AFRICA AGRICULTURAL MARKETS PROGRAM (AAMP)

The Value of Accurate Crop Production Forecasts

T.S. Jayne and Shahidur Rashid

Paper prepared for the Fourth African Agricultural Markets Program (AAMP) policy symposium, *Agricultural Risks Management in Africa: Taking Stock of What Has and Hasn't Worked,* organized by the Alliance for Commodity Trade in Eastern and Southern Africa (ACTESA) and by the Common Market for Eastern and Southern Africa (COMESA).

Lilongwe, Malawi, September 6-10, 2010.

T.S. Jayne is a Professor of International Development, Department of Agricultural Economics, Michigan State University. Shahidur Rashid is a Senior Research Fellow, International Food Policy Research Institute.

Table of Contents

List of Figures

The Value of Accurate Crop Production Forecasts

T.S. Jayne and Shahidur Rashid

Introduction

Crop production forecasts are widely recognized as an important input into food balance sheets and for anticipating production shortfalls. However, the role of accurate crop production forecasting systems in mitigating food price instability and transitory food insecurity is often under-appreciated. This paper explains how crop production forecasting systems affect price instability and risks, and how they can be improved to stabilize the food system.

The following section describes the range of staple crop production forecasting systems in eastern and southern Africa and explains their potential vulnerabilities to errors. Section 3 presents a heuristic example to show how overestimated production forecasts can trigger food crises. Sections 4 and 5 then provide case study experiences from Ethiopia and Malawi. Section 6 concludes by discussing the various options for improving the national crop production forecasting and food balance sheet systems and making them a more valuable tool in food trade and stockholding policy decisions.

Crop Production Forecasting Systems in the Region

Crop production forecasting is central to making food policy decisions in developing countries. Almost all major food security programs—such as food aid imports, strategic food reserves, granting of licenses for private firms to import or export, local procurement by the government and donors, emergency food assistance, and distribution through social safety net programs—rely on crop forecasts for strategic planning. In rainfall-dependent and highly variable agricultural systems, these programs are critical to managing food price risks and other humanitarian crisis. But as will be shown below, inaccurate crop production estimates can lead to unwarranted or ill-fated policy decisions, causing governments to potentially over-export or import unneeded supplies. Errors in trade decisions lead to accentuated food price fluctuations compared to a system which takes the necessary steps to forecast crop production with precision.

There are two basic kinds of crop production forecasting systems in Africa. The most common and longstanding relies on the large administrative network of Ministry of Agriculture extension workers in the rural areas. Each year, the extension officer at the smallest administrative level makes area, yield, and production estimates based on their on-the-ground field expertise. In Ethiopia, for example, there are about 50,000 Development Agents (DA) located throughout the country who each provide their estimates. These production estimates are then aggregated up to the district, province, and national level. Ethiopia, Malawi, Tanzania, Mozambique, and Kenya use this approach each year to produce their official crop production estimates.

The weaknesses of this approach are that

(i) The methods that each DA uses to estimate production, area, and yield are subjective and impressionistic based on informal interviews with farmers and local communities. In some cases, yield sub-plot measurements are used to estimate yields, but these estimates are vulnerable to selection bias that might cause the yield estimates to diverge from the population. Differentiating properly between monocropped maize fields and intercropped maize fields is also problematic with this approach, as the latter tend to produce less maize per unit of land than the former. Estimates of area per farm and the number of farming households in a given administrative unit are particularly vulnerable to error. A final source of area measurement error is that many plots that are planted are not harvested due to waterlogging, drought, or insufficient labor availability. For example, in Zambia, roughly 75-80% of the area planted to maize is harvested, an insight provided from the use of nationally representative Crop Forecast Surveys on over 10,000 smallholder households each year.

