the criteria from stratum B were classified as large-scale farming operators.

Thus, stratum A consisted of small-scale farming households, stratum B is for medium-Scale farmers, while stratum C presented large-scale-farmers.

While the small and medium scale farm operators are canvassed on a sample basis, every effort is made to canvass the large-scale farmers on complete enumeration and where possible through personal interviews.

5. USES OF CROP FORECASTING (INCLUDING DISSEMINATION OF CROP FORECASTS)

Once crop forecast data has been collected, processed and documented, the information is disseminated to all the stakeholders. The early warning crop forecasting information is most useful for government policy makers and for those charged with implementing food security activities. Major users of this information are therefore the government, the private sector especially the millers and traders, NGO’s and the donor community.

Specific uses of crop forecasting data

- Use by the government, donors, NGOs and private traders to plan food imports and or food aid in times of food production shortfall for food exports when production is in excess or food imports/food aid when there is shortage in production. The national food balance sheet is mainly used to assess the food security situation of the country.

- Input into the Vulnerability Assessment and Mapping (VAM) which provides information on household food security. VAM looks at a variety of district level indicators such as rainfall patterns, production trends, sources of income, coping strategies, education and reserve food stocks in order to identify areas that may be especially vulnerable to food security.

- Crop forecasting information is also used by the Bank of Zambia and the Ministry of Finance and Economic Development to project the economic growth of the country.

The Early Warning and Database Management Unit of the Ministry of Agriculture, Food and Fisheries co-ordinates the dissemination of the results of the crop forecasting survey. This Unit convenes crop forecasting meetings of the Early Warning Technical Committee (EWTC) chaired by the Director of Planning and Co-operatives, Ministry of Agriculture, Food and Fisheries. Upon receiving the crop production estimates, the Early Warning Technical Committee estimates the food security estimates through the construction of the Food Balance Sheet. This committee consists of representatives from the Ministry of Agriculture, Food and Fisheries, the Meteorological Department, the Food Reserve Agency, the Disaster Management and Mitigation Unit, the Programme Against Malnutrition, the Zambia National Farmers Union, the Food and Agriculture Organisation of the United nations, the World Food Programme, and the Food Security, Health and Nutrition Information System.

The Early Warning Technical Committee then represents the crop production estimates and the food security estimates to the Early Warning Co-ordinating Committee (EWCC) chaired by the Permanent Secretary, Ministry of Agriculture, Food and Fisheries, which approves crop production estimates and policy recommendations coming from the EWCC meetings. Membership to the Early Warning Co-ordinating Committee include:-

- Central Statistics Office (CSO)
- Department of Meteorology (DOM)
- Food Security, Health and Nutrition Information System (FHANIS)
- National Food and Nutrition Commission
- Ministry of Agriculture, Food and Fisheries
- Private/Parastatal companies of Zamseed, Food Reserve Agency, Sasol and Omnia.
- Millers and agricultural commodity traders
- Disaster Management and Mitigation Unit, Office of the Vice President
- NGO's like PAM, OXFARM, CARE, NGO-CC
- International agencies like FAO, WFP, UNICEF and Famine Early Warning System

Once Early Warning Co-ordinating Committee approves crop estimates and policy recommendations coming from the Early Warning Technical Committee meetings, the information is released by the Minister of Agriculture, Food and Fisheries, through a press statement. The information is also released by the Early Warning Database Management Unit through its Monthly Food Security bulletin.

6. ISSUES, PROBLEMS AND CONSTRAINTS

a) Estimating production of certain crops still a problem. Production estimates of crops like cassava and other tubers is still a problem. After obtaining area under mature cassava, production is estimated by multiplying a standard yield rate and the area under mature cassava. This may over estimated or under estimate production.

b) The general criticism of the current method used and its implementation includes a poor sampling frame, and neglect of some agricultural crops.

   Some stakeholders have urged that the current sample size does not represent the farming practices in the country. This sample size is drawn from a sampling frame which is based on the 1990 census data. Farming practices have changed in the country since 1990, hence the need to update the sampling frame.

   The issue of missing crops in the crop forecasting exercise was taken into account during the 1998/99 agricultural season when all crops with major socio-economic importance grown in the country were included in the crop forecasting questionnaire.

c) Financial Constraints

Improving crop forecasting in Zambia depends on availability of funds. Improving the sampling frame and coverage will increase the cost of undertaking this exercise. Currently, the cost of the survey is about US$90,000. Alternative ways of obtaining crop production information also appears to be expensive. For example, the use of high resolution satellite imagery to estimate crop production is expensive for Zambia. The cost of this kind of forecast for Zambia has been estimated by a Hungarian firm to be US$4 million to establish the system and about US$600,000 annually. The best alternative would be to go back to the old system that adopted by the extension branch who carry out complete enumeration of all farming households, village by village. This method of crop forecasting, though not scientific, may cost less money.

d) Uses of crop forecasting information

Some stakeholders especially the donor community have criticized how government has used crop forecasting information especially in regard to the estimation of national food security. Because of this manipulation of crop forecasting data, some donors have advocated for the elimination of crop forecasting surveys in the country.

7. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

Crop production forecasting is an important activity of the Zambia National Early Warning Systems. It provides information for assessing the food security situation of the country and enables the government and other stakeholders to take timely measures to plan for imports and or food aid in times of food shortages.

However, there is need to improve the quality and timeliness of crop production forecasting information to make it effective for policy implementation. The following recommendations are therefore made to achieve this.

B. Recommendations

1. There are a number of ways that can be implemented to improve Crop Forecasting in Zambia. These include increasing the sample size and using the extension workers to better identify the crop zones for the sample frame. In addition, the current sampling frame should be updated by using agricultural data that will be obtained from the 2000 Census of Population and Housing towards the end of this year.

2. The Ministry of Agriculture, Food and Fisheries should reactivate the crop forecasting exercise that used to be carried out by the extension wing of the Ministry if funding for the CSO crop production forecasting is not made available.

III. TANZANIA FOOD CROP PRODUCTION FORECASTING SURVEY METHODOLOGY

by

A O Ntikha – CMEWU (Tanzania)

1. BACKGROUND AND OBJECTIVES OF THE FOOD CROP PRODUCTION FORECASTING

1.1 The Methodology of Food Crop Production Forecasting Survey and its Background

The Food Crop production Forecasting Survey (FCPFS) was first designed as a collaborative venture involving the leading institutions responsible for the development of agricultural statistics in the country viz. CMEWU, MoA Statistics Unit, the Central Bureau of Statistics (CBS) and the FAO to improve on objectivity of the CMEWU data which was hitherto considered highly subjective. It was then pilot tested in four regions namely Mbeya, Iringa, Rukwa and Ruvuma during the 1992/93 crop season. The survey is so designed as to ensure that a representative sample is obtained in all the districts, regions and the country (CMEWU, 1993).

Following the successful test, the survey was expanded to cover all twenty regions of mainland Tanzania. The first-country-wide coverage was operational in the 1993/94 crop season and has continued in the like manner to date. Given the existence of a bimodal rainfall regime in Tanzania the survey is carried out twice in a year. The first survey produces preliminary forecasts in April while the second one produces final forecasts in June. For the villages in the sample, the main data collected include number of households, normal food, cereal situation (whether deficit, self sufficient or surplus), coping mechanisms in cases of deficit and the crop area assessment for 9 major crops viz. Maize, sorghum, millet, paddy, wheat, pulses, potatoes, cassava and bananas/plantains.

Data collection is facilitated by the use of a questionnaire that has been deliberately made simple and short. For each village in the sample one questionnaire is completed and returned to headquarters. The questionnaire is completed and returned to headquarters. The questionnaire is mainly composed of pre-coded questions and instructions on how to answer each question. It uses Kiswahili, the language of the enumerators thus making it more comprehensible to the latter.

1.2 The Objective of Food Crop Production Forecasting Survey

The main objectives of the Food Crop Production Forecasting Survey are several. It provides a means through which CMEWU monitors the food supply and demand situation in the country. It also enables Crop Monitoring and Early Warning Unit (CMEWU) to provide more refined and timely information to policy and decision makers about impending food shortages and surpluses so that appropriate action is taken by relevant parties. Besides the policy and decision makes within the government administration the other important users of the information from FCPFS include donor countries and agencies such as World Bank, non-governmental organisations (NGOs) such as Oxfam, Red Cross, international organisations such as UNDP, FAO, WFP and UNICEF. It is also used by the regional co-operation institutions such as SADC and the recently revived RAC. Other potential users include the research and training institutions, the private sector and many other institutions, agencies and individuals.

In operational terms CMEWU is responsible for collecting, compiling and disseminating information on the crop and food security situation in the country. For this information to serve its intended purposes, however, it should be adequate – i.e. relevant, reliable and timely. FCPFS whose responsibility rests with the AGSTAT sub-system has the procedures which ensure that the information it supplies is as much as possible adequate and meets the user demand. The purpose of the survey is to provide in advance (in collaboration with AGMET sub-system) indication of crop production prospects before harvest. If provided in a timely manner, this information enables policy and decision makers to take appropriate action such as making necessary arrangements for importing food if indications are that there is going to be a crop failure etc. Donors and NGOs also use it to design their relief intervention programmes against the misfortunes.

1.3 The Context and Organisation of the Paper

This paper constitutes the reference for collecting and analysing the survey in the context of the FCPFS methodology. It covers material up-to the level of forecasting tonnage to be harvested. It would have been desirable to proceed to the food supply analysis in the context of self sufficiency ration determination but based on the terms of reference provided the paper is confined to production forecasts. It also covers basic operational issues involved in the execution of the FCPFS.

The paper is organised into three major sections. Following this introductory section the next one discusses technical issues involved in the collection, processing and analysis of the FCPFS. The final section looks into operational issues particularly those associated with supervision and resource management.

2.0 SURVEY DESIGN AND DATA COLLECTION

With respect to survey design and actual data collection we shall look into sampling method, questionnaire design, training of supervisors and enumerators and filling-in of questionnaires.

2.1 Sampling Method

FCPFS is based on the same sample of villages selected for the current agricultural sample surveys (CASS) and the National Agricultural Sample Census of 1993/94 and 1994/95. During the said crop seasons the FCPFS was based on the National Master Sample of about 540 villages selected using probability proportional to size (PPS), where size is measured by the number of agricultural households in each village. In total, Tanzania has about 9000 villages or about 270 villages per region and about 10 villages per district.

2.2 Questionnaire Design

Data are collected using a simple and short questionnaire (for an example of a data collection form, see appendix 1). For each village in the sample, one questionnaire is filled in and then returned to the headquarters. The questionnaire consists manly of pre-coded questions and instructions on how to answer each question.

The questionnaire is designed to carry out the survey twice in a year in bimodal rainfall areas and once in areas with unimodal rainfall regime. The current design is such that the information collected is forwarded to the headquarters through supervisory channel. By adding a mailing information an alternative route would be through mailing by a pre-paid mail service. Which ever the route taken the design allows that seven categories of information are filled in before the completed questionnaire is finally forwarded to the headquarters.

The categories of information include:

(i) The identifying information in which the enumerator enters the name of the region, district, ward and the village.

(ii) The agricultural potential in which the enumerator enters the number of households and the number of agricultural households in the village. In this case the number of agricultural households should be less than or equal to the total number of the households in the village.

(iii) Food potential versus cash potential in which the enumerator separately enters the names of food crops and cash crops grown in order of importance.

(iv) Normal food situation in which the enumerator codes the situation by 1 for deficit, 2 for self-sufficiency or 3 for surplus.

(v) Expected food situation in which the enumerator codes the situation by 1 for deficit, 2 for self-sufficiency or 3 for surplus as expected for the current season.

(vi) Crop area assessment for all the food crops under CMEWU surveys. This is done on specially designed table in which the enumerator enters month of planting, month of harvesting, percent change in exceeding of falling below 15%. The crop covered include maize, sorghum, rice, bulrush millet, finger millet, wheat, beans, other pulses, banana, cassava, round potatoes and sweet potatoes. For each of these crops which are appropriately listed to form rows from top to bottom the information requested is indicated at the top of each column.

    Column 1 shows the list of the crops while columns 2 through 5 provide spaces for the enumerator to fill in the requested data as follows. On column 2 the enumerator enters the month (1 – 12) in which the crop was planted. If the crop was not grown in the village a dash (-) is indicated. On column 3 the enumerator enters the month (1 – 12) in which the crop is expected to be harvested and as done on column 2 a “-“ is indicated where the crop was not grown.

    The real assessment and remarks are shown on columns 4 and 5. Own assessment based on eye estimate (not at all involving area measurement) is made to compare area under the crop in the village this year with that of last year and presented in code form. The codes and not the percentages are entered on column 4 as follows: 1 for less than 15% of last year; 2 for 5 – 15% below last year; 3 for same as last year; 5 for more than 15% of last year and 6 for inapplicable case where the crop was not grown in that village. Note that "0" is not one of the codes although enumerators have often tended to confuse a 0% change with the code 3. Only "3" must be used and not "0" for a zero change in area planted. On column 5 relevant factors that deemed important in causing large increase or decrease in area under crops (more than 15% change) using: 1 for outbreak of disease; 2 for wild animal attack; 3 for drastic change in cropping/farming practices; 4 for supply situation of inputs; 5 for floods and 6 for any other cause not stated above.

(vii) Enumerator and supervisor commitment on intellectual honesty in which both the enumerator and the district supervisor commit themselves for the truthfulness of their investigation and supervision. They do so by signing and dating on the spaces provided.

