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Weather patterns, food security and humanitarian response in sub-Saharan Africa

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Although considerable achievements in the global reduction of hunger and poverty have been made, progress in Africa so far has been very limited. At present, a third of the African population faces widespread hunger and chronic malnutrition and is exposed to a constant threat of acute food crisis and famine. The most affected are rural households whose livelihood is heavily dependent on traditional rainfed agriculture. Rainfall plays a major role in determining agricultural production and hence the economic and social well being of rural communities. The rainfall pattern in sub-Saharan Africa is influenced by large-scale intra-seasonal and inter-annual climate variability including occasional El Niño events in the tropical Pacific resulting in frequent extreme weather event such as droughts and floods that reduce agricultural outputs resulting in severe food shortages. Households and communities facing acute food shortages are forced to adopt coping strategies to meet the immediate food requirements of their families. These extreme responses may have adverse long-term impacts on households' ability to have sustainable access to food as well as the environment. The HIV/AIDS crisis has also had adverse impacts on food production activities on the continent.

In the absence of safety nets and appropriate financial support mechanisms, humanitarian aid is required to enable households effectively cope with emergencies and manage their limited resources more efficiently. Timely and appropriate humanitarian aid will provide households with opportunities to engage in productive and *sustainable* livelihood strategies. Investments in poverty reduction efforts would have better impact if complemented with timely and predictable response mechanisms that would ensure the protection of livelihoods during crisis periods whether weather or conflict-related. With an improved understanding of climate variability including El Niño, the implications of weather patterns for the food security and vulnerability of rural communities have become more predictable and can be monitored effectively. The purpose of this paper is to investigate how current advances in the understanding of climate variability, weather patterns and food security could contribute to improved humanitarian decision-making. The paper will propose new approaches for triggering humanitarian responses to weather-induced food crises.

Keywords: emergency appeal; extreme weather; food insecurity; humanitarian response; early warning; agricultural monitoring

1. INTRODUCTION: THE MILLENNIUM DEVELOPMENT GOALS

World leaders, national governments, the humanitarian community and donor agencies have made commitments at various international summits and conferences to address the root causes of poverty and chronic hunger and reduce human suffering. The World Food Summit in 1996 produced the Rome Declaration on World Food Security. This was reaffirmed by the Millennium Declaration of the United Nations Millennium Summit in September 2000, where world leaders adopted the millennium development goals (MDGs), which set clear targets for reducing poverty, hunger, disease, illiteracy and discrimination against women by 2015. Subsequently, the Johannesburg Declaration on Sustainable Development, September 2002, affirmed the objectives set by the World Food Summit and recognized that sustainable agriculture and rural development are essential for increasing food production and enhancing food security and food safety in an environmentally sustainable way.

During the period 2000–2002, there were more than 850 million chronically undernourished people worldwide (FAO 2004). Sub-Saharan Africa accounts for 25% of the global figure of chronically undernourished. In 2001, the total population of sub-Saharan Africa was estimated at 667 million with 436 million rural, of which 92% (400 million) are agricultural (FAO 2003). The number of undernourished has risen from 170 million in 1990–1992 to 204 million in 2000–2002. According to the Hunger Task Force of the UN Millennium Project (2005) analysis, 80% of the chronically undernourished are rural households. The agricultural sector supports the employment of more than 70% of the economically active population in the region (FAO 2003).

Despite national and international efforts a third of the African households are still exposed to the risks of food shortages and hunger. At current level of progress Africa will miss achieving the key MDGs (UN Millennium Project 2005). Progress towards meeting

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the MDGs will require comprehensive programmes that aim to simultaneously address: (i) declines in the productivity of the agricultural sector in Africa; (ii) meeting people's immediate food needs when exposed to natural and man-made disasters and (iii) expanding the scope of livelihood opportunities for poor and food insecure households so that they are able to better manage the risks associated with natural and man-made emergencies. These three, inter-related, objectives should be integrated into national poverty reduction strategies with a focus on agricultural and rural development.

The above issues highlight the important linkages between poverty, food insecurity and vulnerability. Addressing these problems will require rethinking of the way in which developmental strategies are framed and implemented. Mitigating the effects of shocks and risks will require improved analytical and operational framework. Extreme weather events and droughts have been identified as dominant consumption risks for rural households that are mainly dependent on rainfed agriculture. Appropriate disaster risk management systems should be put in place in order to protect livelihoods as well as safe guard developmental gains.

The purpose of this paper is to investigate how current advances in seasonal climate prediction and agro-meteorological modelling could contribute to humanitarian decision-making. We will start by reviewing the linkages between climate variability, droughts, agricultural production and food insecurity in sub-Saharan Africa. The importance of rainfall in determining agricultural production and local food availability will be highlighted. A summary of recent drought occurrences and associated humanitarian emergencies will be presented. A review of the current process of humanitarian decision-making practice that includes the various steps such as early warning, assessments and resource mobilization activities will be presented. We will argue that the current model of humanitarian response mechanisms to drought-induced emergencies based on agricultural assessment at the end of the growing season is not making the best use of current advances in agro-meteorological modelling and monitoring. A mechanism that better integrates agro-meteorological and climate information in humanitarian decision-making process will be proposed. New innovations of financing humanitarian assistance using weather index as a trigger such as the acute hunger insurance project of the World Food Programme will be reviewed. We will conclude by providing practical recommendations on how climate information could be better integrated into the humanitarian decision-making process.

2. MAIN CAUSES OF FOOD INSECURITY IN SUB-SAHARAN AFRICA

Food insecurity is greatest in sub-Saharan African countries compared to other developing countries. The major reasons include: low agricultural productivity, lack of agricultural policies, poor infrastructure and high-transport costs, lack of appropriate marketing strategies, frequent extreme weather events, high-disease burden including malaria and HIV/AIDS, weak financial support systems, lack of safety net systems and political conflicts (the UN Millennium Project 2005; the Commission for Africa report 2005; Reducing Disaster Risk UNDP 2004). The underlying crisis of child malnutrition and under-education undermines the potential of Africa's future generation.

Food insecurity is most severe for communities living in remote areas of the continent. Access to markets and utilities is constrained due to the lack of infrastructure and prohibitive high-transport costs. Compared to other parts of the world transport costs are highest in sub-Saharan Africa. In a typical sub-Saharan country the cost of a local transport can be as high as 800 USD per metric tonne compared to 300 USD in Asia (Millennium Project 2005). Farmers cannot get their produce to markets at a competitive price due to the high-transport costs. Lack of appropriate storage facilities in remote areas also contributes to high-post harvest agricultural loses. Access to agricultural inputs such as fertilizers and seeds becomes too expensive for farmers to afford.

Household food security is also influenced by social vulnerability factors such as household health, composition, household head (female, child) and availability of labour and social standing in the community and culture. The HIV/AIDS pandemic is contributing to increased food insecurity and vulnerability of households as summarized in Gillespie & Kadiyala (2005). In the agricultural sector, HIV/AIDS reduces households' ability to produce their own food leading to food insecurity (Barnett 1994; Guerny 2002). In addition, the financial cost of looking after the chronically sick is puts a heavy burden on the economic situation of households, the community and the country (Gillespie *et al.* 2001; Barnett & Topouzis 2003; De Waal & Whiteside 2003).