(ii) Area estimates for year *t* are generally based on differences (as perceived by local extension workers) in area in previous years, which themselves may be far from accurate;

(iii) at times, food production estimate may be vulnerable to upward or downward revision for political reasons. For example, if Ministry of Agriculture officials are recognized or rewarded for their success in promoting national food production, the crop forecasting system may face internal pressures to overestimate production levels. Governments seeking large food aid pledges from donors in order to minimize their food import bill may seek to underestimate food production levels.

The second approach which is increasingly utilized in the region is the use of nationally representative annual crop forecast surveys. These surveys are generally implemented by the national statistical office with survey design support from the Ministry of Agriculture. The surveys generally involve administering surveys to thousands of randomly selected farm households following sampling techniques that – if done correctly – allow the area and yield estimates of the sample to be inflated to the national level based on sample/population weights derived from the previous national census. The weaknesses of this approach are as follows:

(i) the sampling must follow carefully designed statistical procedures;
(ii) proper weights, which allow information from the sample to be extrapolated to the national population of smallholder farm households require the listing of all households in a particular administrative area, which itself may be incompletely implemented;
(iii) poorly trained national statisticians may incorrectly extrapolate or "weight" findings from the sample to derive national level estimates (see for example, Megill, 2005);
(iv) it is sometimes difficult to include large-scale farmers in these surveys;
(v) it is costly to maintain a statistically-representative survey-based crop production system. In Zambia, for example, the Central Statistical Office spends roughly $380,000 each year to survey roughly 10,000 households, enter the data into computer software programs, search for data entry mistakes and correct them ($38 per survey). Egerton University's Tegemeo Institute spends roughly $90,000 on the same tasks in maintaining their tri-annual survey of 1,300 farm households in Kenya ($69 per survey). The final section of the paper identifies means to improve the precision of statistical survey-based methods, which are clearly within the reach of the national statistical organizations in these countries.

Some countries, for example Ethiopia, Mozambique, and Malawi, produce estimates from the Ministry of Agriculture each year and periodically augment these with nationally representative survey-based estimates. The method based on Ministry of Agriculture extension workers generally produces staple food production estimates that are substantially higher than the statistically based survey method, as much as 60% higher in the case of Ethiopia in 2007/08 and 35% higher in the case of Malawi in 2006/07 (Rashid, Minot and Teffasse 2008; Dorward et al, 2009). In Malawi's case, much of the difference stems from the fact that the National Statistical Office reports that the number of rural farm households in Malawi is 2.5 million based on the last national census in contrast to the Ministry of Agriculture estimate of 3.6 million (Dorward et al., 2009). Regardless of which set of estimates are more accurate, discrepancies in national food production estimates of 35% or more can cause great uncertainty in actual production, create mistrust and second-guessing of import and export requirements resulting from food balance sheet exercises, and lead to overshooting or undershooting of actual import, export, and food aid decisions. All of these problems exacerbate food price risks and market unpredictability.