2.3 Training for Data Collection

Training is done once every year to remind all the personnel involved in the execution of the survey the roles they are to play in order to make the survey a success. The training is conducted alongside the MoA Statistics training since the same participants do get involved in the survey. The training is conducted just before the crop season takes off, that is, around August. This is a suitable time for training partly because it offers easy recall to previous season experience whilst still fresh in mind. It is easy to recall the desirable and undesirable experience and work towards reducing the undesirable ones. This is often done to enable evolution of better methodology as years unfold. Following such attempts there have been substantial changes in the questionnaire design from its original form to the current one.
In this way the training has enabled: refining the questionnaire through inclusion of desirable questions which work towards the goals of the survey; simplifying the language and coding styles to make the questionnaire more comprehensible to the enumerators (for example the original questionnaire which was designed in English has evolved into the current form which employs Kiswahili, the language of the enumerators). Furthermore, training works towards reducing ambiguity and making it more specific to the purpose of Food Crop Production Forecasting Survey, easing the task of processing, analysis and ultimate forecasting. It also enables practical conversations which work towards making the survey more conscious of the timeliness aspect of early warning as opposed to late warning. To be able to catch up with the fresh memory of the previous season it is advisable that training is conducted between mid July and August.

The training which is currently combined with the training for MoA Statistics surveys e.g. CASS and Expanded Area Forecasting Survey (EASS) focuses on the importance of the survey, how and when to fill the questionnaires and how and when to return them to the headquarters.

Importance of the Survey: The training is supposed to stress on the importance of the survey for example to policy and decision makers, donors, NGOs, private entrepreneurs etc and the importance of collecting data that are timely, reliable and accurate as well as consistent.

How and when to fill the questionnaire is explained, elaborated and illustrated with live cases obtained from previous experiences. In particular the following issues are to be stressed: Meaning of response codes and how to use them, how to estimate the percentage change in area, need for consistency in responses, importance of editing questionnaires (this can be illustrated with the help of examples from previous surveys), errors arising from poor responses.

As to when to fill in, this varies from place to place depending on when first rains started which determined planting dates and therefore when planting ended. As soon as it is clear that planting for the season is over, that is the right time when to fill the questionnaires. In general it differs among vuli, masika and msimu seasons as follows: In bimodal rainfall regime the planting for vuli lies between mid-December and mid-February while for masika it lies between mid-April and mid-May. In unimodal rainfall regime planting lies between mid-December and mid-February. The msimu season is generally found in the Central, Southern and Western regions. Both vuli and msimu plantings occur concurrently between mid-December and mid-February but harvesting occurs differently from April to May and from June to July respectively.

How and when to return to the headquarters: As to when to return the questionnaires to the headquarters it has been finally concluded that the best way is through the use of the same route followed by the existing supervisory field organisation. That is, having finalized the filling-in the enumerator forwards the questionnaire to the DS who edits and appropriately signs if satisfied. If the DS is not satisfied the E wont get the signature and will have to redo the work. If satisfied, the DS forwards it to the RS who keeps them and sooner or later forwards them to the CMEWU Headquarters.

An alternative route of collection was tried during the 1994/95 season. This involved enumerator posting the filled in questionnaire straight to the HQ using a pre-paid mail service the traditional approach used in all other CMEWU surveys. The approach was seeking a lasting and a sustainable route before concluding.

Deadlines for receiving questionnaires must be set. In this respect there is need to stress on the need for timeliness and the effect of delays on early warning reports.

2.4 Supervision of Data Collection

Instant supervision is a follow-up to the implementation of what was learned during the training. It ensures that the importance of the survey is practically known to all the parties involved in the survey and the enumerators are filling-in the questionnaires in the manners and timings agreed during the training. It also ensures that the enumerators practically return the completed but edited questionnaires in the manners and timings agreed upon in the training. All in all supervision encourages field level supervisors and enumerators about the practical problems they are likely to face in the process of implementing the survey. An in this way supervision reduces the observed high level of unconsciousness on the aspect of timeliness, problem of non-response and inconsistent filling-in of the FCPFS questionnaires. Supervision doesn’t eradicate these problems but it minimises them while enhancing the sustainability of the methodology.

In a given crop season supervision is therefore planned to a number of regions depending on the observed poor performance in the past surveys. The criteria for the selected of such regions will include the extent of time lag experienced in receiving the questionnaires at the headquarters (taken as a measure of timeliness), problem of non-response and inconsistent filling-in of the FCPFS questionnaires. The regions so selected must be indicated together with what has gone wrong with them and the extent of the problem as observed in the previous surveys.

3. DATA PROCESSING AND ANALYSIS

With respect to data processing and analysis the main issues will include the step-by-step procedure from the time when questionnaires are received from field to the time when final area forecasts are produced. Finally, a word is given on the level of automation achieved in the processing and analysis of FCPFS.

3.1 Step-by-step procedure of manual calculation

The processing and analysis of survey data goes through three major stages. Once questionnaires have been received from field the process starts with compilation, followed by analysis and ultimate forecasting. The last stage in the processing and analysis is that of dealing with missing data the common problem with early warning data.

3.2 Compiling Relevant Data from Questionnaires into Processing Forms.

Three steps are involved in this data compilation stage. The steps include sorting, editing and recording. As soon as the questionnaires are received from enumerators sorting is the first and immediate step taken to process the data. In sorting the questionnaires are distinguished between crop seasons; that is, between vuli and masika from bimodal rainfall villages and msimu from unimodal rainfall villages as applicable. Each season's set of questionnaires is then separately processed and analysed before they are finally rejoined in the last stage of data processing and analysis to give district level crop forecasts.

The second step is editing and validation of responses in the questionnaire. In editing the questionnaires are checked in terms of adherence to the given ranges (hence also called range checks) and in term of consistency (also called consistency checks). In range checks responses are examined in terms of their conformity to the definition given in the questions. For example in the coded crop area assessment any response outside the range of '1' to '6' as defined therein e.g. '0' becomes invalid.

In consistency checks answers to different parts of the questionnaire are checked if they match. Kiregyera has shown that it is possible for responses to different questions to be acceptable and yet mutually contradictory. For instance the pair of the month of planting (1 – 12) could be contradictory. Also if date of planting and harvesting are given but area assessment is not given consistency will be lacking in such cases (Kiregyera, 1995).

Any questionnaires which are incomplete and those which do not have area assessment given should be rejected.

In the case of recording it is customary to make use of processing forms to record the names of crop, region, district and season on top of the form. Then you record village name on column 1, number of agricultural households on column 2 and area assessment codes on column 4.

The Main Features of the Processing and Analysis Form

The Main Features of the Processing and Analysis Form are as shown in the figure below. At the topmost the form identifies the relevant crop followed by name of region, district and the relevant season. The main body of the form is composed of columns 1 to 5 with titles shown in the figure below.

Processing Form

Crop: ………………

Region ……………………….. District………………… Season ………………..

Village name	No. of HHs	Village Weights	Assessment code	Value	Value* weight
C_1	C_2	C_3	C_4	C_5	C_6
Total					

3.2.1 Analysis and ultimate forecasting

Having transferred data from questionnaires into processing forms, the next steps include calculation, estimated and ultimate forecasting. This analysis is covered in four steps: Calculation of village weights, decoding of percentage change in area under crops, calculation of district percentage change and ultimate forecasting.

Calculation of Village Weights

In calculating village weights use is made of the Processing Form. An example is given to illustrate this and the following stages of the analysis. In this example maize forecasting is illustrated for region R_1, districts D_1, D_2 and D_3. The sample villages are V_1D_1, V_2D_1, V_3D_1 and V_4D_1 from district D_1; V_1D_2, V_2D_2, V_3D_2, V_4D_2 and V_5D_2 from district D_2; and V_1D_3, V_2D_3, V_3D_3, V_4D_3, V_5D_3 and V_6D_3 from district D_3. National level forecasts are arrived at by computing relevant variables from regions R_1, R_2, R_3, and R_4.

The first thing is to calculate the total number of households and enter this in the last row of column 2. To calculate village weights the number of households given in column 2 is divided by the total number of households (*See Example 1*).

The table shows village name on column 1 number of households on column 2 and village weights on column 3. Weighting ensures that no change in area for any village exerts disproportionate influence on the overall change in area under the crop in the district. Column 4 gives assessment codes which represent percentage changes of area cultivated from last year to current year.

Decoding of Percentage Change in Area under Crops

Decoding of Percentage change assessment codes is done in order to be able to calculate actual percentage changes. The assessment codes are transferred from the assessment table of the questionnaire *(See below*) to column 4 of the processing form (*See Example 2*). The assessment codes, percentage changes and the corresponding interpretation are summarised below.

Assessment code	% change	Interpretation
1	-15	more than 15% off last year
2	-7.5	about 7.5% off last year
3	0	about the same as last year
4	+7.5	about 7.5% over last year
5	+15	more than 15% over last year

The codes and not the percentages are entered on column 4 as explained earlier under the previous chapter. Then for each recorded code the corresponding percentage change is entered on column 5.

Details of this coding style are as per questionnaire design section (2.2.0) of the previous chapter.

Calculation of district percentage change

District percentage change calculation is as per Example 3 below. For each season, district average percentage change in area is calculated by multiplying values in column 3 (village weights) by values in column 5 (decoded percentage changes) and enter these in column 6. Obtain their total and enter this in the last row of the column. This total gives an estimated district average percentage change in area. It is arrived as follows:

Let X_i = value of percentage change for village I and

W_i = the weight for that village

Then, for district j

X_j = value of percentage change for village I and

w_i = the weight for that village

Then, for district j

$X_j = \sum X_i W_i / \sum W_i = \sum X_i (W_i / \sum W_i)$

= sum of the product of values and weights of individual villages in the district.
= sum of the products, column 5*column 3 as shown on column 6.

This statistical formula is derived on appendix 2

From this particular example the district average change in area = ..0.45%

Ultimate Area Estimation

In this step current year district area under the crop is estimated. It involves use of the last season area estimate and the district average percentage change in area obtained in step three above to compute area for the current season.

Therefore, Area (current season) = Area (last season) + [district percentage change in area *area (last season)].

In *Example 4* we illustrate how to obtain district area estimates for current season give area from last season (column 2) and percentage change in column 3. Area change in column 4 is obtained as a product of column 2 and 3. And in column 5, area estimate for current season is obtained as a sum of area last season and area change (*See Example 4*).

Note that the last season area used in this calculation is the area estimate obtained from objective area measurements (CMEWU, 1993).

Regional Forecasts

Regional Forecast of Area, Production and Yield

The procedure of estimating regional area and forecasting production and yield is in the order of first calculating district forecast of production followed by total area under crop in a region, total production for the crop in a region and finally average crop yield for the region.

(i) District forecast of production (*Example 5*) is obtained as a product of area (*column 2*) and average district yield (*column 3*). The latter is obtained from AGMET.

(ii) Total area under the crop in a region is obtained as the sum of district area estimates (See Example 6).

(iii) Total production for the crop in a region is obtained as the sum of district production estimates (See Example 7).

(iv) Average crop yield for the region is obtained by dividing total production by total area. (*See Example 8*).

Two Rainfall Seasons

The above example relates to one rainfall season (unimodal rainfall). Where there are two rainfall seasons, masika and vuli, the estimate for each season will have to be made separately and then combined as per examples 9 and 10.

(i) Estimates of average yield for the crop of both seasons is obtained as the ratio between production and area under the crop.

Example: Given regional forecasts of total production of 5685.69 tonnes and 3904.44 ha of maize the yield forecast is 5685.69 tonnes/3904.44 ha = 1.46 t/ha

In summary, given area and yield of various districts, the district production is easily forecasted. Likewise, given district area and production, regional totals of these can be easily used to forecast regional yield.

National Forecasts

(ii) The national estimates of area and production are obtained as the sum of regional area and production respectively (See Example 11).

(iii) The national estimate of average yield is obtained as the total national estimated production divided by total national estimated area under the crop (See Example 12).

3.3 Dealing with Missing Data

In food crop area forecasting the most common technical problem encountered include late response and/or total non-response leading to late release of the forecasts. When forecasts are not released early enough to meet the requirements of data users they are as good as not collected. For this reason it is strongly advisable that delays should be avoided. Kiregyera advises that to ensure that timeliness is well observed strict deadlines must be set and observed. But this will be true only if by the deadline enumerators are convinced that planting has ended. Otherwise it all ends up with blank questionnaire returns. A range of time could perhaps be more realistic. Nevertheless in some cases delays are inevitable.

Delays are often encountered when data collected are not received in time in the processing office (CMEWU Headquarters). In the case of FCPFS such delays are not acceptable. In districts and regions where retrieval of questionnaires has been delayed or for some reasons has not been possible some data will not be available for analysis. But pressure on timely release of the district, regional and national forecasts of food continues and something ought to be done about it. How do we do that?

When data was missing imputation is attempted at the relevant level most notably at district and regional level. According to Prof. Kiregyera (1995) if data are missing for the whole district or region an average change for the two districts or regions in close contact or with environmental similarities likely influencing each other's current agricultural performance should be averaged to give data for the missing district or region. If data for the region are missing the two regions should come from the same agro-ecological zones as per MoA's Basic Data (MoA), 1993:28-30). An example could make this point of view clearer.

Generalization:

The general features of the imputation model are shown in example 3.