In sub-Saharan Africa climate variability and extreme weather events such as droughts, excessive rains and floods are among the main risks affecting agricultural productivity and hence rural household food security. A failure of the rainy season is directly linked to agricultural failure reducing food availability at household level as well as limiting rural employment possibilities. In recent years, the largest food crises in Africa that required large-scale external food aid have been attributed fully or partially to extreme weather events (Dilley *et al.* 2005). The food crises of 1974, 1984/1985, 1992 and 2002 that affected the lives and livelihoods of millions of rural households have been mainly caused by droughts. Recovery from such big drought events could take several years as shown in Dercon (2004). Often the poorest in rural areas occupy the most marginal lands that are vulnerable to disaster risks (UNDP 2004). Natural disasters and economic shocks if not addressed properly could lead to increased environmental degradation, deforestation and possible conflicts over resources triggering political instability. This re-enforces vulnerability to disasters. Many developing countries lack the necessary emergency response and preparedness capacities and financial means to protect their populations from natural disasters and economic shocks.

3. WEATHER PATTERNS AND DROUGHT OCCURRENCE IN AFRICA

To develop appropriate response strategies for weather-related food crises we need to understand the linkages between weather patterns, agricultural productivity and food security in rural Africa. The impacts of agricultural failure due to extreme weather events could be better mitigated and managed with improved climate prediction and enhanced rainfall monitoring capabilities. In §3a, we will focus on understanding weather patterns and drought occurrence in Africa with particular emphasis on climatic parameters that determine rainfall patterns, the amount, temporal and spatial variability.

(a) *The dominant weather systems in sub-Saharan Africa*

The African continent enjoys a wide variety of climate regimes ranging from humid climate in the tropics to arid and semi-arid climate in the sub-tropics. Africa's location, size and shape play a major role in determining its climate. The seasonal pattern of rainfall is determined by the north–south seasonal migration of the inter-tropical convergence zone (ITCZ) following the position of maximum surface heating associated with the meridional displacement of the overhead position of the sun. The equatorial regions experience a bi-modal rainy seasons while regions further pole-ward experience a mono-modal rainfall season. The length of the rainy season which in turn determines the length of growing season becomes shorter as we move away from equator. The timing of the advance and retreat of the ITCZ determines the length and quality of the rainy season at a given location.

The rainfall pattern of sub-Saharan Africa is modulated by large-scale intra-seasonal and inter-annual climate variability. The El Niño-Southern Oscillation (ENSO) is the most important phenomenon responsible for inter-annual climate variability over eastern and southern Africa. More specifically, periods of strong warm and cold ENSO phases have been associated with large-scale rainfall anomalies over many parts of Africa including the Sahel region, eastern Africa and southern Africa (Folland *et al.* 1986; Nicholson & Etekhabi 1986; Ogallo *et al.* 1988; Ropelewski & Halpert 1989). However, the magnitude of ENSO influence on the local climate variability varies significantly from one location to another as well as from season to season and year to year and hence further research is required to better understand ENSO impacts at local level.

The potential use of ENSO, Indian sea surface temperature (SST) and Atlantic SST products in the prediction of seasonal rainfall anomalies in Africa has been a key area of research interest over the last several years (Lough 1986; Palmer 1986; Goddard *et al.* 2001). This is strengthened by recent expansion of meteorological observation networks as well as ability of computer models to provide skilful forecasts of ENSO-related information several months in advance (Cane 1991). ENSO predictions combined with traditionally existing prediction methods adapted to a given region or locality can provide useful predictions of seasonal rainfall anomalies that can be inputs to national and regional food security early warning systems (Cane *et al.* 1994; Glantz 1994, 1996; Dilley 2002).

(b) *Recent drought occurrences in sub-Saharan Africa*

Throughout African history droughts have occurred with varying degree of frequency and intensity affecting many countries. To highlight this, we have used data from the Centre for Research on the Epidemiology of Disasters (CRED)/Office of U. S. Foreign Disaster Assistance (OFDA) (figure 1) to show the frequency of drought reports per country in the period from 1970 to 2004. During that period 14 countries reported drought more than 10 times (1 in 3 years) and they include Somalia, Ethiopia, Eritrea, Sudan, Chad, Niger, Burkina Faso, Mali, Senegal, Mauritania, Kenya, Tanzania, Mozambique and Zimbabwe. Most of these countries are located in arid and semi-arid regions of Africa where rainfall is the most critical factor in determining the livelihoods of subsistence farmers and pastoralists. Most of the severe droughts have been linked to ENSO events. For example, Wolde-Georgis (1997) compares ENSO events with historical drought occurrence in Ethiopia since 1539 and finds a remarkable association.

Most of the population in the countries identified as experiencing high-drought frequency are agro-pastoralists whose livelihoods are constantly threatened rainfall variability. These countries are among the poorest in Africa and are extremely vulnerable to drought risks (Dilley *et al.* 2005) and are unable to cope with the impacts of droughts. With climate change, rainfall variability and extreme weather events are expected to increase (IPCC 2001). Any future development effort in such countries needs to factor in mechanisms for climate adaptation.

(c) *Drought scale of severity*

Large-scale droughts that affect several countries simultaneously have wider implications on food security. Regional markets will be constrained with considerable reduction in regional and cross-border trade. Adequate resources may not be available to provide humanitarian assistance if several countries are affected at the same time. It is important to identify the frequency of drought occurrence but also the scale of geographical coverage. Figure 2 shows the number of countries that have reported droughts in a given year over the last 35 years. In 1983, 30 countries reported drought making it the largest drought since 1970 followed by the drought of 1984 with 24 countries affected. In 1992, 18 countries reported drought but this drought mainly affected southern Africa resulting in severe food shortages. The Horn was again severely affected in 2001 with 19 countries reporting drought.

Overall the 1983/1984 droughts were the most severe that we have witnessed in the last four decades causing wide spread famine in the Sahel and the Horn of Africa requiring massive humanitarian food aid. The question now is can such a drought happen again? If it does what would be the impact and cost? Considering the current state of food insecurity in most of the countries in sub-Saharan Africa, a drought of the scale of 1983/1984 would be devastating. Climate change studies indicate that climate variability and extreme weather events would increase in Africa (IPCC 2001) and hence the occurrence of a large-scale drought is a