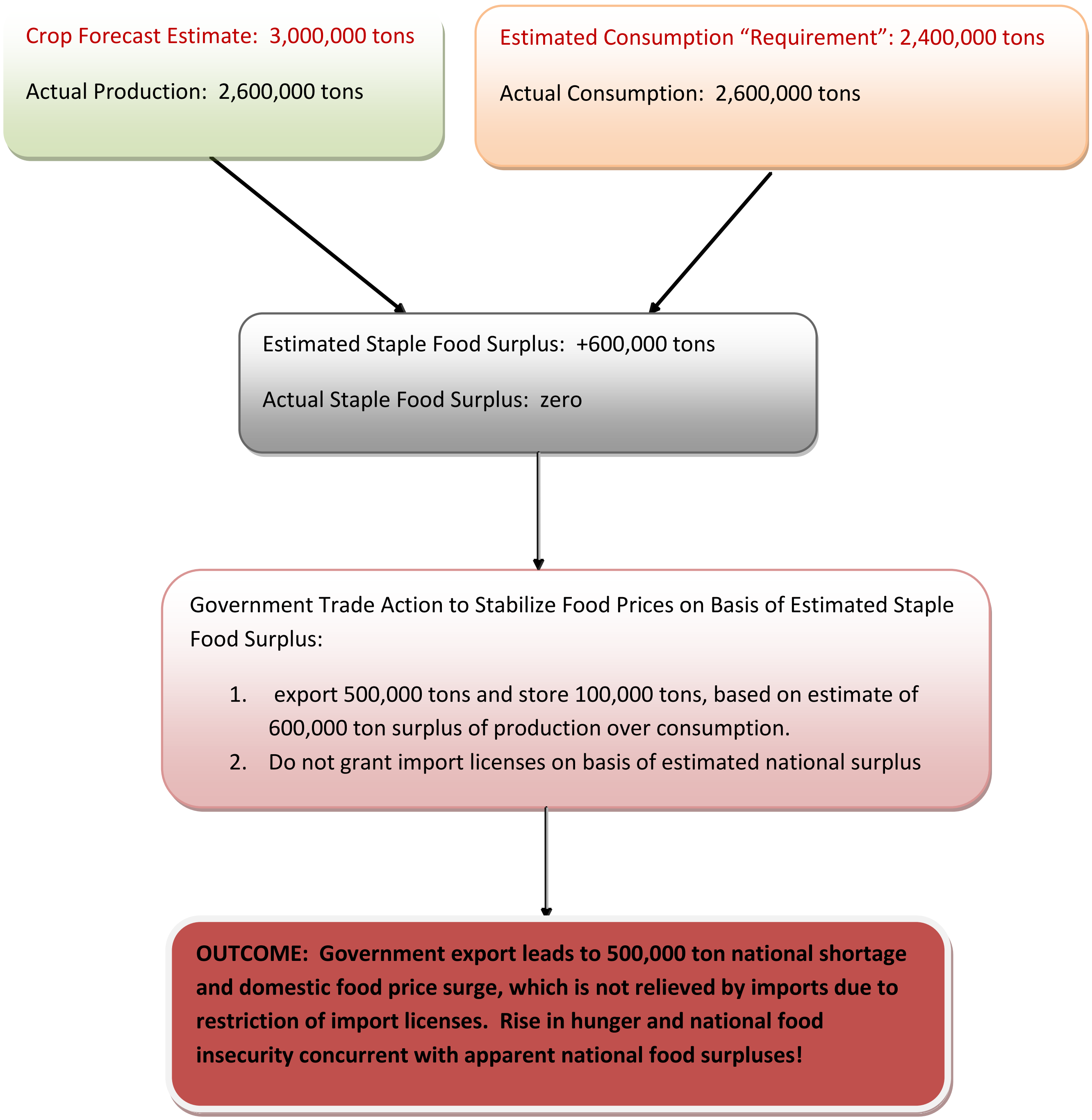
A Heuristic Example

This section provides an illustrative example of how a relatively small percentage difference between forecasted and actual production can potentially lead to a major food shortage. Suppose, for example, that in a hypothetical country that the forecasted staple food production is 3 million tons, when actual production is only 2.6 million. Suppose also that the staple food consumption "requirement" is estimated at 2.4 million tons in the food balance sheet when actual consumption is 2.6 million tons. According to the simple food balance sheet (which ignores stocks), the estimated staple food surplus is 3.0 – 2.4 = 0.6 million tons. However, the actual staple food surplus is zero (2.6 – 2.6 million tons).

The appearance of a 600,000 tons surplus according to the food balance sheet might easily cause government to start worrying about how to prevent prices from crashing and take steps to export the lions' share of the surplus and store the rest in order to defend a floor price for farmers. The government might also seek to restrict imports by not granting import licenses to private firms, in order to prevent a possible further decline in market prices during the apparent surplus year. If government actually arranged an export deal for 500,000 tons, it would have inadvertently contributed to a deficit situation in which actual supplies fall to 2.1 million tons in contrast to consumption requirements of 2.6 million. Such a situation would be expected to cause upward pressure on food prices and major stress on low-income consumers, especially if import restrictions remained in force.