If R_k and R_s are any two regions in the same agro-ecological zone and preferably in contact the imputation model allows you to enter data on all the unshaded cells K_1, K_c, S_1, S_c and T_1 which have been unprotected. Contents in the rest of the cells (shaded) will be automatically calculated in response to changes made in any one or more of the unprotected cells. Interest is to impute a figure in T_c and this is achieved as the model responds to entries in the unprotected cells.

If R_t is the region for which imputation is being carried out then, assuming equal influence on contagious regions,

$$\% \Delta T_c T_1 = \% \Delta X_c X_1$$

That is on average any one region in the zone will be equally influenced in terms of farmer decision on field expansion or contraction as agro-ecological factors change. In other words, if rainfall is on average favourable this season in R_s and in R_k then it will likewise be favourable in any other region, R_t. In turn same percentage changes ($\% \Delta T_c T_1 = \% \Delta X_c X_1$) are expected. Therefore, the percentage change so derived can be used to T_1 to T_c.

4.0 SUPERVISORY AND EXECUTIVE OPERATIONS

This Section looks into operational issues that are likely to affect the success of FCPFS in a particular year. Initially it discusses the importance of supervising data collection then it examines specific roles of different institutions including the National Statistical Technical Committee (NSTC) prior to the survey, roles of the enumerators during the survey, roles of RSs and DSs throughout the survey, roles of headquarter supervision during the survey, roles of NSTC after the final forecasts and the roles of funding agency in financing and resource management.

4.1 Roles of National Statistical Technical Committee prior to the Survey

The National Statistical Technical Committee (NSTC) is the national body responsible for technical design and execution of agricultural statistical surveys and censuses. Before a questionnaire is send out for the survey NSTC will normally go through it and discuss it in terms of relevance, simplicity, coverage and practicality of retrieval system. It is advisable that the presenter is equipped with background experiences of the questionnaire, current status and proposal for future changes if at all. As much as possible NSTC will offer advises with respect to necessary changes for improvement. Only after considering the advice can you get the NSTC blessing for a go ahead. There is a meeting to prepare surveys every year.

4.2 Roles of Headquarter Supervisor

Headquarter supervisors are person from headquarters assigned the role to oversee the surveys at the regions, districts and sometimes villages. They have to see that the survey is being done in the lines agreed in the preparatory NSCT meeting. In particular, the headquarters supervisor ensures that the techniques of data collection are being observed by all the parties involved. They also act as a kind of backstopping mission when they are out in the field. As they are the agents of the headquarters and NSTC they are also playing a monitoring role. If there are any problems they may advise and execute as conveniently as it deems necessary. They may therefore need to participate in the survey in order to either demonstrate technical expertise or provide administrative solutions to problems in the field. If necessary they may seek advises from headquarters whilst still out in the field and execute as per advise on behalf of the headquarter authority. Headquarter supervisors have to report back all the findings in order to make field work as transparent as possible to the headquarter authorities. In this way headquarters can monitor and evaluate the progress of the survey as it is being executed as a necessary feedback to planners, financiers and policy decision makers.

4.3 Specific Roles of Headquarter Supervisors

The specific roles of headquarter Supervisors are to train RS on the importance of the survey, when to fill the questionnaires, how to fill the questionnaires and the deadlines for receiving questionnaires. The training has to be done in view of improving the accuracy of the crop assessments leading to better results of the Food Crop Area Forecasts.

4.4 Roles of Regional Supervisors

The principles of supervision as outlined above apply. However, specific roles include: training of DSs and Es, supervising work in the regions, to distribute questionnaires to DSs, to collect and edit the questionnaires and to forward the questionnaires to the headquarters.

4.5 Roles of DS

Again the same principles of supervision apply as outlined above. Specific roles however, are to distribute questionnaires to Es, to supervise work in their districts, to collect and edit questionnaires from Es and to forward questionnaires to RSs.

4.6 Roles of ES

The roles of ES are to collect data and complete the questionnaires as per the enumerator instruction and to forward the questionnaires to DSs.

4.7 Roles of Financier

As for any survey financing agency or financier plays perhaps the most crucial role in the operation of FCPFS. The main role is to finance all activities as per action plan. The action plan which provides guidance to both the financier and the survey organisers is prepared initially on the basis of budget allocation.

5.0 SPECIAL REMARKS AND PRACTICAL EXPERIENCE

The FCPFS was developed both to inculcating objectivity in the Early Warning forecasts and to ensure that timely and credible forecasts are available on time for food situation reporting and as an indispensable to annual plan and budget both for Government and Non Governmental institutions.

Examples

Objective: To be able to design execute and analyse crop forecasting surveys and make correct interpretation of the results for food security management.

Example 1: **DATA ENTRY AND VILLAGE WEIGHTING**

PROCESSING FORM

CROP: MAIZE

<u>Region</u>: R <u>District</u>: D_1 <u>Season</u>: MASIKA

Village Name (i)	**No. of HHs**	**Village weights (w_i)**	**Assessment code**	**Value**	**Value* weight**
C_1	C_2	C_3	C_4	C_5	C_6
V_1D_1	413	0.29	3		
V_2D_1	241	0.17	3		
V_3D_1	348	0.24	2		
V_4D_1	435	0.30	4		
Total	1,439				

<u>Region</u>: R <u>District</u>: D1 <u>Season</u>: MASIKA

Village Name (i)	**No. of HHs**	**Village weights (wi)**	**Assessment code**	**Value**	**Value* weight**
C_1	C_2	C_3	C_4	C_5	C_6
V_1D_1	413	0.29	3	0	
V_2D_1	241	0.17	3	0	
V_3D_1	348	0.24	2	-7.5	
V_4D_1	435	0.30	4	7.5	
Total	1,439				

CALCULATION OF DISTRICT PERCENTAGE CHANGE

Let X_i = value of percentage change for village i and

W_i = the weight for that village

Then, for district j

$X_j = \sum X_i W_i / \sum W_i = \sum X_i (\sum W_i)$

= sum of the product of values and weights of individual villages in the district.

= sum of the products, column 5 * column 3 as shown on column 6.

This statistical formula is derived on appendix 2

Example 3: **CALCULATING DISTRICT AVERAGE CHANGE IN AREA**

CROP: MAIZE

Region: R District: D1 Season: MASIKA

Village Name (i)	**No. of HHs**	**Village weights (wi)**	**Assessment code**	**Value**	**Value* weight**
C_1	C_2	C_3	C_4	C_5	C_6
V_1D_1	413	0.29	3	0	0.00
V_2D_1	241	0.17	3	0	0.00
V_3D_1	348	0.24	2	-7.5	-1.80
V_4D_1	435	0.30	4	7.5	2.25
Total	1,439.00				0.45

From this example the district average change in area = 0.45%

Ultimate area forecasting

Area (current season) = Area (last season) + [district percentage change in area * area (last season)].

Example 4: **EXAMPLE OF AREA FORECASTING FOR THE CURRENT SEASON**

Given district level area figures from last season and percentage change as derived above, area change and ultimately current season area can be computed.

District	**Area last Season**	**%change**	**Area change**	**Area current season**
C_1	C_2	C_3	C_4	C_5
D_1	1765	6.45	113.84	1,878.84
D_2	1075	0	0.00	1,075.00
D_3	980	-3	-29.40	950.60

Note that the last season area used in this calculation is the area estimate obtained from objective area measurements (CMEWU, 1993).

Regional Forecasts

(i) District forecast of production is obtained as a product of area and average district yield.

Example 5**: DISTRICT PRODUCTION FORECASTS**

DISTRICT	**AREA**	**YIELD**	**PRODUCTION**
C_1	C_2	C_3	C_4
D_1	1878.84	1.2	2,254.61
D_2	1075	1.6	1,720.00
D_3	950.6	1.8	1,711.08

(ii) Total area under the crop in a region is obtained as the sum of district area estimates

Example 6: **REGIONAL AREA FORECASTING**

District	**Area last Season**	**%change**	**Area change**	**Area current season**
C_1	C_2	C_3	C_4	C_5
D_1	1765	6.45	113.84	1,878.84
D_2	1075	0	0.00	1,075.00
D_3	980	-3	-29.40	950.60
REGIONAL TOTAL				3,933.44

(ii) Total production for the crop in a region is obtained as the sum of district production estimates.

Example 7: **REGIONAL PRODUCTION FORECASTS**

DISTRICT	**AREA**	**YIELD**	**PRODUCTION**
C_1	C_2	C_3	C_4
D_1	1878.84	1.2	2,254.61
D_2	1075	1.6	1,720.00
D_3	950.6	1.8	1,711.08
REGIONAL TOTAL			5,685.69

(iii) Average crop yield for the region is obtained by dividing total production by total area.

Example 8: **REGIONAL YIELD FORECASTS**

DISTRICT	**AREA**	**YIELD**	**PRODUCTION**
C_1	C_2	C_3	C_4
D_1	1878.84	1.2	2,254.61
D_2	1075	1.6	1,720.00
D_3	950.6	1.8	1,711.08
REGIONAL ESTIMATES	3,904.44	1.46	5,685.69

For both seasons where there are masika and vuli the process goes further:

(i) Estimates of total area under the crop for each district and regional is obtained as the sum for both masika and vuli seasons.

Example 9: **DISTRICT AREA FORECASTING IN BIMODAL DISTRICTS**

DISTRICT	**VULI AREA**	**MASIKA AREA**	**TOTAL AREA**
C_1	C_2	C_3	C_4
D_1	1200	678.84	1,878.84
D_2	750	325	1,075.00
D_3	450.6	500	950.60
REGIONAL AREA	2,400.60	1,503.84	3,904.44

(ii) Estimates of total production for the crop for each district and region is obtained as the sum of both masika and vuli seasons.

Example 10: **DISTRICT PRODUCTION FORECASTING IN BIMODAL DISTRICTS**

DISTRICT	VULI PRODUCTION	MASIKA PRODUCTION	TOTAL PRODUCTION
C_1	C_2	C_3	C_4
D_1	1440	814.61	2,254.61
D_2	1200	520	1,720.00
D_3	811.08	900	1,711.08
REGIONAL PRODUCTION:	3,451.08	2,234.61	5,685.69

(iii) Estimates of average yield for the crop of both seasons is obtained as the ration between production and area under the crop.

Example: Given regional forecasts of total production of 5685.69 tonnes and 3904.44 ha of maize the yield forecast is 5685.69 tonnes/3904.44 ha = 1.46 t/ha

NATIONAL FORECASTS

(iv) National estimates of area and production are obtained as the sum of regional area and production respectively.

Example 11: National area and production forecasting

REGION	AREA	PRODUCTION
C_1	C_2	C_3
R_1	3904.44	5685.69
R_2	2580	4900
R_3	4200	5200
R_4	1987	2015
NATIONAL FORECASTS	12,673.44	17,803.69

In this case the national forecast of area is about 13 thousand while that of production is 18 thousand tonnes of maize.

(v) National estimate of average yield is obtained as the total national estimated production divided by total national estimated area under the crop.

Example 12: **NATIONAL YIELD FORECASTING**

REGION	**AREA**	**PRODUCTION**	**YIELD**
C1	C2	C3	C4
R1	3904.44	5685.69	1.46
R2	2580	4900	1,90
R3	4200	5200	1,24
R4	1987	2015	1.01
REGIONAL ESTIMATES	12,673.44	17,803.69	1.40

In this case the national forecast of yield is 18,000 tonnes/13,000 ha = 1.4 t/ha.

Example 13: **DEALING WITH MISSING DATA**

GENERALIZATION:

From generalized imputation model we proceed as follows:

REGION	**LAST**	**%Δ**	**CURRENT**
C_1	C_2	C_3	C_4
R_k	K_1	$\% \Delta K_cK_1$	K_c
R_s	S_1	$\% \Delta S_cS_1$	S_c
R_x	X_1	$\% \Delta X_cX_1$	X_c
R_t	T_1	$\% \Delta T_cT_1$	T_c

In this year, region R_t was missing during preliminary forecasting. Basic Data booklet indicates R_s and R_k qualified for imputation exercise to derive current season area forecast for region R_t. Based on the 1994/95 final forecasts, area under maize was 60,500 ha for R_s and 40,700 ha for R_k and the just ended 1995/96 regional level preliminary forecasting shows that the figures are 73,200 ha for R_s and 37,450 ha for R_k. Given that the last year figures for R_t were 77,500 ha and no short rains season in the regions, estimate he current season area for this region.

Let K_c = current year forecasts of the area for R_k
K_1 = last year forecasts of he area for R_k
S_c = current year forecasts of the area for R_s
S_1 = last year forecasts of the area for R_s
T_c = current year forecasts of the area for R_t
T_1 = last year forecasts of the area for R_t
X_c = current year forecasts of the areas for $R_k + R_s$
X_1 = Last year forecasts of the areas for $R_k + R_s$

(1) Calculate X_c and X_1

$X_c = K_c + S_c$ = 37,450 + 73,200 = 110,650 ha
$X_1 = K_1 + S_1$ = 40,700 + 60,500 = 101,200 ha

(2) compute the % change of X_c from C_1

(1110,650 – 101,200)/110,650 * 100 = 9.34%

(3) Use the % change of X_c from X_1 as arrived at in (2) to compute T_c from T_1

$T_c = T_1 + [T_1$ * % change $(X_cX_1)]$
= 77,500 + (77,500 * 9.34/100) = 84739 ha

TANZANIA CROP MONITORING AND EARLY WARNING UNIT

United Republic of Tanzania
Ministry of Agriculture and Co-operatives

FOOD SECURITY DEPARTMENT

FOOD CROP FORECASTING QUESTIONNAIRE
1998/99

The completed questionnaire should be returned o the Headquarters before 15/5/99

IDENTIFICATION PARTICULARS

Region …………………. District…………………. Ward …………… Village ……………….