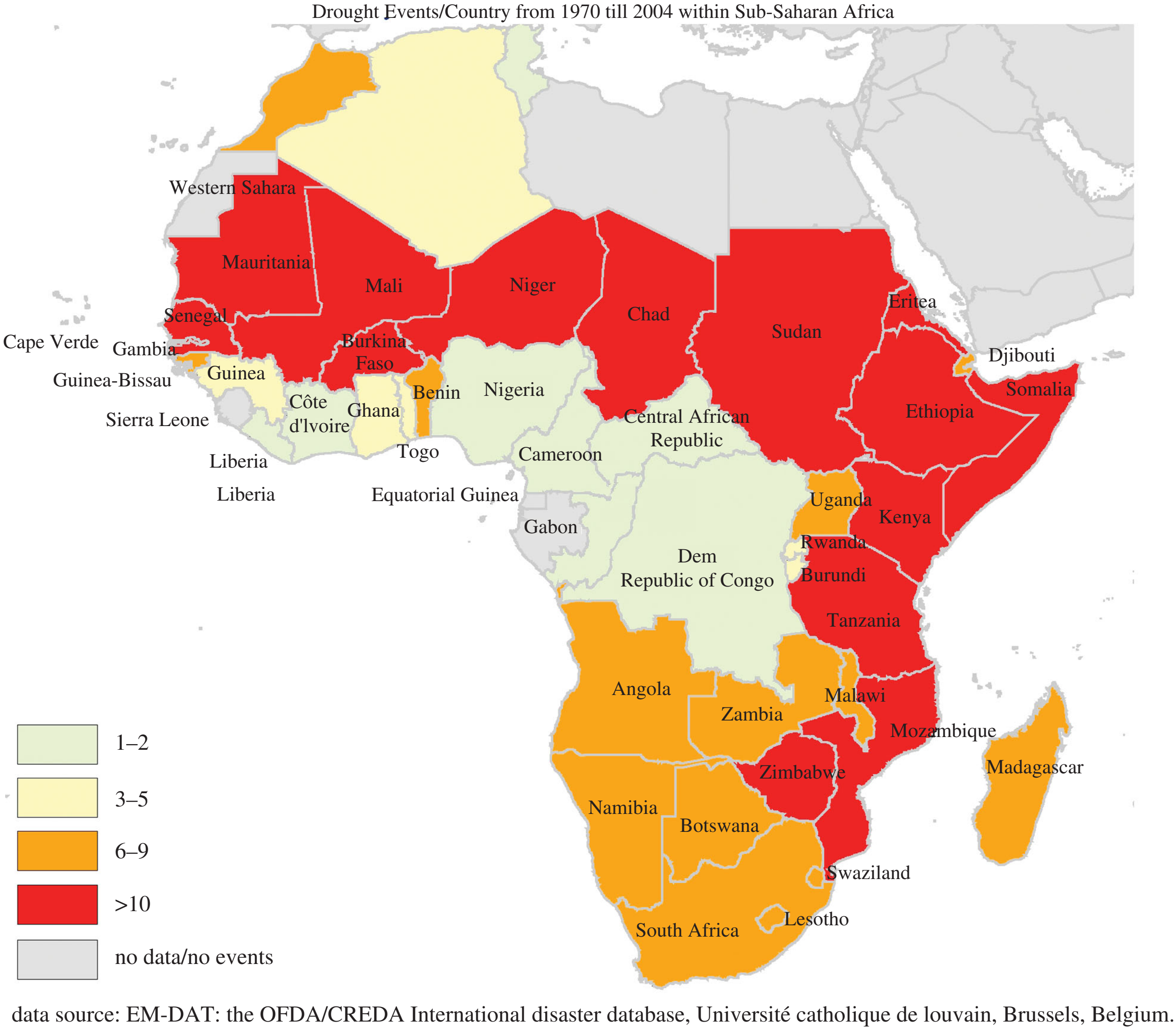


Figure 1. Drought reports per country from 1970 to 2004.

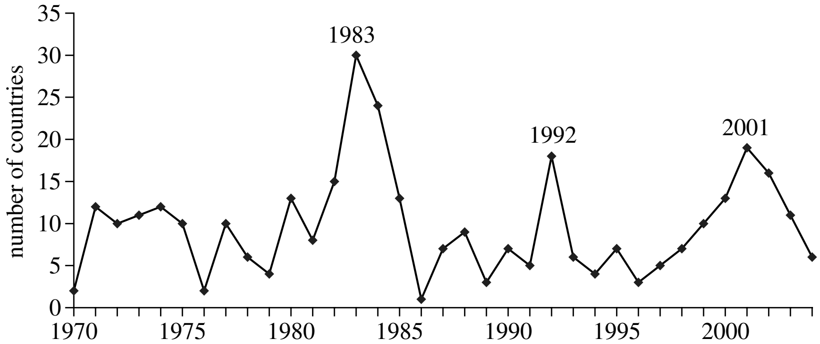


Figure 2. Number of countries affected by drought between 1970 and 2004 (data from CREDA/OFDA).

real possibility. A drought of that extent would undermine all developmental gains achieved unless the necessary preparedness plans are put in place.

4. RESPONDING TO DROUGHT CAUSED FOOD INSECURITY

(a) *Household and community responses*

During drought periods poor households that do not have access to the necessary resources that would enable them to cope with transitory food shortages become exposed to food crises and hunger that threaten the lives and livelihoods of their families. In the absence of functioning safety nets and rural financial mechanisms poor households will be unable to cope with droughts while continuing to engage in sustainable economic activities. To cope with acute food shortages, households may be compelled to engage in economic activities and strategies that focus on meeting the immediate food requirements of their families. The strategies may include: divesting of productive assets such as livestock and exchange of their land for food; fire wood sale increasing deforestation; consumption of their seeds; pulling children out of school; migration to look for jobs often in less productive sectors. In extreme cases households may abandon their villages and mass migrate to urban centres and refugee camps.

In summary, food emergencies do not only threaten lives but also have a devastating impact on the livelihoods of the affected households. Long-term exposure to multiple-risks of food insecurity erodes households' ability to manage their adverse effects, leading to situations of chronic crisis, whereby households regularly face shortages in food and income. Household vulnerability to future risks increases and they become trapped in poverty and hunger. As a result of droughts, competition for natural resources may increase triggering conflicts. Under such circumstances, even a minor climatic shock could have a major impact on the food security status of rural people.

(b) *Government responses*

The effectiveness of government responses to drought-related food crises depends on many factors including the political set-up of the government; emergency preparedness and response capacity of the government; and availability of reliable food security information. The immediate response is to mobilize the necessary resources and meet the immediate food requirements of those affected. This may include: using contingency funds, reallocating funds from development projects and requesting humanitarian aid through international emergency appeals. While addressing the immediate food crises governments recognize the need for developing comprehensive national response mechanisms that would ensure timely intervention that would protect the livelihoods of their populations.

Following the severe droughts of 1974/1975 and 1983/1984 that caused major food crises in sub-Saharan Africa, many countries, supported by the international community have initiated national and regional humanitarian response systems. For example, in Ethiopia the disaster prevention and preparedness commission and in the Sudan the humanitarian aid commission have been established to address food emergency. Similar government institutions exist in other countries. A drought emergency response framework may include various components such as food security monitoring systems to provide early warning information; strategic food reserve systems to enable timely delivery of food assistance and contingency funds to enable the emergency operation.

In a recent New Partnership for Africa's Development (NEPAD) study aimed at enhancing the effectiveness of existing and future national food-reserve systems in supporting food security policies in sub-Saharan Africa eight countries have been reviewed. They include: in the Sahel, Burkina Faso, Mali and Niger; in southern Africa, Malawi, Tanzania and Zambia; and in the Horn of Africa, Ethiopia and the Sudan. Lessons from this study indicate that the effectiveness of drought emergency response systems vary from country to country. The main constraints that the systems share appear to be lack of resources; lack of appropriate strategy and political will; and lack of reliable and timely food security information. A common observation of most national humanitarian response systems is that they are heavily dependent on donor funding and lack government commitment to allocate adequate resources from its national budget.

To coordinate and harmonize their efforts, governments have also created regional groupings such as InterGovernmental Authority for Development (IGAD), Southern African Development Community (SIDC) and Comité Permanent Inter Etats de Lutte Contre la Sécheresse dans le Sahel (CILSS). The purpose of these regional institutions is to promote regional cooperation and facilitate sustainable development as well as humanitarian intervention through improved regional food security information systems. In addition, regional centres to provide climate services to member states have been created through international agreement. They include: African Centre of Meteorological Applications for Development (ACMAD) and Research Center for Agriculture, Hydrology and Meteorology (AGRHYMET) based in Niamey, the SADC Drought Monitoring Centre in Harare and the IGAD Climate Prediction and Applications Centre in Nairobi.

(c) *International humanitarian response*

In sub-Saharan Africa, despite the efforts of national governments, large-scale humanitarian aid has been required to respond to food emergencies caused by extreme weather events. In recent years, the volume of emergency food aid to sub-Saharan Africa has significantly increased indicating the worsening food security status. In 2003, the humanitarian community delivered a total of 5.3 million tonnes to the region. This is more than 50% of the global food aid. The World Food Programme (WFP) that accounts for more than 50% of the food aid delivery to Africa assisted 36.4 million people in 2003 while in 1999 it assisted 20 million. The average food aid has been around 3.5 million metric tonnes with 20–30% purchased locally or regionally. Overall the trend of food aid requirement in sub-Saharan Africa has been increasing since 1997 as shown in figure 3.