This example illustrates how a relatively small percentage error in the production forecast (in this case a 13% overestimate of production, and an 8% underestimate of consumption) can give rise to a quite severe 21% food shortfall. In the absence of trade or food aid, the main mechanism for resolving this shortfall would be dramatic rise in market prices as the scarcity principle sets in to restrict consumption – a scenario that could be potentially disastrous.

Figure 1. Heuristic Example of How Inaccurate Crop Forecasts Can Lead to National Food Insecurity



Malawi Case Study: 2007 TO 2009

Malawi has recently received critical acclaim for its success in transforming the country from a food-aid dependent importer to a food secure exporter (New York Times 2007).[1] In 2005/06, the government re-introduced a large-scale fertilizer subsidy program (see Dorward et al. 20010 for a detailed assessment). Erratic rainfall in 2005/06 impeded the impact of this program in 2006. In the 2006/07 crop year, the combination of favorable weather and the distribution of improved maize seed and fertilizer through the subsidy program produced what was considered to be a record maize harvest in 2007. The government issued an official maize production estimate of 3.4 million tons. Domestic consumption requirements were believed to be in the range of 2.1 million tons, indicating a surplus of well over a million tons.

In response to the reported surplus for the 2007/08 marketing season, the government issued tenders to private traders to supply 450,000 tons for export to other countries in the region. However, the private sector reported scarcity in the markets and was unable to source this quantity of maize. By late 2007 Malawi had exported only 283,000 tons. The government then suspended further exports due to an unanticipated rapid escalation in domestic market prices. Within several months after the harvest, maize prices reached near record highs, exceeded only in the major crisis year of 2001/2 and the drought year of 2005/06 (Figure 3). By late 2007/early 2008, maize prices in Malawian markets were US$100 to US$150 per ton higher than in other regional markets. The 2007/08 season was also characterized by reports of localized maize shortages, rationing of maize by the marketing board ADMARC, and net maize inflows of over 50,000 tons from neighboring countries, primarily Mozambique and Tanzania (Reuters 2008; FEWSNET 2008a). These signs of domestic shortage were considered surprising in light of the Ministry of Agriculture's official estimates of a record maize harvest of 3.4 million tons in 2007.

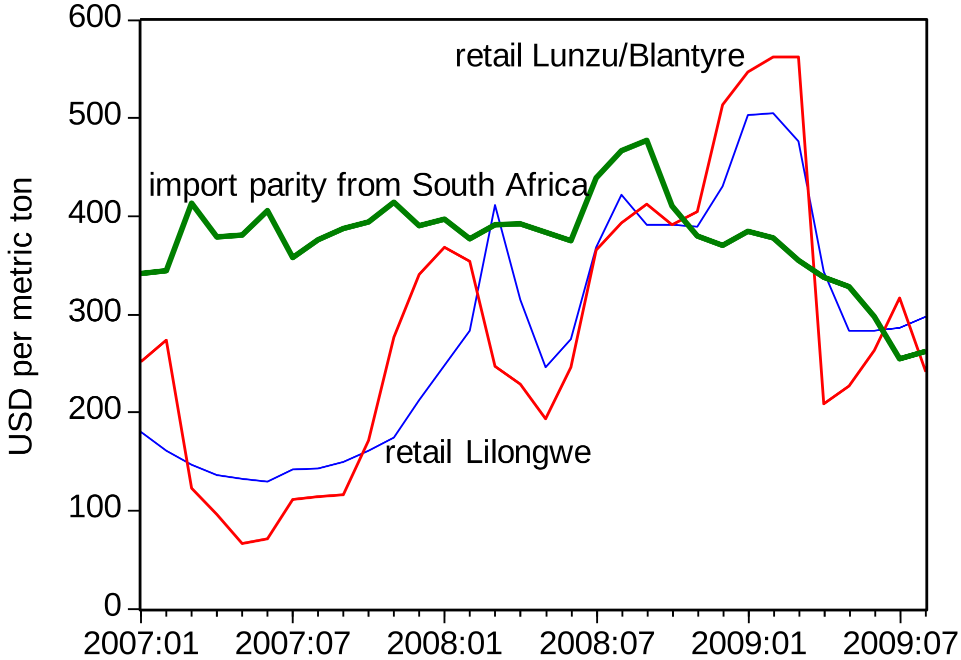
In May 2008 the Government of Malawi reported that the country had produced another major maize surplus, estimated at 500,000 tons over consumption requirements. In an effort to provide a floor price for this surplus and to accumulate food security stocks, the government instructed ADMARC to aggressively purchase more maize than usual to defend a floor price for farmers. To achieve this, ADMARC announced