Month…………………...

1. Number of Households and Crops Grown

2.1 Number of Households in the village 2.2 Number of agricultural households

1.3 Fill in food crops in order of importance

1 ______________ 4 ______________ 7______________________________

2 ______________ 5 ______________ 8 ______________________________

3 ______________ 6 ______________ 9 ______________________________

Fill in cash crops in order of importance

1 _______________ 2 ______________ 3 ______________________________

2. FOOD SECURITY ASSESSMENT

3.1 Normal food situation 3.2 Expected Food Situation

1. Deficit 2. Self-Sufficient 3. Surplus *[Fill in the relevant code]*

3.3 Mention deficit coping strategy *[Fill in the relevant strategies]*

1. Cash crop sale
2. Buying food
3. Livestock sale
4. Restricting use of food to food
5. Engaging in non agricultural activities
6. Other strategies [*Mention]*
   ____

The completed questionnaire should be returned to the Headquarters before 15/5/99

The completed questionnaire should be returned to the Headquarters before 15/5/99

4. FOOD CRP AREA ASSESSMENT:

1	2	3	4	5
CROP	Month planted (1 – 12)	Month harvested (1 – 12)	Percentage change of under foodcrop from last year (1-6) [See Note below]	Remarks (for more than 15% change (1-6) [See Note below]
Maize				
Sorghum				
Paddy				
F. Millet				
B. Millet				
Pulse				
Other Pulses				
Wheat				
Banana				
Cassava				
Sweet Potatoes				
Round Potatoes				

Note: In column number 4 and 5 jilli relevant cores as shown below:

Column 4:
1. Less than 15% of last year
2. Less than between 5% and 15% of last
3. Equal to last year
4. An increase between 5% and 15% of last year
5. More than 15% of last year
6. Not applicable

Column 5:
1. Crop pets and diseases
2. Rodents
3. Increased adoption of improved technology
4. Availability and distribution of farm inputs.
5. Floods and droughts
6. Other reasons (mention)

5. Confirmed accuracy

5.1 Name of Enumerator …………………… Sahihi…………………….. Date……………………..

5.2 Name of District Supervisor Sahihi……………………. Date……………………..

5.2 Name of Regional Supervisor ……………… Sahihi …………………… Date ……………………

The completed questionnaire should be returned to the Headquarters before 15/5/99

Summary of HIFFA (High Frequency Forecasting Approach)

(Alternative Approach)

1. Food Crop Production Likelihood, Sept/Oct.
   At the pre-season – during land preparation or immediately after final forecast
   Only past trend analysis is considered upto final forecast and projected into future.
   This can best be done around September/October.
   e.g. Pre-1998/99 Food Crop Production Likelihood, September/October 1998.
   *Data 1: Post harvest view (PHS Report) – if available by September, can also be considered.

2. Season's Onset Food Crop Production Forecast, November/December

   At the Season's Onset (November/December) – Following Land Preparation/planting
   e.g. 1998/99 Season's Onset Food Crop Production Forecast, Nov/Dec, 1998.
   *Data 2: Crop Targets, October

3. Early Food Crop Production Forecast, Feb/Mar

   At the end of Vuli rains – Following end of vuli (in bimodal areas) and active planting for and msimu (in unimodal areas) as masika planting starts (in bimodal areas) *February/March.*

   e.g. 1998/99 Early Food Crop Production Forecast, *February/March 1999*.

   *Data 3: Implementation Report I/PHS Report, December

4. Preliminary Food Crop Production Forecast, *March/April*

   At the end of Msimu rains as msimu crop in unimodal areas matures and masika crop in bimodal areas continue to actively vegetate *(March/April).*

IV. LESOTHO METHOD OF CROP PRODUCTION FORECASTING

By

Ms M. Molatoli, Bureau of Statistics (BOS), Lesotho

The Kingdom of Lesotho is a small country of about 30,355 sq km in the Southern part of Africa with a total population of about 2 million. Maize is the dominant domestically produced staple food crop and it accounts for 50% of arable land. Sorghum accounts for 25% followed by wheat with 15%. Other food crops are beans and peas.

As the member of SADC , Lesotho is also a member of Regional Early Warning System for food security. The co-ordinating office of National Early Warning in Lesotho was established in 1987 and has three permanent members, senior economic planner, economic planner and an assistant economic planner. Besides these three officers, there are part-time members from other government departments which are, two members from the Department of Meteorology and two statisticians from the Bureau of Statistics (BOS).

BOS is the main supply of information concerning crop production estimates and area planted. It also provides the unit with field enumerators during Crop Forecasting Survey (CFS). There are 80 permanently hired field assistants who are supervised by 18 field officers and 4 senior field officers. During CFS field assistants are responsible for data collection in the fields and are closely supervised by their supervisors to ensure data of high quality.

TRAINING OF FIELD ASSISTANTS

Training of field staff is usually conducted during the last week of March and it's done at headquarters of BOS by members of NEWU and BOS senior officers. They are trained on data collection methodologies and how to fill the questionnaires. The training takes three to four days especially if there are new staff members. The first two days are for theory while the remaining days are for practicals.

CROP FORECASTING

Sampling Method

BOS conducts Agricultural Production Survey (APS) annually and they have developed a Master Sample with enumeration areas that constitute Primary Sampling Units (PSU) which are identifiable by boundaries defined by physical features and important land marks and were delimited in terms of population size from the population census data. These PSUs are selected with probability proportion to size using stratified multi-stage sampling where district is domain of study and ecological zone is the strata. Eighty (80) PSUs are selected in all and in each about 25 households is selected using systematic random sampling method. PSUs are first sampling units and farming households are secondary sampling units.

Data for Crop forecasting is collected from a sub-sample of 5 fields per PSU out of 10 fields per PSU that are selected for crop cutting by BOS.

How to select the 5 fields for crop forecast.

All 10 fields that are selected for maize crop cutting are numbered and fields with even numbers are selected for forecasting.

In case of sample with less than 10 fields, the sub-sample for crop forecasting will be reduced accordingly. For example if fields planted to maize in a PSU are only 8, then only 4 will be selected for forecasting.

Data Collection for Maize

To be able to get production two components are required: planted area and yield per hectare. Planted area is calculated by BOS from the Agricultural Production Survey. This is an exercise where enumerators do physical measurement of all fields operated by selected households by using compass to get bearings and measuring tape to get the lengths.

Data is collected from two sub-plots of 10 square meters each from selected fields. To mark the sub-plot, the enumerator has to select a random number (N1) (from random numbers sheet), which is between 1 and the longest length of the field and the second random number (N2) between 1 and the longest width of the field. Using a tape, he will measure along the length a distance equal to the first number (N1). Where it ends he will measure at right angle into the field, the distance equal to the second random number (N2). Where it ends will be the centre of the sub-plot and using sub-plot instrument he constructs the first plot. The same procedure will be used to construct the second plot in the same field.

After constructing sub-plots the enumerator will take the following steps:

In Plot 1

1. Count the number of effective plants in that sample-plot. A plant is effective if it has at least one effective cob.

   Count the number of effective cobs in that sample-plot. An effective cob is a cob that has some grains on it.

2. Select 5 effective plants in the following manner:

   Plant 1: Select effective plant nearest to the Centre in the sample plot

   Plant 2: Select effective plant farthest to the North in the sample plot.

   Plant 3: Select effective plant farthest to the East in the sample plot

   Plant 4: Select effective plant farthest to the South in the sample plot.

   Plant 5: Select effective plant farthest to the West in the sample plot.

   If total number of effective plants are 5 or less, then all plants taken which means selection of plants is not done.

3. Count number of effective cobs on the 5 selected effective plants are counted and their cobs are serially numbered. The serial numbers are entered in column 1 of the Form.

4. Uncover the cobs of the 5 selected plants and using a tape measure the length (which is covered by grain) of each cob in millimetres (mm) and record the results in column 2 of the form.

5. Then measure the maximum circumference of each cob in mm and record the readings in column 3

6. Then check the fullness of the each cob and record that in column 4. In some cobs the effective surface area may not be fully covered by grain. To account for such cases the fullness of each cob is recorded in percentage. If the cob is full of grain it is recorded as 100% full, for cob which is □ full it is recorded as 75%, □ full is recorded as 50% full and 1/4 is recorded as 25% full. After recording all data for sample-plot one in columns (1) to (4) of form 1, record similar data for sample-plot two in columns 5 to 8 in the same form.

   Note that one form is for one field.

   Out of the five plants of sub-plot one selected in step 3, select the plant in the centre and the plant in the north for collecting cob samples. Collect all effective cobs on these two plants with sheaths on them, put them in a perforated plastic bag. Write all the identification particulars of the sample-plot on the label provided and place it inside the plastic bag. The bags are closed securely, holes in the bag will allow some air to circulate inside. When data are ready, bags are sent to the field officer who will send them to BOS headquarters.

   Data collection for Sorghum

   Selection of fields for collecting data is the same as in maize.

   1. Count number of effective plants as in maize. An effective plant is a plant with at least one effective head.

   2. Count number of effective heads on five effective plants. An effective sorghum head is the one with grain.

   3. Select 5 effective plants as in maize. Thus one nearest to the Centre, one farthest to the North, one to the East, one to the South and one to the West.

   Count number of effective heads on the five plants.

   Then remove all effective heads from effective five plants and put them in the bag as in maize.

Data Analysis

Data analysis is done by Agro-economist and Agro-statistician.

Maize

To estimate yield per district a linear regression model between dry grain weight and cob size is fitted. This is because it has been established that weight of maize grain on a cob is correlated with its size. The regression relationship is therefore, estimated between the dry weight of the grain, which is the dependant variable and cob size, which is an independent variable. It is calculated using the cobs that were collected from the two effective plants in sub-plot 1 during data collection.

Calculation of dry Weight

From the cobs that were collected from the two effective plants, calculate moisture content and grain weight. Since the cobs are collected prior to harvesting time and before they have fully dried, it is necessary to measure their moisture content. Upon arrival of the cobs from the districts, they are shelled individually and their wet weight is taken. The moisture content of grain is observed using a moisture meter and the results are recorded. In case where the grain is too small and its moisture content can not be read, combine the cobs from the same field and measure.

To get the dry weight the following formula is used:

$$\text{Dry weight} = W * ((100 - M)/(100-13))$$

Where W - is the wet weight of shelled grain
M - is the % of moisture content observed from the shelled grain
13 is the % of moisture content in completely dry grain.

The cob size and the dry weight are calculated individually for all cobs that were selected in the district.

Calculation of cob size

To calculate the cob area the following formula is used:

$$\text{Cob Size} = (L * C * F)/\pi$$

Where L is the length of the cob
C is the circumference of the cob
F is the fullness of the cob
π is taken as 3.143

The cob size and the dry weight are calculated individually for all cobs that were collected in the district.

The regression analysis

Linear regression analysis is run for the district with the calculated dry weight and the calculated cob size. The regression gives the coefficient of the cob size in the district and constant. To estimate the yield per hectare using the regression equation, we calculate average cob area and substitute the results in the regression equation. It should be like this:

$$\mathbf{Y = aX + b}$$

Where Y is weight of dry grain
a is the coefficient from the regression
X is total cob area
b is the constant from the regression

After running the regression relationship then, calculate the average cob area per district. The calculated average cob area per district is then substituted in the regression equation to give estimates of average weight of dry grain per district. The substitution is done in the following manner:

$$Y = a(Aca) + b$$

Where Y = estimate of average weight of dry grain
a = coefficient from regression analysis
Aca = average cob area per district
b = constant from the regression analysis

Yield per hectare

Yield per hectare is calculated using the following formula

$$Y/ha = Anc * Agw$$

Anc = Average number of cobs
Agw = Average weight of dry grain

Production

Production is estimated by multiplying area planted to maize with estimated yield per hectare. Area planted is collected by BOS.

SORGHUM ANALYSIS

In sorghum crop there is no regression analysis. To estimate yield per district, first estimate yield per field in grams.

Formula used to calculate yield of each field is as follows:

$$\mathbf{Y = (E_{p1} + E_{p2})/2 * (Dw/E_{sp})}$$

Where Y is the estimated yield in grams
E_{p1} is the number of effective heads in sub-plot 1
E_{p2} is the number of effective heads in sub-plot 2
Dw is the dry weight

E_{sp} is the number of effective heads in five selected plants from sub-plot 1

Dry weight is calculated by shelling all heads from each field, weighing the grains together to get wet weight and then calculate the dry weight using the same formula as in maize crop. The calculated yield which is in grams per 10 m^2 is then converted into kilograms per hectare.

For example if yield per 10 m^2 is 1200 gms then yield per hectare will be 1200 kilograms

i.e. If 10 m^2 = 1200 gms
Then 1000 m^2 = ?

(1000* 1200)/10 = 120000 gms

Then to get kilograms divide the results by100 = 1200 kg/ha

After getting the yield per field using the above formula then calculate the average yield per PSU or District. The results will be yield per district/PSU in kilograms.