The effectiveness of humanitarian aid to address critical food shortages depends not only on how much aid is provided but when it is provided and in what form. Humanitarian response needs to be timely, reliable and predictable so that governments and households can consider it in their economic planning. This will enable households to manage their limited resources more efficiently enabling them to engage in more sustainable livelihood strategies and avoid the use of undesirable coping strategies. The humanitarian aid should be complimented with investments in sustainable poverty reduction efforts that address the root causes of poverty and chronic hunger.

5. CURRENT AGRICULTURAL MONITORING SYSTEMS

The main purpose of a food security information system is to provide the humanitarian community, local government and donor agencies with reliable information on who the most vulnerable communities and households are: why they are vulnerable and what are

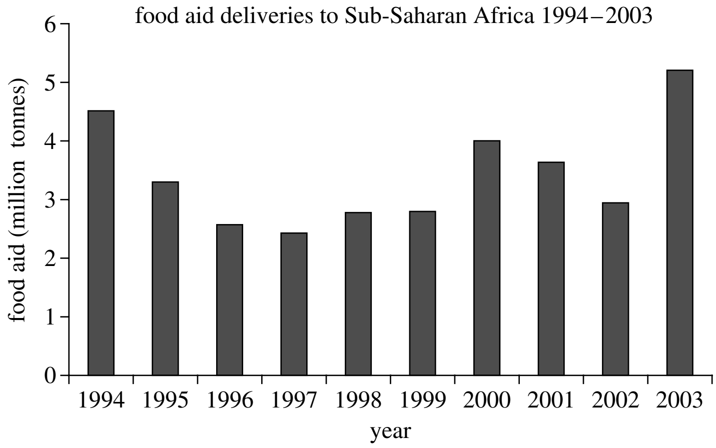


Figure 3. Food aid delivery to sub-Saharan Africa from 1994 to 2003 (data from the international food aid information system (INTERFAIS).

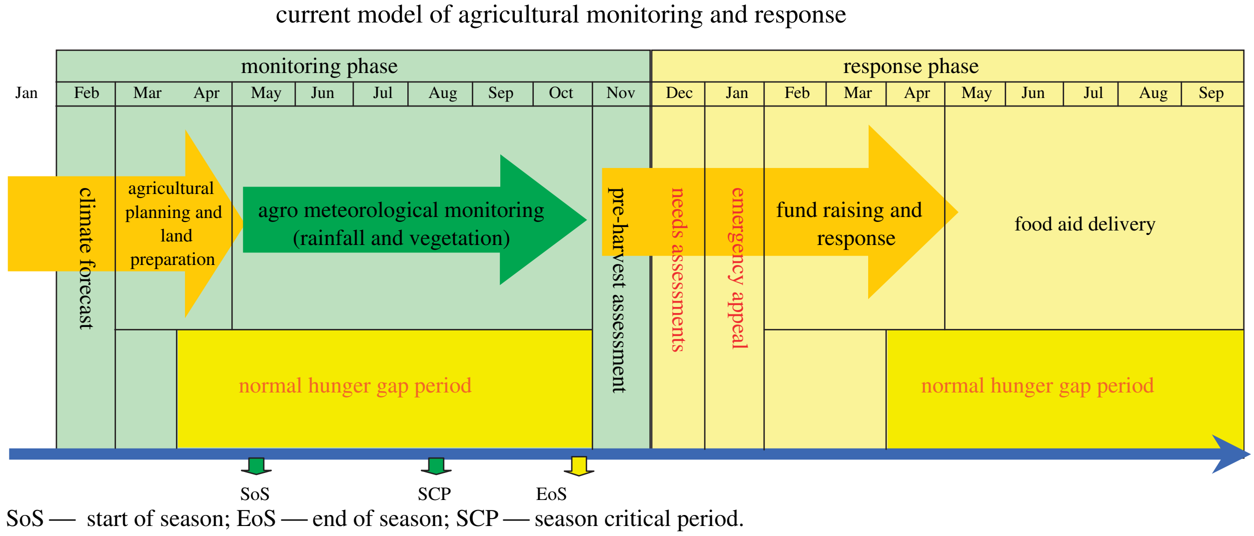


Figure 4. Food security monitoring and humanitarian decision-making framework.

the main risks affecting their food and livelihood security. In this section, we focus mainly on agricultural monitoring as it is the main determinant of the food security situation in rural Africa. The key components of agricultural monitoring framework include: seasonal forecasting; agro-meteorological monitoring and post harvest assessments. Figure 4 summarizes the various relevant activities within a given season taking Ethiopia as an example. In the next section, we will focus more on the monitoring phase which extends from February to October or November.

(a) *Seasonal climate outlook*

Through various regional and international collaboration initiatives seasonal forecasts are being developed which will have practical applications in food security early warning systems. Seasonal forecasts can help decision-making bodies such as agricultural planners to advise on seasonal agricultural strategy (planting schedules, fertilizer distribution, seed choice, etc.), future food and marketing needs, further grazing areas for livestock, etc. and also external agencies to assess food security and relief food requirements. In addition, information on possible droughts and disasters will help decision-makers, government officials, donors and NGOs to prepare and allocate adequate resources to alleviate a potential food crisis. More importantly, at the start of the agricultural season farmers need to make critical investment decisions such as how much land to prepare and how much to spend on agricultural in puts. Seasonal forecasts could help farmers to make informed decisions.

In sub-Saharan Africa seasonal climate forecasting is being provided through the regional climate outlook forums (RCOFs) which include: SARCOF (southern Africa), GHACOF (Greater Horn of Africa) and PRESAO (West Africa). The main purpose of these forums is to generate consensus forecasts by bringing together climate forecasters and facilitate cooperation and dissemination of climate information. RCOFs have been organized jointly by the regional meteorological institutions, world meteorological organization (WMO) and the international research institute for climate prediction (IRI) with funding support from donor agencies. In GHA, it is supported within the framework of the USAID funded project, ‘applications of meteorology to the reduction of climate and weather-related risks to food security, water resources and health for sustainable development in the Greater Horn of Africa sub-region'. Participants and contributors to the climate outlook include representatives of the Meteorological Services from member states, climate scientists and other experts from national, regional and international institutions, NGOs and UN agencies involved in food security such as WFP and FAO. Currently there are discussions on the formation of Food Security Outlook Forum linked to the COFs which would focus mainly on the forecast implications on food security.

Recent advances in crop modelling techniques using seasonal forecasts are encouraging. There is, however, a need to find ways of integrating such developments in agricultural monitoring. The advantage of having early agricultural forecasts will enable appropriate planning of the various options.

(b) *Agro-meteorological monitoring*

Seasonal climate outlook information will provide the general expectation of the rainy season. The actual start of the growing season and hence agricultural activities are determined by the arrival of adequate rains. In this context, agro-meteorological monitoring refers to the continuous assessment of rainfall and agricultural situation. Monitoring of the start of season (SoS) is critical and provides the first indication of the situation of the agricultural season. Once the rainy season is fully under way, variations in the rainfall amount and distribution will determine the performance of crops, pasture and natural vegetation. The analysis of the timing of the start of the rainy season and the temporal and spatial variation through a region will highlight areas of early, on time or late onset of the growing season. These provide early indications of the quality of the agricultural season and hence expected agricultural situation. The length of growing period (LGP) which is the period between SoS and the end of season (EoS) indicates the length of the rainy season (see figure 4).