[1] President Bingu Wa Mutharika was recently awarded a United Nations (UN) Global Creative Leadership Award and also received the first Food, Agriculture and Natural Resources Policy Network (FANRPAN) food security policy leadership award for reviving the country's fertilizer subsidy programme. He also was honored at the 2008 African Green Revolution Conference in August 2008 for the country's success in promoting food security.

commodity buying prices early in the season and also started buying earlier than usual. ADMARC also opened more seasonal markets and temporary buying points to reach out to farmers.

ADMARC began procuring maize at 20,000 kwacha (US$140) per ton at the start of the 2008 harvest, but found that it was acquiring insufficient maize at this price. To acquire more maize, ADMARC quickly raised its buying price to 25,000, then 30,000, and then 40,000 kwacha (US$280) per ton to offer prices that were competitive with those of private traders. Market prices rose dramatically in response to the scramble for maize (Figure 3). By early August, ADMARC and the National Food Security Reserve Agency (NFRA) had procured only 60,000 tons combined, which by most accounts was considered to be too little to meet the demand for grain at ADMARC depots through the upcoming lean season. By early August 2008, only 2-3 months after the reportedly good harvest, maize prices had reached historic highs, exceeding $550 per ton in retail markets in the south according to the Ministry of Agriculture price reporting system (Figure 3). Many in Malawi felt that these price rises were orchestrated by private traders. On August 19, the Government of Malawi announced a ban on private maize trade, then in September instructed traders to operate within the official floor and ceiling price of 45,000 kwacha (US$316 per ton) and 52,000 kwacha (US$366) per ton. However, market prices were already far above this level and many traders simply stopped buying grain in response to the government decree. The Government then arranged a contract with one large trader to supply maize to ADMARC at prices well above the ceiling price.

Figure 2. Retail Maize Prices, Blantyre vs. Import Parity from South Africa, 2000-2009



Source: Ministry of Agriculture monthly price bulletins for retail maize prices; SAFEX and hauliers transport rates for import parity prices.

There is increasing speculation that the official government maize production forecasts are systematically overestimated (e.g., Dorward et al. 2010; Lea and Hanmer 2009). Reduced confidence in official crop forecasts creates difficulties in determining whether formal imports are required, and may lead to major food price surges, consistent with those shown in Figure 3 during the 2008/09 period. Evidence suggesting that the 2007 and 2008 Ministry of Agriculture maize production estimates may have been overestimated is based on three points:

(1) *Estimates of substantial informal maize imports from neighboring countries:* While national maize production estimates for the 2007 and 2008 harvests were both far above national consumption requirements, imports from Mozambique and Tanzania have been streaming into the country almost continuously since January 2004 when the Famine Early Warning Systems Network (FEWSNET) began monitoring informal cross border trade in the region. According to FEWSNET, Malawi has been a net importer of

maize in virtually every month, importing 59,000 tons of maize in the 2007/08 season through informal cross-border trade flows. In the first 6 months of the 2008/09 season alone, Malawi has imported over 55,000 tons of maize (FEWS Net 2008a). In 2007, the Government of Malawi did export roughly 300,000 tons of maize to Zimbabwe, but with the apparent consequence of causing rapid price escalation to unprecedentedly high levels in late 2007 and early 2008 as shown in Figure 3.