19…./00

MAIZE FORECAST SURVEY IN LESOTHO

Form 1 Data for Maize yield measurement

District ______________________ Zone ______________________ PSU ______

Name of H.H. Head ___________________________ S. No of selected Field ______

Field area (ha) __________________

Details of Sub Plots

Sub – Plot 1

No. of effective plants _____________________

No. of effective cobs _____________________

No. of effective cobs in 5 sel. Plants __

Sub-Plot II

No. of effective plants _________________

No. of effective cobs _________________

No. of effective cobs in 5 sel. Plants _______

Details of cob measurements

SUB-PLOT I				**SUB-PLOT II**			
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
number	**length**	**(mmcir.(mm)**	**fullness**	**%number)**	**Length**	**(mmcirc.(mm)**	**Fullness(%)**
Comments:							

19……/00

SORGHUM FORECAST SURVEY IN LESOTHO

FORM 2: DATA FOR SORGHUM YIELD MEASUREMENT

District ____________________________ Zone ____________________ PSU ____________

Details of Plant and Head Count

Serial number Selected Field	Name of Household Head	Sub-plot I					
		Number of Effective plants	Number of Effective heads	No. of heads in 5			

REMARKS

Name of enumerator: ____________________ Date: _____________ Signature: ______________

Verified by: _____________________ Date: ________________ Signature:_________________

V. MALAWI METHODOLOGY OF CROP PRODUCTION FORECASTING

1.0 BACKGROUND AND OBJECTIVES

Prior to 1991, the Ministry of Agriculture and Irrigation through extension staff used to estimate smallholder crop production using non-scientific methodologies, which were entirely subjective. However, realizing the importance of reliable and timely pre-harvest and immediate post-harvest crop estimates, the National Crop Estimates Committee (N.C.E.C) recommended the use of an improved methodology for forecasting crop production. A sample survey methodology was therefore designed to provide objective and accurate results. With the support of the National Crop Estimates Committee (N.C.E.C) and the cooperation of Agricultural Development Division extension staff, the new methodology was adopted in the 1992/93 growing season.

The objectives of the crop production forecast survey are:

(a) furnish policy makers with estimates of crop production timely ;
(b) provide reliable information using verifiable, practical and cost effective methods; and
(c) furnish decision makers and researchers with crop production data.

2.0 SCOPES AND COVERAGE

The survey approach divides the crops into two categories:

Major crops - which together account for about 95% of the total crop area in an individual Agricultural Development Division.

Minor cops - which together account for about 5% of the total crop area in an individual Agricultural Development Division.

- The survey covers all Agricultural Development Divisions and covers twenty crops grown by smallholder farmers in Malawi.

- The sampling procedure involves the selection of individual agricultural households for major crops and selection of individual blocks for minor crops.

3.0 INSTITUTIONAL ORGANIZATION/STRUCTURE

Malawi is divided into eight Agricultural Development Divisions (ADDs). ADDs are further divided into two to five Rural Development Projects (RDPs).

- The RDPs, are divided into Extension Planning Areas.
- Extension Planning Areas (EPAs) are subdivided into sections
- Sections are subdivided into blocks.

4.0 SOURCES OF DATA

The main sources of information for crop forecasting are:

- Meteorological Department,
- National Statistical Office,
- Agricultural Development Divisions,
- Input Private traders

5.0 METHODOLOGY FOR CROP FORECASTING

5.1 Crop Production Forecast Sample Survey Phases

The survey, which is conducted annually, occurs in four distinct phases:

- **First phase -** listing of agricultural blocks is prepared from which the sample blocks are selected on a random basis.
  In the same phase, agricultural households in each selected block are listed. The survey sample households are then selected from the list on a random basis.

- **Second phase -** Involves area measurement of major crops grown by sample household in selected blocks. The results obtained are then used to forecast EPA, RDP and ADD area for crops concerned.

  Also during this phase relative yield estimates are determined for forecasting crop production.

- **Third phase -** involves final area measurement of major crops grown by the sample household and the result obtained to forecast EPA, RDP and ADD area for the crop concerned. New survey estimates of yield and production are also prepared at this stage.

- **Final phase -** This implemented at harvesting time of the major crops. No changes are made during this phase to crop areas determined previously since activities are concentrated on the measurement of the quantity harvested for major crops using selected sampled households.

5.2 Sampling Procedures for the Crop Production Survey Forecast Sample

- A stratified two-stage systematic sampling method is employed for major crops. EPAs in each RDP constitute the strata and the block is the Primary Sampling Unit (PSU).

- The first step in sample identification involves the selection of 25% of the blocks in each EPA. These blocks are selected by systematic random sampling.

- The second step requires identification of agricultural households drawn from the selected blocks. In each selected block, all agricultural households are listed. From the list, a survey sample of 20% but in any case not more than 15 households, is identified using systematic random sampling.

- The overall sampling fraction represents about 5% of all agricultural households. Data on major crop area, yield and production is gathered from these block survey sample households.

5.3 The Assessment of Crop Area, Yield And Production during the First Crop Forecast

5.3.1 Measuring Crop Area in Hectares

Once selected blocks and households have been identified, Field Assistants gather data on crop area, yield and production.

- All gardens and plots within a garden cultivated by selected agricultural households are measured regardless of whether or not they are planted at the time of area measurement.

- Since gardens/plots within gardens are often of various irregular shapes, Field Assistants first approximate the gardens and plots concerned either to rectangles or squares as appropriate using give and take method. Then, the length and width of the individual rectangles or squares are measured in paces.

(After completing garden /plot measurement for major crops for the selected households the information is recorded in Form 1)

5.3.2 Assessment of Crop Yield in Selected Block for the First Crop Forecast

The initial assessment of yield for all crops is made by Field Assistants soon after the planting of crops has been completed.

- Subjective assessments are made in relation to crop situation at the same time in the previous growing crop season and takes into account the general crop appearance, weather situation, input supply (seeds and fertilizers) and crop germination together with the Field Assistant judgement. The assessment is made for the whole block and not for individual selected households.

- These yield assessments are recorded in terms of scores viz. 0,1 or -1, 2 or -2 and so on.

(After completing yield assessments for all the crops in the selected blocks, the information is recorded in Form 2)

5.3.3 Tabulation of Crop Area and Yield Assessment for the Selected Blocks

The final activity requires the Field Assistant to estimate individual crop area and yield in the blocks for which they are responsible, using results already obtained from the selected blocks and households. In order to achieve this, Field Assistants are required to calculate the following:

- **Total crop Area -** this is the sum of the crop area grown by the block's sample households. This is calculated by adding the individual household crop areas.

- **Average crop area per household -** this is obtained by dividing total crop area for major crops in the selected block by the number of households in the block. The divisor is the same for all major crops in the selected block even if the crop is not grown by some households in the selected sample.

- **Estimate of block area -** to determine the crop area in the block, the average crop area per household is multiplied by the total number of agricultural households in the block.

- **Block Yield Assessment -** Yield assessments for the current season are made taking into account factors like general crop weather situation, inputs supply, germination rates and Field Assistant's careful judgement.

(After estimating crop area, yield and production for the EPA, the information is recorded in Tabulation Sheet 1)

5.3.4 Estimate of EPA Crop Area, Yield and Production

To estimate EPA crop area, yield and production, Development Officers calculate the following:

- **Total EPA Crop Area -** To calculate total individual crop area of selected blocks in an EPA, the total area of selected blocks in an EPA is divided by number of blocks selected and multiplied by total number of blocks in the EPA.

- **EPA Crop Yield -** to calculate EPA crop yield (kg/ha), the Development Officer averages the yield scores for the selected blocks for each crop and convert the scores to actual yields using guidelines for converting yields

- **EPA Crop Production -** to calculate EPA crop production forecast, Development Officer multiplies the EPA estimate of crop area (hectares) by the EPA forecast of crop yield (kg/ha) and the product is reported in tonnes.

(After estimating crop area, yield and production for the EPA, the information is recorded in Tabulation Sheets 2 and 3)

5.3.5 Estimates of RDP Crop Area, Yield and Production for the First Crop Forecast

- To prepare crop area, yield and production for the RDP, Project Officers, aggregates EPA data submitted earlier to them by Development Officers in their RDP. The Project Officers then submit aggregated RDP data to the Programme Manager who in turn aggregates for the ADD.

- In the second round of the crop production estimates the procedures of estimating area, yield and production remain the same.

- However, emphasis is put on updating crop areas and reassessing crop yield.

Field Assistants select three farmers per crop whose output would be weighed in the last round.

(After aggregating crop area, yield and production for the RDP, the information is recorded in Tabulation Sheet 4 and submitted to the ADD)

5.3.6 Objective Estimates of Crop Yield and Production for the Third Crop Forecast

5.3.6.1 Estimate of Block Crop Area, Yield and Production

Yield and production assessments for major crops are based on actual measurement rather than subjective judgement.

To accomplish this work:

- Three sampled households are used to determine crop production and yield.

- Field Assistants are supplied with spring balances for weighing crop production.

- To increase accuracy of determining yield and production of crops, Field Assistants remind the three farm households selected for each crop to carefully note the number of harvest units obtained for each crop.

- Field Assistants weigh a sample of at least two harvests units for each crop and to average the answer obtained.

(After recording crop area and production for the block, the information is recorded in Form 4 and submitted to the Development Officer at the EPA)

5.3.6.2 Estimate of EPA Crop Area, Yield and Production

- **Estimate of Crop Area at EPA level** - since the updated area estimates are not required for the last phase, Development Officers use EPA area estimates determined during the second crop forecast.

- **Crop Yield and Production Estimates -** Crop yield data for the selected blocks is given in actual yield in kilograms per hectare. An average of the selected block yield is calculated by dividing the sum of the yield by the number of selected blocks growing the crop.

- **EPA Crop Production -** Crop production is estimated by multiplying EPA area for the crop by average yield per hectare for the EPA. The resultant production figure is reported in tonnes.

(After estimating crop area, yield and production for the EPA, the information is recorded on Tabulation Sheets 2 and 3)

5.3.6.3 Estimates or RDP Crop Area, Yield and Production For The Third Crop Forecast

Project Officers next work with data from completed Tabulation Sheets 2 and 3 submitted by their Development Officers to aggregate RDP crop area, yield and production in exactly the same way as in rounds 1 and 2 of the crop production forecast.

(After aggregating crop area, yield and production for the RDP, the information is recorded in Tabulation Sheet 4 and submitted to the ADD)

6.0 USES OF CROP PRODUCTION FORECASTS

Crop production forecasts are the main source of information on crop production data and are used by different stakeholders for planning, research and policy analysis. The main interested bodies in crop production forecasts are Government departments, Non Governmental organisations, the private sector and research institutions.

7.0 ISSUES, PROBLEMS AND CONSTRAINTS

While technically sound the methodology suffers from a lot of administrative problems.

- Lack of financial resources for the supervision tend to result in negligence of Field Assistants thereby undermining the accuracy of crop production estimates.
- Lack of weighing scales and calculators result in few objective measurements being made in third round of the crop production forecast survey.
- The sample size of thirty households per Field Assistant has been argued to be very large to be accommodated among the numerous demands of the Field Assistant, forcing Field Assistants adopting short cut methods for area measurement.
- High staff turnover results in some sections not being manned.
- There is a high risk of computational error resulting from manual calculation of figures at different stages (from the section to the ADD).
- Lack of a methodology for forecasting horticultural production.

8.0 CONCLUSION AND RECOMMENDATIONS

The current crop production forecast methodology is scientific, providing objective and verifiable crop estimate figures. Most of the problems with the current crop estimate survey hinge around lack of resources. Once maximum support is given to Field Assistants nearly accurate crop production estimates are produced. The methodology produces crop production forecasts timely for policy makers, planners and researchers.

VI. MAURITIUS FOOD CROP PRODUCTION FORECASTING

By

Mr. R.K. Ramnauth

1. INTRODUCTION

In Mauritius, food crop production is undertaken by some 15,000 private growers on small scale. The total physical area used for the cultivation of food crop is estimated at around 4000 ha. Out of this total area some 600 ha are under permanent gardens while the rest are either sugarcane interlines or rotational lands. Since the crop cycle of food crops are generally very short it is possible to harvest 2 to 3 round of crops from the same are during the year. The average total annual harvested area is estimated at around 6500 ha. Depending on climatic conditions the total food crop production is situated between 90,000 to 100,000 tonnes.

The plots cultivated under food crop range from 0.1 ha to 2 ha and there are very few growers cultivating over 2 ha. A relatively small amount of the total planted area is irrigated while the rest are mainly rain fed. Concerning fruit production, the area under orchards is estimated to be around 400 ha and is expected to increase in the coming years. However, fruits other than banana and pineapple are mostly grown in the backyards although some commercial citrus and litchi orchards have recently been established.

Monitoring of food crop production has been performed for more than 20 years. Data collection has been performed by Field Officers of the Extension Services who have been trained for the purpose.

2. OBJECTIVE OF FORECASTING

Food crop production forecasting is mainly conducted to provide early estimates to policy makers and stakeholders in agriculture. The production of potato and onion is not sufficient to meet the local demand, thus early forecast is required to plan importation of these commodities. Furthermore, monitoring of food crop production and production forecast is intensively used by the Extension Service to advise and assist growers in drawing their cropping calendar and planning their production.