Various crop models have been developed for monitoring crop performance and estimating agricultural production. One of the most important variables in any crop model is rainfall distribution and amount and this has different impacts on crops depending on the stages of the crop development cycle. For the most common crops grown in a given area, specific crop calendars have been developed. The main purpose of a crop calendar is to indicate the timings of the different stages of the growing season such as sowing, flowering and harvesting. During a given growing season a season critical period (SCP) can be identified that indicates the critical months or weeks during the growing season. For the example in figure 4, August is the critical month.

Agricultural monitoring capacity is improving rapidly as a result of technological developments. Using latest satellite technologies we are now able to monitor more accurately cropped areas, crop development and estimate yields and production. Through integrated monitoring of crop models, water requirement satisfaction index, vegetation vigour (NDVI) and field reports widespread crop and pasture failures can be identified several weeks before the EoS. The level of crop loss or the expected harvest can be estimated. We can confidently estimate the level of expected production by mid-growing season.

Depending on the analysis different decision options could be taken. If the information indicates crop failure, further analysis will be initiated on whether humanitarian intervention would be required and trigger response planning. On the other hand, if the analysis indicates exceptional surplus harvest then the decision could be to initiate a marketing strategy to avoid market failure. It is important to recognize that it is not only the drought years that could cause food insecurity but also the surplus production years due to market failure. The challenge is how to use such information to support humanitarian decision-making. In the current humanitarian response model such information is not effectively used.

(c) *Pre-harvest crop assessments (estimate of national production)*

A main component of the agricultural monitoring is the pre-harvest assessment that is undertaken at the EoS when harvesting starts. This is often conducted by FAO and WFP at the invitation of a drought affected government. The main purpose of the crop and food supply assessment mission (CFSAM) is to assess the status of food production and provide independent information to the humanitarian community to facilitate a possible external intervention. The mission has two components.

(i) The FAO component assesses the national level food availability using a national food balance sheet approach and considers national production, food imports and utilization, and estimates the national level deficit that may be required to be filled by donors or the humanitarian community.
(ii) The WFP component focuses on food availability and access at the household and community level. National level food availability does not translate to food availability and access for all households and communities.

The FAO and WFP mission is a necessary condition if a major food aid intervention is required as a result of agricultural failure. It is a formal recognition of an impending food crisis by both the national governments and the humanitarian community. Following the FAO and WFP reports specific food needs assessments would be undertaken. In some cases, the food needs assessment and the CFSAM may be conducted in parallel. Results from these assessments are used as input to the UN consolidated appeal process (CAP).

For example for Ethiopia, Sudan and Eritrea, Crop and Food Supply Assessment Mission (CFSAM) reports are completed and published in most years in January. Under the current practice, as demonstrated in figure 4 there could be about four months delay between the first possible accurate estimation of production failure and the official CFSAM report on which many donors depend to respond.

Figure 5 shows total cereal production for Ethiopia, Sudan and Eritrea during the period 1994–2004. What is clear from these graphs is the large year-to-year

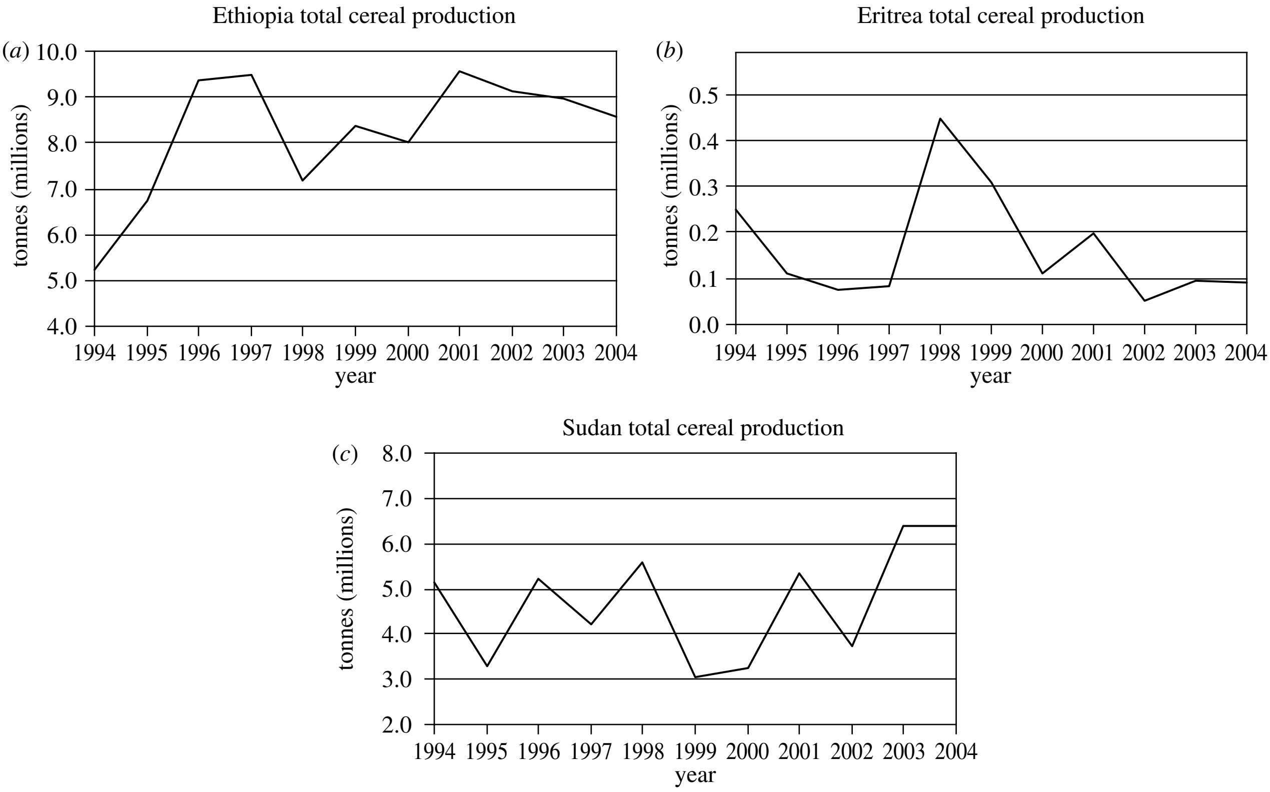


Figure 5. Total cereal production for (*a*) Ethiopia, (*b*) Eritrea and (*c*) Sudan (data from FAO STAT; see http://faostat.fao.org).

production fluctuation. Note the 1999 low production in the Sudan was not due to drought but due to farmers' economic decision not to plant as the market prices during the previous year were too low.

As indicated in earlier sections extreme agricultural failure or agricultural surplus can be identified several weeks before the end of the growing season. This knowledge should be used appropriately to determine what intervention would be required. We propose response mechanisms for extreme weather-related agricultural outcomes to include our current understanding of climate and weather variability.

6. CURRENT HUMANITARIAN RESPONSE SYSTEMS

In this section, we will focus on how humanitarian response to drought-induced crises is coordinated within the UN. Essentially the link between agricultural monitoring that we have described in the previous section and the response phase is critical for humanitarian assistance to be effective. In what phase of the monitoring system should a humanitarian intervention be triggered? What are the consequences of delayed responses?