(2) *maize prices in Malawian markets have, for most of the 2007/08 and 2008/09 marketing years, exceeded those in nearby regional markets in Mozambique, Tanzania, and Zambia.* At certain times, such as late 2008, Malawian prices have been at least US$50 per ton higher than market prices observed on the other sides of the border. In early 2008, after the government exported maize to Zimbabwe, Malawian prices surged over US$400 per ton, exceeding those in the neighboring Zambian and Mozambique markets by US$100 per ton. By contrast, Malawi maize prices over the 2000-2007 period have averaged only $147 per ton in Lilongwe and $164 per ton in Lunzu/Blantyre, and it is difficult to explain how official estimates of a record maize harvest could coincide with price levels over twice as high as long-term average prices.

(3) rationing of maize by ADMARC: reports in Malawi's newspapers and focus group discussions with farmers in Central and Southern Malawi in 2008 (Reuters, 2008; Jayne et al, 2009) reveal frequent stock-outs and rationing of maize sales by ADMARC in both 2007 and 2008. The combination of maize shortages at ADMARC depots, continuous net imports of maize from neighboring countries, and price levels in Malawi that are higher than those of regional neighbors all suggest that official maize production estimates in recent years have been somewhat overestimated.

The likelihood of food deficits in the 2008/09 season was manifesting in the form of rapidly rising food prices in late 2008. NGOs and World Food Programme (WFP) have indicated that they were unable to source maize in Malawi for school feeding and relief operations because they are forced to tender at prices below 52 kwacha per kg, a level at which both large traders and ADMARC were refusing to sell. Relief organizations could not request financial support for relief food purchases without a formal recognition of a food problem, which is politically difficult given that the President of Malawi has received international acclaim for his success in turning Malawi into a surplus food producer. Consequently, social entitlement programs were undermined by the continued price regulations, while relief food operations were at least temporarily impeded. In early October, 2008, the Malawi Vulnerability

Assessment Committee released a report estimating that 1.5 million people were vulnerable to food insecurity, as many rural households had run out of maize and were forced to purchase their residual food requirements at prices that were extremely high. According to interviews with traders in late 2008 and mid 2009, applications for import licenses were rejected on the grounds that official food balance sheet estimates concluded that Malawi had sufficient maize supplies, even as prices especially in the southern parts of the country continued to soar over $450 per ton, well above the cost of importation from South Africa.

Ethiopia Case Study: 2007/08 Season

There are five separate sources of information on crop forecasts and production estimates in Ethiopia annually: the Central Statistical Authority (CSA); the Ministry of Agriculture and Rural Development (MoARD); Crop and Food Security Assessment Mission (CFSAM) estimates supported by the FAO and WFP; the Bellmon analysis commissioned by the U.S. Agency for International Development (USAID); and the Cereal Availability Study (CAS) that is used by WFP but funded by various agencies. Of these sources, only the CSA and MoARD engage in primary data collection. The other sources rely on participatory rapid assessments to triangulate the secondary data and derive their own estimates. This report is part of a larger project, funded by the Joint Research Commission of the European Union, to better understand the recent trends in grain markets and their implications for cereal availability assessments. It has reviewed methods and results, focusing on 2007/08 *Meher* season, based on CSA, MoARD, and CFSAM; and generated some baseline estimates of cereal (wheat, maize, and sorghum) availability for 2007/08.

The report finds that the methodological approaches vary significantly across various sources. The CSA production forecasts rely on large survey based method, which involves mobilization of over 2000 enumerators who visit over 50 thousand farm households and measure area and yield of more than 400 thousand randomly selected plots. By contrast, MoARD relies on its large administrative network, which, with more than 50,000 DAs, can reach the smaller administrative units. However, the method is subjective and largely based on informal interviews by DA's with farmers and local community leaders.