3. SCOPE AND COVERAGE

Food crop covers all major vegetables that are produced and consumed locally and also include banana, melon and pineapple. The length of crop cycle varies from crop to crop the smallest being that of green bean (5 weeks) and the longest is given by chillies (12 months). Some of the crops like cabbage, potato, onion etc, are harvested in a single round while others like aubergine, tomatoes etc. are harvested in more than one round. A list of currently grown vegetables with estimated yield and number of harvest rounds is given in annex I. A small amount of selected vegetables and pineapple are exported for short periods of the year. Monitoring of production covers all commercial plantations over the island. A small amount of vegetables is also produced in the backyards either for own consumption or sold on the local market. The amount produced is not significant and thus is not covered in the monitoring process. However, a significantly large amount of fruits especially banana is grown in the backyard. This data is not collected and adjustment to take account of this fact is made in final production estimates.

3. INSTITUTIONAL ORGANISATION/STRUCTURE

The Agricultural Research and Extension Unit (AREU) falling under the aegis of Ministry of Agriculture is responsible for the monitoring of food crops production over the island. Collection of field data is conducted by the officers of the Extension Department of AREU. Extension Assistants, under the supervision of Senior Extension Officers, conduct field surveys at monthly intervals in their respective zones for data collection. Data is collected on prescribe forms and is centrally reported to the Biometry and Statistics Unit at the head Quarters of AREU. All data entry, validation and processing is conducted by the Unit.

4. BASIC STRUCTURE

The island is divided into 9 administrative districts. The districts have been regrouped to form 5 main regions viz. North, South, East, Centre/West and Tea Diversification Area. The North, South and East regions are further divided into 4 zones while the Centre/West region is divided in 3 zones only. The Tea Diversification area is a zone by itself. The zones are referred to as N1,N2,N3,N4,S1,S2,S3,S4,E1,E2,E3,E4,W1,W2,W3, and DA. The physical areas covered by each zone are not necessarily equal and zone delimitation is based on the cultivated area and number of planters. Each zone is further subdivided into 10 equal sub-zones for the purpose of extension activities. A Senior Extension Officer is responsible for each region and each zone has its own Extension Assistant for the collection of data.

5. METHODOLOGY

5.1 Data Collection and Reporting

Field surveys are conducted over the whole island at monthly intervals by Field Assistants in their respective zones. Thus, each cultivated field is visited at least one a month. Data is collected from observations taken directly from the field and from information given by the grower. The information gathered is compiled by locality for each crop and reported on prescribed forms referred as the ‘Food crop Statistics Return’ (annex II a & b). The following are reported in the Food crop Statistics Return for each month:

a) Zones,
b) Sub-zone,
c) Locality (village),
d) Ownership (owner, sugar estates, metayer),
e) Type of cultivation (interline, full stand etc.)
f) Crop observed,
g) New area under cultivation,
h) Area harvested for each crop,
i) Estimated yield for each crop,
j) Harvest number if crop is harvested in more than one round.

5.2 Estimation of Cultivated Area

Both newly planted and harvested areas for each crop are reported at monthly intervals in the Food crop Statistics Return. The exact area of most of the fields is obtained from the owners. Area estimation is necessary when more than one crop is grown in the same field or when part of the field is left fallow. Areas are estimated by using the steps method. Most fields are rectangular and easy to measure. Non – rectangular fields are reduced to rectangles and triangles for measurements.

5.3 Crop Yield Assessment

Crop yield assessment is conducted by Extension Assistant under the supervision of the Biometry and Statistics Unit. Under normal conditions yield assessment for common crop is conducted once or twice in a year. In case of a calamity event like drought, cyclone or flood a set of fresh assessment is made to review yields estimate. Yield assessment for specific crops like potato, onion and, tomatoes are carried at harvest time using a specific methodology.

5.4 Potato Yield Assessment

A minimum of five fields is selected at random from each zone. Separate samples are taken from regular and interline plantations falling in a zone. From the selected fields ten plots of 160 cm X 150 cm are selected per hectare of plantation. Each sample consists of 2 rows giving a total of 10 plants. The first plot is selected from any corner of the field on the 15th plant of the 16th row. The plot will include 5 plants from the 17th and 17th row respectively. The next subsequent plot is selected 32 rows and 30 plants away from the first/preceding plot in the direction of the field. The harvested potato tubers are weighed after cleaning and removal of non-marketable tubers using a pan balance reading an accuracy of at least 50g.

5.5 Onion Yield Assessment

A minimum of five fields is selected at random from each of the three main growing areas for respective varieties. Five equally spaced bed strips are selected starting from one corner of the field leaving one bed strip on each side. A sample plot of 300 cm in length is selected from each of the selected beds measuring 120cm wide. The first plot is taken at 300 cm inside from the border of the field and the subsequent plots are taken following the diagonal line of the field on the selected bed strip. The harvested onion bulbs are weighed after topping and removal of non-marketable bulbs using a pan balance reading an accuracy of at least 50g.

5.6 Yield Assessment for Other Crops

Five fields are selected at random from each zone. From each field five equally spaced rows are selected. Random plots of 2 rows of 5 plants running along the length of the row are selected. In this case there are some crops having multiple harvest which are conducted usually between 2 to 7 days or more. The harvested vegetables are weighed, at each harvest rounds, after cleaning and removal of non-marketable parts using a pan balance reading an accuracy of at least 50g. The cumulated weight of produce from each harvest round from a plot is used as the total yield of the plot.

5.7 Plot Yield Estimate

The average yield of a plot of specified size is obtained by using a simple average of yields from assessed plots. The average yield is then multiplied by the corresponding factor (10,000 divided by size of plot in m5) to obtain the estimated yield per hectare. Care must be taken to adjust for pathways and non-cultivated areas between beds which varies from crop to crop. Some crops may have non-cultivated area as large as 20% of total field.

5.8 Crop Forecasting

Production forecasting is conducted at various points in time depending on crop and requirement of users for this information. However, production forecasts are required either for a long term or start of planting season.

Long term forecast (forecast before any plantation has started) is derived from linear trends obtained from past five years production data. Adjustments are made in respect to the current climatic situation and other factors influencing production such as availability of land and inputs.

The next method used for forecasting is estimation of production through the amount of seed required for the season. This method gives a fairly good initial estimate in the case of potato production as the total seed required for the season is supplied only by the Agricultural Marketing Board. The production estimate is obtained by multiplying the amount of potato seed in tonnes by the yield factor. The yield factor is the amount of ware potato obtained from one tonne of seed potato. This method is useful where data is available on the total amount of seed allocated or available for actual plantation.

The other method of forecasting involves newly planted area. The production forecast is obtained by multiplying the total newly planted area for the month by the previously observed yield of that particular zone. Thus the total of all the zones provides a national estimate. Here the forecast is at a point in time distanced by the length of the crop cycle from the date or month of plantation. The production estimates for crops having a planting season over more than one month is obtained by adding the estimates from previously planted areas which have not been harvested yet. Though this method yields a good estimate it is not suitable to forecast beyond the length of the crop cycle.

Forecasted estimates are updated taking into consideration climatic changes and pest and disease evolution. However, a production forecast can always originate from a long term one, updated if data is available on seed allocation and the estimate is further refined with area put under cultivation. Finally, the forecasted figures may be verified with actual production figures.

6. USE OF INFORMATION

The estimates obtained are used by the Early Warning Unit and is disseminated to other stakeholders in agriculture although the Food crop Outlook, which is a monthly publication of AREAU. Early estimates are also used by the Central Statistics Office for use in National Accounts and Economic Indicators. Production forecast for potato and onion is used by the Agricultural Marketing Board for planning importation of these commodities. The Ministry is also a user of such an information to ensure a constant supply of vegetables for local consumption and the tourist industry. Other users are the Chamber of Agriculture, the Agricultural Services and FAO.

7. PROBLEMS AND CONSTRAINTS

The main constraint of high importance is the unavailability of a methodology for forecasting and estimating fruit production. Transport facilities has been a constraint, for quite some time, for conducting surveys especially to access fields in sloppy regions and places which are difficult to access by car.

Equipments are not available at regional level to facilitate data capture. Thus, the system takes a lot of time from data collection to actual processing, as all the field reports are processed centrally.

8. CONCLUSION

The present methodology is providing sufficient information to users but there is a lot of room for improvement. However, it is expected that in future there will be a demand for earlier and more accurate production forecast which prompts for an update in the present methodology used.

(ANNEX 1)

List of Foodcrops grown in Mauritius

Crop	Average Yield (t/ha)	Harvest Rate (Months)	Crop	Average Yield (t/ha)	Harvest Rate (Months)
Asparagus Bean	6.3	3	Ginger	3.5	1
Banana	19.4	12	Green Pea	1.7	1
Bean	4.4	1	Groundnut	2.9	1
Beet	17.2	1	Ladies Finger	4.9	6
Bittergourd	3.5	3	Leek	10.9	1
Brinjal (A)	11.1	6	Lettuce	13.7	1
Brinjal ©	14.0	6	Maize	5.2	1
Broccoli	15.5	1	Cassava	15.3	1
Cabbage	20.8	1	Onion	28.8	1
Calabash	11.6	2	Patole (Snake Gourd)	7.1	2
Carrot	14.3	1	Petsai (Chinese Cabbage)	15.8	1
Cauliflower	20.0	1	Pineapple	16.8	3
Chillies (C)	5.9	4	Pipengaille	10.1	3
Chillies (L)	4.0	6	Potato	23.2	1
Chillies (S)	3.8	12	Pumpkin	14.2	2
Chouchou	21.8	6	Squash	9.6	1
Cucumber	9.5	2	Sweet Pepper	13.2	1
Eddoes (C)	9.3	1	Sweet Potato	14.0	1
Eddoes (V)	8.3	1	Tomato	10.3	2
Garlic	6.7	1	Watermelon	13.5	1

VII. ZIMBABWE FOOD CROP PRODUCTION FORECASTING METHODS

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Executive Summary

In Zimbabwe, crop-forecasting exercises are carried out twice a year, during the cropping season. A number of organisations are involved in food crop production forecasting exercises. In order to have an official crop-forecasting figure, a National Crop forecasting Committee was formed. The Central Statistical Office issue out official figures, which are agreed upon by the National Crop forecasting Committee.

Most of the organisations with food crop production forecasting methodology are the Central Statistical Office (CSO), National Early Warning Unit for Food Security (NEWU) within Agricultural Technical and Extension services (Agritex), Farmer Organisations and seed houses. The methodologies used by these organisations, other than CSO, are included in this paper.

CSO carries out surveys in the large-scale commercial (postal) and the communal sector whilst NEWU produces crop-forecast figures for the small-scale commercial and the communal sector. The department of Agritex conducts data collection for NEWU. Visual assessments are conducted in the two sectors but sample survey is also conducted in the communal sector. Farmer organisations produce figures for their members, and seed houses provide the overview of seed sales. During a committee meeting, all the organisations present their figures for each crop and the figures are discussed until one national figure is produced. A report which cover all methodologies used by organisations involved in was produced by CSO in 1998.

Organisations that utilise the information are policy and decision-makers in government ministries and departments, Non governmental organisations and the private sector. The information is disseminated to the users by post from CSO and by request to other organisations involved in forecasting. NEWU uses the information in food security assessments, which are disseminated in monthly food security bulletins, and other reports.

The recommendation from the food crop forecasting committee members is that, there is a need to standardise the methodologies used by member organisations. The other recommendation is that of combining resources in order to come up with one figure for each crop by sector.

1. INTRODUCTION

1.1 Background Information

There are many organisations involved in crop forecasting in Zimbabwe. In order to have agreed official figures, a National Crop Forecasting Committee was formulated in 1986. The Central Statistical Office (CSO) chairs this committee. The committee is composed of Marketing Boards, Farmer organisations, Seed houses, government and other private organisations. The National Committee is subdivided into three functional subcommittees, namely; Cotton, Grains and Oilseeds and Tobacco Crop forecasting Subcommittees. Each subcommittee is chaired by a marketing institution of the respective crop. The other subcommittee is the methodology subcommittee chaired by CSO, which is non-functional at the moment.

The officially accepted crop forecasts cover ten crops, of which five are food crops (namely; maize, sorghum, finger and bulrush millet and groundnuts. Crop forecasts for other food crops, not officially forecasted, such as wheat and edible beans, are available in some organisations. The Grains and Oilseeds subcommittee chaired by Grain Marketing Board forecasts all of the food crops. Organisations that are involved forecasting of food crops are Farmer organisations, National Early Warning Unit for Food Security (NEWU) housed in Agricultural Technical and Extension Services (AGRITEX) and Central Statistical Office. These organisations present figures to the Grains and Oilseeds sub-committee, for the sectors where they carry out surveys. The figures are deliberated upon and a consensus on national figures is reached. The figures will be presented to the Main Crop forecasting committee for validation and forecasts are issued each year by the chairing organisation, CSO. The preliminary forecasts are issued in March or April and the final forecasts are issued in May.

1.2 Objectives of Crop Forecasting

Food crop production forecasting is carried out in order to determine, in advance, indication of the production prospects before the harvest and the expected retention and sales.

1.3 Uses of Crop Forecasts

Crop forecasts are used at international, regional, national and sub national levels. The figures are incorporated into the regional and international statistics and used in formulation of trade policies and planning of food aid. At national levels the figures are used in the assessment of food availability in the country to enable:

- Preparedness in cases of expected national food deficits or surplus (e.g. import-export planning and food aid by Non Governmental Organisations).
- Planning of procurement programmes by traders, millers and storage companies.
- Preparation of storage facilities by storage companies.
- Formulation of crop market strategies.
- Articulation of policies pertaining to crop prices and subsidies e.g. policy formulation by Ministry of Lands and Agriculture).
- Estimation of the contribution of the food crop to Gross Domestic Product.
- Research by academic and research institutions.
- NEWU assess the food security situation in the country using crop forecasting figures, and publish the information in Food Security bulletins which are disseminated to policy and decision-makers in government departments and the private sector.