As the frequency of disasters and food emergencies increases so does the number of people needing humanitarian assistance, requiring more resources from donor governments. With limited available funds to support emergencies, resource mobilization, prioritization of interventions and resource allocation become necessary. Appropriate coordination mechanisms are required to ensure assistance is provided to the most needy and efficient usage of the resources. Among UN agencies humanitarian response is normally organized through the UN office for the coordination of humanitarian affairs. In 1991, the United Nations General Assembly created the CAP a mechanism used by aid organizations to plan, implement and monitor their activities. Working together in the world's crisis regions, they produce a common humanitarian action plan and an appeal, which they present to the international community and donors. Within CAP food security-related issues are handled by WFP and FAO. In the next sections, we will describe the current model of humanitarian assistance to drought-related problems.

(a) *Food needs assessments*

As indicated in the previous sections, the FAO WFP CFSAM is fielded by FAO and WFP jointly to assess agricultural production in a given country. Depending on the results of CFSAM further intervention processes and options could be initiated. These may include: humanitarian needs assessment, emergency appeal that forms part of the CAP and actual humanitarian aid delivery that may include food and non-food components. In other cases, the response may require a totally different intervention such as market stabilization in case of surplus production.

The link between the agricultural monitoring highlighted in figure 4 and humanitarian response mechanism is the needs assessment process. The purpose of needs assessment is to:

(i) quantify the magnitude and geographical extent of food crises;
(ii) determine the number of people affected;
(iii) estimate the amount of resources required (food and non-food);
(iv) assess local and national capacities to respond to the problem through their own mechanisms; and
(v) assess the role of markets.

Needs assessment concludes with a recommendation of whether external humanitarian assistance is required or not.

The main challenge in the whole process is that by many humanitarian agencies drought is considered to be a slow onset disaster and hence there is an assumption that there would be enough time for response. In reality, for the drought-affected families this is not the case. Households would start planning their coping strategies as soon as they have assessed the agricultural situation. This is done early on in the season. If humanitarian assistance is to be effective it needs to be coordinated and harmonized with households' critical decision-making period. In the current set-up of humanitarian response, the funding procedure is dependent on the formal completion of the needs assessment and this can delay the humanitarian operation considerably.

(b) ***Emergency appeal and resource mobilization***
Following the results of needs assessment in a given area the next steps will be preparing funding proposals for humanitarian intervention. This can take different forms depending on the country and the emergency response mechanism in place. The appeal document that is often prepared for a country has various sectors among which food security is the main component. The food security sector is mainly covered by WFP and FAO. In this case, WFP coordinates and leads the food aid response aspect while FAO leads the provision of agricultural inputs such as seeds and tools that would help farmers to regain their productive capacity. As a result, WFP and FAO in collaboration with other relevant agencies and government entities coordinate food security monitoring activities and assessments.

A general problem with the appeal-based fund raising process is that it is based on a voluntary contribution. The humanitarian community will not know in advance what resources will be available and in what form. This makes humanitarian operational planning more difficult. In addition the time gap between agricultural failure—needs assessment—appeal—resource mobilization—and then the actual humanitarian delivery is too long. The whole process from the first identification of crop failure (August in figure 4) to humanitarian aid delivery on average takes about 8 months. This arrangement saves lives but will not save livelihoods as all the necessary decisions that farmers have to take to minimize the impacts of drought on their families would have been done months earlier. Lack of reliable financial mechanisms that can ensure timely delivery of humanitarian resources contributes to the delay of appropriate responses. The result is that the necessary resources may not be available when needed. If funding is not available planned humanitarian intervention will not be implemented fully.

(c) ***Planning delivery of humanitarian assistance***
Needs assessment provides the necessary information for implementing a humanitarian intervention once resources are available. The first challenge humanitarian agencies have is getting adequate resources on time. Any humanitarian response should be planned to complement local efforts to optimize the impacts. It needs to be timely in order to spare households from disposing of their productive assets to cope with food shortages. It needs to be reliable so that households can include humanitarian resources in their decision-making process.

To plan appropriate humanitarian interventions it is important to understand the decision-making cycles of farming communities. For example, in Sahelian Africa the critical period for major household decision-making is around September just after assessing the production prospect in that year. At this stage farmers know what to expect from their own production, which is the main component of their income. With that in mind they would plan what activities to undertake during the following season. This may include whether to save local seeds, get agricultural credit, sell livestock, migrate and take out children out of school.

Another critical time in the agricultural decision-making is just before land preparation starts. Households have to decide on how much they have to invest in their own farming in the next agricultural season. Accordingly, decisions will be made on how much should be spent for agricultural preparation including land preparation, purchase of agricultural inputs and setting aside the necessary household labour. Households will not invest in agriculture if they do not have the necessary resources to continue working on their farms. These decisions have important implications on the short- and long-term food security and livelihoods of the involved communities.

The period from the start of agricultural season to harvest time is the time when households require the maximum support they can get. This period is often called the hunger gap period (figures 4 and 7) and is the time when households will be working on their farms. During this period, households often run out of their food stocks. Market prices often become too high hence purchasing capacity becomes a limitation. If resources for humanitarian aid are made available in predictable manner then appropriate modalities of assistance could be planned.

(d) ***Managing the surplus production years***
Humanitarian interventions to weather-related factors have been focused on responding to droughts and to food shortages. However, serious food insecurity may also be caused by not managing properly the surplus production years. During such years due to lack of infrastructure, storage capacities and marketing strategies the surplus production could over supply the local markets resulting in price crises. Farmers could find themselves unable to sell their products so that they can pay back their loans and credits. Under such circumstances farmers will be discouraged from further investing in agriculture.

This problem is often overlooked by governments and the humanitarian community. In the absence of appropriate management strategies surpluses in good years may not be used for smoothing production variability in drought years. Several examples could be provided where surplus production years have caused market failure resulting in farmers making economic decisions to reduce their investment in