Although they all rely on secondary data and rapid assessment, the other three sources vary in terms of duration, geographic coverage, and nature of triangulations. The

Bellmon analysis involves five weeks field works, CAS involves 3-4 weeks, and CFSAM teams carry out field works for five weeks in two phases. In terms of geographic coverage, CFSAM teams cover much larger parts of the country, with a larger and diverse group of experts, than do the CAS and Bellmon analysis. In presenting results, CFSAM presents zonal level estimates, CAS presents its estimates in selected surplus zones, and Bellmon produces only national level estimates. Although it uses MoARD data that are criticized on a number methodological ground, our review suggests that CFSAM uses the most rigorous triangulation method involving physical measurement of yields and standardizing teams' crop condition observations with Pictorial Evaluation Tools (PET).

Although they all rely on secondary data and rapid assessment, the other three sources vary in terms of duration, geographic coverage, and nature of triangulations. The Bellmon analysis involves five weeks field works, CAS involves 3-4 weeks, and CFSAM teams carry out field works for five weeks in two phases. In terms of geographic coverage, CFSAM teams cover much larger parts of the country, with a larger and diverse group of expatriates, than do the CAS and Bellmon analysis. In presenting results, CFSAM presents zonal level estimates, CAS presents its estimates in selected surplus zones, and Bellmon produces only national level estimates. Although it uses MoARD data that are criticized on a number methodological ground, our review suggests that CFSAM uses the most rigorous triangulation method involving physical measurement of yields and standardizing teams' crop condition observations with Pictorial Evaluation Tools (PET).

Given methodological differences, it is not surprising that the crop production estimates vary by sources, sometimes by a significant margin. Based on the respective source's last year's estimates, total cereal production is reported to have increased by 9.96 percent (forecast) by CSA, about 8 percent by MoARD, and 9 percent by CFSAM. Both MoARD and CFSAM estimates for 2007/08 are larger than CSA estimates in all aspects—that is, planted area, yield, and total production. The most striking difference is the production estimates, where MoARD and CFSAM estimates for wheat productions are larger than CSA estimates by 79 and 83 percent respectively. The estimates for maize and sorghum are similar between MoARD and CFSAM; and larger by 35 and 30 percent, respectively, than that of CSA estimates. Historical data analysis shows the similar pattern. Over the period 2001-2006, the CFSAM has consistently generated estimates of cereal production that are 16% to 31% higher than the estimates of CSA. Most of this difference is due to higher estimates of area planted to cereals. In contrast, the Bellmon analysis tends to generate production estimates that are below those of CSA.

Discussion and Implications for Government Action

Accurate crop production forecasting is necessary to make informed food policy decisions and to allow rapid response to emerging problems. This is particularly true in countries depending on rainfed agriculture, where weather causes significant variation in food production and marketed supplies as well as in market demand. Various marketing, trade, and emergency response programs are in place to ensure household food security in the face of food production and price fluctuations, and nearly all of them depend on the accuracy of crop production forecasts.

Our assessment is that statistically based survey methods derived from recent agricultural censes have the greatest potential to provide unbiased and reasonably precise cereal production forecasts. However, poor implementation at certain stages of the process can lead to major forecasting errors, and the potential for improved forecasting in most cases remains great. The number of enumerators required to carry out a census is so large that it is impossible to ensure that all of them are adequately trained and supervised. Data entry errors, if unchecked, can cause problems. The most important source of bias in survey-based production forecasts is generally in the computation of weighting factors to extrapolate from the surveyed sample to the farm population. External consistency checks can and should be used to cross-check production estimates with other economic data. For example, forecasts indicating a major production expansion would seem to be inconsistent with rising prices, assuming relatively stable demand. However, there are often alternative explanations for apparently contradictory results.