At sub national level crop forecasts are used in the assessment of food availability in the communities. The assessment will give an indication of districts were there is excess food and those that have inadequate food. The assessments enable decision-makers in;

- Planning of transport by transporting companies, who transport food to deficit areas
- Planning of storage of the food crops by storage companies
- Identification of areas which require food aid
- Research and developmental work in the communities

2.0 METHODOLOGIES USED BY GRAINS AND OILSEEDS CROP FORECASTING SUBCOMMITTEE MEMBERS

The organisations covered in this paper are members involved in food crop production forecasting other than CSO.

2.1 National Early Warning Unit for Food Security

2.1.1. Introduction

NEWU has the mandate to provide advance information on the food and nutrition situation at national and sub-national level for the formulation and implementation of national and regional policies and action programmes, with the long-term objective of improving food security. Major activities aimed at achieving the Unit's objective include crop production forecasting, estimation of food availability and accessibility, yield modeling, monitoring of crop, livestock and water supplies situation, crop assessment and vulnerability assessments.

Crop forecasting is conducted in the communal and small-scale commercial sectors and data is available at national, provincial, district and communal land levels. The figures are utilised by private and governmental organisations, National Crop Forecasting Committee, and also for the Unit's own analysis, for food security early warning purposes. Crop and livestock monitoring (executed at a fortnightly period from November to end of the cropping season), crop assessments and yield modeling are some of the tools that are used to verify of crop forecasting data.

Agritex staff collects and submits data for the Unit. The Field Staff (Extension Officers) are the enumerators and each is responsible for one ward. The data to be collected during the crop forecasting exercise include area planted, expected production (or yield), retention for own consumption and expected sales to all marketing outlets. Two methods are employed during the crop forecasting exercises, and these are: (i) Subjective (Traditional) survey, also used in small-scale commercial sector and (ii) Sample survey (objective). The Sample survey was introduced in the 1989/90 cropping season in order to complement the subjective method. Crop forecasting is carried out in all provinces and the exercises are carried out twice a year.

2.1.2 Subjective Method of Crop Forecasting

The Traditional Survey is more subjective and qualitative. The information collected relies on the Field Officer's subjective judgement, experience, intuition (or simply opinion) to estimate the yield and area under each crop. Estimates are obtained at communal land level. Thus the data collected could be utilised at communal land and district levels.

The data is collected early January (for the First round of crop forecasting) and in early March (for the second round/final of crop forecasting). Crops covered are major cash crops (tobacco, cotton, sunflower, soyabeans, paprika and edible beans), grain crops (maize, sorghum and millets) and groundnuts. Agricultural Extension Officers use different approaches to estimate the area and yield (some use farmer interviews) and their experience to estimate the sales and retention for that season.

The officer submits ward totals or small scale commercial total to their supervisors (an officer at the district) who compiles the total for the communal land and fills in the pre-designed forms. Forms are submitted to the NEWU via the Provincial offices.

Strengths of the method

- It is easy and cheap to carry out given the limited resources that are faced by Agritex.
- All the forms are submitted to the NEWU offices in time because there is less work involved in the collection of the data.
- Estimation of data at communal area level. This level gives a clear picture of the food availability situation at the lowest level in the assessment of food security situations.

Weaknesses

The information is undependable since no formal survey is carried out and also due to the fact that it is subjective.

2.1.3 Sample Survey

Sampling

This is an objective and quantitative data collection method, which involves sampling of households from a village. The sampling was designed to fit into the Agricultural Extension Officers' work programme without disrupting their normal duties. The first round (preliminary) crop forecasting is done in January and a final forecast in March so that the figures could be presented to the Crop Forecasting Committee.

The sampling design is a stratified two stage random sampling. The sample is selected from the 5th administrative levels, the ward, which is composed of about 5 to 6 villages (about 500 - 1000 households). The villages in a ward are the primary sampling units (PSU) where one village is selected. The households in a village are the second sampling unit (SSU) where 10 farming households are randomly selected. The village selected may change after five years when the officer is allotted a random serial number for the villages.

The District Agricultural Extension Officer uses the Random Table prepared by NEWU to allot random numbers to each Field officer in the district. The first number is the random village number, which is used to select the village in the ward. This is accomplished by listing the villages (in the ward) in alphabetical order, and selection of the village with the allotted serial number. The second allotted serial number is the random household number, which the field officer uses in the selection of the first households in the selected village. The field officer lists all the crop-growing households in the selected village in alphabetical order and systematically selects the households. A sampling interval of ten percent of the households in the selected village is applied. The national sample size is about 12 000 households.

Crop Coverage

The crops covered in this survey are Maize, Sorghum, Mhunga, Rapoko, Groundnuts, Cotton and Sunflower. Data on retentions and sales is collected through careful interviews with the respondent. In the second round, data on available stocks from last year's production is also collected.

Area Measurement

The method used for area measurement is the pacing method and area will be the Length of the field multiplied by the Width**.** In most cases the shape of a field is not regular so the **'give away'** and **'take in'** method is used to approximate the field to a square or a rectangle. The aim is to approximate the field to a regular shape, either a square or a rectangle. The portion of the field 'given away' should be approximately equal to the portion 'taken in'.

The Enumerator paces normally along the length and width of the field counting and noting down the number of paces. The number of paces will be converted to metres using the pacing coefficient and a ready reckoner provided by NEWU. The area of the field will be converted to hectares.

Yield Measurements

The yield is measured using Farmer Appraisal Method and the Extension officer's experience (visual assessments). The Agricultural Extension Officers average the farmer and their own yield estimates to estimate average yield per farmer per crop and later production (production = area X yield). Some of the variables used to estimate yield are Crop stand, Crop population, Crop condition and Crop stage.

Data Tabulation

The data collected for 10 households in a village is recorded in a pre-designed form. This data is extrapolated to village and then ward level. To estimate the collected data at ward level, a multiplication factor is multiplied with the totals for the sampled households. The formula for the multiplication factor (K) is as follows:

$$K = \frac{(T_V \ X \ T_H)}{10}$$

Where: K = Multiplication factor
T_V = Total number of villages in a ward
T_H = Total number of households in the sampled village

The ward level data is then compiled together to get the district total. The District Agricultural Extension Officer fills up the district tabulation sheet, which is compiled by NEWU at national level.

Strengths of the Method

- It gives more reliable and more accurate data as compared to the visual assessments since the method is less subject to the Enumerator's opinion. The area and production estimation is based on systematic sampling of the selected farm households.
- The sampling design of the sample survey has an advantage that it fits into the Extension Officer's programs without disrupting the normal activities.
- Since the National Early Warning Unit is also interested in the sub-national level food availability, the sample survey gives better estimates of area planted, production and available stocks at district level.
- The method has a probability of estimating the sampling errors.
- The method has the advantage of using Field Extension Officer because farmers are more open to reveal their estimates of expected sales to a person with a good rapport with them.

Weaknesses

- ❖ The sample size is very small to use the estimate at ward level. This is caused by the use of Field Extension Officer as enumerators because they feel that they are now having much more work to do since the survey requires more work as compared to the subjective method.
- ❖ This method is more costly as compared to the subjective method.
- ❖ The other weakness of this method is that, the sample is taken from one village, which can be totally different from another village in the ward. This causes more error as compared to sampling from the whole ward especially for crops that are minor in some areas such as finger millet.
- ❖ The crop yield and production is based on a subjective method since the cob measurement was not implemented.

2.1.4 Fortnightly crop and livestock monitoring

In addition to the crop forecasting exercise, the Unit uses a monitoring tool during the growing season. Pre-designed forms are dispatched to the field staff via provinces. Field extension officers are instructed to report on area plantings, planting dekad[i], stage and condition of the following crops and graze: maize, sorghum, finger and bulrush millets, soyabeans, groundnuts, sunflower, cotton, edible beans, tobacco, pasture and veld. The field officers are required to give comments in the comment columns. Expected yields are also assessed from the last dekad of January. The report is by district and by major farming sectors namely: large scale commercial, small scale commercial, communal and resettlement.

2.1.5 Crop assessment

NEWU carries out crop assessment exercises, in collaboration with other organisations; to crosscheck on the crop forecasting submissions received. The crop assessment is carried out in February when the first round of crop forecasting has been done. After the exercise, the NEWU team will have a general overview of the situation on the ground. This experience will be used in coming up with national figures during the crop forecasting committee meetings, correction of questionable data submitted and use in different meetings.

2.1.6 Water Requirement Satisfaction Index (WRSI) Model and Remote Sensed Data

NEWU agro-meteorologist carries out dekadal crop forecasts using a modified FAO developed model. The agro-meteorologist uses the model based on water requirements of a crop versus the actual amount of rainfall received. The yield figure is used to crosscheck on crop forecasting figures. During the past two years, the model was not functional since there were excessive rainfall since the model does not indicate negative effects of excess water on yields. The agro-meteorologist also use remote sensed information from The Southern Africa Development Community - Regional Remote Sensing Unit to determine vegetative cover and rainfall activities which will help in crop assessment and forecasting.

2.1.7 Constraints and Recommendations

Constraints

- Since the methods use the Extension Officers that have other duties, forecasting and estimating data adds more work to their normal activities, thereby reducing accuracy and timely collection of data.
- The supervision of data collection involves district and provincial staff that have other activities resulting in lower supervision of data collection. Some of the figures are not cross checked before they arrive to the NEWU offices.
- The implementation of the sample survey required resources such as transport, stationery and other equipment such as the tape measures, which need more financial resources, which are not always available. Most of the Extension officers use bicycles and sometimes walk to reach farmers which are not appropriate for the surveys.
- Training of new staff on data collection is not carried out effectively due to lack of financial resources.
- There is a new structure in the Agritex field division, where one extension officer (who is a specialist e.g. agronomist), will be responsible for four or more wards. It will be very difficult for the officer responsible for crops to cover all wards during crop forecasting.

Recommendations

To address some of the constraints highlighted above the following recommendations could be followed.

- Although data collection is part of the extension staff's normal activity, there is need to make resources available during the crop forecasting periods.
- Training of field officers should be incorporated into the Agritex training programs at district level.
- Since there is lack of proper supervision, there is a need to have a separate financial base for crop forecasting in order to increase mobility of supervisors.
- The sample size in the survey should be in percentage terms since population in wards is changing.

2.2 Farmer organisations

The farmer organisations involved in food crop forecasting are the Commercial Farmers union (CFU), Zimbabwe Farmers Union (ZFU) and Indigenous Commercial Farmers Union (ICFU). Each organisation produces forecasts for its members. In the past few years there were no formal figures from the ICFU and rough estimates were used for their members.

The Commercial Grains Producers Association (CGPA)[ii], subsection of CFU, carries out surveys in April every second year covering about 1 800 Large Scale Commercial Maize producers, with a 45 percent return. Date of plantings, varieties, fertiliser applications and harvest date intentions are analysed. The survey gives the area planted to maize or sorghum, and an early projection of yields. Monthly surveys are undertaken during the periods September to June, by a sample-base of 40 large-scale commercial maize producers countrywide. Trend of plantings ratio between Yellow/White maize, actual yield previous season, and expected yield current season are captured in the surveys. Expected yields are adjusted each month, as the season progresses. Rainfall recordings and distribution are closely monitored so as to assess the effects of excessive/lack of rainfall and the stage of development of the affected crop. The forecasts from CGPA give rough indication of grain production for the season since there are fewer ICFU members. The CFU also forecast groundnut production for its members through surveys.

The ZFU provides forecasts for their members in the small holder sector (small scale commercial, communal and resettlement). The organisation uses commodity representatives in each ward that reports on area planted, and constraints and opportunities faced by the farmers. Area forecast is limited to ZFU members only, so there is need to use figures from other organisations. The yield forecasts are very useful in coming up with national yield figures. ZFU mostly works in collaboration with Agritex and in some cases uses NEWU fortnightly reports in arriving at their figures. ZFU also works in collaboration with NEWU on carrying out crop assessment exercises.

2.3 Seed Houses

Seed houses provide trends in seed sales of grains and oilseeds to the grains and oilseeds crop forecasting subcommittee. The members of the subcommittee will then use the information in coming up with crop forecasting figures for each crop.

3. ISSUES, PROBLEMS AND CONSTRAINTS

3.1 Issues and Problems

- There has been duplication of activities by organisations involved in crop forecasting which will give rise to a subjective way of coming up with the nationally accepted crop forecasts.
- In some cases the users do not rely upon the forecast figures and the subcommittee cannot defend itself due to subjectivity used at national level.
- There is no mechanism in place to standardise the crop forecasting methods used by all stakeholders in crop forecasting.

3.2 Constraints

- Most of the government organisations involved in crop forecasting do not have adequate financial and human resources.
- Some of the organisations are not mandated to do crop forecasts so they do not have the skills to carry out statistically sound surveys.
- Although some of the private and donor organisations are willing to help the crop forecasting exercises in Zimbabwe, there are institutional problems that are

hindering co-ordination among the stakeholders. Some of the organisations are not willing to combine resources with others.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusion

The major problems faced in crop forecasting are centred on inadequate resources whilst there is duplication of resources by organisations (mostly government) that are involved in crop forecasting. Therefore there is a need to combine resources by the organisations and do crop forecasting together or to give the responsibility to one organisation. This action will improve on supervision of data and will centre more resources to the organisation so that more accurate figure will be obtained.