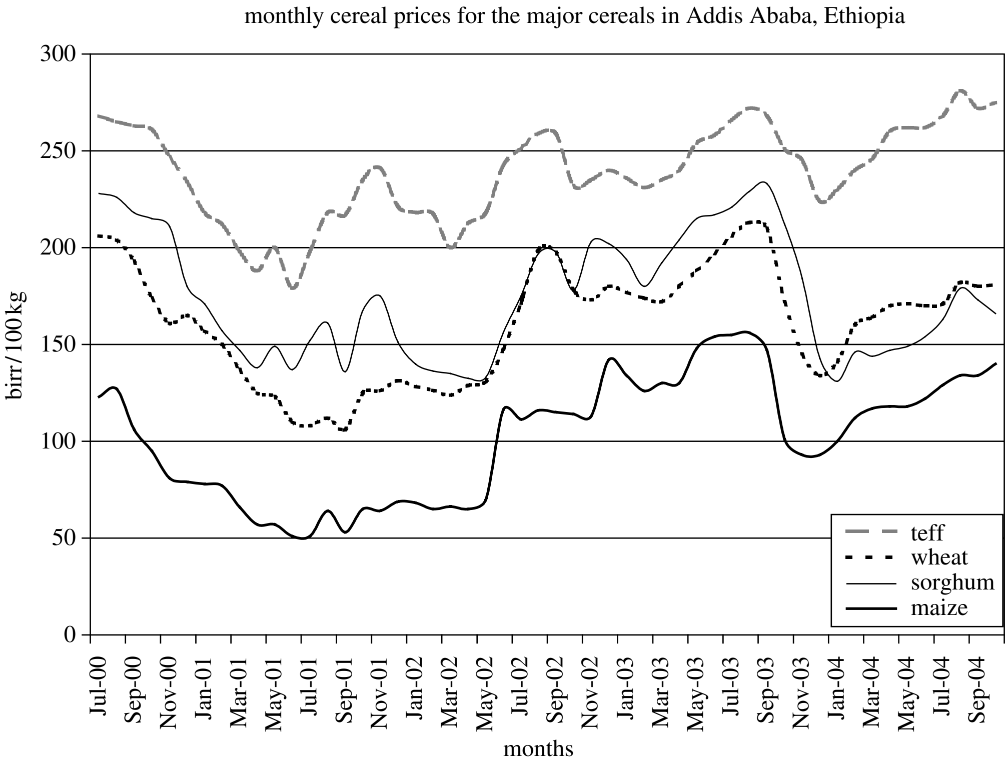
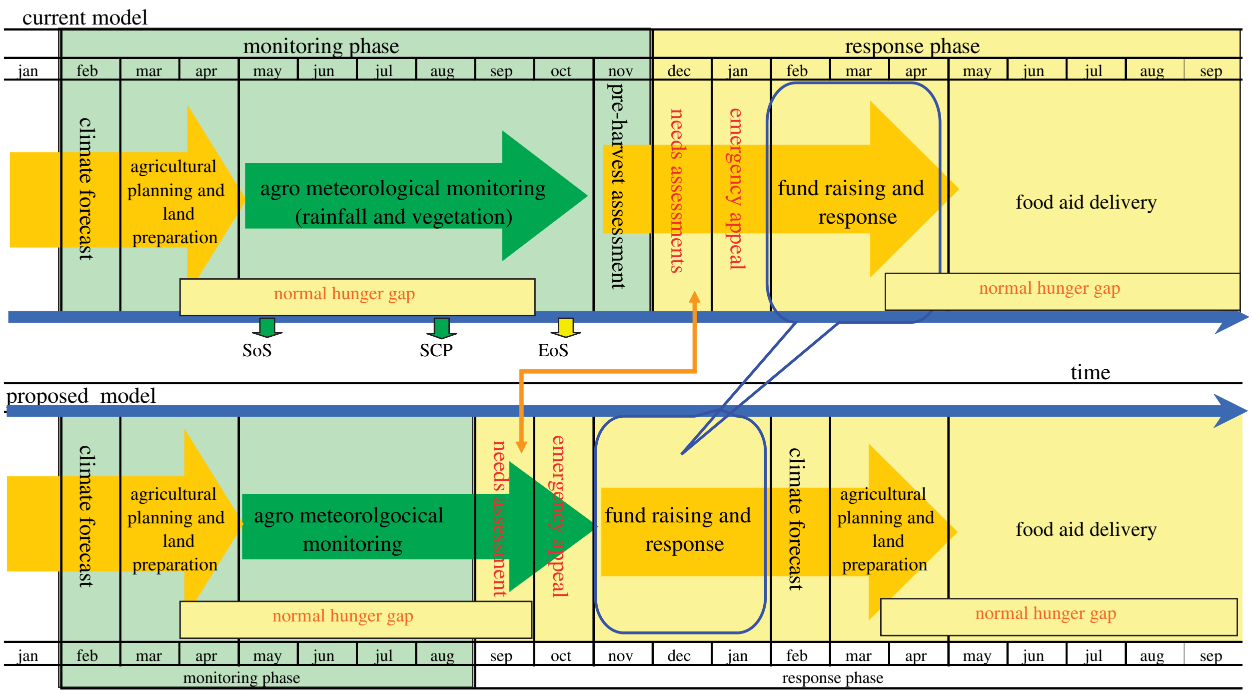


Figure 6. Average cereal market prices in Addis Ababa, Ethiopia.



SoS — start of season; EoS — end of season; SCP — season critical period.

Figure 7. Proposed model of food security monitoring and humanitarian decision-making.

agriculture the following year. The problem is if the following year is a drought year then the production will be very limited.

The widely known food crisis of 2003 in Ethiopia, where more than 13 million people were affected may have had its roots partly in the 2000 and 2001 production years. Figure 6 shows monthly prices of the main cereals in Ethiopia, Addis Ababa market. We note particularly the price of maize from January 2001 to April 2002 was extremely low. This was due to the excellent production in 2000 and 2001. In July 2001 the price of maize in Addis Ababa was 50 birr per 100 kg equivalent to 65 USD per tonne. The price would be much lower than that at the farm level. At this price farmers could not even cover the cost of production. As a result of the complete market failure many farmers decided to reduce their investment in maize production. Unfortunately in 2002, Ethiopia faced a wide spread drought. The combination of market failure in the previous year followed by a severe drought year can lead to extreme food shortages. This could be avoided with appropriate planning and financial backing.

The FAO WFP CFSAM Ethiopia reports of 2002 and 2003 are good examples of linkages between surplus production, drought events and food security issues. The 2002 CFSAM report highlighted the sharp fall of cereal market prices, particularly for maize and suggested that this could result in severe financial difficulties for farmers and predicted reductions in area planted the next season. It urged donors to take the opportunity to meet part of the food aid needs locally, given the availability of cereals. In contrast, the 2003 CFSAM report highlighted the problem of drought that resulted in a decline of grain production in 2002. Reduced use of improved seed and fertilizer also contributed to the decline in production. The report concluded by highlighting the need to strengthen price stabilization mechanisms to minimize the adverse effects of such price volatility. If the surplus production of 2000 and 2001 had been better managed the impact of the food crisis of 2003 would have been minimized.

7. IMPROVING RESPONSES TO EXTREME WEATHER-INDUCED FOOD CRISES

In sub-Saharan Africa progress towards the achievement of the MDGs will be a function of how well households are protected against impacts of extreme weather events as they are mostly dependent on rural agriculture. Hard earned developmental gains can be wiped out by emergencies if not properly protected against major risks. Emergency preparedness and response strategy with appropriate financial mechanisms should be a pre-requisite for any serious development initiative. Humanitarian aid has an insurance function as it protects lives and livelihoods. However, the implementation of a successful humanitarian intervention is dependent on the availability and reliability of resources. Current humanitarian aid based on an appeal process is often too unreliable, and unpredictable for it to be taken seriously by recipient governments and households in their decision-making process. There is a need to setup flexible but reliable response mechanisms to provide resources when required. Improving early warning information does not necessarily result in better intervention if not integrated with an appropriate financial response system.

At present the main mechanism for financing emergencies by the humanitarian community is through the appeal process, where following a needs assessment report an appeal would be launched and donors asked to contribute. The problem with this approach is that funding is not guaranteed, as it will depend on many other factors such as competing needs that may exist. This makes the assistance unpredictable and unreliable. In addition, donor governments decide on what they will provide and at times this may not be the most efficient. For example at times it may be cheaper and more efficient to buy food locally and hence cash donation would be preferred. In other cases, it may be better to provide food hence food donation would be more effective.

The financial system should be flexible enough so that it can be used to deal with different problems. Some countries with the support of donors have initiated mechanisms to ensure timely food delivery. The emergency food security reserve of Ethiopia is a good example that attempts to pre-position food stocks in remote and vulnerable areas. Food reserve systems should be complimented with local purchase when local production is high and local markets are threatened.

(a) *Integrating needs assessment in the monitoring phase*

Improved agricultural monitoring which integrates field observation, advanced crop models and remote sensing will enable the accurate estimation of agricultural production. Baseline pre-season weather risk analysis combined with agricultural monitoring will provide a clear indication of who will be affected and what type of response is required. This approach can enable us to come up with relatively accurate picture of the humanitarian requirements early.

Essentially the needs assessment window could be shifted forward and done during the critical time of the season. This will shift the whole process by about four months. This can provide a very important lead time. In this way our knowledge of climate and monitoring ability will be directly linked with humanitarian decision-making. The benefits are that the whole humanitarian process will move forward by about four months. Instead of waiting until January, we could now start the appeal process as early as October (refer to figure 7). The implication of this is that there will be a good lead time that could allow early intervention.