Procedures for improving the accuracy of national survey-based crop forecasting systems would include the following:

i. Invest in long-term capacity building of the national statistical organization to design and carry out agricultural censes and surveys. Despite the costs involved, the foregoing sections have provided examples of how potentially great the costs can be – in terms of unanticipated food price shocks, hunger and food insecurity – due to inaccurate crop production forecasts.

ii. Ensure major attention to achieving full listings of farm households in each administrative unit, which is essential to generate correct weighting factors to enable accurate extrapolation of results from the sampled farm households to the population.

iii. Recognize that demand fluctuates annually as well as production. In drought years, for example, an increasing proportion of rural farm households become buyers of grain, raising the demand for grain.

iv. Ultimately, food balance sheets can become more accurate by moving to a more sophisticated approach that recognizes how "requirements" are not a fixed number, they respond to changes in prices. Nor is "supply" fixed either. Even in the short-run, supplies of staple foods can increase or decrease markedly in response to price movements and expectations about future price movements, which are in turn influenced by expectations about future government actions. For example, in the event of drought, farmers in dual staples zones may dig up supplies of cassava for home consumption, enabling them to sell more maize than they otherwise would to take advantage of high prices that usually accompany a drought year (Haggblade and Nyembe, 2008). These cross-commodity dynamics may produce major errors in estimates of marketed supplies unless properly understood and reflected in food balance sheets.

v. Production forecasting and food balance sheets can benefit from accounting for changes in regional and global market conditions, changes in trade and marketing policies, as well as changes in consumption and production behaviors. The key adjustment parameters will include revised estimates of marketable surplus, changes in consumption behaviors, requirements for national food assistance programs, and the analyses of the domestic and international price transmissions.

References

Dorward, A., E. Chirwa, V. Kelly, T. Jayne, R. Slater, and D. Boughton. 2008. Evaluation of the 2006/7 Agricultural Input Supply Programme, Malawi. Final report, School of Oriental and African Studies (SOAS), Wadonda Consult, Michigan State University, and Overseas Development Institute (ODI), undertaken for the Ministry of Agriculture and Food Security, Government of Malawi. March.

Dorward, A., E. Chirwa, and T. Jayne. 2010. The Malawi Agricultural Inputs Subsidy Programme, 2005/6 to 2008/9, in Punam Chuhan-Pole and Shanta Devarajan (eds). Yes Africa Can: Success Stories from a Dynamic Continent. The World Bank Group, Africa Region.

FEWSNet, 2008. Informal Cross Border Food Trade in Southern Africa. Famine Early Warning Systems Network, July 2008.

FEWSNet, 2008. Report on the joint field trip on post-harvest food security and maize marketing monitoring: 16th - 25th June, 2008, FEWSNet, WFP, Government of Malawi, and FAO, http://www.fews.net/docs/Publications/Joint%20Trip%20report-%20Post-Harvest%20Food%20Security%20and%20Maize%20Marketing%20Monitoring%20Junel%202008.pdf

Haggblade, S. and M. Nyembe. 2008. Commercial Dynamics in Zambia's Cassava Value Chain. Working Paper 32, Food Security Research Project, Lusaka.

Jayne, T. S., J. Mangisoni, N. Sitko and J. Ricker-Gilbert (2010). Malawi's Maize Marketing System, Report commissioned by the World Bank and Government of Malawi/Ministry of Agriculture, Lilongwe.

Lea, N. and L. Hanmer. 2009. Constraints to Growth in Malawi. Policy Research Working Paper 5097, Africa Region, Southern Africa Poverty Reduction and Economic Management Unit, World Bank, Washington, DC.

Megill, D. 2005. Recommendations for Adjusting Weights for Zambia Post Harvest Survey Data Series and Improving Estimation Methodology for Future Surveys. Working Paper 13, Food Security Research Project, Lusaka.

Rashid, S., N. Minot, and A. Taffesse. 2008. Assessment of Cereal Production and Availability Forecasts in Ethiopia: A Review of Existing Studies. International Food Policy Research Institute study submitted to the Joint Research Commission (JRC) of the European Union, Brussels.