4.2 Recommendations

- The method used in reaching a consensus for national production figures are subjective and not well accepted. Therefore, there is a need to formulate one methodology, which is scientifically based, for all the farming sectors, to give more accurate and reliable figures. There should be a separate budget for crop forecasting purposes in the organisation responsible for crop forecasting.
- The two government departments (i.e. CSO and AGRITEX) involved in crop forecasting should combine resources (either human or financial resources) to carry out the crop forecasting exercise. These two departments are duplicating each other in carrying out crop forecasting surveys in the communal areas using more resources than necessary.
- Most of the new Officers are not trained on how to carry out crop forecasting. Therefore, enumerators (i.e Extension staff) should have basic training and refresher courses at district level.
- The extension officers have many activities to carry out during the crop forecasting exercise resulting in compromise of the figures. In this case the enumerators should have adequate time to carry out the exercise in order to come up with reliable figures.
- There is need to have Crop Forecasting Committees at district and provincial level rather than having the committee at national level alone. This will reduce the subjectivity of the figures at national level since the committees at lowest level will have a clear picture of what is on the ground compared to national committee.
- A post harvest survey, involving stakeholders in crop forecasting, should be carried out in order to test the accuracy of forecasting figures. For the past years, the Crop Forecasting Committee was producing food crop production figures without testing the accuracy of the figures through a post harvest survey.

VIII. THE USE OF TIME SERIES IN CROP FORECASTING

LINEAR MODELS VERSUS NON-LINEAR MODELS

Prepare by

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1. INTRODUCTION

In some countries, linear models, based on time-series are used for crop forecasting. These models are often econometrics models of the form:

$$\mathbf{Y_t = \beta_0 + X_{1t}\beta_1 + X_{2t}\beta_2 + X_{3t}\beta_3 + \ldots\ldots\ldots\ldots + X_{nt}\beta_n + \in_t}$$

Where Y_t = the value of the dependent variable at time t

X_{nt} = the value of independent variable n at time t

β_n = the value of the regression coefficient of the variable X_n

β_o = the value of the constant

$\in_t$ = the random variable

The most simple of these models is the simple regression linear model, with only one independent variable, and the most commonly used in time-series based forecasting is the Trend, which equation is:

$$Y_t = b + at + \in_t$$

where b is the constant term and a three regression coefficient which can be interpreted as the value of annual average (if t is in years) of growth. The estimated model could be written as follows:

$$\acute{Y} = b + \tilde{a}t$$

In this model, while b is of positive sign in general, ã can be of negative or positive sign. Therefore, the forecast values derived from the model will be either continuously increasing or decreasing, depending of the sign of a

The use of such model is absolutely inconsistent for short-term crop forecasting, since although with have evidence of the decrease of the production, due for instance to drought during the previous crop seasons, our model will continue to yield increase of the production, if (**a**) is of positive sign as it is usually the case.

This is why we are proposing an alternative, where time-series are to be used for crop forecasting: the use of non-linear model, which have the possibility of yielding increase or decrease forecast values. The more popular of non-linear models are those of Box & Jenkins, and Exponential smoothing models. The estimation of parameters in Box and Jenkins are very complicated and their interpretation as well. The exponential smoothing models are more simple are also as efficient as Box & Jenkins models (ARMA and ARIMA models). Furthermore, we have designed small software (a component of ECOSTAT) for the forecasting using a simple exponential smoothing model. However, software such as STATPLAN or TSP could also be used in the subsequent chapters, we will give a theoretical overview of the model, and a concrete example using the model and a linear model.

2. EXPONENTIAL SMOOTHING MODELS

Exponential smoothing refers to a class of methods in which the value of a time series at some point of time is assumed to be determined by past values of the time series. The importance of the past values declines exponentially as they get older. This technique is similar to moving average s except that with exponential smoothing, the past values have different weights and all past values contribute in some way to the forecast.

Exponential smoothing methods are short-term forecasting methods. They usually produce good forecasts for one or two periods into the future. The advantage of exponential smoothing is that it is relatively simple to apply. Exponential smoothing should not be used for medium or long-term forecasts. Since it depends heavily on the more recent data points, it tends to perform well in the very short term (case of crop forecasting) and very poorly in the long term.

Exponential smoothing model produce forecast by combining the forecast for the previous period with an adjustment for past errors. Thus, this technique tries to automatically adjust for past errors. In exponential smoothing, the amount of response to past errors is determined by the smoothing constant. The smoothing constant is a number between 0 and 1 and indicates the fraction of the past error to use in adjusting the next forecast. If the smoothing constant is 0, there is no adjustment for past errors. When the smoothing constant is close to 1, there is maximum adjustment for past errors. The best smoothing constant for any time series is usually found by determining the value that gives the best fit to some historical period.

Exponential smoothing models are generally classified in three categories: single, double and triple. We will limit our study to the single exponential smoothing model that is the simplest of these techniques. It produces forecasts using the following equation:

$$F_{t+1} = \beta X_t + (1-\beta)F_t$$

Where:

F_t = forecast at time t
X_t = actual value of time series at time t
β = smoothing constant

It should be noted that, this model is most appropriate for use with time series that has no trend since the error correcting mechanism is simple, these forecasts will always lag behind any series that has an increasing trend.

According to our experience, the default value of the smoothing constant could be set at a starting value of 0.7, and then modify this value, by studying the correlation between the actual time series and the calculated values. The definitive value to be kept will be the value which provide the best correlation coefficient between the observe time series and the forecast one.

3. CASE STUDY.

We will use the evolution of maize production in Zimbabwe from 1990 to 1999.

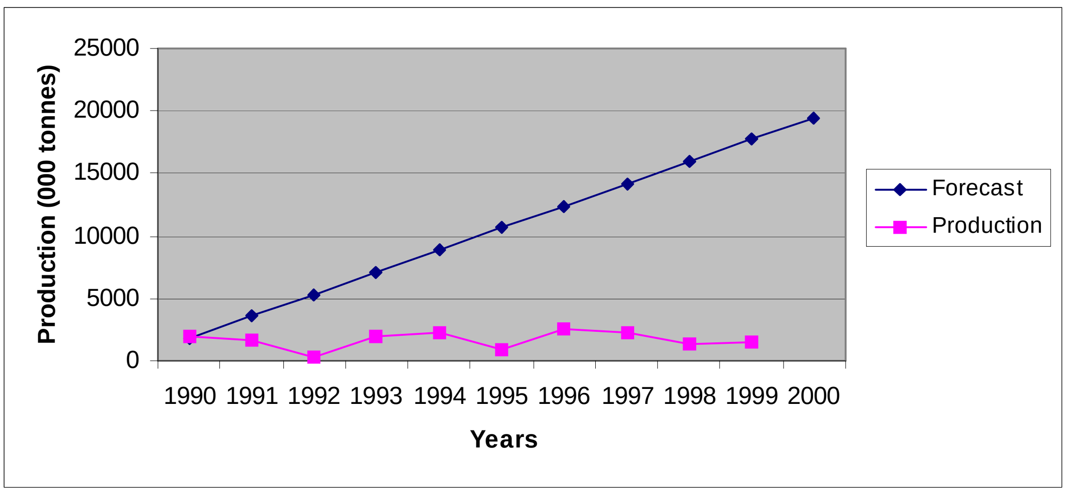
Years	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Production('000 MT)	1994	1586	361	2012	2326	840	2606	2192	1418	1520

Use of the Trend in crop forecasting

From the above series, the estimated model is $\acute{Y} = 0.0016 + 1770\ t$

The following table and chart give the observed and forecast values from year 1990 to year 2001.

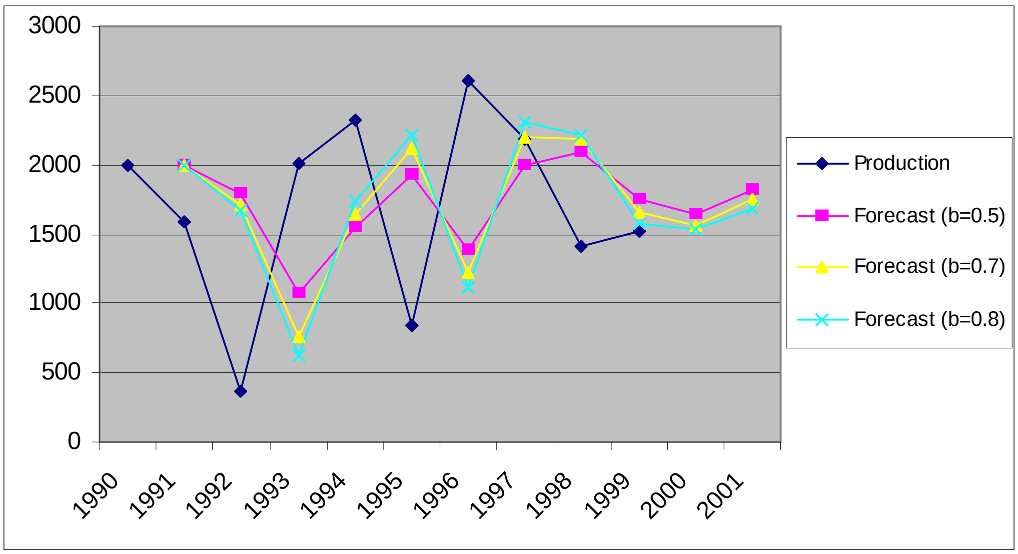
Years	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Production('000 MT)	1994	1586	361	2012	2326	840	2606	2192	1418	1520	…
Forecast ('000 MT)	1770	3540	5310	7080	8850	10620	2606	2192	1418	1520	19470



You can notice on the chart that the real production is completely under the chart of the forecast production. You will always forecast an increase in the production and never a decrease despite the high variation.

3.2 Use of Smoothing model for forecasting.

Years	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Production('000 MT)	1994	1586	361	2012	2326	840	2606	2192	1418	1520	…	…
Forecast(β=0.5)	-	1994	1790	1075	1543	1934	1387	1998	2095	1756	1638	1818
Forecast(β=0.7)	-	1994	1708	765	1637	2119	1223	2193	2192	1650	1559	1749
Forecast (β=0.8)	-	3540	5310	7080	8850	10620	2606	2192	1418	1520	19470	1818



You can notice in this chart, that according to my assumption, the smoothing constant 0.7 is the best, because it yields the forecast more closer to the reality.

According to this model, we can say that the production of maize in Zimbabwe will not exceed 1 650 000 tons this year.

This might not be true, however, my intention is to draw you intention to the fact that, if you want to use time series for crop forecasting, you should use non-linear model. The forecast yield by the trend (which is a linear model) is 19470 000 tons which is absolutely impossible.

IX. REPORT ON A WORKSHOP DISCUSSION ON CASSAVA PRODUCTION FORECASTING AND ESTIMATION

1. IMPORTANCE OF CASSAVA

- Provides food, income and employment for 500 million people in Africa, Asia and Americas,
- 40% of these people i.e. 200 million people (half the population of Africa) – eat cassava daily (FAO, 1993),
- important crop in 30 Africa countries,
- Southern and Eastern Africa sub-region, important in
    - Angola,
    - Mozambique,
    - Tanzania,
    - Zambia,
    - Malawi.

- Need to reflect cassava production/consumption in food balance sheet,
- Suitable crop for (limited) cross-substitution.

2. WHY IS CASSAVA SO IMPORTANT A CROP?

Many reasons, among them:

a. Grows in soils with low fertility,
b. Does not require chemical fertilisers and is more resilient t pets and diseases,
c. Drought tolerant (not necessarily drought resistant),
d. There is certainty of at least some yield, even under adverse conditions,
e. Possibility of continuity of supply throughout the year,
f. Has many end uses – human consumption, animal feed, industrial application,
g. Emergency crop,
h. Correlation between levels of poverty and importance of cassava; a candidate for commodity – based approach to poverty alleviation.

3. MAIN CHARACTERISTICS OF THE CROP

The main characteristics of the crop making cassava production estimation difficult:

a. Continuos planting,
b. Occasionally have cassava fields with a crop at different stages of maturity,
c. Crop is occasionally harvested: "**piece –meal**",
d. Crop can be stored in the ground for many months when it is ready for harvest,
e. Yields tend to "peak" after 8 – 15 months, thereafter decline.

4. STATEMENT OF THE PROBLEM

a) If there is continuous planting,
   - ♦ How do you estimate AREA PLANTED during one season?

b) What constitutes cassava production? Is it:

   - ♦ "in the ground availability"
     or
   - ♦ "harvested cassava"?

c) If cassava is continuously harvested,

   - ♦ How should the HARVESTED AREA within a given crop season be estimated?
   - ♦ How should the HARVESTED QUANTITY within a given crop season be estimated?

5. LIMITATIONS OF CURRENT METHODOLOGIES

a) Planted area – usually subjectively determined.
b) Yield:
   - Usually subjectively determined,
   - Sometimes use estimate from research station,
   - Crop-cutting measurement – gives "in the ground availability".

6. POSSIBLE METHODOLOGIES:

a) Area estimation (planted and/or harvested)
   - Pacing method

b) Harvested Production
   - Recording method,
   - For crop-cutting randomly select plants,
   - Estimation of percentage of "in the ground available",
   - Harvested within a season.

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[i] A dekad is a ten-day period.
[ii] V. Mckay (ZGPA) provided the information on CGPA methodology.
Information for the other organisations are as in the Crop Forecasting Report by CSO.