The realization of possible early humanitarian intervention would encourage households to take appropriate decisions. Normally the farmers start planning for the next season during the current season and many decisions are taken based on what they perceive. If the current season is a failure then they would plan to minimize the impacts of the drought on food consumption of their families.

By providing early humanitarian assistance we would facilitate the critical decision-making. For example seasonal forecasts can be useful inputs to farmers who have already decided to stay on their farms and farm in the next season. They will be unable to take that decision if there are uncertain whether they will be able to farm the next season.

To ensure this there are two things that should happen. (i) There is a need to strengthen the monitoring capacity as well as undertake appropriate risk analysis. Capacity building efforts will be required. (ii) Set up appropriate financial mechanisms that will allow timely response, which does not exist at the time. Early warning information with out financial setup will not work. We look at the options of new financial systems that may be useful.

(b) *New ways of financing humanitarian aid to drought-induced food crisis*

The current practice of funding emergencies in most developing countries is through international appeal following field needs assessment reports. Humanitarian aid provides an insurance function of last resort for households caught up in food emergencies and compensate their consumption losses. The main problem with the appeal-based emergency financing is that it is unpredictable with no real knowledge about how much funding will be available, when it will be available, in what form and who will receive it. The assistance often arrives after the disaster and hence most of the time it is too late to save livelihoods.

The international community is more likely to be willing to respond with resources when there is a quick onset natural disaster such as hurricanes, floods, tsunami and earthquakes. International aid is often slow to come when the natural disaster is a slowly developing drought. Risk-coping strategies that rural households may rely upon will fail where farming is the major source of income as it is in sub-Saharan Africa. However, with current improvements in weather and agricultural monitoring capacities, droughts are more predictable and household income losses as a result of the drought quantifiable. The impact of drought on poor rural households could be reduced with appropriate financial tools and planning.

In recent years, various financial instruments are becoming available in the market that can be used to finance natural disasters (Goes & Skees 2003; Skees *et al.* 2004). Skees *et al.* (2004) in their paper 'Can financial markets be tapped to help poor people cope with weather risks?' give details of how financial markets may be used to fund drought emergencies more efficiently. Among the various available mechanisms they propose rainfall index-based approach. Further discussions and examples on how rainfall index can be used including a WFP proposed pilot project for Ethiopia can be found in a recent World Bank (2005) report and also in Hess & Syroka (2005).

The basic principles of a rainfall index approach as described in Skees *et al.* (2004) is to develop rainfall index contracts to insure against drought during the critical cropping season over a specified period and geographical area.

The procedure will involve first establishing a correlation between rainfall and rural household income to determine loss incurred due to lack of rainfall, second designing a prototype of rainfall trigger that will capture variance of rural household income essentially calibrating rainfall deficits with certain income losses. Rainfall index as summarized in Skees *et al.* (2004) can be used in addressing weather-related disasters in several ways: (i) as a replacement for traditional crop insurance; (ii) as a means to insure groups of farmers and facilitate mutual insurance; (iii) as a means of providing more affordable reinsurance for traditional crop insurance and (iv) as a mechanism to trigger objective humanitarian assistance.

Building a rainfall index as a means of trigger tool in drought assessment has several advantages. It is objective and it can be understood by partners and donors once they have agreed on what thresholds to use. Detailed risk analysis studies are conducted before building a rainfall index. Such studies are very useful for understanding the linkages between weather patterns, food insecurity and humanitarian costs. It also facilitates the maintenance of meteorological networks for the public good. This is a positive step towards national capacity building. Data that have been gathered for developing the project could also be used for other relevant projects such as agricultural and environmental planning.

The main constraint to the rainfall index approach for humanitarian purposes is that, generally, the areas that require humanitarian assistance do not have the necessary rainfall networks. Hence with out long-term rainfall data we cannot create a rainfall index. However, there are new efforts and approaches that attempt use a combination of rainfall and earth observation satellites while earth observation products, inferred from the synergy of optical and radar data, intend to provide information on the crop development.

(c) *Current agricultural practices—the need to adapt to the changing world*

Farmers make farming decisions often following traditional agricultural calendars that have been developed through the past experience of the generations. In most farming systems, local crop calendars are established that are often followed by farmers in their decision-making. Traditional agricultural calendars are based on the mean climate occurrence in a given area over many generations. Farmers have developed specific dates for planting various crops that they follow. Of course, after the event, farmers may discover that they have made the wrong decision but, in general, over a large number of farms and many years, the local calendar will give the best results. However, due to climate change the long-term mean might be changing hence traditional crop calendars may not give the best results. Essentially farming decisions are based on long-term mean which may be now changing as a result of climate change.

Climate change might affect the likely start dates of the season and length of growing period. This increases the uncertainty for farmers in the marginal drought prone areas. This uncertainty in turn leads to sub-optimal production decisions. Over the generations farming communities have developed various traditional strategies to minimize the impact of climate variability on their agriculture and livelihoods. These strategies may not be effective in an environment where climate variability and extreme weather events become more pronounced as a result of climate change. Farming practices need to adapt to the new reality but this is not easy for the marginal farmers who would not want to take new risks. This is an area where our current understanding of climate could contribute to farming decision-making. There is a need to develop a strategy on how to achieve a better guidance.

8. CONCLUSION

This paper has identified important weaknesses in the current model of humanitarian response to food crises triggered by extreme weather events. In the current system food aid requirements are determined by crop assessment missions at the end of a growing season. Depending on the level of severity of the food crisis, resources are mobilized through a national or international emergency appeal to the donor community. With this process two major problems have been identified: (i) humanitarian response is often delayed by several months and (ii) the assistance is unpredictable and unreliable as it is based on voluntary contribution. International humanitarian response, to be effective and contribute to longer-term sustainable social and economic development it needs to be timely, predictable and appropriate.

The problem of delay could be partly addressed by bringing forward the needs assessment. During the past several years weather observation and monitoring capacity has greatly improved due to latest developments in the field of meteorological modelling, increased satellite data availability and advancements in information and communications technology. Similarly advances in crop modelling, improved cropped area estimation and enhanced vegetation monitoring capacity have contributed to improvements in agricultural monitoring. The ability to better monitor weather and agriculture means that major agricultural and pasture failures can be detected early and agricultural losses predicted several months before the end of the growing season. In this way, humanitarian needs and resource requirements could be determined much earlier than is possible in the current system. By doing so, we can gain several months for the intervention and hence humanitarian resources could be delivered timely and save livelihoods.

The unpredictability and unreliability of financing humanitarian responses is a major problem in implementing appropriate emergency programmes. The appeal-based emergency financing which is widely used in the current humanitarian response model is not efficient when addressing predictable emergencies such as those caused by droughts. The main weakness of the appeal-based resource mobilization process is that it is heavily dependent on the perception of donor representatives of the gravity of the crisis. In many cases, high profile and politically interesting emergencies are easily funded while others may be ignored. There are many factors that can influence decisions on resource allocation including the media, resource availability and other emergencies. As a result appeal-based financing is not dependable and that households and beneficiary governments will not factor it in their economic planning.

In summary, to respond to extreme weather-related food crisis more effectively and contribute towards the achievements of the MDGs the paper recommends:

(i) drought prone countries should have a clearly defined national emergency preparedness and response strategy framework that will include: risk management and information systems, resource mobilization strategy and a well defined response strategy;

(ii) establish and invest in weather and agricultural monitoring systems as summarized in figure 7; and

(iii) investigate the use of new financial instruments including rainfall index-based insurance to facilitate timely resource availability to support appropriate humanitarian response.

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